GATES

INSTRUCTION BOOK

FOR

FM-20B 20 KW

FM BROADCAST TRANSMITTER

6/22/61
I.B. #888 0619 001

GATES RADIO COMPANY
Quincy, Illinois

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Additional Instruction Books - M-6023 Recycling Unit
M-5675 Amplifier (FM)
M-6095 Exciter (FM)

Photos:

800 0184 002 Front View
800 0202 001 Rear View

Drawings:

A-35549
813 6239 001
813 6243 001
A-35515
AP-34983 Sheet #1 only
AP-34980 Sheet #1 only
AF-34982 Sheet #1 only
AP-35170 Sheet #1 only
826 7807 001
826 7887 001
B-67314
B-65503

813 6026 001
B-65555
842 3313 001
D-23127
837 9748 001
842 3276 001
852 5797 001

SPECIFICATIONS FOR FM-20B

Power Output:	20 KW
Frequency Range:	88 - 108 Mcs.
R.F. Output Impedance:	50.0 ohms
Output Fitting:	3-1/8" EIA Flange
Type of Oscillator:	Direct crystal controlled
Frequency Stability:	± 0.001%
Type of Modulation:	Phase Shift employing pulse techniques.
Modulation Capabilities:	±100 KC (±75 KC considered 100% Modulation)
Audio Input Impedance:	600 ohms
Audio Input Level:	For 100% modulation - +10 dbm, ±2 db.
Frequency Response:	Within 1 db of standard 75 microsecond pre-emphasis curve, or flat ±1 db, 50 to 15,000 cycles, whichever is desired (specified).
Distortion at 100% Modulation:	1% or less - 50 to 100 cps.
	0.5% or less - 100 to 10 KC
	1% or less - 10KC - 15 KC
Noise:	65 db below 100% modulation (FM)
	50 db below equivalent 100% (AM) modulation.
Harmonic Attenuation:	At least 80 db (ratio of any single harmonic to carrier).
Power Input:	115 V., 50/60 cps, 1 phase, 500W. demand.
	230 V., 50/60 cps, 1 phase grounded and neutral 5KVA demand 230 V., 50/60 cps, 3 phase 35 KW consumption at 20KW level

Tube Complement:

6 - 6AU6	2 - 4-400A
1 - 12AX7	1 - 6360
3 - 6J6	1 - 6AQ5
2 - 0A2	1 - 6080
2 - 6146	2 - 4CX10,000D
1 - 7025	3 - 6201

Silicon Rectifier Complement:

2 - S5019
2 - 66-3206
16 - 1N2071
152 - 50KN7

Maximum Altitude:	7500 feet
Maximum Ambient:	45°C
Size:	Width - 84" (less end bells) 87" (with end bells)
	Depth - 36-1/2"
	Height - 78"
Weight:	2600 lbs. (approx.) net.
	3200 lbs. (approx.) packed.

DESCRIPTION

The FM-20B is an FM Transmitter with 20,000 watts nominal power output, operating on one fixed frequency between 88 and 108 mcs. The operating characteristics exceed those required by the Federal Communications Commission for standard FM broadcast service. The Transmitter is designed for continuous broadcast operation and consists of Exciter Unit, two intermediate Power Amplifiers and the Power Amplifier.

Three cabinets are required to house the entire Transmitter. The dimensions are given on the Specification Sheet. The left cabinet houses two Intermediate Power Amplifiers, Control Panel, Exciter and the 3,000 volt Power Supply.

The center cabinet houses the Amplifier, a pair of 4CX10,000D power tetrodes, the blower and blower controls, the Power Amplifier filament transformer, and the motor driven variable transformer for the driver plate transformer.

The right cabinet houses the control panel, the 6500 volt plate supply, the 1500 volt screen supply, and the bias supply for the 20KW Amplifier. This cabinet houses all the relay equipment for starting and stopping the amplifier, and all overload and protection equipment that pertains to the Power Amplifier.

The M.6095 Exciter, used in this Transmitter, employs a phase shift modulator using pulse timing techniques and may be adapted to single or dual channel Multiplexing on a plug-in basis, with blank panel space provided for the addition of the Multiplex unit.

Approximately 4 watts are required from the Exciter to drive the first Intermediate Power Amplifier, which is a pair of 6146's, which in turn drives a pair of 4-400A's to a kilowatt output. These in turn drive a pair of 4CX10,000D's to a nominal 20KW output. From Exciter output to transmission line at 20,000 watts there are only three radio frequency stages. An important feature of this Transmitter is the lack of frequency multiplication, after the Exciter. This helps to eliminate spurious frequencies and improve tube life.

The driver, a nominal 1KW unit, uses a pair of 4-400A power tetrodes. The plate circuit consists of a 1/4 wave length shorted distributed open transmission line. The plate circuit is tuned by adjusting a grounded vane which changes the inductance of the plate circuit distributed lines, and thus the resonant frequency of the plate circuit. The output of the driver is coupled into the transmission line by means of an inductively coupled loop. Less than 400 watts is usually required from the driver for a 20KW output from the final Amplifier.

The final amplifier employs a pair of 4CX10,000D power tetrodes, in a push-pull grounded cathode type circuit. These tubes are conservatively rated at the 20KW output level. The plate circuit consisted of a distributed shorted 1/4 wavelength line. This line is tuned by pivoting a shorting bar at one end to change the electrical length of the line.

The output circuit consists of an inductively coupled balun which is rigidly mounted in the amplifier enclosure and is at d.c. ground at all points. The output loading is adjusted by means of a vacuum capacitor across the output balun.

The tube socket is of a special design for VHF frequencies. The RF by-passing for filaments and screens is built into the socket.

At the output of the amplifier there is the micro-match unit, which is used to meter the r.f. power of the transmitter and to indicate the standing wave ratio of the transmission line.

This output is connected directly to a low pass filter that substantially eliminates the second and higher order harmonics. The filter is 6-1/8" transmission line with distributed filtering elements inside. The output of the filter is fitted for a 3-1/8" E.I.A. flange. The filter is supplied as part of the transmitter and is tuned to the customers frequency at the factory.

All power supplies in the FM-20B use silicon rectifiers. All voltage supplies in the Amplifier are separate and adjusted and operated independently for optimum amplifier operation.

All power supplies are protected by primary circuit breakers or fuses and the secondary of each power supply is protected by d.c. relays in the secondary return.

The high voltage plate supply is a 3 phase, full wave bridge configuration with a choke input. This supply is rated at 6500 V. d.c. at 5 amps. For preliminary testing this supply can be switched to about 3200 volts.

The screen and grid bias supplies for the Amplifier are single phase full-wave bridge configurations. The screen supply is rated at 1500 volts at 500 ma. Both of these supplies can be adjusted from the front panel of the power cabinet.

The driver plate supply is a single phase full-wave type of design with a double section choke input type of filtering.

This supply is variable by means of a motor driven variable primary transformer and is controlled from the front panel of the P.A. power cabinet. This supply is capable of about 3000 volts at 500 ma. The 20KW Power Amplifier and the Intermediate Power Amplifier are totally enclosed, both tubes and components, in a non-ferrous type housing. Air from individual blowers cool both tubes and parts.

The P.A. tubes are air cooled by pressurizing the area below the anode and leaving a space above the anode to the ambient air pressure of the room. A blower mounted in the base of the amplifier cabinet is capable of supplying enough air for operation up to 7500 feet, and ambient air temperature up to 45°C and 50 cycle operation. Air enters the cabinet through a filter at the back of the cabinet and is then blown past the grid seal, screen seal and out through the radiating fins of the anodes and is exhausted through the top of the amplifier cabinet. Complete air cooling of all parts of the tubes and components associated with the power amplifier is accomplished in this manner. It will be noticed that the blower is ducted directly through the back of the cabinet and all air intake for cooling the final tubes is taken through a filter, so that all air cooling the final amplifier cabinet is fresh filtered air. A disposable type filter is used. In case the disconnect box supplying power to the transmitter would open, there is enough inertia in the blower itself to cool the tube down to a safe value, and there is no need to worry about heat rising within the tube, thus causing overheating of any of the tube seals. Of course, standard practice would be to shut down the blower with the off delay relay and let it run for approximately three minutes after the transmitter, itself, is shut down.

