INSTRUCTIONS

Installation and Operation of Vanguard II
1000/250 Watt AM Transmitter

INDEX

YOUR VANGUARD II

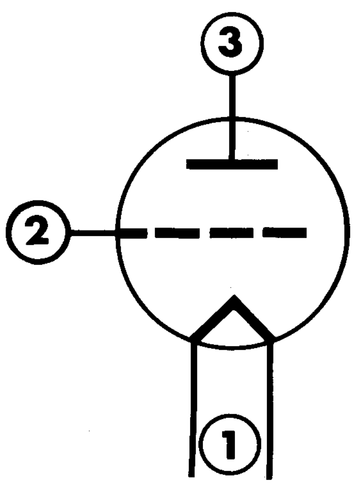
Vanguard II is a new concept in AM broadcast transmitters. When carefully installed, the broadcaster should have a transmission quality and reliability never before attained in AM broadcasting equipment. As Vanguard II is new, we urge reading this instruction book carefully. Understanding the difference between Vanguard circuitry and all other transmitters will not only make installation quicker but demonstrate to the engineer why it is better.

Dozens of innovations will be noted but three basics are obvious: (1) there is only one tube, which means Vanguard II is nearly all transistorized, (2) low level modulation replaces the high level modulation that has been universal in 1000 watt transmitters, and (3) the 1000 watt output stage is a linear amplifier instead of a Class C amplifier. Remembering these three basic differences and trying to become acquainted with them will greatly aid installation and the superb performance attainable.

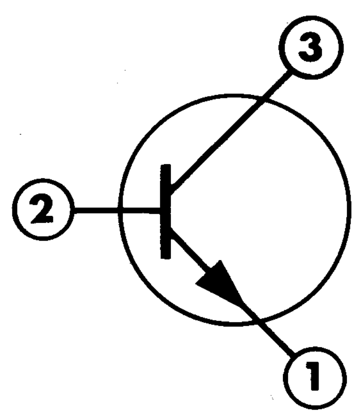
A WORD ABOUT TRANSISTORS

To most of us, transistors are less familiar than tubes. By remembering that transistors do the same thing as tubes; namely, rectify and amplify, we can immediately regain our familiarity. As we are all familiar with tube symbols, the comparison below to tube versus transistor symbols will aid in circuit diagram analysis and understanding.

TUBE SYMBOL



TRANSISTOR SYMBOL



1. For a tube this is known as the filament or cathode. For a transistor this is known as the emitter.

2. The tube grid is likened in a transistor to what is called the "base".

3. The plate of a tube is known as a collector in a transistor--so:

   Tube cathode is same as transistor emitter.
   Tube grid is same as transistor base.
   Tube plate is same as transistor collector

THE SOLDERING IRON is to a transistor as Raid is to flies. If you must change a transistor, and there should not be a need unless mal-handling or lightning becomes a cause, use a very small pin tip type of soldering iron and do not leave heat applied any longer than to make the soldered connection.

METERING for transistors is usually provided only for tuning indications. As transistors have essentially no wear, the more elaborate metering such as with tubes that must be replaced, is not desirable with transistors.

MEASURING TRANSISTOR CIRCUITS improperly will run the danger of destroying the transistor. As a transistor is a low voltage device, the battery voltage in a volt-ohmmeter may actually be higher than the rating of the transistor. If it is necessary to check resistance or point to point continuity, always use the highest possible resistance scale on the volt-ohmmeter that is readable. For example: On point to point continuity readings, never use the low ohmage scale but the highest ohmage scale. This will insert more resistance between the battery and the test prods of the voltohmmeter and reduce the voltage across the transistor during a check.

BUT TRANSISTORS are a very rugged and stable device. Like a fuse, if the rating is substantially exceeded, they are destroyed. In all Gates products the transistors are rated many times their operating point and should be much more reliable than tubes and last indefinitely. -- The caution and comments are only to help in becoming acquainted with this new and wonderful technical advancement as applied to broadcasting equipment.

TUBE DEGASSING

In Vanguard II there is only one tube. This tube has been selected for long life to complement the indefinite life of transistors. All large transmitting tubes at times become gaseous when not in use such as on the shelf or even in transit. Under a gaseous condition, if the high voltage is immediately applied, the tube could be destroyed. To prevent this, follow these simple steps:

1. After initial installation of the transmitter, turn on the filaments only for 30 minutes. Do not apply the high voltage during this period.
2. Without modulation of any kind (zero audio input) operate the tube for 15 minutes with the high voltage applied. Of course the tuning procedures on the following pages have been adhered to.
3. The tube should now be degassed and ready for normal use.

NOTE: The spare tube on the shelf, to prevent gassing, should have the above procedure applied at the regular maintenance periods and at least once monthly.

LOW LEVEL MODULATION simply means that instead of modulating the power amplifier stage as in other 1000 watt transmitters, an amplifier stage between the oscillator transistor and the final amplifier is modulated. By doing this, less than one watt of audio is required for modulation instead of the about 700 watts required in other transmitters. Because of this, it can be easily understood why audio performance can be so much improved.

LINEAR AMPLIFIER: The linear amplifier differs from the Class C amplifier as it is amplifying the modulated radio frequency signal at the same time as it is developing radio frequency power. Any Class AB or Class B circuit must be correctly matched to the load for proper performance. In Vanguard II the radio frequency output impedance is very important. The correct match of Vanguard II output to the transmission line or load is a vital necessity. As a Class C amplifier, used in earlier transmitters, is not as critical to load, the engineer may discover for the first time, when changing to Vanguard II, that a load mismatch always existed and by readjusting the antenna tuning equipment for correct load, he not only has Vanguard II performance supremacy but the added performance resulting from correct matching which may have represented power loss in the past.

Learn Vanguard II thoroughly and its wonderful benefits both in performance and reliability will be an engineering satisfaction long to be enjoyed. We are now ready to start installing Vanguard II.

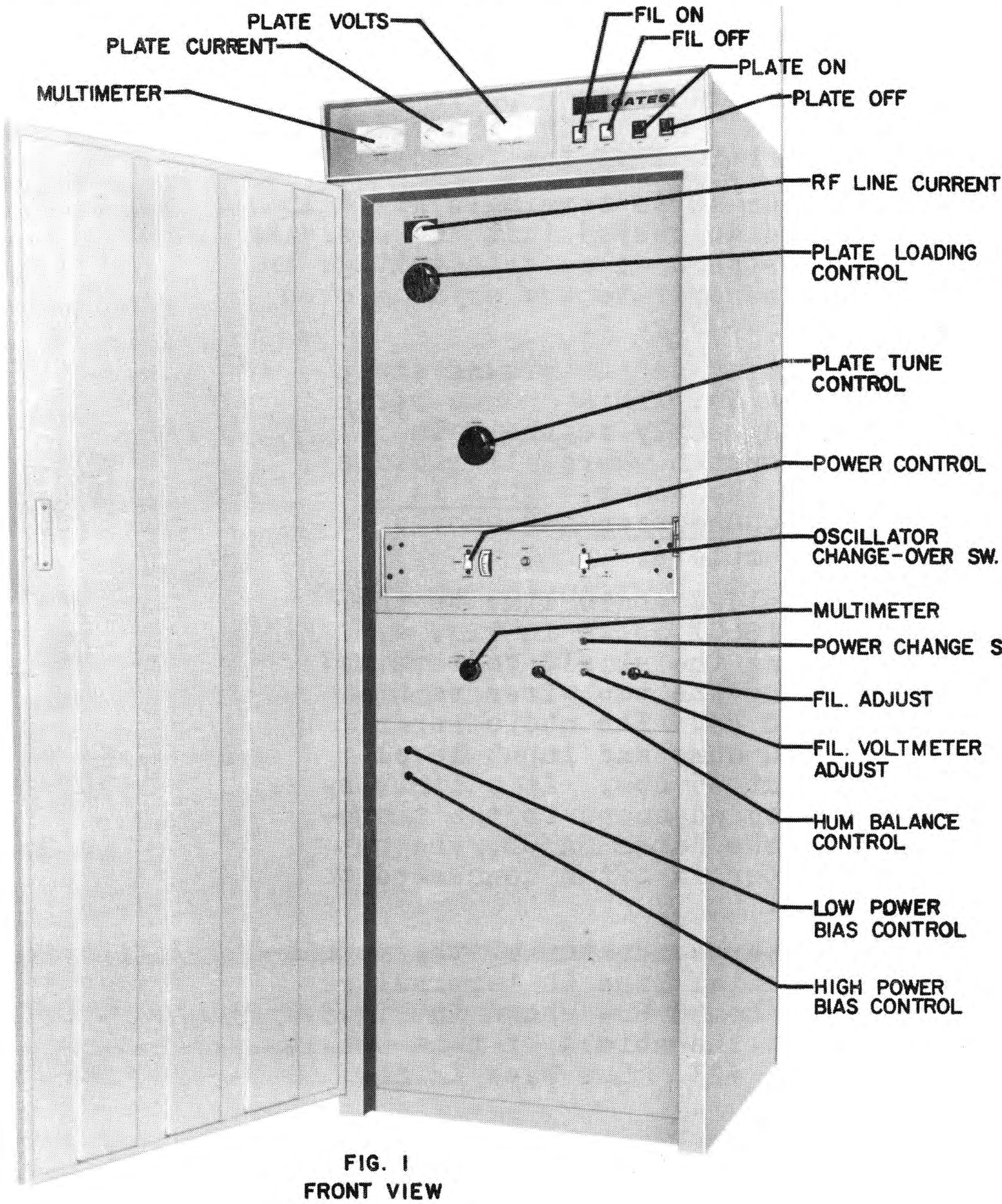


FIG. I
FRONT VIEW

INSTALLATION

Uncrating Transmitter:

The packing list is attached in an envelope on the outside of the transmitter crate. Check out every item. Be sure and not leave small items on the floor, they could be stepped on. Take your time in uncrating. You will find the equipment well packed. Should there be any damage, file a claim with the delivery transportation company immediately.

Preparing The Transmitter Location:

Refer to the drawing on Page 6. You will find all of the connecting wires defined to place the Vanguard II transmitter into operation, together with the recommended point at which the individual wires should enter the base of the transmitter.

Installing Transmitter:

Go over the complete transmitter carefully for tightness of bolts. Then proceed in the following manner:

1. Set the transmitter in place.
2. Connect the main transmitter power wiring to the fuseblock as shown in Fig. 2, Page 7. Make sure that the neutral wire is connected to the center terminal of the fuseblock.
3. Connect 115 volts AC to terminals #14 & 15 on TB603. It is suggested that the building lighting circuit be used as this voltage is always left on to operate the crystal oven continuously. See Fig. 2.
4. Connect at least 1" copper ground strap (see Page 7, Fig.3). This ground strap should connect directly to the main antenna ground system where all radials terminate under the tower. This is a very important connection and should be done well and complete.
5. Connect the shielded audio line to the terminal board TB601 shown in Fig. 4, Page 7, grounding the shield to terminal #2 and connecting the two wires to terminals #1 and #3. The audio input impedance is 600 ohms and input level required is about +5 dbm. If a limiting amplifier is used adjacent to the transmitter such as the Gates SA39B, the output of the limiter is often connected to these terminals.
6. Connect the center conductor of the modulation monitor coaxial line to terminal #24 on the terminal board 604 shown in Fig.5, Page 7. Connect the shield of this coaxial line to terminal #23. See Page 12 for adjustments.