Metering of all important stages is accomplished with meters located on the sloping panels at the top of the two end cabinets. Metering of the P.A. consists of filament voltmeter, and a switched multimeter for total grid current and individual screen currents,a switched total and individual plate current meter, a plate voltmeter, and a switched power output and VSWR meter.

Also located on the front panel of the power cabinet are meters for screen voltage and grid bias voltage.

Similar meters are on the driver cabinet to determine driver operation.

The control panel for the driver portion of the FM-20B is located in the first cabinet. This panel consists of the off-on switches for the line, and the off-on switch for the driver plate voltage, and various indicator lights, the "local-remote"switch, and the "tune-operate" switch. The control panel for the power amplifier is in the right cabinet and consists of the "off-on" switch for the power amplifier plate supply, a switch for filament voltages, a switch for grid and screen currents, a switch for plate currents and the various lights indicating the operation of the amplifier.

All over current and under current relays in the FM-20BTransmitter are telephone type relays. The plate overload of the driver and the plate and screen overload of the amplifier along with the grid over drive relay in the amplifier control circuit are in a "locked out" type of circuit and after experiencing an overload these overload relays must be reset before plate voltage can again be applied.

Mechanically, the FM-20B has been designed to be easily maintained. Ready accessibility to all parts is accomplished by lift off type doors. The sides for both cabinets may be easily removed by removing two screws from the holding bracket at the bottom of the side panels and the side panels lifted off.

The use of drop down front panels in the amplifier and P.A. power cabinet also increase the accessibility of components mounted on the bottom of the cabinets from the front of the transmitter.

Another feature is a swing-out panel in the P.A. power cabinet. By removing the end bell, the swing-out panel is free to open. In doing this, maintenance from the side is also possible.

The control panel located in the power cabinet is also hinged and is free to drop down. This completely exposes all metering circuits, overload relays, and switches so that it is possible to service from the front.

The meter panel for both the driver and the power amplifier are hinged and may be lifted up by first loosening the fastener one-quarter turn using a screwdriver or coin, and then lifting the meter panel up. This will give access to meter terminals and wiring of the Reflectometer or Micro-match switching section. The control circuit of the 20KW Amplifier is dependent on the control circuitry of 1kw driver. If for any reason the 20KW becomes inoperative, the driver can be connected to the transmission line and operated independently of the 20KW Amplifier.

INSTALLATION

In advance of actual placement and adjustment of the transmitter, certain preliminary planning should be done. The use of the floor plan drawing will assist in locating the power and audio inputs and power output of the transmitter. Power audio leads for the transmitter may be brought in through a trench provided under the transmitter if a concrete floor is used. If this is impossible a framework of 2 x 4's or 4 x 4's may be made to set the transmitter on.

Leads from a low reactance power sources of 240 volts, 50/60 cycles, 3 phase with a 60 KVA capacity, also 230 volts, 50/60 cycle, single phase grounded neutral with a 5KVA capacity, and 115 volts, 50/60 cycles with a 500 watt capacity should be placed underneath the proposed transmitter location or platform. These wires should be in agreement with local electrical codes and which would be practical to carry the current of the transmitter.

Running of the power leads inside a steel conduit is highly recommended to obtain both audio and radio frequency shielding near the transmitter.

To assist in keeping RF currents in nearby audio equipment to a minimum, a good ground at these frequencies is mandatory. One of the best known methods of doing this is the installation of a sheet of copper or a ground system beneath the complete transmitter layout. RF usually shows up in one of two ways, feedback or high noise, or both. It should be pointed out that even a small amount of unshielded wire makes a very efficient antenna at FM frequencies, for transferring RF to the grids where it is rectified and passed on as noise and feedback. It is preferable to have a single common ground point from the transmitter copper shield to a good ground.

Since heat is developed in the transmitter, it will be necessary to provide a means of exhausting air expelled through the top outlets of the unit to the outside. An air duct leading to the outside should be provided, and provisions made for utilizing this heat in the winter if desired. There are several kilowatts of heat dissipated, and if allowed to recirculate back through the transmitter, the forced air cooling will become very inefficient and can cause damage to tubes and other components. The duct work where the transmitter is used should not introduce any back pressure.

UNPACKING AND READYING FOR OPERATION

The FM-20B is carefully checked and packed at the Gates plant to assure its safe arrival at its destination in proper mechanical and electrical condition.

Tests of many different kinds are made at the factory, and the unit is operated for several hours on the customer's operating frequency to assure correct adjustment of proper operating conditions.

Immediately after the FM-20B has been received and unpacked it should be carefully checked for mechanical damage. If damage is noticed in any section of the equipment a claim should be filed immediately with the delivery transportation company and the necessary replacement parts ordered from the Gates Radio Company.

It is good precautionary practice to completely go over the equipment to check for loose connections, loose components, broken insulators, etc., that might have become loosened or damaged in shipment. Make sure all relay contacts are free and in good mechanical operation. Make sure all mechanical connections are tight. The power contactors are either tied down or blocked sufficiently to keep them from vibrating during shipment. These should be checked and the shipping material removed. A good overall visual inspection may save much time later in actual trouble getting the transmitter to operate correctly.

Certain parts of the transmitter were removed for shipment and are packed separately to insure safe handling. These parts on the FM-20B have been kept to a minimum, and are mainly plug-in units, relay covers and heavy components. The tubes that are not clamped in for normal operation are also removed. Reference to the packing check list included in this book will list the items removed for shipment. As the components are removed, the wires connecting each component are numbered, or tagged, for replacement of these parts. Photographs are supplied to assist in the proper placement and orientation of these components that have been removed for shipment.

As the three cubicles of the transmitter are unpacked, and heavy transformers, chokes, etc. are unpacked, it will be noted that the components and wires that were connected to them have been marked. The high voltage plate transformer and heavy components in the right cabinet, that have been removed for shipment, should be installed in the cabinet before the first and second cabinets are finally bolted together for final installation. The heavy components in the driver cabinet, that have been removed for shipment, should be re-installed in their proper place before the first and second cabinets are bolted together. It will be noted that all inner cabinet wiring has been terminated on terminal boards which are directly opposite the adjoining cable. All that is necessary to connect the cabinets together is to connect the cable to the matching terminals on the terminal boards. The terminal board drawings which are included in the instruction book should be refered to in order to eliminate the possibility of errors in connecting the cubicles.

Particular attention should be noted of the wires that are connected to TB803, the main line input terminal board. If these wires are not connected in the proper phase relation the blower will run backwards. On first turning the transmitter on, this should be noted. If the blower runs backwards from the direction indicated on the blower housing, reversing any two wires will reverse the phase and cause the blower to run in the right direction. It should be well to note here that this blower, running in a backward direction will not supply sufficient air for cooling the amplifier tube, neither will there be sufficient air to close the air switch. Therefore, it will be impossible to energize the filament transformer for the amplifier filaments if the blower is running backwards.

THEORY OF OPERATION

When the low voltage "On" button, S502, is pressed on the 1KW control panel, contactor, K501, is energized. When K501 is energized, line voltage is applied to the cabinet fan, blower, primary to all filament transformers, the low voltage power supplies and the exciter power supply in the left cabinet. With the energizing of K501, K804 in the amplifier control cabinet is also energized. With the energizing of K804, the primary circuit is complete to K602, which is the blower off delay relay. Also, when K602 energizes, K601, which is the blower starting relay, will also energize. With the energizing of K601 the blower will start. As the blower comes up to speed, S605, which is the air switch, will close. With the closing of the air switch, the auxiliary filament contactor K806 will then close and complete the primary circuit to the P.A. filament transformer.

At this time all low voltage supplies, fan, blowers and tube filaments should be operating. This will be indicated by the lights on the control panels of the driver and the power amplifier.

If all of these lights are not on, high voltage to the driver or the amplifier can not be applied.

This condition will occur if these conditions are satisfied:

1. All door interlocks closed.
2. Grounding hooks in place.
3. Both air switches closed.
4. Voltage applied to the filament transformers.
5. Grid bias developed in the driver.
6. Sufficient fixed bias developed by the P.A. supply.

Because of the nature of this control circuitry, all functions in the driver must be complete before any indications occur on the P.A. control panel.

With the closing of S506 the high voltage "on" button on the 1KW control panel, K503 is energized and both plate and screen voltages are applied to the driver. With the pressing of S704, the high voltage "on" button on the power amplifier control panel, K805 is energized and plate voltage is applied to the power amplifier.

Voltage is then applied to CR801. This voltage is rectified and operates a slow-operate relay K802. This relay then closes and energizes an auxiliary relay K801. When this occurs the main contactor, K808, coil circuit is completed and full line voltage is applied to the plate transformer, T801.

At the same time K801 completes the circuit to T802 and screen voltage is applied to the amplifier. This step-start technique eliminates much of the transients which occur on starting.

S801, which is the high-low switch, switches the input to the filter from the output section of the rectifiers to the center tap of the plate transformer, thus giving half voltage output which is useful in initial tune-up and primary checking of the transmitter.

A micro-match is used as an indicating or sampling device for the RF output and is also used to indicate the match to the transmission line and the antenna. The Micro-match in the driver and the Micro-match in the amplifier are the same in their operation, the only difference being the power handling capabilities. The Micro-match unit in the 20KW output is modified to the extent of placing a sampling loop in the output end, and this loop can be used for monitoring. It is also used for remote output metering for remote control operation.

Since the power contactors are non-circuit breaker type and require a momentary "on" and a momentary "off" type of function to energize them, the transmitter is easily remote controlled.

To facilitate easier remote control application the off-on functions of the transmitter have been brought out to terminal boards.

To Multiplex the Gates FM-20Bis relatively a simple matter. The main channel Exciter in the driver side was specifically designed with Multiplex in mind. Space has been provided directly below the Exciter for the placing of the Multiplex unit. A minimum amount of connections are necessary to connect this unit to the main channel exciter. Connections necessary are the coax connectors to the Multiplex exciter in the Multiplex chain. This is done on the front panel of the two units. Other connections necessary are power from 115 volts source. This can be taken off of 115 volt terminals of the main channel exciter and the connecting of the audio to the terminal board on the Multiplex unit completes the necessary wiring. The Multiplex unit is capable of handling two sub-channels and, therefore, there are two audio input terminal arrangements available on the terminal board of the Multiplex unit.

INITIAL OPERATING AND TUNE UP PROCEDURE

Before attempting to tune up the transmitter, make sure it is connected to the transmission line and antenna that will present a load of a nominal 50 ohms, or a non-reactive dummy load with the proper power handling capability. At this time, reference should be made to the Factory Test Data Sheets and all controls and adjustments set to the readings given. Before actual tune-up begins, the tube data sheets included in this instruction book should be carefully studied and compared with the factory test sheet. In general these ratings are maximums and should not be exceeded under normal operating conditions.

Inserting 4CX10,000D into sockets:

1. Pick up tubes by handles.
2. Carefully align the tube so that it is directly over the plate line contact ring.
3. Carefully contact the anode radiator with the plate contact ring.
4. Continue lowering the tube into the socket.
5. When the tube has made contact with the filament contact rings, a gently downward thrust will set the tube in place.
6. When the tubes have seated, the tube should be rocked slightly to insure that all contact surfaces have mated.

DO NOT AT ANY TIME twist the tube into the socket.

Before applying any high voltage it is recommended that an ohmmeter check be made of all power supplies to see that they have not become grounded by accident. The supplies will read about 100,000 ohms once the filter capacitors have charged.

After the installation is complete, all input and output cables have been connected and the crystal operating for a couple of hours or more, primary power may now be applied. Before applying primary power, the switches on the driver control panel should be in the following position. S518, which is a local-remote switch, should be in the local position. The tune-operate switch, S519, which is used in conjunction with the automatic recycle unit should be in the tune position. Next, press the low voltage "on" button on the driver control panel. This applies all primary power to the complete transmitter. At this time it is well to check the rotation of the main blower in the #2 cabinet to make sure the blower is running in the right direction.

As previously mentioned, if the blower is running backwards change any two of the three phase wires on TB803 to change rotation of the blower to the right direction.

Check P.A. filament voltage and adjust filament voltage with powerstat, T803, to read 7.5 volts as read on the filament voltmeter of the amplifier, M801. Next, place switch, S801, which is the high voltage-low voltage switch of the amplifier in the low voltage position. Next, reduce the driver plate voltage by depressing button marked "lower" on the amplifier power cabinet control panel.

This powerstat will be set to nearly maximum on receipt from the factory. It requires approximately 15 seconds for the motor driving the powerstat to take the powerstat from full maximum to minimum. Depress button marked "lower" for approximately 15 seconds, or until "Low "Limit" light operates. The powerstat should then be at minimum. Then depress the "Raise" button for approximately 4 seconds. This should give 600 to 700 volts on the driver as read on the driver plate voltmeter, when the driver high voltage switch, S506, is depressed.

Provision is made on the first IPA driver stage for metering the grid bias voltage of the IPA driver by means of a test point on the panel. A meter such as a Simpson Model 260, or equivalent, may be used. With negative meter lead plugged into this test point and the positive lead on ground, a rise in grid voltage will be observed as the Exciter comes up to operating temperature. This is a good check on the exciter operation.

Place the switch, S512, which is a test meter switch located on the bottom center of the driving amplifier panel, in the grid position or extreme counterclockwise. If the exciter and IPA are functioning properly, about 20 ma, of driver grid current will be indicated. If this is not the case a bit of trimming of the previous tuned circuits will be necessary. When this has been achieved initial tuning can proceed.

When originally checking the driver portion of the FM-20B care must be exercised in keeping the driver plate voltage to a low setting. High plate voltage on the driver will result in excessive screen current due to rectified grid voltage on the amplifier.

Press the high voltage "ON" button, on the driver control panel, and immediately check the plate voltage on the driver. Adjust as necessary for 700 to 800 volts of plate voltage on the driver. Increase the plate voltage on the driver to about 1,000 volts and check driver plate resonance with control marked "plate tuning." At this time P.A. grid current will be indicated. There should be about 50 MA. depending on how much drive is applied and how much fixed bias is being used. It may be necessary at this point to reduce the fixed bias to about 200 volts. The grid tuning control to this time may need to be trimmed for maximum grid current.

Before pressing high voltage "ON" button on the amplifier control panel, reduce the amplifier screen voltage, as controlled by powerstat, T804. Press high voltage "ON" button on the amplifier control panel. Reduce screen voltage to approximately 400 volts. It is best at this point to set the screen grid cirrent switch, S702, which is located on the amplifier control panel to the screen current position and monitor screen current as the transmitter is progressively tuned.

Increase the driver plate voltage in steps to approximately 2,000 volts. This should give approximately 6 kilowatts output on the amplifier. Check tuning of the final amplifier with the control marked "Plate tuning". It will be noted that when tuning the amplifier plate circuit, the best indication will be obtained by watching the output meter, as the amplifier is quite heavily loaded and plate current dip is slight. This is in accordance with operating characteristics of tetrodes. They should be operated in a heavily loaded circuit.

It will be noted that the output loading or output coupling control has a great effect on the power output. This control should be adjusted at a point where maximum power and minimum screen current occur simultaneously. This will not be the point where a possible minimum screen current could occur.

This control should be trimmed for maximum power output every time the amplifier operating characteristics are changed on initial tuning.

It is well to note here that the tuning of an FM Transmitter in the frequency range of 88 to 108 mcs offers greater difficulty in regard to tuning various circuits than is normally encountered on the lower AM frequencies. This results in greater reaction between various circuits caused by small inductance and capacitive reactances that can be normally ignored at lower frequencies, but which can become increasingly important at these high frequencies. Therefore, when tuning a high frequency transmitter it is well to constantly recheck the previous adjustment as tuning progresses.

If all of the above conditions exist and all seems normal you are ready to go to full plate voltage on the amplifier with full power output.

First, turn the driver plate voltage off and the amplifier plate voltage off. Next, place the 6500/3000 volt switch to the 6500 volt position, then turn the amplifier plate voltage on and the driver plate voltage on. Increase the amplifier screen voltage to about 800 volts. Increase driver plate voltage to the amount required to obtain 20KW output. A slight amount of retuning may be necessary on the grid of the amplifier to obtain maximum grid current in conjunction with minimum VSWR between stages. The plate tuning of the amplifier may also have to be adjusted slightly for minimum plate current in conjunction with 20KW of output power. Again, check the driver plate circuit for resonance by adjusting control on the driver panel marked "plate tuning".