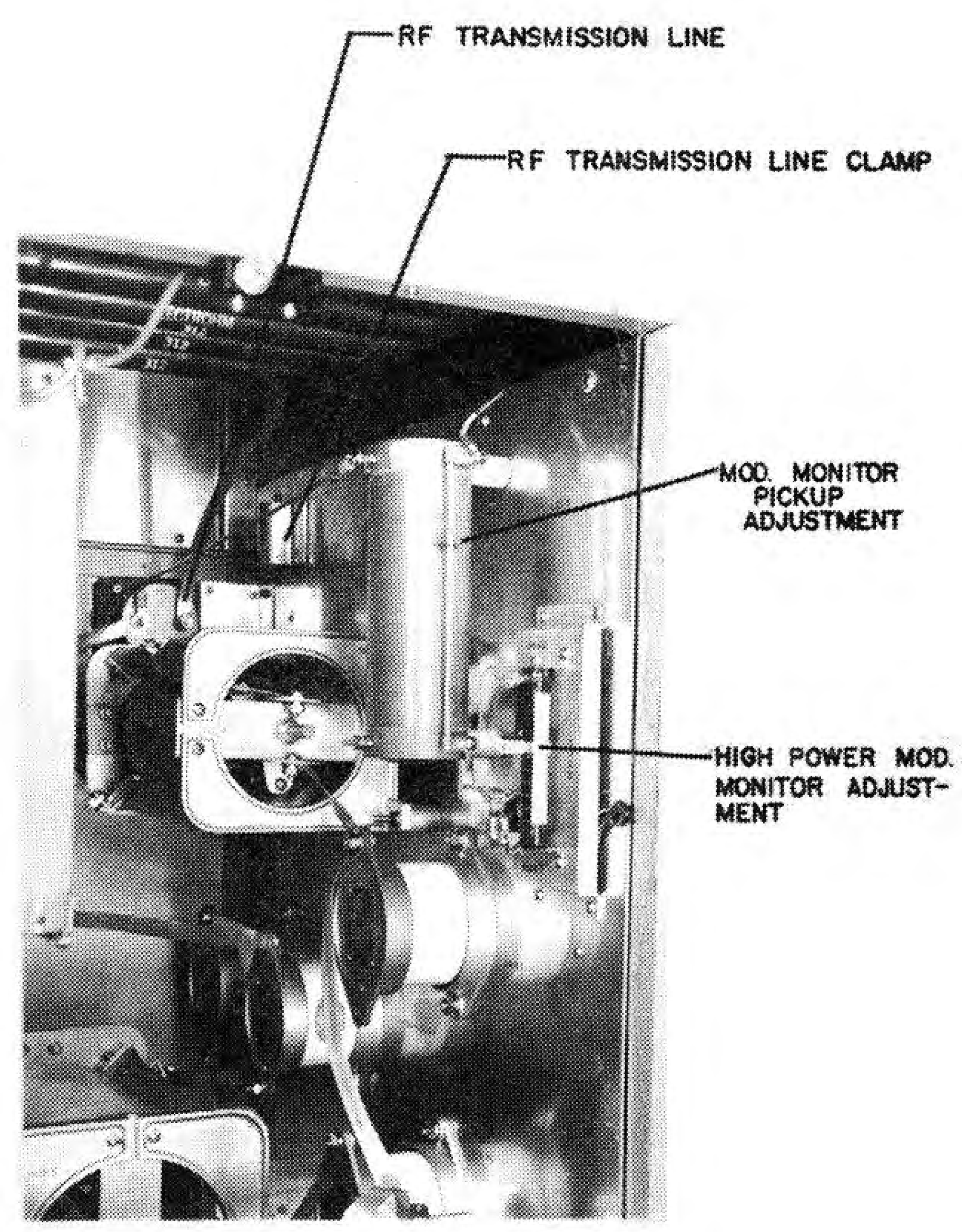


FIG. 6

UPPER REAR-LEFT SIDE

7. Connect the frequency monitor coaxial line to this same terminal board, (TB604), with the center conductor of this line on terminal #21 and the outer shield on terminal #22. About 5 volts RMS is provided, which will operate all modern frequency monitors such as the Gates M4990.

   It is suggested that RG59U coaxial cable be employed to connect both modulation and frequency monitors to the transmitter. In connecting the shield of the RG59U cable, trim back outer sleeve carefully and wrap a #18 wire around the shield twice and solder. This becomes the ground or shield connection as mentioned above.

8. As supplied, your Vanguard II is connected to the inbuilt dummy antenna (see Page 9,Par. 4). Attach the output coaxial transmission line. This should be at least 7/8" line, 50 ohms impedance. You will not attach the center conductor until after initial tune-up on the dummy antenna but it should be in place. The clamp provided is to secure the outer conductor both mechanically and electrically, <u>a very important electrical connection</u>. If an insulated jacketed coaxial cable is used, be sure and peel back the jacket so the clamp is directly to the outer metal shield.

   When you place the transmitter on the air, the dummy antenna is disconnected from the R.F. line meter and the center conductor of the coaxial cable is connected to the R.F. line meter (see Page 4,Fig.6). However, do not make this connection at this time as we will test on the inbuilt dummy antenna.

9. Install the plate power transformer as shown in Fig. 7,Page 13. Bolt securely to the transmitter base with bolts provided. Make all connections to the transformer using the terminal wiring indicated on the cable leads as a guide. Install and connect the transient suppressor assembly on the high voltage power transformer as shown in Fig.7.

<u>IMPORTANT</u> -- Your transmitter comes from the factory wired for operation 230 volts, 60 cycles. If your primary power service is for 208 volt operation, refer to the over-all transmitter schematic diagram. Wires to three transformers are changed and are well noted on the drawing. Filament transformer T603 remove the wire from terminal #3 and place on terminal #2. Power transformer T601 remove the wire from terminal #3 and place on terminal #2. Bias transformer T602 refer to terminal board TS601 and remove the wire from terminal #5 and place on terminal #4. -- Now refer to the diagram 842-4678-001 on the oscillator-buffer-modulator unit. On transformer T502 which connects to terminal strip TS 1 remove the wire from terminal #1 and place it on terminal #2. -- The blower and relays are designed for both 208 and 230 volts without wiring change.

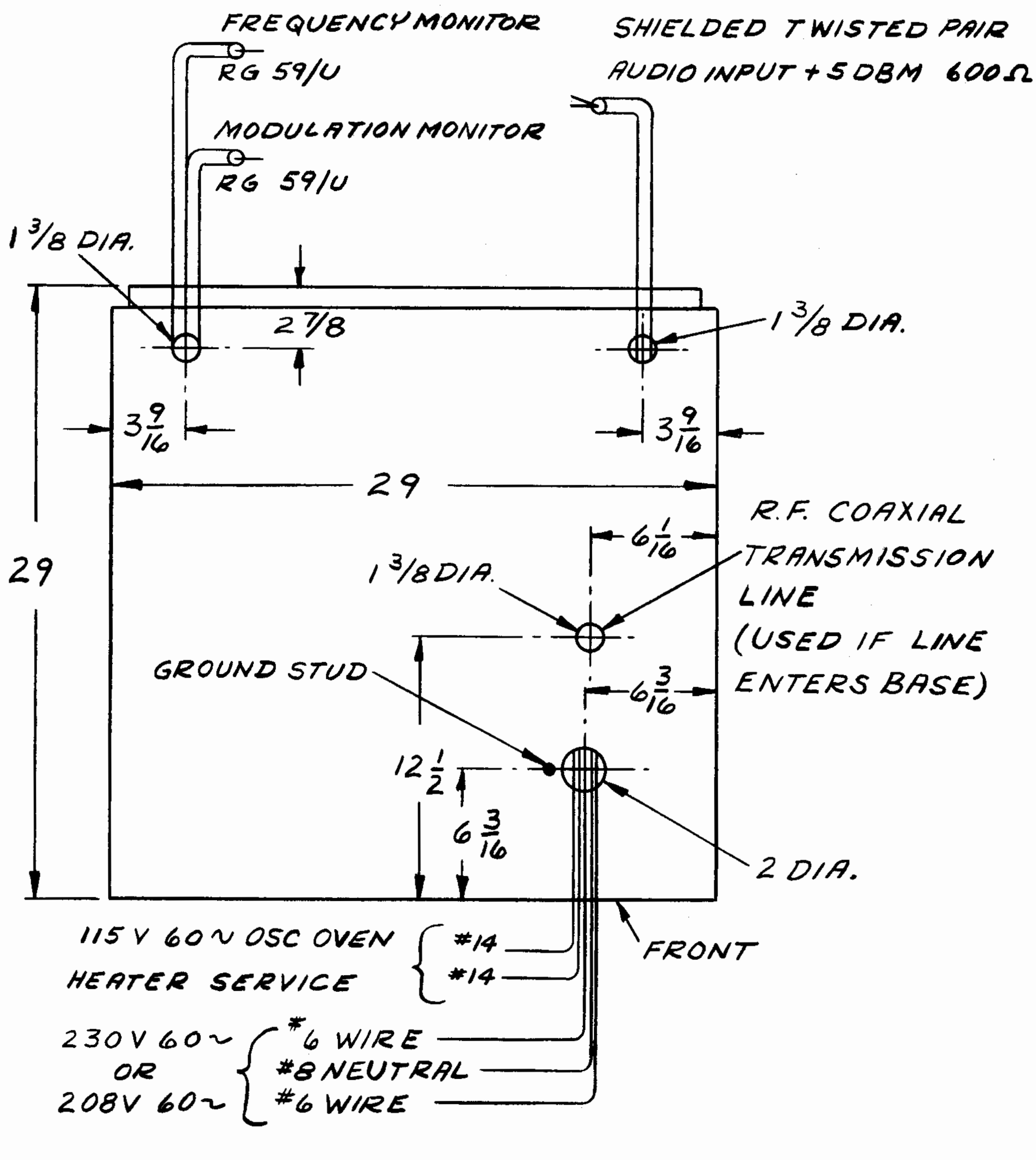
10. Install the two time delay relays, K604 and K605 in their respective sockets located just under the tube shelf on the right wall of the transmitter cabinet. These are vacuum type relays resembling a small vacuum tube.

11. Using extreme care, remove the 4CX3000A tube from its shipping carton and place in its socket, rotating a little clockwise to lock in place. Don't forget the degassing procedure earlier referred to.

12. Install the plate parasitic choke assembly, supplied separately. On one end of this assembly you will notice the connector that attaches to the tube plate. The other end is connected to a small bolt in the center of a teflon insulator on the left wall of the tube compartment.

13. Now check to see that all relays operate freely. Look over the transmitter thoroughly. Have all connections been made professionally? It is unlikely but now is the time to be sure no soldered connection has broken loose during transit. -- In short, give your Vanguard II the eagle eye as you are about to turn it on.

NOTE: BINARY DIVIDER -- By referring to drawing 842-4678-001, a binary divider will be found in the upper center. This is only supplied in transmitters ordered for a carrier frequency below 1000 Kc. Crystals used in Vanguard II are 1000 Kc. or above and in this case are on exact carrier frequency and the binary divider is not used. If the carrier frequency is below 1000 Kc., then a sub-multiple of the crystal frequency is employed and the binary divider is added. (Example I) If carrier frequency was 1200 Kc., a 1200 Kc. crystal would be used and no binary divider. (Example II) If carrier frequency was 600 Kc., a 1200 Kc. crystal would be supplied and a binary divider added.