At this time a check of the match between the driver and the amplifier grid should be made. The grid tuning control C618 and C619 should be adjusted for maximum grid current and the grid loading control C620 adjusted so that maximum grid current and minimum VSWR occur simultaneously. A VSWR of 1.1-1.4 is normal.

The transmitter should now be operating normally.

Each installation has different conditions where the Transmitter works best because of transmission line and antenna characteristics. A careful trimming of the amplifier should be made. These are the conditions which should be strived to achieve:

1. Minimum drive to the driver and amplifier grid for a given output power.

2. Plate circuits tuned to resonance, (Tetrodes which are heavily loaded, a plate current dip is very slight).

3. Plate and screen dissipation at a minimum for a given power output.

4. Operation of amplifier with as much fixed bias as necessary without reducing the power output or excessive drive requirements for a given operating point.

5. Output loading control trimmed for maximum loading conditions.

6. Minimum VSWR between driver and amplifier.

If a reduction in power output is desired this can be done by lowering the screen voltage and reducing the drive. The amplifier should then be reloaded for this new operating point. Under no conditions should the power output of the amplifier be reduced by unloading the amplifier.

NEUTRALIZATION

DRIVER

The driver has been properly neutralized at the factory on the customer's frequency. Due to rough handling during shipment neutralization may be affected. Improper neutralization is indicated by several abnormal conditions showing up in the operation as follows.

1. When the grid current does not rise to maximum with a dip in plate current as the amplifier plate tank is tuned to resonance.
2. If excitation is removed from the amplifier and the P.A. grid relay does not open. This indicates oscillation in the power amplifier. This self oscillation produces grid current which holds the relay, K506, closed; thus, keeping the plate voltage applied allowing the amplifier to continue in self oscillation.
3. If the balance control, R504 and R505, do not enable tube plate currents to maintain a balance within 10%.
4. A radical change in grid current from the value given on the Factory Test Data Sheet.
   The neutralizing controls for the driver have been brought out to the front panel of the driver to a special machined bushing. In the center of this special bushing is a shaft for the machined screwdriver slot. It will be noted that on both the special bushing and the internal screwdriver shaft there are two black dots. These two dots are aligned in a vertical position and the neutralizing capacitors are of maximum capacity. It will also be noted that on this special machined bushing is a red dot, which will appear directly opposite the black dot on the moveable portion of the shaft. This red dot on the special machined bushing indicates the location of the neutralizing capacitors as they were set at the factory. These marks will serve as a good starting place if complete re-neutralization is necessary. These neutralizing capacitors are locked in place with a locknut on the rear of the capacitor shaft.

If any of the aforementioned conditions are observed when the unit is first placed in operation, this indicates that reneutralization is in order. This is accomplished as follows:

1. Remove the bottom cover from the P.A. tank.
2. Loosen the locking nuts on the rear of the neutralizing capacitors slightly, so the shaft will turn free with a slight drag on the shaft.
3. Remove one of the plate caps from the high voltage rectifier.
4. Replace the bottom cover on the amplifier tank.
5. Apply low plate voltage and adjust either C303 or C308 in one direction and again check for neutralization.
6. If improvement results, adjust the other capacitors the same amount in the same direction and again recheck for neutralization.
7. Continue this procedure step by step rotating capacitor C303 and C308 in the direction that indicates proper neutralization.
8. Replace cap on high voltage rectifier for normal operation and recheck neutralization.
9. Remove the bottom cover of the amplifier tank and retighten the locking nuts on the rear of the neutralizing capacitors, being careful not to move the adjustment when these locknuts are retightened.

AMPLIFIER

The amplifier also must be neutralized for proper operation. Improper neutralization is indicated by possible self-oscillation and great fluctuations of grid current as the plate tuning and loading controls are adjusted through plate resonance.

To eliminate this condition:

1. Remove amplifier tubes from their sockets.
2. Loosen hardware securing neutralizing capacitor plates C624 and C625, and move capacitor plates simultaneously either toward the tube or away from the tube.
3. Secure hardware, install tube, and turn on driver but do not apply plate voltage.
4. Tune grid circuit to resonance.
5. Tune plate circuit through resonance and watch for abnormal reflections into the grid circuit.
6. Repeat the previous 5 steps until minimum interaction and grid current fluctuations occur.

Another possible method of neutralizing is to couple a sensitive R.F. metering device into the Amplifier Transmission line output. This can be done in the following steps:

1. Couple the RF device into the transmission line.
2. Turn on the low voltage filaments and apply grid drive but do not apply plate voltage.

3. Tune plate to resonance for maximum meter indication.
4. Tune grid to resonance.
5. Adjust neutralizing capacitors for a minimum feed-thru of R.F. power.

AUTOMATIC RECYCLE OPERATION

With the transmitter operating properly, all that is necessary to place the transmitter in automatic recycle operation is to place the "tune operate" switch in the "operate" position. This places the recycle unit into the transmitter's control circuit.

The recycle unit is described in a separate series of instructions which is a part of this instruction book. The following will take a typical transmitter malfunction and trace its operations:

1. The P.A. amplifier plate circuit experiences an overload. Relay K708 energizes and locks closed. At the same time the plate overload indicator light will be extinguished.

2. The primary auxiliary overload relay, K3 in the recycle unit, is energized by the contacts of K708 closing, which perform three functions.

   a. It breaks the 240 volts a.c. circuits to the high voltage contactors, K503 and K805 in the driver and power amplifier control circuit.
   b. It applies 117 volts a.c. to the time delay relay, K4, in the recycle unit.
   c. It also applies 120 volt d.c. to R1 in the recycle unit, which starts the recycle sequence.

3. After an elapsed time of approximately 3 seconds, relay K3 again opens. The overload relay which was previously locked down and K708 also opens and relay K2 closes, which in turn energizes the high voltage contactor coils. If the overload is still present the same sequence of operation will be again performed. This will happen a total of three consecutive times, after which the transmitter will remain off until it is reset and the overload cleared.

With the "tune-operate" switch in the "operate" position, the following is the sequence of operation.

With the application of plate voltage on the driver, drive is applied to the amplifier.

With the application of drive to amplifier, K702, the grid under drive relay is energized. With the energizing of K702 one set of contacts in this relay complete the coil circuit to K703, an auxiliary relay. When this relay closes, its contacts complete the coil circuit to K805, which is the HV contactor. K805 closes and completes the primary circuit to the HV plate transformer; thereby, applying voltage to the amplifier.

GENERAL INFORMATION

There are some facts about the driver which should be known and remembered that will help in operation of the equipment and contribute to better operating results.

1. Tuning of the plate circuit changes the effective electrical length of the plate tank. Increasing the spacing between the tuning vane and the plate tank line lengthens the effective length of the plate line and lowers the frequency. Conversely, decreasing the spacing will raise the frequency.

2. Switch, S510, located on the driver panel in the lower left hand corner is provided for checking individual cathode currents of V301 and V302.

   The balance control, R504 and R505, is provided on the front panel to enable the operator to maintain a balance of plate currents. When S510 is in mid position the meter, M503, is reading total plate current of V301 and V302.

   The sum of plate currents as indicated by switching S510 either left or right of the mid position is not equal to the total plate current as indicated on M503 when this switch is in the mid position. When S510 is switched either left or right of mid position, the meter is reading cathode current of that particular tube. The switch must be left in the normal or mid position while the transmitter is operating except on initial tune up or for checking balance between tube plate currents.

   S512 is a multi-meter switch, which is used to read either total grid current or individual screen currents of the driving amplifier tubes.

   Protection against electrical shock, from high voltage circuits, is provided for by door interlock switch, S514. When the back door is removed, S514 will open and immediately remove the high voltage from the amplifier. When S514 opens, relay K502 is de-energized and opens the holding circuit on K503. Therefore, removing the primary plate voltage from the high voltage transformer.

These are some facts about the amplifier which will contribute to better operation.

1. The amplifier control circuits are dependent on the driver.

2. There are, basically, two distinct systems. One series of circuits in the driver and the amplifier are for interlocks, air switches and grid bias functions. Because of the nature of the system, all functions must be complete and satisfied in the driver before indications can occur in the amplifier.