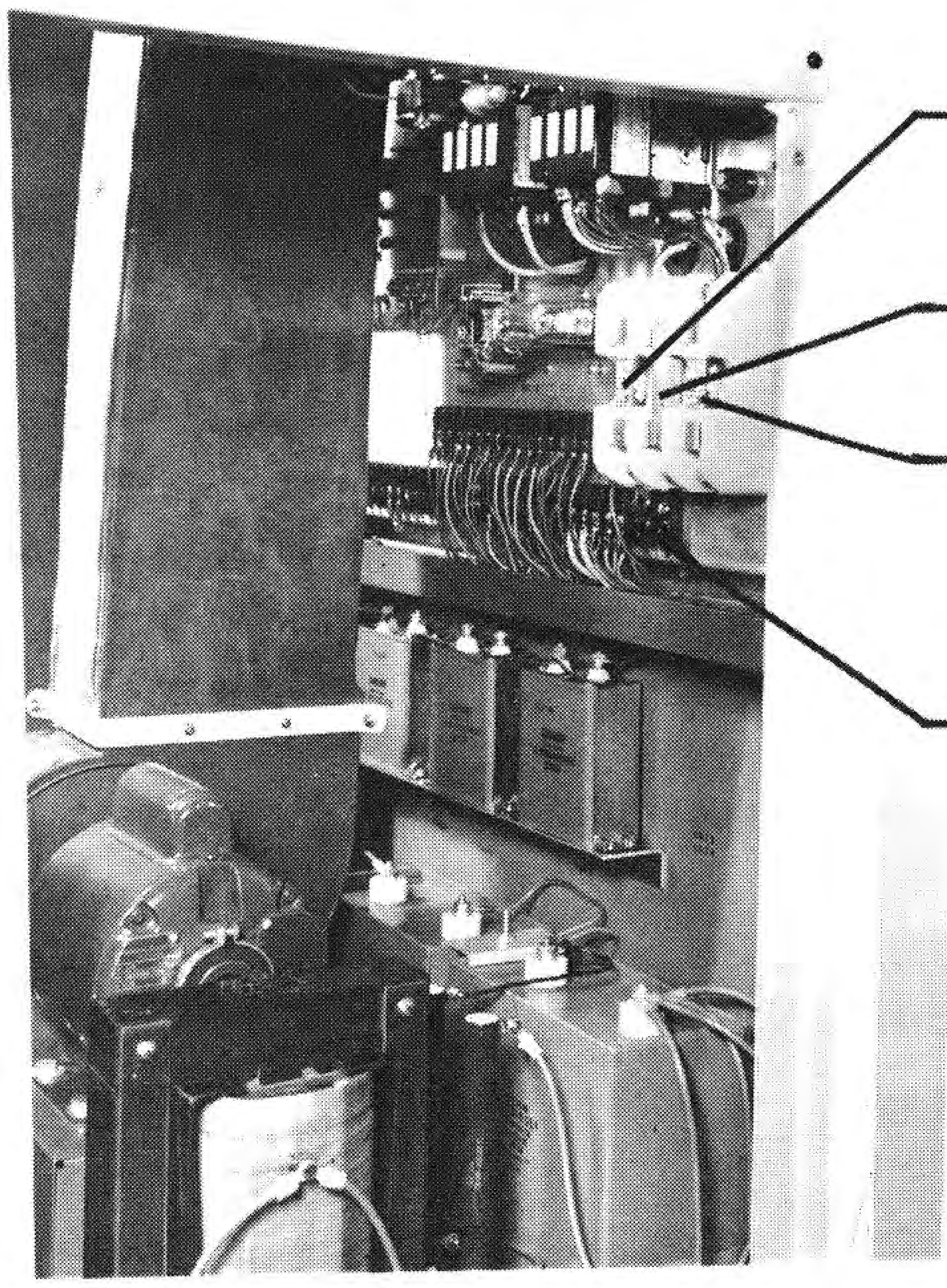


FIG. 2
LOWER CABINET-RIGHT FRONT

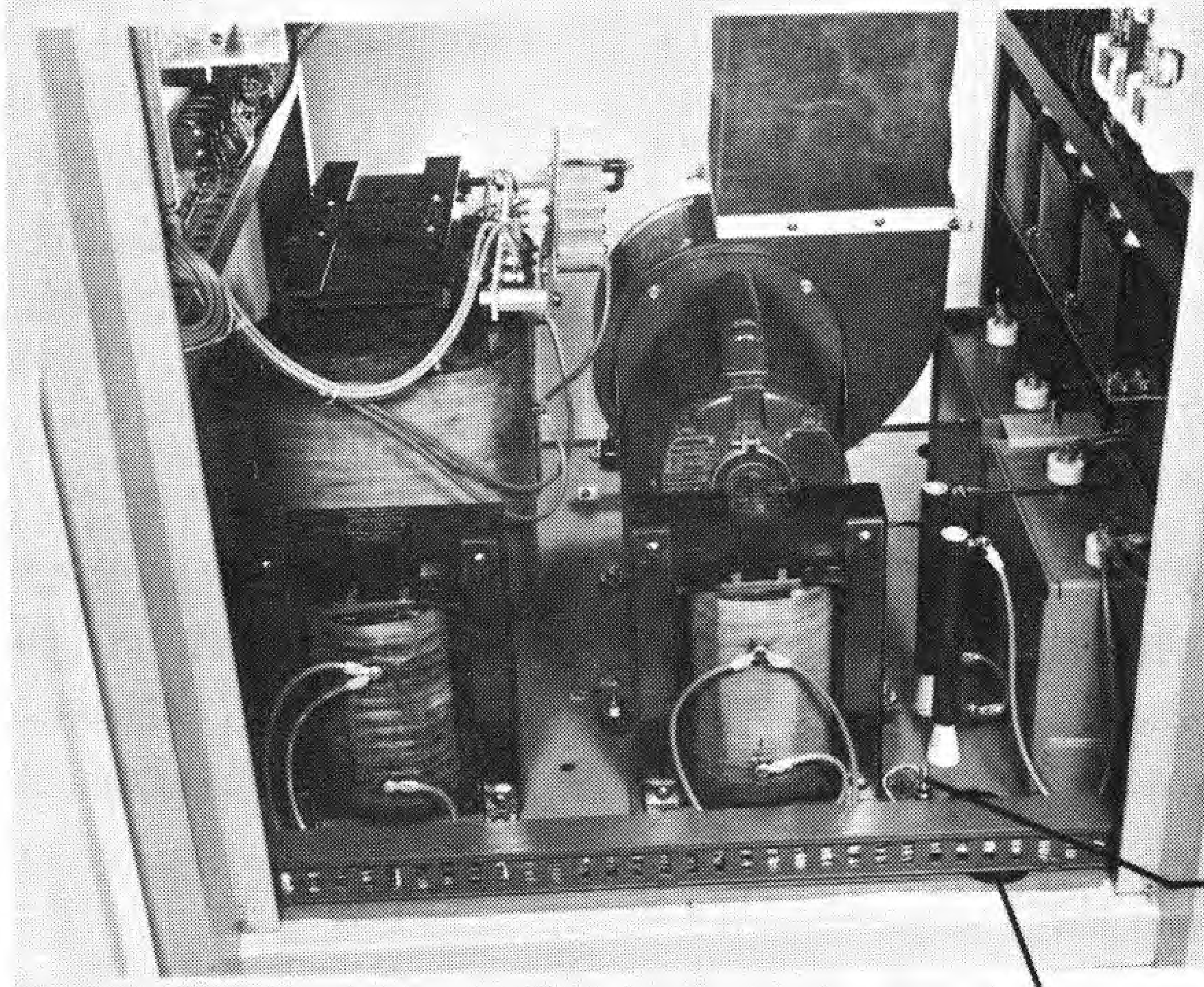


FIG. 3
LOWER CABINET, FRONT

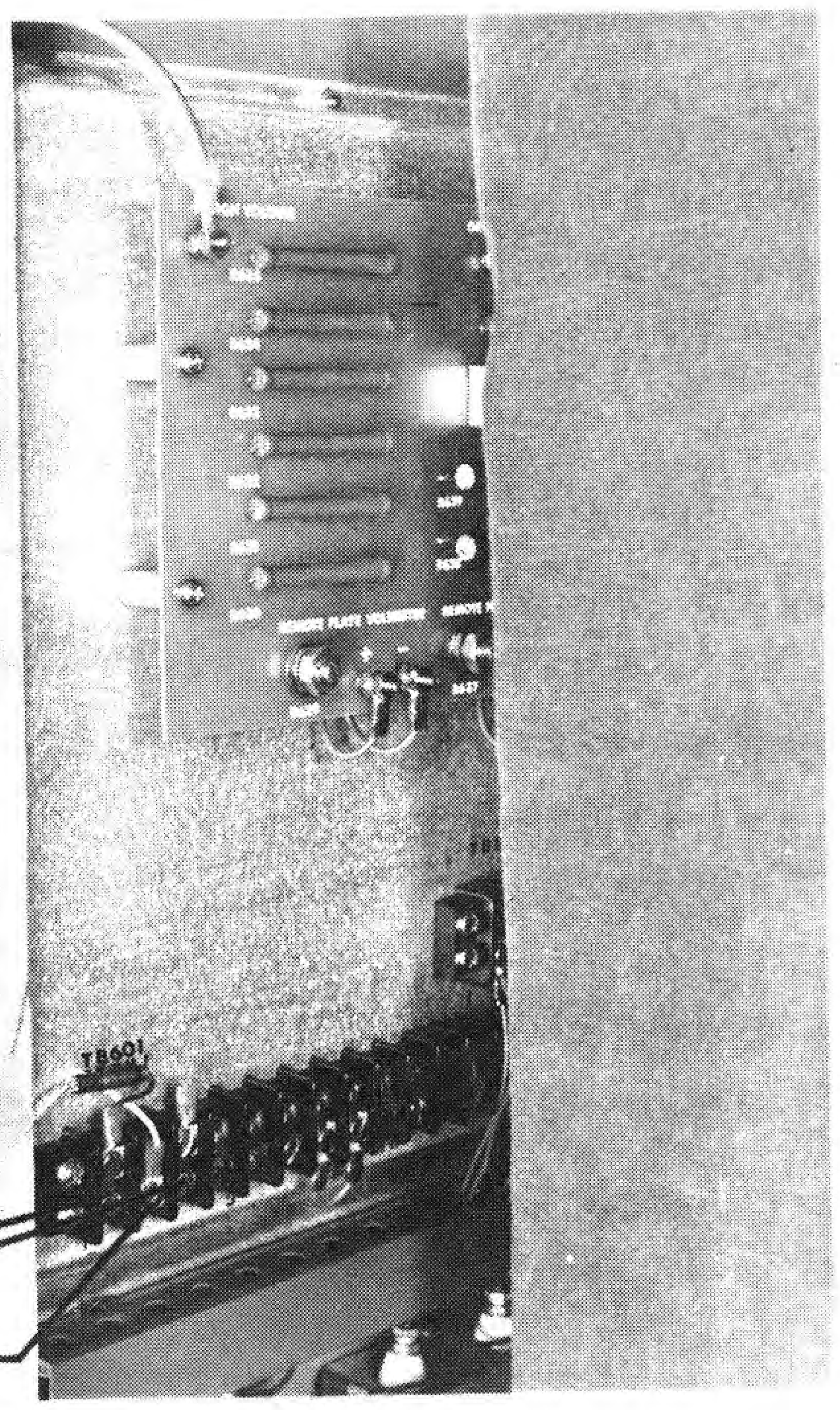


FIG. 4
LOWER REAR-RIGHT SIDE

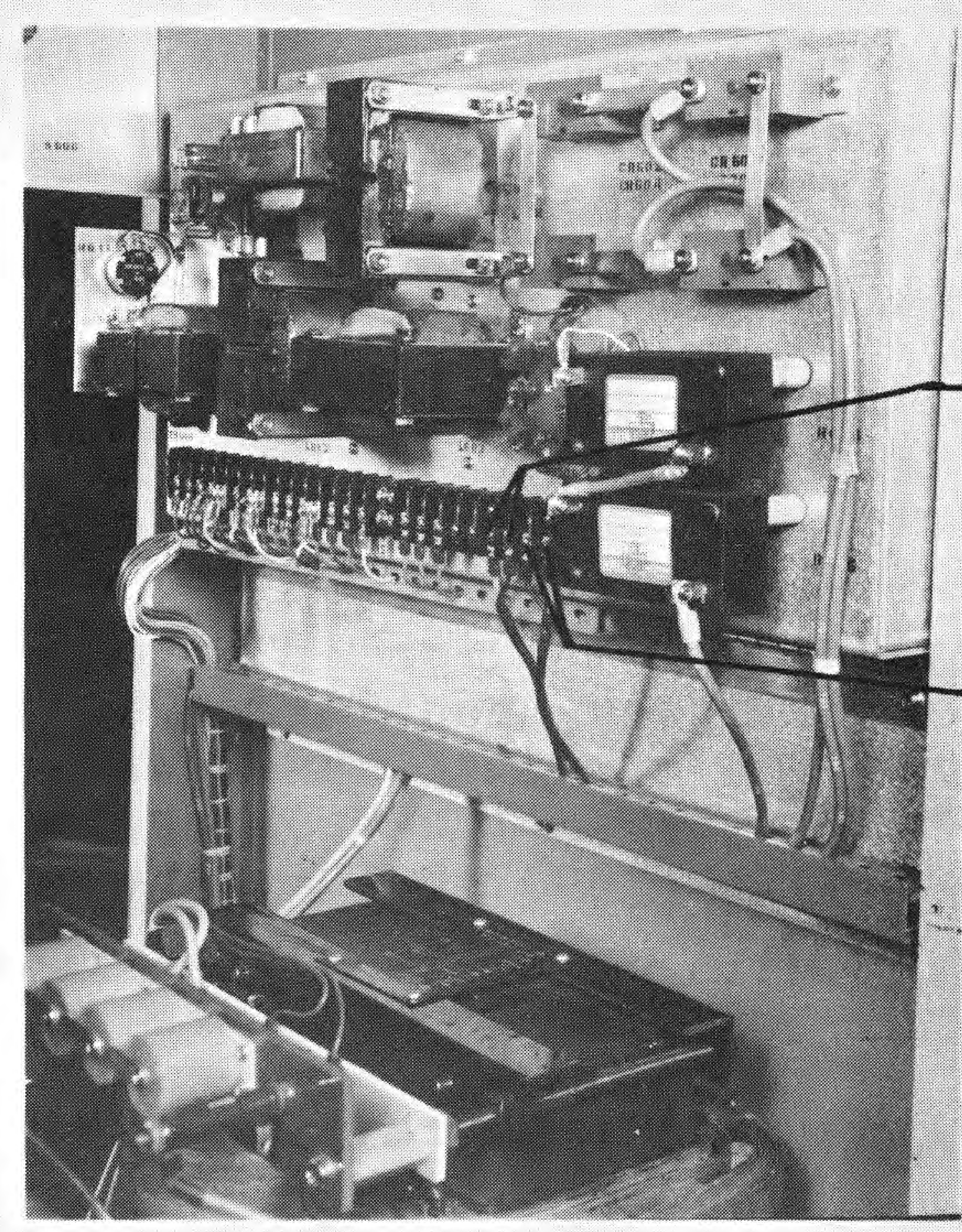


FIG. 5
LOWER REAR-LEFT SIDE

GENERAL TUNING PROCEDURES

Your Vanguard II transmitter has been completely adjusted at the factory. The correct setting of the output network coils are marked at the factory by small black marks on the coil bar at the turn where the rotor or coil clip was placed during factory adjustments. All internal controls have been sealed to denote that the adjustments have been made. After the transmitter has been installed, adjustment of any control should probably not be required to place the transmitter into operation into its built-in dummy load. The controls, may require some readjustment, however, when the transmitter is operating into the station antenna system because of the following two possible conditions:

1. The line voltage of your power supply differs by a few volts from that of the supply used during factory tests.
2. The load impedance of the antenna system and transmission line is probably somewhat different than the impedance of the inbuilt dummy load. This includes the characteristics of the antenna impedance over the full bandwidth of the transmitter.

Factory Adjustments

Your Vanguard II is thoroughly factory tested. Other than tune-up for proper power output and loading, there should be no need of any adjustment in the exciter unit. -- If first results, after turn on, are not as you expect them to be, please do not start random turning of adjustments in the exciter. -- It is reasonable to say that if the exciter is providing drive to the final amplifier, it is probably funtioning very well.

Test equipment, such as listed below, is necessary to make initial and periodic proof of performance measurements required by the Federal Communication commission. This equipment is not mandatory for putting Vanguard II into operation. It is, however, almost indispensable for year-in and year-out maintenance, whether for Vanguard II or any broadcast transmitter and for proof of performance.

This instruction book does cover detailed adjustments. If necessary, and only if necessary, follow the readjustment instructions. Otherwise, follow the normal instructions for tune-up and final on air operation.

Required Test Equipment

The Vanguard II transmitter is primarily adjusted to achieve its superior performance characteristics. For this reason, the following test equipment is desirable before adjustments are begun:

1. A suitable source of detected R. F. output signal from the transmitter, such as, a high fidelity audio output from the station's modulation monitor, and is provided in the Gates M5693 modulation monitor, or the filtered output of a diode detector such as the Gates M3626 diode unit.
2. An audio oscillator with less than 1% distortion such as the Model 210.
3. A noise and distortion meter such as the Model 410.

The above test equipment or similar is normally part of most modern radio station maintenance facilities and is required for the purpose of making FCC proof of performance tests. However, if, as with a new station, it should not be immediately available, it may be obtained from stock as single items or as the complete proof of performance package SA131 shown in Gates catalog.

CAUTION: The Vanguard II transmitter performance characteristics exceed those of most other transmitters. Therefore, each piece of test equipment as well as the detected R. F. signal supplied for operating the test equipment must be as free from extraneous noise and distortion as possible if the performance of the Vanguard is to be correctly measured. Make sure that all leads to the test equipment are carefully shielded and the equipment itself is thoroughly grounded.

Step-By-Step Tuning Procedure

1. The transistorized exciter unit should be un-loosened and pulled out of the transmitter. It will rest in this extended position, on its slide rails. Remove first its top cover, then the small cover over the high and low power feedback potentiometers.

2. Turn the HIGH POWER FEEDBACK CONTROL full counterclockwise (left). See Fig. 8, Page 13.

3. Place the POWER CHANGE SWITCH in the 1000 watt position, Fig. 2, Page 7.

4. Check to see that the P.A. output tuning coils have their shorting clip or rotors in the position marked during factory tune-up. Also check to see that the R. F. line meter is connected to the inbuilt dummy antenna. This means that the main coaxial line is disconnected.

5. Connect the test equipment to the transmitter as shown in the sketch on Page 15.

6. Start the transmitter by pressing the FILAMENT ON switch, Fig. 1, Page 3. The blower should start and the pilot light on the MULTIMETER should light. Reread the first part of these instructions on tube gassing.

7. Place the MULTIMETER switch in the BIAS position and adjust the HIGH POWER BIAS VOLTAGE CONTROL, Fig. 1, Page 3, so that the bias voltage is 195 volts.

8. Now place the MULTIMETER switch in the FILAMENT position and turn the FILAMENT ADJUST control, Fig. 1, Page 3 until the meter reads 8.5 volts.

NOTE: One of the advantages of the Vanguard II transmitter is that the final amplifier tube filaments may be operated as low as is consistent with good performance characteristics and thereby assure longer tube life. See Care of P. A. Tube, Page 16.

9. POWER CONTROL: This control on the exciter front panel is motor tuned and provided with a slip clutch arrangement so that when it reaches either extreme (high or low), it will slip rather than damage the control mechanics. It has been set in the center at the factory (halfway between high and low). This control will be used for power output adjustment. The Raise/Lower meter indicates position of this control.

10. Turn on the plate voltage by pressing the PLATE ON button.

11. Adjust the R. F. line current by operating the POWER CONTROL until this meter reads a full 1000 watts into the dummy antenna, or about 4.45 amperes, when output impedance is 50 ohms.

12. Read all meters. The readings obtained should fall within the ranges listed under TYPICAL METER READINGS, Page 19.

13. HIGH POWER FEEDBACK CONTROL: (See Fig. 8, Page 13. This control has been set at the factory for optimum performance and is only adjusted to further reduce the already very low distortion. As feed-back relates to power, this control will have a best position for each individual station. This control never operates fully clockwise. Without test equipment, about 1/8 turn from full counter clockwise end is satisfactory. With test equipment, this procedure may be followed:

    Modulate the transmitter 100% with 1000 cycle tone from the audio oscillator. Read distortion on noise and distortion meter. Adjust HIGH POWER FEEDBACK CONTROL, clockwise, until there is a noticeable jump in the distortion reading. Now with distortion meter in CALIBRATE position, adjust input to distortion meter until it reads 4 db. below full scale. Turn HIGH POWER FEEDBACK CONTROL counterclockwise until distortion meter now reads full scale. This establishes the correct feedback adjustment for high power operation of the Vanguard II transmitter.

14. Make noise and distortion measurements of the Vanguard II in the manner described in the noise and distortion meter manual. These should agree fairly well with the Typical Performance Measurements shown on Page 18. However, even though there is some variance from these readings, continue with the Adjustment Procedure as further adjustments may tend to correct them.

15. Turn the transmitter off by pushing the PLATE OFF button. Disconnect the dummy load from the R. F. line meter and connect the main coaxial line (antenna system) to the R. F. line meter at the same terminal.

16. Turn the transmitter back on. Adjust POWER CONTROL to produce 1000 watts output unmodulated into the transmission line feeding the antenna system. Read all meters. They should agree substantially with the readings previously obtained with the transmitter operating into the dummy load. If they do not, it is a strong indication that the impedance of the transmission line differs substantially from the output impedance of the transmitter. If the adjustments in Par. 17 following, do not produce satisfactory performance characteristics, then the load impedance will have to be adjusted to equal this impedance.

17. With the transmitter adjusted for 1000 watts output, the PLATE CURRENT METER should read between 600 and 750 milliamperes and the SCREEN CURRENT should read less than 10 milliamperes.

   a) If the above readings are low, advance the POWER CONTROL (Fig. 1, Page 3).

   b) If the plate current is lower than suggested and the screen current is too high, the PLATE LOADING CONTROL, Fig. 1, Page 3, should be moved a little counterclockwise and the PLATE TUNING CONTROL resonated.

   c) The amplifier is too heavily loaded when the plate current is too high and the screen current is less than 5 milliamperes. Adjust the PLATE LOADING CONTROL a little clockwise, re-resonate the PLATE TUNING CONTROL and adjust the POWER CONTROL for 1000 watts output.

<u>IMPORTANT</u> -- Unless the impedance into which the transmitter is delivering power is accurately known, it is impossible to determine the exact power output of the transmitter and the complete performance characteristics of the transmitter will be affected. This can be measured, where not known, by your consulting engineer.

18. Modulate the transmitter 100% at 1000 cycles and calibrate the distortion meter to full scale. Reduce the signal generator so that the distortion meter indication drops 1/2 db. This provides 95% modulation. Recalibrate the distortion meter and measure the distortion.

   NOTE: Distortion measurements at 100% modulation are meaningless since, at this point, distortion measurements are not repeatable.

19. The distortion measured in Step 18 above, should be substantially less than 3%. If this is not the case, increase the BIAS CONTROL a very slight amount and observe the distortion again. Each time an adjustment is made, however, assure that the transmitter power output has not changed. This step provides the optimum BIAS adjustment for the power amplifier.

20. Readjust the signal generator for 100% modulation, turn off the signal generator and measure the noise. Adjust the HUM BALANCE CONTROL, Fig. 2, Page 7 for minimum noise. Assure that test equipment leads, and power supply connections are not contributing to the measured noise.

21. Check the carrier shift of the transmitter as indicated on the station's modulation monitor. If the carrier shift is in excess of 3%, it may be improved by repeating Step 19 for a slight increase in P. A. bias; by repeating Step 17(b) for an increase in P. A. loading; or, by a slight change in P. A. tuning watching for an improvement in carrier shift while maintaining the correct power output.

Adjustments for Low Power Operation

1. Place the POWER CHANGE SWITCH to the low power position. See Fig. 2, Page 7.

2. Repeat Step 13, Page 10, except this time adjust the LOW POWER FEEDBACK CONTROL, Fig. 8, Page 13.

3. Adjust the LOW POWER AUXILIARY CONTROL, Fig. 8, Page 13, until the correct R. F. LINE CURRENT is obtained for the lower power operation. At 250 watts into the inbuilt dummy antenna, this would be about 2.22 amperes.

4. Adjust the LOW POWER BIAS CONTROL, Fig. 1, Page 3, for minimum distortion at 95% modulation at 1000 cycles as was done in Step 19.

The above adjustments provide for operation at either power level without changing any control setting.

Adjustment of Modulation Monitor Pickup

1. Operate the transmitter in the low power position.

2. Set modulation monitor pickup coil for correct R. F. drive to the modulation monitor. See Fig. 6, Page 4.

3. Switch the transmitter to high power operation.

4. Adjust the HIGH POWER MODULATION MONITOR ADJUSTMENT slider resistor to provide the same modulation monitor R. F. drive as obtained for the low power operation. If the adjusted resistance is 50 ohms or less, the 150 ohm resistor R624 should be replaced with the 50 ohm unit that is supplied with the transmitter.