3. The other control circuits have to do with driver and amplifier overload functions. When an overload occurs, the associated relay closes. When this occurs, three events happen -

   a. The indicator light is extinguished.
   b. 110 V. d.c. applied through R708 holds the relay closed.
   c. The contacts of section A of the relay complete the circuit to the recycle unit.

If the "tune-operate" switch is in the tune position, the relay which has experienced the overload must be de-energized by pushing the manual reset button.

If the transmitter is in the operate position, the transmitter will recycle and try to turn itself on.

The filament voltage on the amplifier will change with output power. This is because of power line loading. The filament voltage during operation should be maintained at 7.5 volts.

The balance control, R806, has an effect on the individual grid bias voltage and is used to adjust the plate and screen currents to similar values.

These currents should be within 10% so that there is somewhat equal dissipation of each tube.

The grounding hooks which are a part of the transmitter should be used when making repairs and adjustments on the transmitter. These devices must be returned to their hook before the transmitter is operated because this is part of the interlock system.

REMOTE CONTROL FACILITIES

To remote control the FM-20B, three remote control functions will be required. These are:

1. The fail-safe control function required by the FCC.

2. A momentary "off", momentary "on" function required to turn the driver plate voltage off and on.

3. A raise-lower function for controlling the motor that is used to drive the plate voltage powerstat.

The first two remote control functions are terminated on TB503 in the driver portion of the FM-20B transmitter. The third, raise-lower function is terminated on TB604 in the amplifier cabinet.

Six metering functions have been provided, these are driver plate voltage and current, and amplifier plate current and voltage, filament voltage and RF output. The metering functions of the driver are terminated on TB503. The metering functions of the amplifier are terminated on TB604.

RESETTING OVERLOAD RELAYS BY REMOTE CONTROL

K507 is the remote overload relay reset and is connected to a 6 V. d.c. source from one of the stepper positions on the remote control unit. All that is necessary to reset the overloads remotely is to dial through the position, on the stepper relay, to which K507 is connected.

CONNECTIONS FOR USING GATES RDC-10C REMOTE CONTROL UNIT

RDC-10C	TB503	DRIVER
	1	
TB3-31	2	Filaments On
TB3-32	3	
TB5-2	4	Plate Off
TB5-1 TB3-29	5	N.C.
TB3-30	6	Plate On (N.O.)
TB2-5	7	Remote Plate Cur.
TB2-6	8	Remote Plate Voltage
	9	
To Stepper Position to Reset Overload-Relays	10	K705 Remote Reset Relay

Jumper TB5-1 to TB3-30
Jumper TB604-13 to ground

RDC-10C	TB604	AMPLIFIER
TB2-1	7	Remote Plate Current
TB3-25	8	Transmitter Ground
TB2-2	9	Remote Plate Volts
TB2-3	10	Remote RF Output
TB2-4	11	Remote Filament Volts
	12	Not Used
	13	Not Used

RDC-10C	TB604	AMPLIFIER
TB3-26	14	Raise function
TB3-28	15	Lower Function
TB3-27	16	Common
TB3-17	17	6V. Stepper relay position
	18	Ground
	19	
	20	110V. a.c. from Driver

Studio Unit RDC-10C

Position #2	P.A. Plate Voltage
Position #3	P.A. Plate Current
Position #4	P.A. Power Output
Position #5	P.A. Filament Voltage
Position #6	Driver Plate Voltage
Position #7	Driver Plate Current

REMOTE CONTROLLING THE GATES FM-20B

1. Connect the two wires from the fail-safe relay in the remote unit betwee n TB503-2 and TB503-3.

2. Remove jumper between TB503-4 and TB503-3.

3. Connect the momentary "on" function to these two terminals for plate off.

4. Connect two wires from remote unit to TB503-5 and TB503-6 for momentary plate on function.

5. Place "local-Remote" switch in "Remote" position.

6. Place "Tune-Operate" switch in "Operate" position.

7. Connect "Raise-Lower" function relays between 14,15 and 16 on TB604 with TB604-16 common.

8. Connect interlocking voltage to TB604-17.

9. Connect remote P.A. plate voltage meter to TB604-9.

10. Connect remote P.A. plate current meter to TB604-7.

11. Connect remote P.A. RF output meter to TB604-10.

12. Connect remote P.A. filament volts to TB604-11.

13. Connect remote driver plate voltage meter to TB503-8.

14. Connect remote driver plate current meter to TB503-7.

MAINTENANCE

Maintenance of the FM-20B should consist of periodic checking of tubes, cleaning, visual inspection and lubrication where required. The use of air filters materially assist in keeping the transmitter interior clean; however, often periodical removing of dust will still be necessary. Since electrostatic fields create "dust catchers", attention should be paid to these places. Support insulators in the tank are probably the worse offenders. They must be kept clean and free of all foreign material at all times. Not to do so may result in arcing and shattering of the insulators.

Particular care must be taken to remove dust from the high voltage feed through capacitors in the amplifier. These capacitors should be cleaned both inside and outside of the amplifier enclosure. This part is probably the most critical in the high voltage wiring because of its nature to attract small particles of dust.

The teflon deck which acts as an air chimney for the tubes, should also be wiped clean.

The underside of this deck should also be kept clean. The removal of the tubes will be necessary for this operation.

When inspection of air filters discloses dirt or foreign material, they should be discarded and replaced with new ones. The type of filter used in the FM-20B is a disposable type filter and may be replaced at most any local hardware or heating supply store.

Once a month the entire transmitter should be cleaned of dust. In the same case of the power amplifier, open the back door of the enclosure and thoroughly wipe it clean of dust after checking for HV present. In the case of the driver amplifier, the back door is removed by loosening six Lion fasteners, the interior of this amplifier should also be wiped clean of dust.

The protective relays should have the dust cleaned out as required and contacts burnished with a burnishing tool. These relays are protected with dust covers and are telephone type relays and should require little attention.

The contact areas of the shorting bar in the plate line assembly should be lubricated occasionally with a silicon base lubricant. This will make for easier tuning and reduced wear. The moving parts in amplifier should also be lubricated for the same reason.

The bearings for the blower of the motor for the P.A. are sealed bearings normally giving long trouble free operation.

They are lubricated for approximately 20,000 hours of operation. If for any reason the transmitter is inoperative for long periods of time the grease in these bearings should be changed. This is done by taking the drain plug out of the bottom of the bearing and a grease fitting should be attached to the upper plug on the bearing and new grease applied until the new grease runs out of the drain plug at the bottom. In the case of the blower in the driver portion of the transmitter it should require a periodic drop or two of oil in the oil cups provided. The exhaust fan in the driver and amplifier have sealed bearings and require no lubrication.

This transmitter is a precision electrical device and as such should be kept, at all times, clean and free of dust or foreign material. Dust shortens the life of many components due to flash-overs, arcs, etc. which damage same. Also, dust and moisture condensation will lead to possible arc overs and short conductive paths and possibly reduce the efficiency of the amplifier.

A small brush and a soft rag can be used very effectively in keeping the equipment clean.

A good preventive maintenance schedule will provide best assurancefor trouble free transmitter operation.

PARTS LIST

1KW TRANSMITTER CABINET

Symbol No.	Drawing No.	Description
B501	430 0002 000	Fan, 115V., 50/60 cy. 1500 RPM, 650 cfm.
C501,C502	510 0246 000	Cap., 4.0 mfd., 5000 V.(W)
F501,F502	398 0186 000	Fuse, 30 amp., 230 V.
L501,L502	476 0105 000	Choke, 10 Hy.
R501	552 0405 000	Rheostat, 15 ohm, 150 W.
R502,R503	540 0618 000	Res., 2000 ohm, 2W. 5%
R504,R505	552 0721 000	Rheostat, 2 Section in tandem, 300 ohm per section
R506,R507, R517	542 0056 000	Res., 20 ohm, 10W.
R508	542 1051 000	Res., 2.5 ohm, 10W.
R509	550 0029 000	Control, 10K ohm
R511	548 0004 000	Res., 5 meg. meter multiplier
R513	542 0565 000	Res., 100K ohm, 190 W.
R510	550 0067 000	Control, 10K ohm
S509,S511	600 0162 000	Switch, rotary
S510	600 0302 000	Switch, 1 section, 3 circuit 5 position
S512	600 0280 000	Switch, Rotary
S513	604 0086 000	Air Switch, close at .25", open at .1" water column
S514	604 0061 000	Interlock Switch
S516	926 6665 001	Interlock Switch and Grounding Hook Assembly
T301,T302	472 0111 000	Transformer, P.A. Filament
T501	472 0307 000	Transformer, Power
TB501	614 0047 000	Terminal Board, Audio
TB502,TB517	614 0092 000	Terminal Board, 115V. A.C. and FM-10A jumper
TB506	614 0052 000	Terminal Board, Contactor Panel
TB507	614 0046 000	Terminal Board, Fan
TB510	614 0100 000	Terminal Board, Contactor Panel
TB511	614 0093 000	Terminal Board, Powerstat FM-10A
TB514	614 0046 000	Terminal Board
XF501	402 0015 000	Fuse Block