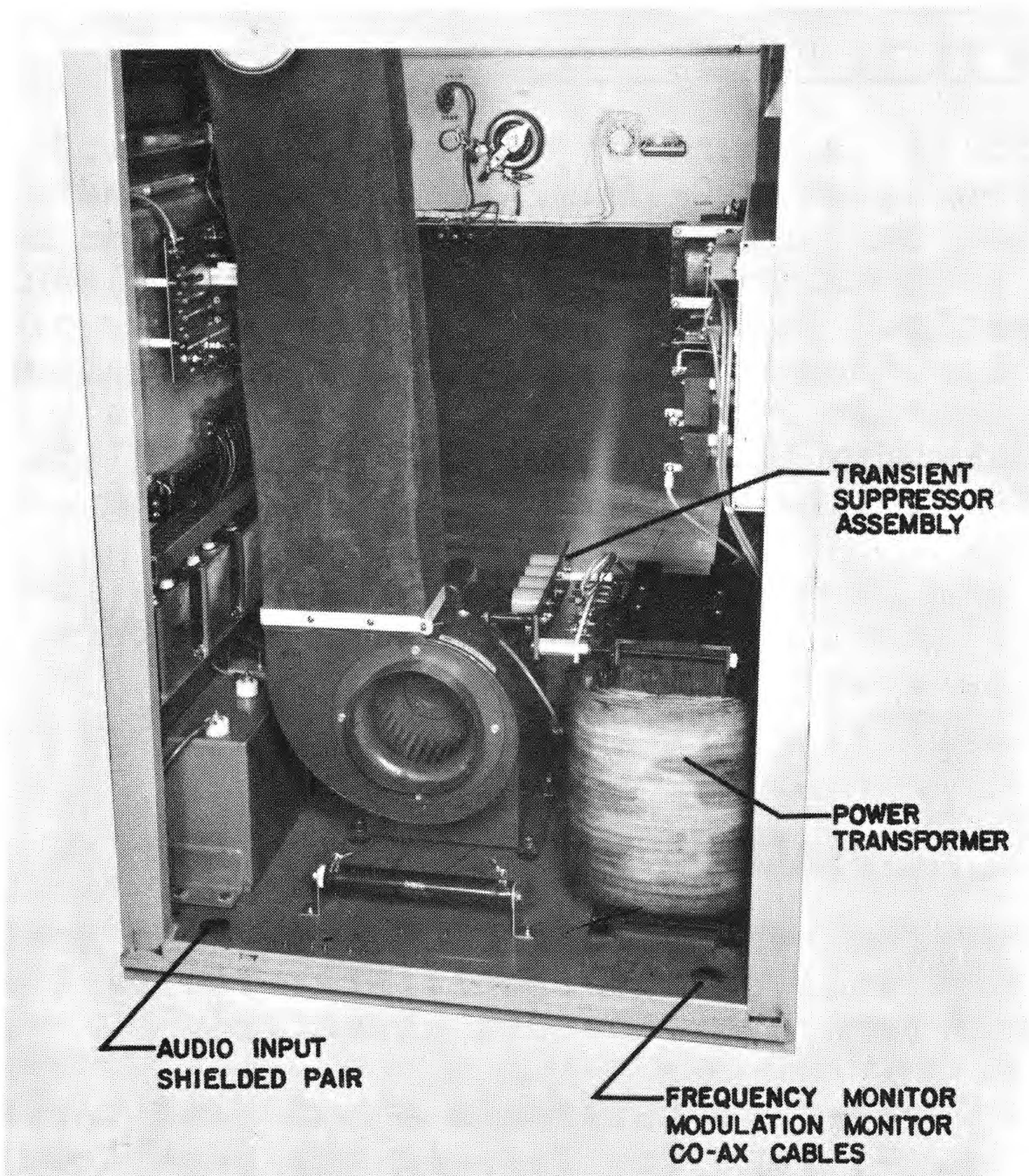


FIG. 7
LOWER REAR

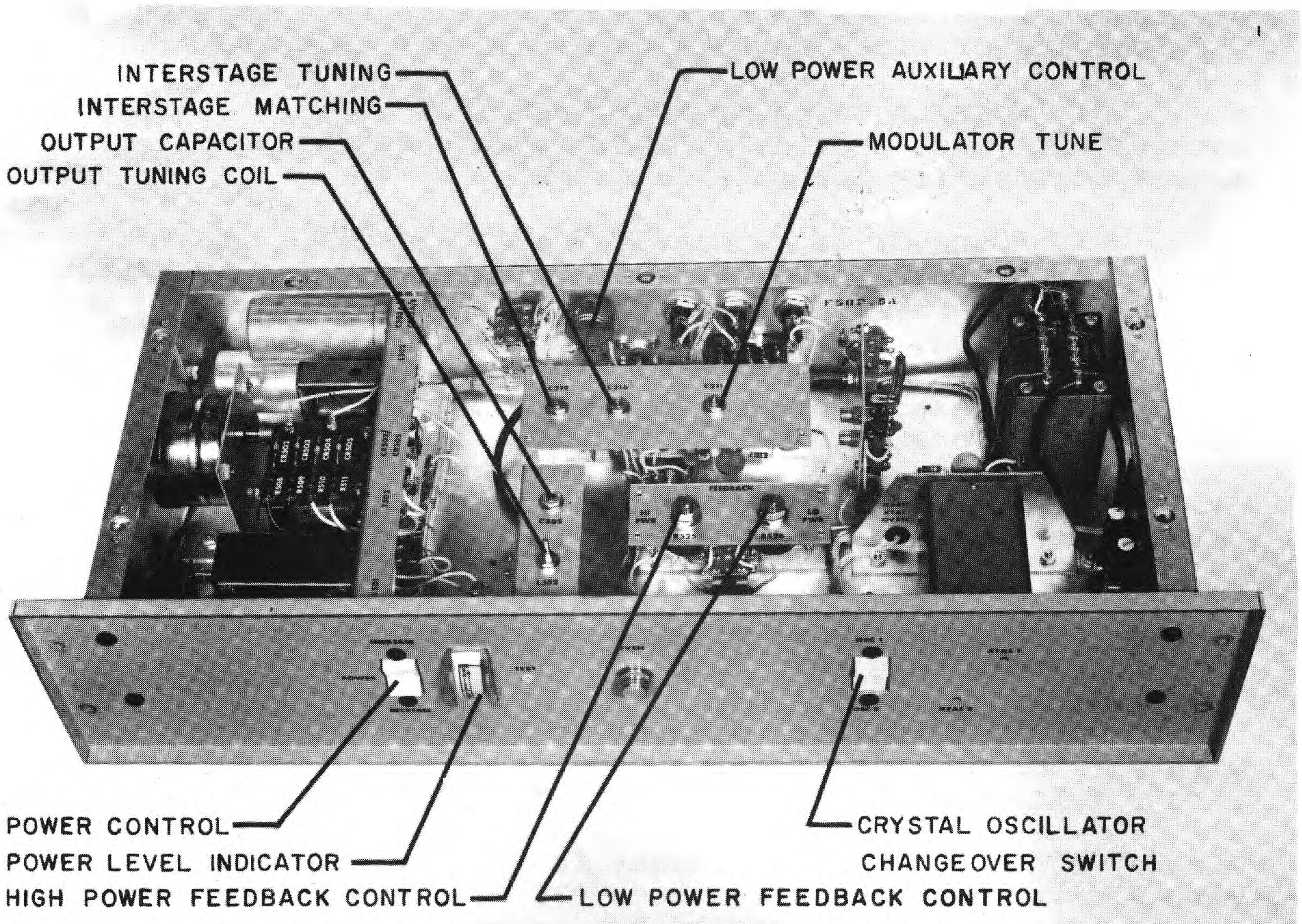


FIGURE 8
TRANSISTORIZED EXCITER

OPERATING VANGUARD II BY REMOTE CONTROL

Where Vanguard II is operated unattended, a remote control system is used, such as the Gates RDC-10AC. When using remote control, it is well to re-emphasize that regular maintenance is even more important, or -- there is no such thing as remote control of cleaning, checking and pride of ownership. Not strangely, the premises of remote operated transmitters is often not as tidy as operator attended installations. Excessive dust on the floor or walls combined with a wide variety of temperatures and humidity will eventually be harmful to the equipment. The engineer's life will be happier with an exacting maintence program.

Terminations are provided for all required FCC functions to remotely operate: (1) Filament ON-OFF with failsafe feature, (2) Plate (high voltage) ON-OFF, (3) Power Output raise or lower, (4) Power Change 1000 watts on low power, (5) Metering plate current, and (6) Metering plate voltage.

Remote Control Connections

Terminal boards for remote control connections are located at the lower right side wall of the transmitter facing the front. All terminal boards have their number stenciled.

FILAMENT ON: Connect to terminals 4 and 5 of terminal board TB601. See Fig. 4, Page 7. This is the same terminal board to which you have earlier connected the audio input line. NOTE - After these connections are made, it is necessary to disable the holding contact circuit of the transmitter filament contactor K601. This can be easily done by removing brown wire #51 from its terminal on filament contactor K601 contact "E". Tape the lug of wire #51, the wire will not be used.

PLATE ON: Connect to terminals 6 and 7 of TB601. The remote control unit must provide normally open contacts which are closed momentarily for this function.

PLATE OFF: Connect to terminals 7 and 8 of TB601 and remove the jumper between these terminals. The remote control unit must provide normally closed contacts to these terminals which are opened momentarily for this function.

POWER RAISE/LOWER: Connect to terminals 1, 2 and 3 on TB603. This terminal board is behind TB601 toward the front of the transmitter. The remote control unit must close terminals 1 and 2 to lower power output and close terminals 2 and 3 to raise power output.

POWER CHANGE: Connects to terminals 9 and 10 on TB601. The remote control unit must close these terminals for low power operation and leave them open for high power operation.

PLATE CURRENT METERING: Connect to terminals 14 and 15 on TB601 with #14 the positive meter connection. This circuit provides 3 to 5 volts to operate the remote meter.

PLATE VOLTAGE METERING: Connect to terminals 12 and 13 on TB601 with #12 the positive meter connection. This circuit provides 3 to 5 volts also, to operate the remote meter.

ADDITIONAL METERING: It is of course possible to provide added metering circuits by minor wiring changes to insert a meter kit such as listed in Gates catalog. This normally is not necessary unless the buyer happens to prefer more.

REMOTE OPERATION OF MONITORS: As this is not part of the transmitter installation instructions, it is suggested that the instruction books on monitor remoting equipment be referred to.

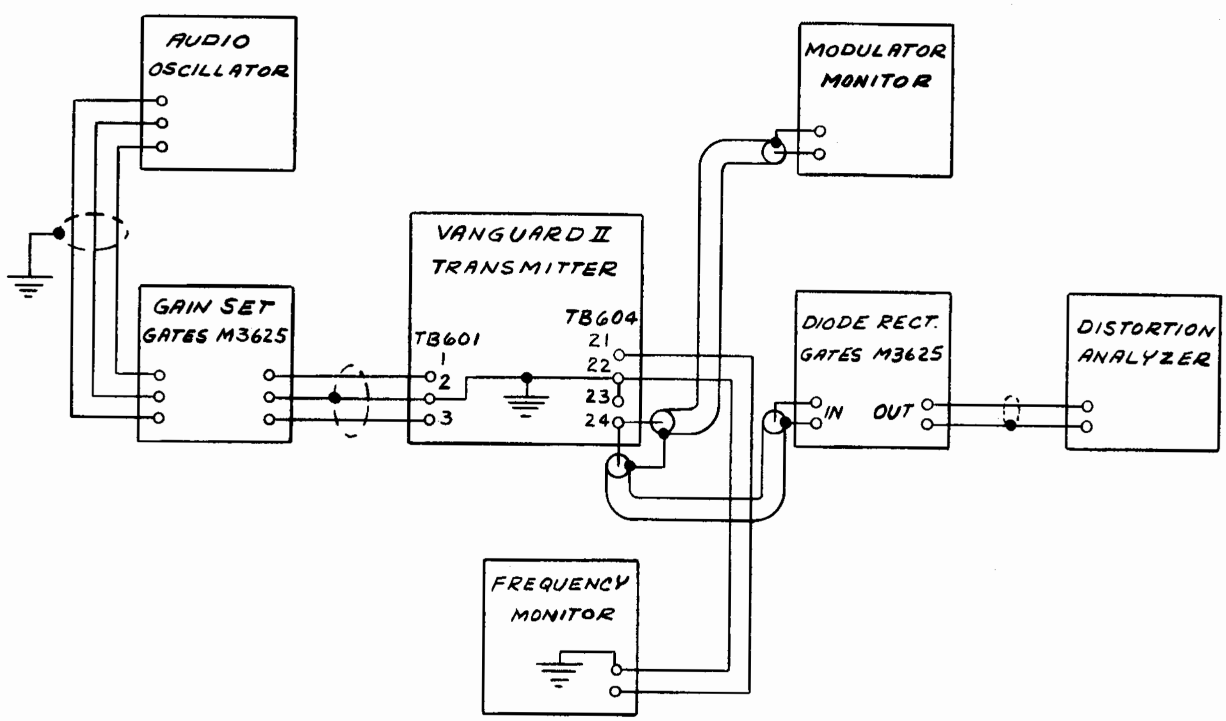


Diagram showing typical test arrangement for response, distortion and noise measurements of Vanguard II. The Gates SA131 proof of performance set listed in Gates catalog is used.

TRANSMITTER MAINTENANCE

General Maintenance

Dust and dirt are always the greatest enemies of any electronic equipment. Regular and thorough cleaning of all areas inside the transmitter is imperative for trouble-free performance. Most broadcasting stations set aside a weekly period for complete maintenance which is adhered to without exception.

Relay Care

A regular and systematic check of all relay contacts should be included in the maintenance program. Use a contact burnishing tool to clean dust and dirt from the relay contacts to assure minimum contact arcing and positive relay operation.

Care of Printed Circuit Boards

Use a very soft bristled brush to remove dust and dirt from these boards periodically. Do not use a stiff brush or a dust cloth. They are apt to remove the silicon varnish that protects the printed wiring from corrosion.

Care of P. A. Tube

The 4CX3000A tube is a tetrode. Its life is dependent upon two very important operating conditions:

1. Operation of its filament at the correct voltage.

2. The free flow of air over its anode.

(Filament Voltage) One of the Vanguard II features is the ability to obtain longer tube life from the only tube employed. With a new tube, the voltage is adjusted as low as full power output can be obtained from the transmitter. This is usually between 8-1/2 and 9 volts. As the tube ages, the filament voltage is increased as necessary. The maximum filament voltage is 10-1/2 volts.

(Anode Air Cooling) At the weekly or periodic maintenance period, carefully remove the tube and clean all anode fins. This assures free flow of air and longer tube life.

Be sure and follow degassing procedure prior to use of the spare tube for the first time (see Page 2).

Periodically check the disposable air filter in rear door. Replace when necessary.

TROUBLE-SHOOTING PROCEDURES

Trouble-shooting can cause added damage if certain specific procedures are not followed. If trouble develops either initially or after several years of service, do not start turning controls just to see what will happen. Though elementary, you must:

1. DEFINE THE PROBLEM. Most problems are small but like the chain, it is the weak link that reacts as a big problem.

2. ISOLATE THE PROBLEM. Whatever the problem is, it is in one place. There are always symptoms. For example, if you have zero R. F. drive to the power amplifier, the problem is probably not in the power amplifier but ahead of it.

3. DETERMINE THE CAUSE. Knowing what caused the problem helps solve it. Oftentimes you do not know but think of the events preceding the problem.

CAUTION: If the problem is located as a defective part, do not attempt adjustments until the defective part is replaced. Usually after replacement of the part, no adjustments are necessary, so why get it out of adjustment to begin with?

Special Problem Solutions

Below are listed three possible problem areas with recommended corrective procedures. If, after careful applications of the principles outlined, a satisfactory solution is not achieved, the reader should contact the Service Manager of the Gates Radio Company.

1. Exciter Output Low

If insufficient drive to the power amplifier occurs with POWER CONTROL fully raised, proceed as follows, referring to Fig. 8 Page 13.

a) Turn the HIGH POWER FEEDBACK CONTROL fully counterclockwise and set POWER CONTROL in approximately center of its travel, as indicated on power indicator meter.

b) Adjust MODULATOR TUNE CAPACITY very slightly in direction which increases power output.

c) Readjust FEEDBACK CONTROL as outlines in Step 13, Page 10.

d) Recheck for distortion and stability as outlined in Step 14, Page 10.

e) If satisfactory results are not achieved, adjust INTERSTAGE TUNING CONTROL in the same manner as in Step (b) above.

f) Repeat Steps (c) and (d) above.

IMPORTANT: Do not set either of the above controls at maximum power output as bandwidth, stability, and distortion will be seriously worsened.

g) If the exciter output is still insufficient, vary the OUTPUT CAPACITOR and INTERSTAGE MATCHING CAPACITOR in small increments.

h) Readjust OUTPUT TUNING COIL as OUTPUT CAPACITOR is changed to maintain minimum distortion and improved power output from transmitter. Also readjust INTERSTAGE TUNING CAPACITOR for same results.

2. High Distortion at Mid-audio Frequencies

a) Repeat adjustment procedures listed in Tuning Procedures. Start at Par. 16, Page 11.

b) Repeat adjustments for low exciter output.

3. High Distortion at High Audio Frequencies

Excessive distortion at high audio frequencies when distortion is near normal at mid-frequencies is most often caused by the selectivity of the antenna system or the radio frequency load into which the transmitter is working. For example, if the load presented to the transmitter becomes substantially reactive at any point within the bandwidth of the transmitter, high distortion will result. When this condition exists, no amount of tuning in the transmitter will correct the problem -- the load itself must be corrected. (See Page 11 under"Important"). The above condition is true for any amplitude modulated transmitter but becomes especially noticeable in the Vanguard because of its extremely low distortion capabilities.

TYPICAL PERFORMANCE CHARACTERISTICS

Actual performance characteristics obtainable with the Vanguard II transmitter at any particular installation are not determined solely by the transmitter itself but are effected in a large measure by external influences, such as the line voltage, the grounding of the transmitter, and especially by the characteristics of the load impedance into which the transmitter delivers power.

The measurement of the fine performance of the Vanguard II is likewise an exacting process because some of the performance specifications approach the measuring capabilities of the test equipment used. For this reason, actual performance measurements lying within the ranges given in the following table are considered superior and of such value that further reduction would not provide detectable improvement.