METER PANEL

Symbol No.	Drawing No.	Description
M501	630 0049 000	Meter, Fil. Volt 3-1/2" 0-10V. AC (non-magnetic panel)
M502	632 0074 000	Meter, PA Grid Current, 3-1/2" 0-50 MA DC (non-magnetic panel)
M503	632 0026 000	Meter, PA Plate Current, 3-1/2" 0-1 Amp. DC (non-mag. panel)
M504	632 0148 000	Meter, Plate Voltage, 3-1/2" 0-1 MA DC movement w/0-5000V. DC Scale (non-magnetic panel)
M505	913 1256 001	Meter, R.F. Output
C503,C504,C505 C506,C507	516 0082 000	Meter By-Pass Cap., .01 mfd., 1KV

DRIVER AMPLIFIER TANK

Symbol No.	Drawing No.	Description
B301	432 0026 000	Blower, 115V. 50/60 cycles,CCW
C303,C308	520 0091 000	Cap., Variable, 50 mmfd.
C304,C305, C306,C307	516 0204 000	Cap., 100 mmfd., 5000 V.(W)
C311	520 0249 000	Cap., Variable, 20 uuf.
C312	516 0233 000	Cap., 500 mmfd., 30 KV.
C313,C314		Neut. Padding Condenser (Det. by Freq.)
DC501	620 0034 000	Micro-match, 0-1200 W. 50 ohm
J301	612 0232 000	Receptacle "N"
J302	612 0230 000	Receptacle "UHF"
L301	813 1281 001	Plate Choke
L302,L303, L306	494 0004 000	Choke, 7 Microhy.
L304	813 1532 001	Input Grid Coil
L305	813 1531 001	Input Coupler Coil
L309	926 5524 001	Plate Line Assembly
L310	813 1060 001	Output Coupling Loop
L311	910 9741 001	Monitor Loop Assembly
R301,R304, R305	542 0728 000	Res., 100 ohm, 2W. 10%
R306	542 0085 000	Res., 3500 ohm, 10W.
R307	542 0088 000	Res., 5000 ohm, 10W.
R308,R309	540 0740 000	Res., 1000 ohm, 2W. 10%
R310	542 0316 000	Res., 2000 ohm, 20W.
TB301	614 0113 000	Terminal Board
TB302	614 0092 000	Terminal Board

Symbol No.	Drawing No.	Description
V301,V302	374 0010 000	Tube, 4-400A
XV301,XV302	404 0055 000	Socket

CONTROL PANEL

Symbol No.	Drawing No.	Description
A501,A505,A506, A507,A508	396 0105 000	Lamp, 14 V.
A503	396 0062 000	Lamp, Neon
R518,R519	540 0202 000	Res., 100K ohm, 1/2W. 10%
S502,S506	604 0067 000	Switch, Pushbutton, Black
S503,S507	604 0069 000	Switch, Pushbutton, Red
S517	604 0150 000	O.L. Reset Pushbutton Switch
S518,S519	604 0032 000	Toggle Switch, D.P.D.T.
XA501	406 0052 000	Pilot Light Assembly, Green
XA503	406 0051 000	Pilot Light Assembly, Red
XA505,XA506, XA507,XA508	406 0053 000	Pilot Light Assembly, Amber

CONTACTOR PANEL

Symbol No.	Drawing No.	Description
CR501,CR502	386 0015 000	Silicon Diode, 10 V.
K501,K503	570 0055 000	Contactor, 4 pole, 25 amp. 230V.
K502	574 0074 000	Relay, 6V. A.C., S.P.D.T.
K505,K506	572 0025 000	Relay, 2-C
K507	574 0014 000	Relay, 6V. D.C., S.P.D.T.
R514	542 0056 000	Res., 20 ohm, 10W.
R515	542 0085 000	Res., 3.5K ohm, 10W.
R516	550 0061 000	Control, 1K ohm, 2W.
R520,R521	550 0057 000	Control, 250 ohm, 2W.
T502	472 0112 000	Transformer, Rect. Fil.
TB503	614 0054 000	Terminal Board
TB504,TB505	614 0104 000	Terminal Board
TB513	614 0034 000	Terminal Board, O.L. Relay Deck
TB515	614 0092 000	Terminal Board
TB516	614 0094 000	Terminal Board
V501,V502	374 0027 000	Tube, 673
XV501,XV502	404 0121 000	Socket

PARTS LIST

M-5652A POWER SUPPLY

Symbol No.	Part No.	Description
C201,C202	510 0071 000	Capacitor, 8 mfd., 1000V. D.C.
F201	398 0015 000	Fuse, 1/2 amp., 250 V.
F202	398 0079 000	Fuse, Slo-Blo, 1-1/2 amp. 125V.
L201,L202	476 0017 000	Filter Reactor
R201	542 0163 000	Resistor, 100K ohm, 20W.
T201	472 0084 000	Filament Transformer
T202	472 0090 000	Filament Transformer
T203	472 0017 000	Plate Transformer
TB201	614 0076 000	Terminal Board
TS201,TS202	614 0189 000	Tie Point
TS203	614 0176 000	Tie Point
V201	374 0020 000	Tube, 5R4GYA
XF201,XF202	402 0021 000	Fuseholder
XV201	404 0016 000	Socket

M-5675 AMPLIFIER

Symbol No.	Part No.	Description
C401	520 0004 000	Capacitor, Variable, 2-19 mmfd.
C402	520 0194 000	Capacitor, 500 mmfd., 500V. Button Type
C403,C404,C405	516 0215 000	Capacitor, 100 mmfd., ±10%
C406	520 0115 000	Capacitor, Variable, 5-25 mmfd.
C407	520 0164 000	Capacitor, Variable, 2-15 mmfd.
C408,C409	516 0227 000	Feedthru Capacitor, 500 mmfd.
C410	516 0235 000	Feedthru Capacitor, 1000 mmfd.
C411	520 0112 000	Variable Capacitor, 2.2-21.5 mmfd.
J401,J402	612 0233 000	Receptacle
L401	813 1772 001	Grid Coupling Coil
L402	813 1762 001	Grid Coil
L403	813 1761 001	Grid Coil
L404	913 1774 001	Plate Coil Assembly
L405	813 1771 001	Plate Output Loop
L406	494 0007 000	R.F. Choke
L407,L408, L410,L411	494 0004 000	R.F. Choke
L409	813 0246 001	Filament Choke
L412	813 3607 001	Coil
L413	813 3608 001	Coil

Symbol No.	Part No.	Description
P401,P402	620 0122 000	Right Angle Adaptor, UG-27C/U
R401,R402	540 0482 000	Res., 15K ohm, 1W., 10%
R403	552 0058 000	Res., 500 ohm, 25 W. Adjustable
R404	540 0367 000	Res., 30K ohm, 1 W., 5%
R405	550 0073 000	Control, 100K ohm
R406	540 0748 000	Res., 4700 ohm, 2 W., 10%
R407,R408	540 0752 000	Res., 10K ohm, 2W. 10% (Used in FM-1B only
TB401	614 0096 000	Terminal Board
TP401	614 0345 000	Test Point Jack
V401,V402	374 0051 000	Tube, 6146
XV401,XV402	404 0016 000	Socket, Octal

M-6023 AUTOMATIC RECYCLING UNIT

C1	524 0091 000	Cap., 200-200 mfd., 150 V.
CR1	384 0020 000	Silicon Rectifier
F1	398 0017 000	Fuse, 1 amp. 250 V.
K1	574 0020 000	Plug-in Relay, Double Pole
K2	574 0040 000	Relay, 115V. AC, D.P.D.T.
K3	574 0073 000	Relay, 6V. A.C. 3p.d.t.
K4	476 0019 000	Time Delay Relay, 115V. 10 Sec.
R1	550 0071 000	Control, 50K ohm, 2W.
R2	542 0135 000	Res., 1.5K ohm, 20W.
R3	540 0166 000	Res., 100 ohm, 1/2W. 10%
R4	540 0724 000	Res., 47 ohm, 2W. 10%
R5, R6	540 0752 000	Res., 10K ohm, 2W. 10%
T1	472 0208 000	Isolation Transformer
T2	472 0090 000	Fil. Transformer
TB1	614 0034 000	Terminal Board
XCR1	402 0017 000	Rectifier Mounting, 1 pole
XF1	402 0021 000	Fuseholder
XK1,XK4	404 0016 000	Octal Socket

POWER AMPLIFIER CENTER CUBICLE

Symbol No.	Drawing No.	Description
A1	384 0006 000	Diode
C1,C2	516 0054 000	Cap., .001 mfd., 1 KV
J1	612 0230 000	Receptacle, "UHF"
L2	494 0004 000	R.F. Choke, 7 microhy.
R1	552 0545 000	Control, 1000 ohm
R2	540 0178 000	Res., 1K ohm, 1/2W. 10%
R3,R4	540 0728 000	Res., 100 ohm, 2W. 10%
TB1	614 0069 000	Terminal Board
B601	432 0042 000	Blower, 1-1/2 H.P., 1750 RPM, 3 ph., 208/230V. 60 cy. C.W. Upblast
C601,C602,C603, C609,C610,C611		Cap., (Part of tube socket Assy.)
C604,C605	516 0082 000	Cap., .01 uf., 1KV
C607,C608	516 0206 000	Cap., 1000 uuf., 7.5 KV
C612,C613,C614, C615,C616, C617	913 5769 001	Feedthru Cap. Assembly
C618,C619, C620	514 0064 000	Var., Vacuum Cap., 3-30 uuf., 15 KV
C621	514 0015 000	Var., Vacuum Cap., 5-100 uuf., 15 KV
C622	516 0281 000	Cap., 500 uuf., 15 KV
C623	913 5768 001	Feedthru Cap. Assembly
C624,C625		Neutralizing Cap. (Part of mech. ass'y.)
CR601,CR602	386 0015 000	Zener Diode
DC601	937 8778 009	Micromatch & Coupling Loop Assy.
F601,F602	398 0186 000	Fuse, 30 amp., 250 V.
F603	398 0032 000	Fuse, 15 amp.
J601	612 0232 000	Receptacle
K601	570 0050 000	Relay, Magnetic,220V. 4 pole
K602	576 0060 000	Relay Pneumatic Timing 208-220 V., 60 cy.
L601	913 5767 001	Screen Choke Assembly
L602	913 5767 002	Screen Choke Assembly
L603,L604	494 0004 000	RF Choke
L605	826 7788 001	Fil. Choke
L606	826 7789 001	Fil. Choke

Symbol No.	Gates Part No.	Description
L607	826 7787 001	Fil. Choke
L608	826 7790 001	Fil. Choke
L609	926 7581 001	Grid Line Assembly
L610	926 7581 002	Grid Line Assembly
L611	926 7587 001	Grid Input Coupling Line Assy.
L612	937 9526 002	Plate Line Assy.
L613	926 7582 001	Plate Output Coupling Line Assy.
L614	926 7593 001	Plate Choke Assy.
R601,R602	550 0061 000	Potentiometer, 1K ohm, 2W.
R603,R604	540 0740 000	Resistor, 1K ohm, 2W.
R605,R606	540 0837 000	Resistor, 250 ohm, 10%
S601	926 5589 002	Switch, High Voltage Gnd.
S602	926 6665 002	Switch, Gnd. Hook Assembly
S603,S604	604 0061 000	Switch, Door Interlock
S605	604 0092 000	Air Switch
T601	472 0337 000	Transformer Filament
T602	474 0050 000	Powerstat, (Two Ganged)
TB601	614 0104 000	Terminal Board
TB604	614 0064 000	Terminal Board
V601,V602	374 0077 000	Tube, 4CX10,000D
XF603	402 0074 000	Indicating Fuseholder
XV601,XV602		Tube Socket Assembly

DRIVER PLATE VOLTAGE CONTROL UNIT (CENTER CUBICLE)

F604,F605	398 0095 000	Fuse, 8 amp., Slo-Blo
L615	476 0230 000	Choke
R818	540 0480 000	Resistor, 10K ohm, 1W. 10%
T602	474 0050 000	Powerstat (two ganged)
XF604,XF605	402 0024 000	Fuseholder

992 1117 001 TUNING MOTOR & LIMIT SWITCH

	436 0003 000	Motor, Speed Reducing
	604 0137 000	Switch
	614 0049 000	Terminal Board

994 4806 002 RELAY ASSEMBLY

K1	572 0050 000	Relay, 2A, 6 V.
K2,K3	572 0011 000	Relay, 2A, 110 V. A.C.
TB1	614 0079 000	Terminal Board
TB2	614 0070 000	Terminal Board

M-6092 REMOTE FILAMENT METERING KIT

Symbol No.	Gates Part No.	Description
C1	522 0014 000	50 mfd., 150 V. Cap.
CR1	384 0020 000	Silicon Rect., 1N-2071
R1	540 0178 000	Res., 1000 ohm, 1/2W. 10%
R2	550 0067 000	Control, 10K ohm
T1		Transformer (Part of mech. assy.)
TB1	614 0069 000	Terminal Board

M-4845 RF OUTPUT CURRENT EXTENSION KIT

Symbol No.	Gates Part No.	Description
A1	384 0006 000	Diode
C1,C2	516 0054 000	Cap., .001 mfd., 600 V.
J1	612 0230 000	Receptacle
L2	494 0004 000	RF Choke
	610 0231 000	Plug
R1	552 0545 000	Control, 1000 ohm
R2	540 0178 000	Res., 1K ohm, 1/2W. 10%
R3,R4	540 0728 000	Res., 100 ohm, 2W. 10%
TB1	614 0069 000	Terminal Board

POWER CUBICLE (RECTIFIER & CONTROL)

Symbol No.	Gates Part No.	Description
A801	396 0062 000	Neon Lamp
B801	430 0012 000	Fan, 115 V. 60 cy., 1500 rpm.
C801	510 0312 000	Cap., 4 uf., 7500 V.
C804,C805,C806, C807,C808,C809, C810	516 0082 000	Cap., .01 uf., 1 KV
F801,F802	398 0137 000	Fuse, 8 amp.
F803,F804	398 0054 000	Fuse, 1 Amp., Slo-Blo
K803	574 0036 000	Relay, 6 VDC
L801	476 0234 000	Filter Reactor
M801	630 0049 000	Meter, 0-10 V. AC
M802	632 0104 000	Meter, 0-300 MADC
M803	632 0398 000	Meter, 0-10 Amp., DC
M804	632 0399 000	Meter, 0-1 MADC, movement with 0-8000 V. DC Scale
M805	913 1256 003	R.F. Output Meter

Symbol No.	Drawing No.	Description
M806	632 0400 000	Meter, 0-500 V DC
M807	632 0132 000	Meter, 0-1 MADC movement with 0-2000 V. DC Scale
R802,R803	542 0539 000	Res., 100K ohm, 160 W.
R804	548 0100 000	Meter Multiplier, 8 megohm
R807,R808	542 0164 000	Res., 1 ohm, 25 W.
R814	552 0160 000	Adj. Res., 5K ohm, 100 W.
R815	550 0067 000	Control, 10K ohm
R816	550 0029 000	Control, 10K ohm
R817	552 0320 000	Rheostat, 1000 ohm, 25 W.
S801		3KV 6500 V. Switch Ass'y.
S802	926 5589 002	H.V. Grounding Switch Ass'y.
S803,S805	604 0061 000	Door Interlock Switch
S804	600 0162 000	Rotary Switch
S806,S807	604 0084 000	Push Button Switch
S808	926 6665 002	Interlock Gnd. Hook Switch Assembly
T801	472 0405 000	Plate Power Transformer
T802	472 0406 000	Screen Pwr. Transformer
T803,T804	474 0034 000	Var. Transformer, 230 V. 50/60 cy., 1 phase
T805	474 0054 000	Var. Transformer, 230 V. 1 phase
TB801	614 0104 000	Terminal Board
TB805	614 0093 000	Fan Terminal Board
XA801	406 0044 000	Pilot Light Assembly, Red
XF801,XF802, XF803	402 0074 000	Indicating Fuseholder
XF804	402 0024 000	Fuseholder

HIGH VOLTAGE RECTIFIER ASSEMBLY

Symbol No.	Drawing No.	Description
	516 0054 000	Cap., .001 uf., 1 KV
	384 0052 000	Silicon Rectifier, S1081
	542 0140 000	Res., 25K ohm, 5 W.