Audio Response...........	±1.5 db, or less, 30 to 10,000 cycles.
Audio Distortion.........	Less than 3% at 95% modulation, 30 to 7500 cycles.
Audio Noise..............	-50 to -60 db.
Carrier Shift............	Less than 3%.

TYPICAL METER READINGS

The following table of meter readings is given as a range rather than a single value. An exact reading will differ from installation to installation because of:

a) Variations in primary line voltage.

b) Variations in exact impedance of antenna system.

c) Differences in exact tuning conditions.

Readings within these ranges generally produce satisfactory transmitter operation.

METER	METER RANGE*
R. F. Line Meter	Depends on exact line impedance (See Note)
P. A. Volts	5100 to 5400 volts
P. A. Current	600 to 750 ma.
Filament Volts	8.5 to 10.5 volts (lowest for new tube)
Exciter	35 to 50 ma.
Bias	195 to 200 volts
Screen Volts	850 to 900 volts
Screen Current	5 to 15 ma.

*Based on 1000 watts output into a known load.

NOTE: When operated into the inbuilt dummy antenna and where the transmitter output is 50 ohms, the antenna current for 1000 watts should be about 4.45 amperes.

VANGUARD II PARTS LIST

When ordering spare or replacement parts, be sure and give the full description such as Symbol No., Gates IBM Part Number and description along with "for Vanguard II". In this way, in case of an error it can be caught before shipping. To assist in quickly locating the part, Vanguard II has been sectionalized in the listing below.

Symbol No.	Gates IBM Part No.	Description
Y1	444 XXXX 000	Crystal ______Kc. operating frequency.
V601	374 0074	Vacuum tube 4CX3000A (see note at end of Parts List)

BINARY DIVIDER

(see Page 6)

Symbol No.	Gates IBM Part No.	Description
C101,C104	500 0818	Cap., 50 pf., 500 V(W), 5%
C102	500 0844	Cap., 1000 pf.,100 V(W), 5%
C103	500 0836	Cap., 500 pf.,300 V(W), 5%
C105	500 0858	Cap., 5000 pf.,300 V(W), 5%
C106	500 0761	Cap., 150 pf., 500 V(W), 5%
CR101,CR102	384 0132	Diode, Silicon
Q101, Q102, Q103	380 0083	Transistor
R101,R109, R111	540 0068	Res.,6200 ohm,1/2W., 5%
R102,R108	540 0191	Res., 12K ohm,1/2W., 10%
R103,R106	540 0183	Res.,2.7 K ohm,1/2W.,10%
R104	540 0174	Res.,470 ohm, 1/2W.,10%
R105,R107	540 0186	Res., 4.7K ohm, 1/2W., 5%
R110	540 0210	Res.,470K ohm, 1/2W.,10%

MODULATOR UNIT

Symbol No.	Gates IBM Part No.	Description
C201	522 0330	Cap., 20 uf., 50 V.
C202 thru C207, C212,C214,C215	516 0081	Cap., .01 uf., 1KV., 20%
C208	500 0759	Cap., 100 pf.,500V., 5%
C209	516 0054	Cap., .001 uf., 1KV., 10%
C210		Cap.,(Det. by Freq.)
C211,C213	500 0787	Cap., 200 pf., 500 V. 5%

PARTS LIST

Symbol No.	Gates Part No.	Description
C216	500 0849	Cap., Variable, 1600-550 pf.
C219	500 0850	Cap., Variable, 3055-1400 pf.
CR201	384 0132	Diode, Silicon
L201	494 0033	RF Choke, 2.5 Mill-hy.
L202	492 0317	Coil, Variable
L203	Order by Freq.	RF Choke
Q201	380 0028	Transistor
Q202 thru Q205	380 0029	Transistor
R201	540 0186	Res., 4.7K ohm, 1/2 W. 10%
R202	540 0189	Res., 8.2K ohm, 1/2 W. 10%
R203	540 0173	Res., 390 ohm, 1/2 W., 10%
R204	540 0174	Res., 470 ohm, 1/2 W. 10%
R205	540 0200	Res., 68K ohm, 1/2 W. 10%
R206,R207, R214,R216	540 0846	Res., 3 ohm, 1/2 W. 5%
R208,R210	540 0026	Res., 110 ohm, 1/2 W. 10%
R209	540 0180	Res., 1.5K ohm, 1/2 W. 10%
R211	540 0073	Res., 10K ohm, 1/2 W. 5%
R212	540 0190	Res., 10K ohm, 1/2 W. 10%
R213	540 0170	Res., 220 ohm, 1/2 W. 10%
R215,R217, R218	540 0166	Res., 100 ohm, 1/2 W. 10%
R219	540 0204	Res., 150K ohm, 1/2 W. 10%
RT201	559 0003	Thermistor, 1K ohm
XQ201 thru XQ205	404 0187	Transistor Socket
	404 0188	Retainer Ring for socket

OUTPUT AMPLIFIER UNIT

Symbol No.	Gates Part No.	Description
C302	516 0081	Cap., .01 uf., 1 KV, 20%
C303	508 0215	Cap., .01 uf., 100 V.
C304	506 0008	Cap., 1.0 uf., 200 V.
C305	500 0861	Cap., Variable, Mica 275-970 pf.
C308	500 0838	Cap., 560 pf., 300(W)V. D.C.
C309	516 0084	Cap., .02 uf., 600 V.
L301	494 0083	RF Choke, 240 Micro-hy.
L302	Order by Freq.	Variable Coil
Q301	380 0027	Transistor, output
R301	540 0846	Res., 3 ohm, 1/2 W., 5%
R303	540 0166	Res., 100 ohm, 1/2 W. 10%
R304	540 0008	Res., 20 ohm, 1/2 W., 5%

PARTS LIST

Symbol No.	Gates IBM Part No.	Description
	AUDIO AMPLIFIER	
C401	522 0331	Cap., 35 uf., 3 V.
C402	522 0166	Cap.,400 uf., 3 V.
C403,C404	522 0330	Cap., 20 uf., 50 V.
Q401,Q402	380 0026	Transistor
R402	540 0094	Res., 75K ohm, 1/2W., 5%
R403	540 0060	Res., 3K ohm, 1/2W., 5%
R404	540 0066	Res., 5.1K ohm,1/2W.,5%
R405	540 0166	Res., 100 ohm, 1/2W.,10%
R406	540 0174	Res., 470 ohm, 1/2W.,10%
R407	540 0084	Res., 30K ohm, 1/2W., 5%
R408	540 0096	Res., 91K ohm, 1/2W., 5%
R409	540 0162	Res., 47 ohm, 1/2W., 10%
R410	540 0065	Res., 4.7K ohm,1/2W., 5%
XQ401,XQ402	404 0066	Transistor socket
	TRANSISTORIZED OSC./BUFFER, MOD. DRIVER UNIT	
A501	396 0062	Lamp, Neon, NE-51-H
B501	436 0058	Motor, Synchronous, 115V, 60 cy., Cap., .47 uf.
C501	506 0006	Cap., .25 uf., 200 V.
C502	524 0117	Cap.,400-800 uf.,100V.
C503	524 0118	Cap.,400-800 uf., 75V.
C504	522 0333	Cap., 150 uf., 50V.
C505,C506	516 0084	Cap., .02 uf., 600V.
CR501	386 0033	Zener Diode
CR502 thru CR505	384 0137	Silicon Rectifier
CR506	386 0067	Zener Diode
F501	398 0016	Fuse, 3/4 amp.,250V., 3 AG
F502,F503	398 0015	Fuse, 1/2 amp.,250V., 3 AG
J501,J502	612 0230	Receptacle
J503	610 0008	Receptacle, Male 15 PIN
J504	612 0372	Receptacle, Female
K501,K502	574 0123	Relay, DPDT, 115 V. AC
L501	476 0255	Reactor, 4 hy., 300 ma.
L502	476 0256	Reactor, 3.5 hy., 100 ma.
M501	632 0593	Meter, 0-1 ma.

PARTS LIST

Symbol No.	Gates IBM Part No.	Description
P501,P502	610 0231	Plug, UHF
P503	612 0102	Connector, Female 15 PIN
R504,R505	540 0192	Res., 15K ohm, 1/2W.,10%
R506	540 0178	Res., 1K ohm, 1/2W.,10%
R508,R509	540 0001	Res., 10 ohm, 1/2W.,5%
R510,R511	540 0846	Res., 3 ohm, 1/2W.,5%
R512	540 0300	Res., 47 ohm, 1W.,5%
R518,R519	540 0035	Res., 270 ohm, 1/2W.,5%
R521	550 0067	Potentiometer, 10K ohm, 2W.
R522	550 0260	Potentiometer, 50 ohm
R524	540 0752	Res., 10K ohm, 2W., 10%
R525	550 0059	Pot., 500 ohm, 2W.
R526	550 0061	Pot., 1000 ohm, 2W.
S502	604 0289	Switch, SPDT, w/center off
S503	604 0291	Switch, SPDT,momentary w/center off
T501	478 0030	Transformer, Audio Input
T502	472 0498	Transformer, Power
TP501	612 0312	Test Point Jack
X501	404 0016	Socket, Octal
XA501	406 0347	Pilot Lamp
XF501,XF502, &XF503	404 0023	Fuseholder

CABINET PARTS

Symbol No.	Gates IBM Part No.	Description
A601A,A601B, A602A,A602B, A603A,A603B	396 0045	Pilot Lamp, 6V.,150 ma.,Bayonet Type #47
B601	432 0063	Blower, 1/6 HP, 1750 RPM, 230V., 60 cy.,counterclockwise,Up Blast
C601,C602, C615,C619, C620	516 0381	Cap., HV. 16,000 pf., 6 KV
C603,C604	516 0382	Cap., HV. 2000 pf., 15 KV
C605A/B	order by frequency	Cap.,Plate Tank, G2 (Value det. by Oper. Freq.)
C606,C607	order by frequency	Cap., Input & Output Loading, G2 (Value det. by Oper.Freq.)
C608,C609, C610	510 0501	Cap.,Screen Filter, 10 uf., 1000 V.
C611,C612	522 0334	Cap., 10-10 uf., 450 V.
C613,C614	510 0422	Cap., HV. 6 uf., 6 KV.

PARTS LIST

Symbol No.	Gates Part No.	Description
C616A,C622	516 0081	Cap., .01 uf., 1 KV
C616B	516 0084	Cap., .02 uf., 600 V.
C617,C618, C621	516 0081	Cap., .01 uf., 1 KV.
C623	914 2348 001	Cap., Variable, 6.5-50 pf.
C624	500 0829	Cap., Mica, 180 pf., 500 V.
C625,C626, C627,C628	516 0233	Cap., Ceramic, 500 pf., 30 KV.
CR601	384 0137	Diode, Silicon, 400 PIV
CR602A/B, CR603A/B, CR604A/B, CR605A/B	384 0149	Rectifier, Silicon HV, 15 KV PIV
CR606A/B,CR607A/B, CR608A/B,CR609A/B	914 1830	Screen Rectifier Assy.
CR610,CR611, CR612,CR613	384 0020	Diode, Silicon, 600 PIV, 1 Amp.
CR614A/B	384 0134	Diode, 1N914
F601,F602	398 0304	Fuse, Cartridge, 40 Amp.
F603	398 0015	Fuse, 1/2 Amp, 250 V. 3 AG
F604	398 0312	Fuse, HV. 1 Amp.
F605,F606	398 0022	Fuse, 5 Amp. 250 V. 3 AG
K601	570 0124	Contactor, Fil. 4 pole, 230 V. 60 cy.
K602	570 0125	Contactor, Plate, 4 pole, 230 V. 60 cy.
K603	570 0114	Contactor, Blower, 3 pole, 220/240 V., 60 cy.
K604	576 0024	Relay, Blower Time Delay
K605	576 0039	Relay, Blower Time Delay
K606	574 0014	Relay, PAOL. SPDT, 6 VDC Coil
K607	574 0123	Relay, DPDT, 115 VAC
K608	574 0012	Relay, SPDT, 230 VAC Coil
L601,L602	476 0258	Reactor, Filter, HV. 5 Hy. 1 A. DC
L603,L604, L611,L612	476 0257	Reactor, 12 Hy.
L605,L616	494 0033	Choke, RF, 2.5 Mill-hy.
L606	926 7569 001	Choke, RF Plate, 2.65 Milli-hy.
L607	931 6583 010	Coil, Variable, PA Tank
L608	931 6138 047	Coil, Input Loading PA
L609	931 6583 009	Coil, Variable, Output Loading, PA
L610	938 0503 001	Coil, Mod. Monitor, Variable
L613	914 2337 001	Parasitic Suppressor Assy.
L614	927 1012 001	Parasitic Suppressor Assy.
L615	914 3393 001	Coil, Neut. (Ind. Det by Oper. Freq.)
M601	632 0556	Multi-meter
M602	632 0557	Ammeter, 0-1 Amp. DC
M603	632 0579	Voltmeter, 0-1 MADC movement with 0-8 KV DC Scale
M604	634 0081	Ammeter, RF, 0-8 Amps.

PARTS LIST

Symbol No.	Gates Part No.	Description
R601	540 0317	Res., 240 ohm, 1 W. 5%
R602	550 0067	Potentiometer, Fil. 10K ohm
R604	548 0166	Res., Multiplier, 1 meg. 2 W. 5%
R605,R606	914 3423	Meter Multiplier, 4 megohm
R607,R608	542 0346	Res., HV Bleeder, 100K ohm, 160 W.
R611	552 0255	Potentiometer, 10K ohm, 4 W.
R612	552 0006	Res., Adj. 10 ohm, 10 W.
R613, R613A	~~552 0258~~ (10KΩ, 5W pot / 15KΩ, 10W resistor)	Bias Pot., ~~25K ohm, 4 W.~~
R614	552 0406	Rheostat, Fil. 25 ohm, 150W.
R615,R616	542 0089	Res., 6K ohm, 10 W.
R617 thru R622	546 0216	Res., Dummy Antenna, Non-inductive, 312 ohm, 200 W.
R624	552 0088	Res., Adj. 150 ohm, 50 W.
R624	552 0085	Res., Adj. 50 ohm, 50 W.
R625	552 0385	Rheostat, 100 ohm, 100 W.
R626	540 0271	Res., Multi-meter, 3 ohm, 1 W., 5%
R627	542 0334	Res., 7500 ohm, 160 W.
R628	548 0166	Res., 1 megohm, 2 W., .5%
R629	550 0067	Control, 10K ohm, 2 W.
R630 thru R635	548 0166	Res., 1 megohm, 2 W., .5%
R636,R640,R641	540 0066	Res., 5100 ohm, 1/2 W. 5%
R637	550 0055	Control, 100 ohm, 2 W.
R638,R639	542 0056	Res., 20 ohm, 10 W.
R642	542 0085	Res., 3500 ohm, 10 W.
R643	540 0353	Res., 7500 ohm, 1 W. 10%
R644	542 0425	Res., 35K ohm, 20 W.
S601	604 0290	Switch, PB, N.O. Natural
S602	604 0284	Switch, PB, N.C. Natural
S603	604 0321	Switch, PB, N.O. Red
S604	604 0286	Switch, PB, N.C. Red
S606,S609	604 0061	Switch, Door Interlock
S607	604 0258	Switch, Air Pressure
S608	600 0415	Switch, Multi-meter
S610	604 0005	Toggle Switch
T601	472 0500	Transformer, Plate & Screen
T602	472 0499	Transformer, Bias & Lamps
T603	472 0501	Transformer, P.A. Filament
TB601,TB602, TB603	614 0123	Terminal Board
TB604	614 0120	Terminal Board (2 required)
TB605	614 0012	Terminal Board
V601	374 0074	Tube, 4CX3000A
XA601A,XA601B, XA602A,XA602B, XA603A,XA603B	406 0348	Socket, Pilot Lamp
XF601	402 0087	Fuseblock
XF603	404 0023	Fuseholder
XF604	402 0088	Fuseblock
XF605,XF606	404 0023	Fuseholder

PARTS LIST

Symbol No.	Gates IBM Part No.	Description
XK604,XK605	404 0016	Socket, Octal
XV 601	404 0177	Socket, for 4CX3000A

FREQ. MONITOR AMPLIFIER UNIT

Symbol No.	Gates IBM Part No.	Description
C701	516 0054	Cap., .001 uf., 1KV.
C702,C703 C706,C708	516 0081	Cap., .01 uf., 1 KV.
C704	522 0268	Cap., 20 uf., 100 V.
C705	516 0084	Cap., .02 uf., 600 V.
L701	494 0155	RF Choke, 10 uhy.
Q701, Q702	380 0030	Transistor
Q703	380 0031	Transistor
R701	540 0200	Res.,68K ohm, 1/2 W.,10%
R702	540 0084	Res.,30K ohm, 1/2 W.,5%
R703	540 0162	Res.,47 ohm, 1/2 W., 10%
R704,R705	540 0190	Res.,10K ohm, 1/2 W.,10%
R706	540 0074	Res.,11K ohm, 1/2 W., 5%
R707	540 0070	Res.,7500 ohm, 1/2 W.,5%
R708	540 0184	Res.,3300 ohm, 1/2 W.,10%
R709	540 0730	Res., 150 ohm, 2 W., 10%
R710	542 1084	Res., 250 ohm, 5 W., 5%
XQ701,XQ702	404 0187	Socket, Transistor
	404 0188	Retainer Ring for Socket

LEGEND FOR PART ABBREVIATIONS:

Cap. = Capacitor or condenser
Res. = Resistor
R.F. = Radio Frequency
Pot. = Potentiometer or small rheostat
Neut.= Neutralize
PB = Push button
NO = Normally Open
NC = Normally closed
K = 000 or 6K is 6000
W = Watts
V = Volts
uf = Microfarads
pf = Micro microfarads

TUBE NOTE: Gates invites orders for the 4CX3000A replacement tube used in the Vanguard II transmitter. Due to the large use of this tube in both Vanguard II and other Gates transmitters, inventory is always fresh, which assures a non-gaseous tube. Same day Shipment.

HELPFUL GENERAL INFORMATION

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

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

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

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 measurement 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.

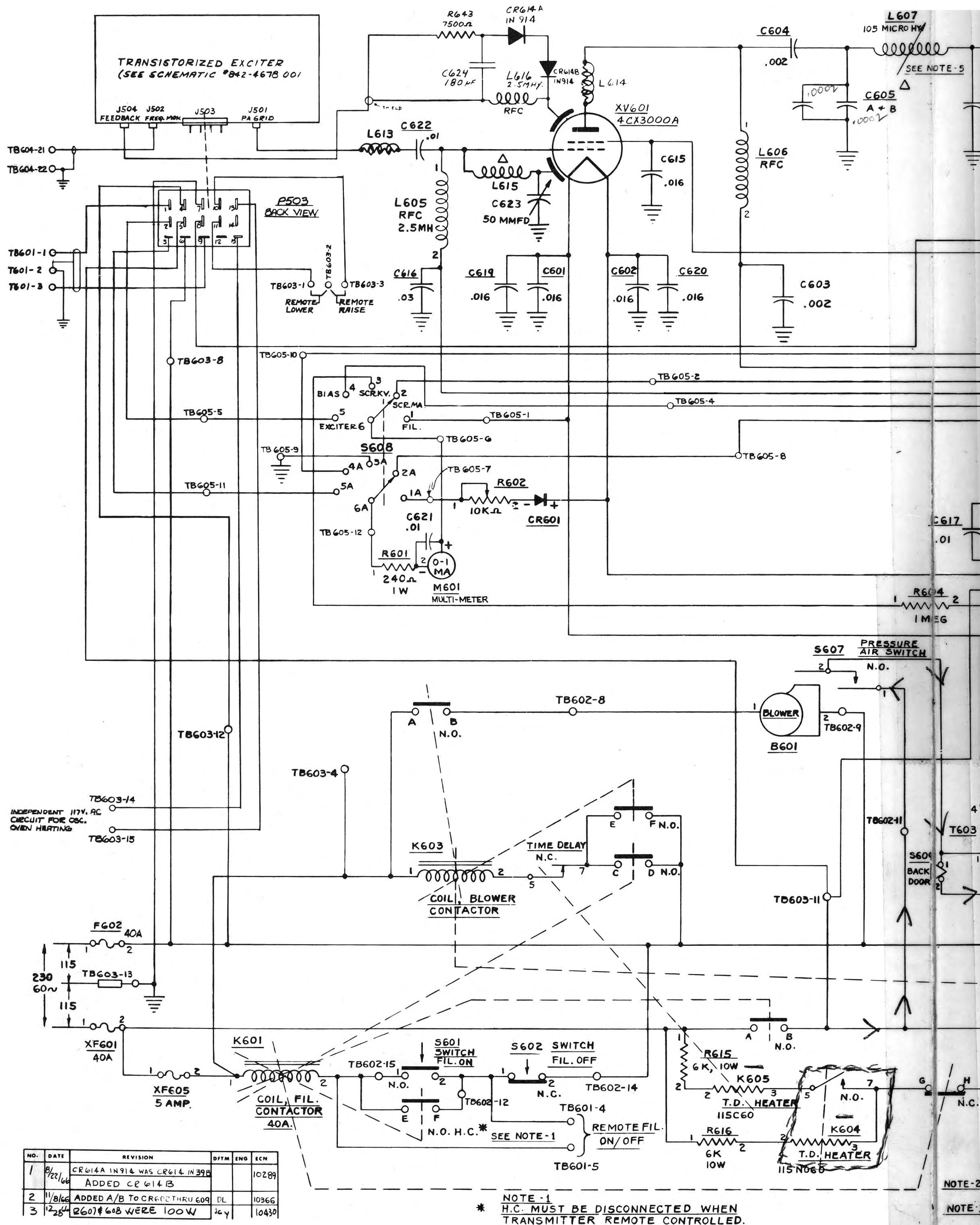
18. THE CHIEF ENGINEER. He has the job of keeping everybody happy - listeners, Manager, and stockholders. When trouble comes, he is under pressure. He will do his best to correct the problem as fast as he can. It is well to remember that electronic equipment has many circuits and many avenues of travel. 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

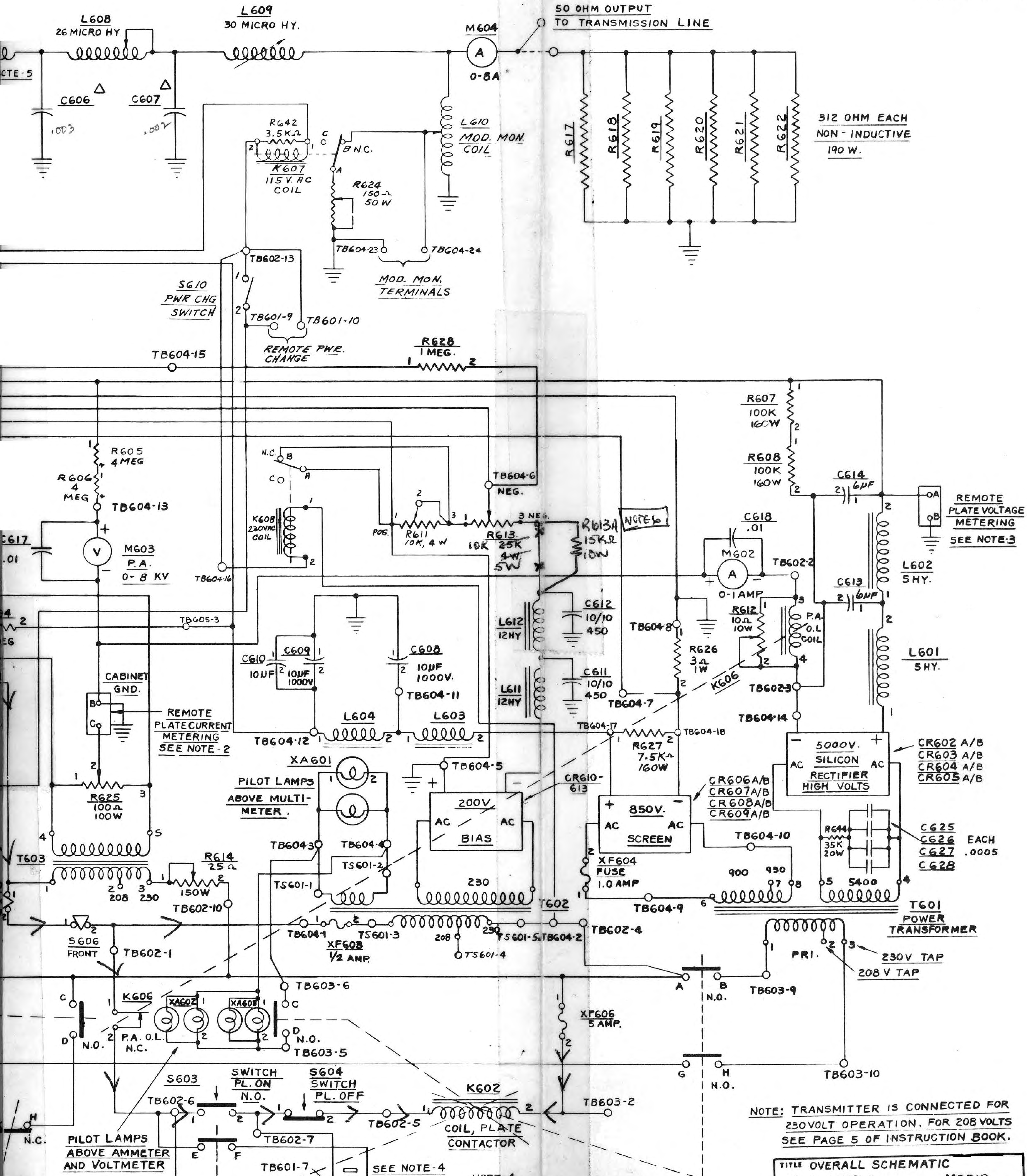
Quincy, Illinois, U.S.A.



NO.	DATE	REVISION	DFTM	ENG	ECN
1	8/22/66	CR614A IN914 WAS CR614 IN398 ADDED CR 614B			10289
2	11/8/66	ADDED A/B TO CR602 THRU 609	DL		10366
3	12/28/66	R601 & 608 WERE 100W	JCY		10430

NOTE-1

* H.C. MUST BE DISCONNECTED WHEN TRANSMITTER REMOTE CONTROLLED.



NOTE: TRANSMITTER IS CONNECTED FOR 230 VOLT OPERATION. FOR 208 VOLTS SEE PAGE 5 OF INSTRUCTION BOOK.

NOTE-2 REMOTE PLATE CURRENT METERING SCHEMATIC # 814-2138-001, PART-2

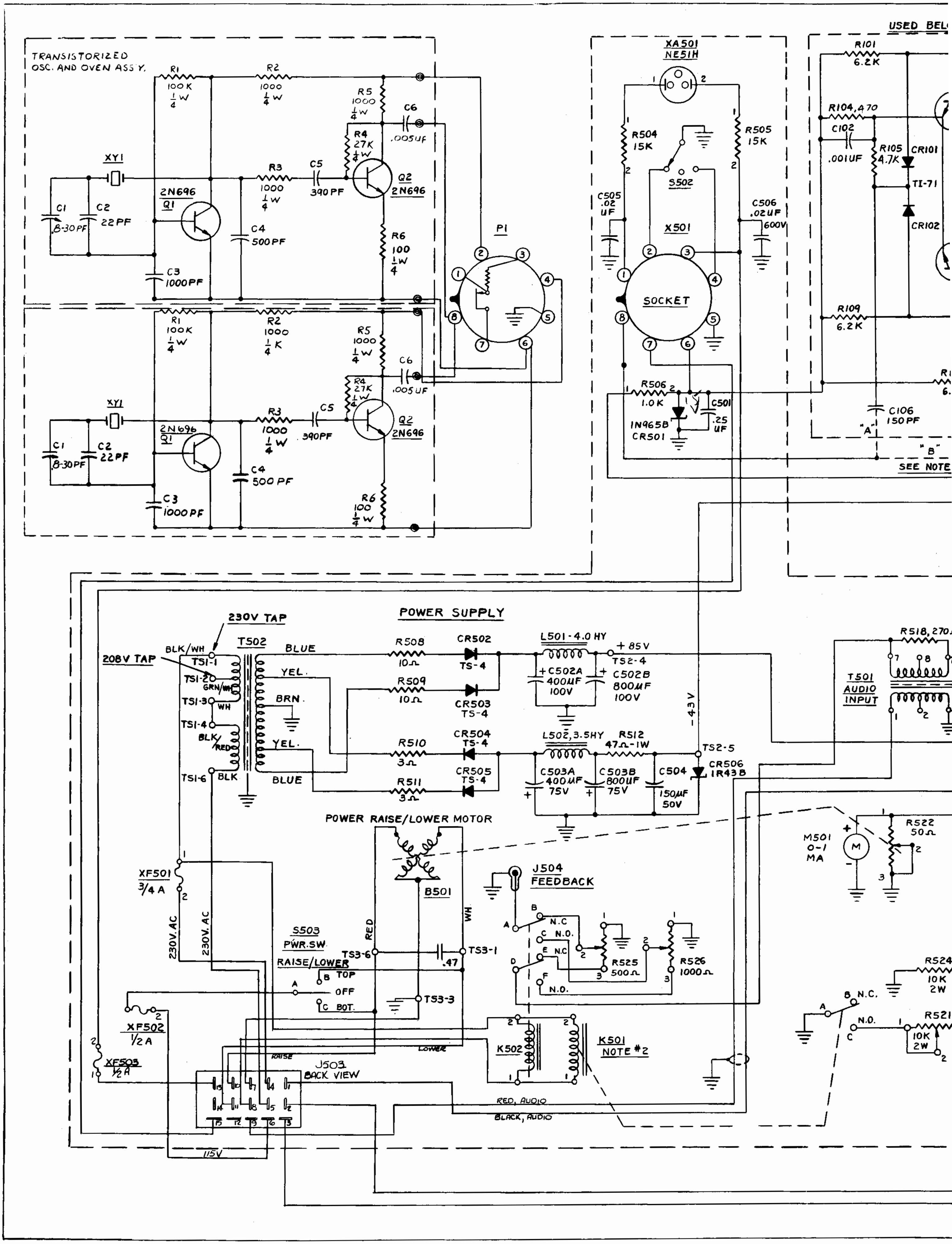
NOTE-3 REMOTE PLATE VOLTAGE METERING SCHEMATIC # 814-2138-001, PART-1

NOTE-4 JUMPER MUST BE REMOVED WHEN TRANSMITTER IS REMOTE CONTROLLED.

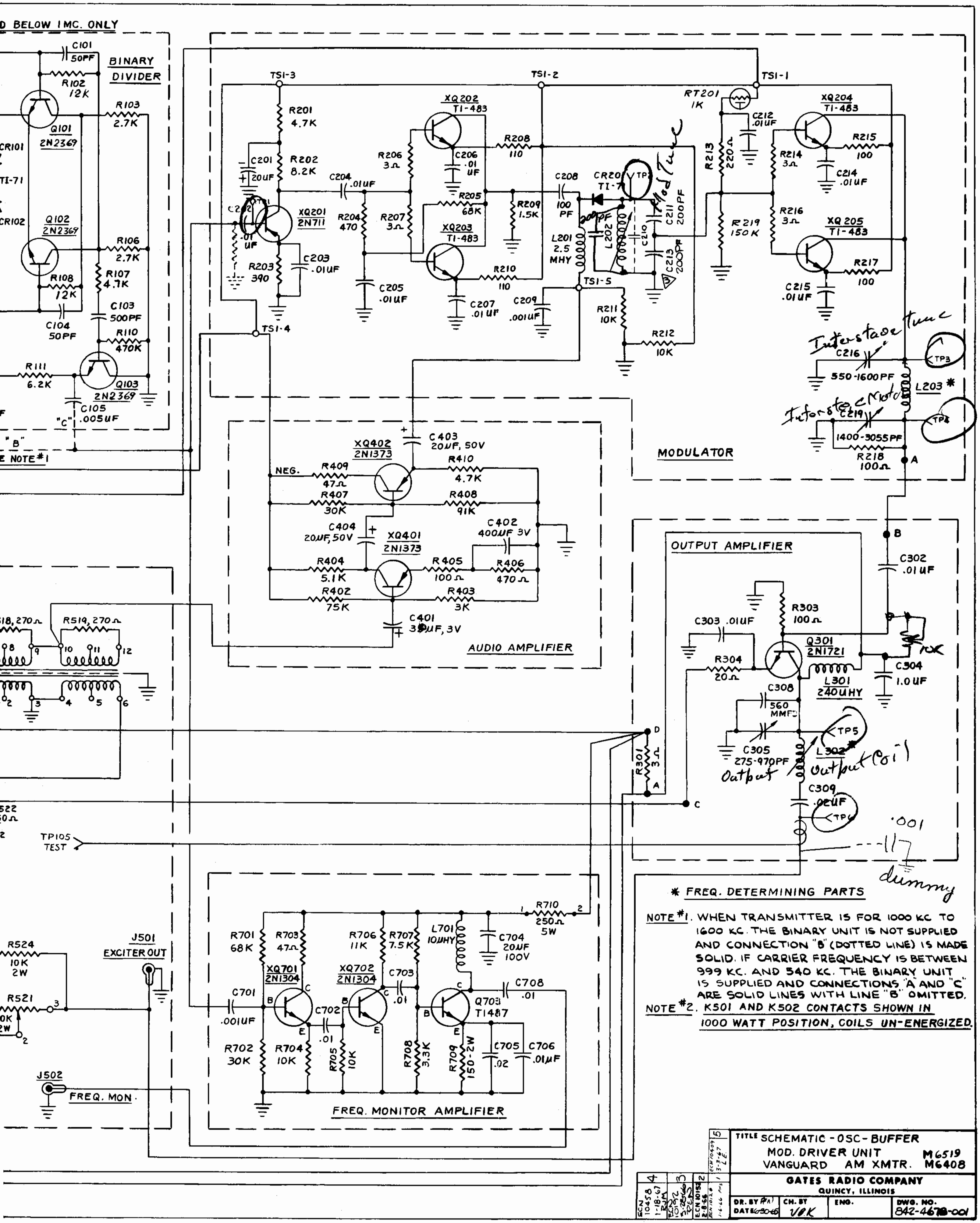
NOTE-5 △ VALUE DETERMINED BY OPERATING FREQUENCY.

Note 6 - R613 changed to: R613 10KΩ, 5W pot, R613A 15KΩ, 10W resistor.
RP Schumeyer, 18 JULY 74

TITLE OVERALL SCHEMATIC VANGUARD 2 M6519 1000/250 W. A.M. BROAD. TRANSMITTER			
GATES RADIO COMPANY QUINCY, ILLINOIS			
DR. BY J B DATE 2-10-66	CH. BY	ENG.	DWG. NO. 842-4916-001



TRANSISTORIZED OSC. AND OVEN ASS'Y.
R1 100K 1/4 W
R2 1000 1/4 W
R5 1000 1/4 W
C6 .005UF
R4 27K 1/4 W
XY1
R3 1000 1/4 W
C5 390 PF
Q2 2N696
2N696 Q1
C1 8-30 PF
C2 22PF
C4 500PF
R6 100 1/4 W
C3 1000PF
P1
XA501 NE51H
R504 15K
R505 15K
S502
C505 .02 UF
C506 .02UF 600V
X501
SOCKET
R506 1.0K
C501 .25 UF
1N965B CR501
USED BEL
R101 6.2K
R104,470
C102 .001UF
R105 4.7K
CR101
TI-71
CR102
R109 6.2K
C106 150PF
"A"
"B"
SEE NOTE
POWER SUPPLY
230V TAP
208V TAP
T502
BLK/WH
TS1-1
TS1-2
GRN/WH
TS1-3
WH
TS1-4
BLK/RED
TS1-6
BLK
BLUE
YEL.
BRN.
R508 10Ω
CR502 TS-4
R509 10Ω
CR503 TS-4
L501-4.0 HY
+85V
TS2-4
C502A 400μF 100V
C502B 800μF 100V
-43V
R510 3Ω
CR504 TS-4
L502, 3.5HY
R512 47Ω-1W
TS2-5
R511 3Ω
CR505 TS-4
C503A 400μF 75V
C503B 800μF 75V
C504 150μF 50V
CR506 1R43B
R518, 270
T501 AUDIO INPUT
POWER RAISE/LOWER MOTOR
B501
RED
WH
XF501 3/4 A
230V. AC
S503 PWR. SW.
RAISE/LOWER
TS3-6
TS3-1
.47
TOP
OFF
BOT.
TS3-3
J504 FEEDBACK
N.C.
N.O.
R525 500Ω
R526 1000Ω
M501 0-1 MA
R522 50Ω
R524 10K 2W
R521 10K 2W
XF502 1/2 A
XF503 1/2 A
RAISE
LOWER
K502
K501 NOTE #2
J503 BACK VIEW
RED, AUDIO
BLACK, AUDIO
115V



*** FREQ. DETERMINING PARTS**

NOTE #1. WHEN TRANSMITTER IS FOR 1000 KC TO 1600 KC. THE BINARY UNIT IS NOT SUPPLIED AND CONNECTION "B" (DOTTED LINE) IS MADE SOLID. IF CARRIER FREQUENCY IS BETWEEN 999 KC. AND 540 KC. THE BINARY UNIT IS SUPPLIED AND CONNECTIONS "A" AND "C" ARE SOLID LINES WITH LINE "B" OMITTED.

NOTE #2. K501 AND K502 CONTACTS SHOWN IN 1000 WATT POSITION, COILS UN-ENERGIZED.

TITLE	SCHEMATIC - OSC - BUFFER MOD. DRIVER UNIT M6519 VANGUARD AM XMTR. M6408
	GATES RADIO COMPANY QUINCY, ILLINOIS
DR. BY / DATE	CH. BY VAK
ENG.	DWG. NO. 842-4678-001

NOTE: TRANSMITTER IS CONNECTED FOR 230 VOLT OPERATION. FOR 208 VOLTS SEE PAGE 5 OF INSTRUCTION BOOK.

NOTE-1
* H.C. MUST BE DISCONNECTED WHEN TRANSMITTER REMOTE CONTROLLED.

NOTE-2 REMOTE PLATE CURRENT METERING SCHEMATIC # 814-2138-001, PART-2

NOTE-3 REMOTE PLATE VOLTAGE METERING SCHEMATIC # 814-2138-001, PART-1

NOTE-4 JUMPER MUST BE REMOVED WHEN TRANSMITTER IS REMOTE CONTROLLED.

NOTE-5 △ VALUE DETERMINED BY OPERATING FREQUENCY.

Note 6 - R613 changed to: R613 10K Ω, 5W pot, R613A 15K Ω, 10W resistor. R.P. Schermeyer, 15 July 74

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TITLE OVERALL SCHEMATIC
VANGUARD 2 M6519
1000/250W. A.M. BROAD. TRANSMITTER
GATES RADIO COMPANY
QUINCY, ILLINOIS
DR. BY J.B. DATE 2-0-66 | CH. BY | ENG. | DWG. NO. 842-4916-001


TRANSISTORIZED OSC. AND OVEN ASS'Y.
USED BELOW 1 MC. ONLY
BINARY DIVIDER
SEE NOTE #1
MODULATOR
AUDIO AMPLIFIER
OUTPUT AMPLIFIER
POWER SUPPLY
230V TAP
208V TAP
POWER RAISE/LOWER MOTOR
J504 FEEDBACK
S503 PWR. SW. RAISE/LOWER
J503 BACK VIEW
K502
K501 NOTE #2
T501 AUDIO INPUT
J501 EXCITER OUT
J502 FREQ. MON.
TP105 TEST
FREQ. MONITOR AMPLIFIER
SOCKET
XA501 NE51H
P1
Mod Tune
Interstage Tune
Interstage Match
Output
Output Coil
dummy
* FREQ. DETERMINING PARTS
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