CONTROL PANEL & BOX FOR POWER CUBICLE

Symbol No.	Drawing No.	Description
A701,A702,A703, A704,A705,A706, A707	396 0105 000	Lamp
A708	396 0062 000	Neon Lamp
C701	516 0082 000	Cap., .01 uf., 1 KV

Symbol No.	Drawing No.	Description
K701, K702, K703, K705, K706, K707, K708	572 0025 000	Relay, 2C
K704	572 0120 000	Relay, 2C, 60V. D.C.
M701	636 0001 000	Total Hour Meter, 230 V., 60 cy.
R701	542 0284 000	Res., 3 ohm, 100 W.
R702, R703	542 0245 000	Res., 4 ohm, 75 W.
R705, R706	542 0164 000	Res., 1 ohm, 25 W.
R707	542 0417 000	Res., 10K ohm, 20 W.
R708	542 0085 000	Res., 3500 ohm, 10 W.
R709, R710	542 0058 000	Res., 50 ohm, 10 W.
R711, R712	542 0056 000	Res., 20 ohm, 10 W.
R713, R714, R715, R716, R717, R718	550 0061 000	Control, 1000 ohm,
R720, R721	540 0492 000	Res., 100K ohm, 1 W.
R722	540 0580 000	Res., 51 ohm, 2 W.
R719, R723, R724	542 0060 000	Res., 100 ohm, 10 W.
R725	540 0728 000	Res., 100 ohm, 2 W.
R726, R727	540 0740 000	Res., 1K ohm, 1W.
S701, S702	600 0186 000	Rotary Switch
S703	600 0300 000	Rotary Switch
S704	604 0067 000	Push Button Switch
S705	604 0069 000	Push Button Switch
S706	604 0061 000	Interlock Switch
TB701, TB703, TB704	614 0062 000	Terminal Board
TP701	614 0189 000	Tie Point
XA701	406 0052 000	Pilot Light Ass'y. Green
XA702, XA703, XA704, XA705, XA706, XA707	406 0053 000	Pilot Light Ass'y. Amber
XA708	406 0044 000	Pilot Light Ass'y. Red

LEFT SIDE PANEL PARTS (POWER CUBICLE)

C802	510 0317 000	Cap., 1 uf., 600 V.
C803	522 0133 000	Cap., 16 uf., 450 V.
CB801	606 0057 000	Circuit Breaker, Curve 2, 3 pole, 240 VAC
CB802	606 0084 000	Circuit Breaker, 3 pole

Symbol No.	Drawing No.	Description
CR801	384 0020 000	Silicon Rectifier, 1N2071
K801	574 0036 000	Relay, MR2TU, 6 V. D.C.
K802	572 0081 000	Relay, 1C
K804,K805	570 0008 000	Contactor, 208-220 V., 60 cy.
K806	574 0035 000	Relay, 230 V. AC
K807	574 0036 000	Relay, 6 V. DC
K808	570 0074 000	Contactor, 220V., 60 cy. A+H CRA-331-U MODEL 65
R801	540 0740 000	Res., 1000 ohm, 2 W.
R805	548 0014 000	Meter Multiplier, 2 megohm
R806	540 0716 000	Res., 10 ohm, 2 W.
R809	542 0412 000	Res., 5000 ohm, 20 W.
R810	552 0006 000	Adj. Res., 10 ohm, 10 W.
R811,R812, R813	542 0441 000	Res., 1 ohm, 50 W.
TB802	614 0096 000	Terminal Board
TB803		Terminal Board (Part of mech. assy.)
TB804	614 0095 000	Terminal Board
TB806	614 0116 000	Terminal Board

SCREEN RECTIFIER ASSEMBLY

Symbol No.	Drawing No.	Description
	516 0054 000	Cap., .001 uf., 1 KV
	384 0052 000	Silicon Rectifier, S-1081
	542 1040 000	Res., 25K ohm, 5 W.

SCREEN FILTER DECK (POWER CUBICLE)

Symbol No.	Drawing No.	Description
C901,C902	510 0145 000	Cap., 10 uf., 2 KV
E901,E902, E903	926 5727 003	Feedthru Insulator Assembly
L901,L902	476 0034 000	Filter Choke, 10 Hy.
R901	542 0235 000	Res., 100K ohm, 50 W.

GRID BIAS SUPPLY DECK (POWER CUBICLE)

Symbol No.	Drawing No.	Description
C1001, C1002	522 0312 000	Cap., 30 uf., 500 V.
L1001	476 0016 000	Filter Choke, 6 hy.
T1001	472 0407 000	Bias Transformer
TB1001	614 0112 000	Terminal Board

RECTIFIER BOARD ASSEMBLY

516 0054 000	Cap., .001 uf., 1 KV
384 0020 000	Silicon Rectifier 1N2071

STATION GUARDIAN

This FM-20B is also equipped with a device which protects the transmitter, transmission line, and antenna from abnormal load conditions.

The unit consists of two sensitive d.c. amplifiers whose input signals are taken from the Micromatch coupler. The voltages from the coupler are amplified and operate a pair of multi-contact relays which operate the associated indicator lights and alarm functions.

This unit can be set to operate under any pre-determined VSWR conditions. This is done by adjusting the control R11 located on the deck below the meter panel on the power cabinet.

The same procedure is then used in adjusting power control R10 to the desired level at which the relay RY1 operates.

The normally closed terminals of RY1 and RY2 are connected in series and are included in the interlock circuits.

Therefore, if any malfunction occurs because of improper transmission line impedance or power, the interlock circuit is opened. The plate voltage on both the driver and amplifier is dropped. The only way the transmitter can be operated is to clear the responsible malfunction.

THEORY OF OPERATION

General

The unit is designed to provide a low voltage source for pilot lights and interlock circuits. In addition, with the transmitter wired properly, it provides a lock-in function on overloads for maximum indication of source of trouble. This lock-in feature can be reset manually at the transmitter or at a remote point.

The third function of the unit makes recycling possible when an overload occurs and the "tune-operate" switch is switched to "operate" position. An R/C circuit operating an auxiliary relay provides three complete recycles during a 10 second interval.

NOTE: The above number of recycles can be changed by adjusting a potentiometer to almost any desired number within a certain time period. Also, the total recycle time can be changed by inserting another time delay relay of the desired type. When using a 10 second time delay and the transmitter has overloaded, the following will occur. If, during the 10 second interval, the transmitter overload has not corrected itself, the transmitter overload at fault will lock out and remain locked out until manually reset. If the transmitter experiences one or two overloads and then clears itself, the recycle unit will again be ready for three more complete recycles after approximately 15 seconds.

Circuit Description

The time constant which determines the pulse interval for recycling is the 50 K 2 W. potentiometer, R1, and the capacity of C1A. When the voltage on the positive terminal of C1A equals the voltage necessary to close the relay K1, this occurs causing the capacitor to discharge through R3, 100 ohm to ground. The discharge time constant is chosen to allow sufficient time for the high voltage contactor to close prior to the reopening of relay K1.

This discharge interval must not be sufficiently long to allow damage to the transmitter in an overloaded condition.

The second set of contacts on relay K2, a slave relay, switches the heavier currents involved in closing the high voltage contactor and also breaking the 130 volts D.C. which locks in the overload relays. Therefore, recycling of the reset occurs just prior to the closing of the high voltage contactor.

The time delay relay K4 is activated the instant that K3 energizes which occurs when an overload relay locks down. After an elapsed time of ten seconds or three recycle periods, K4 closes, shorting the coil of K1 to ground, thus stopping the operation of the time constant circuit. After this elapsed time of ten seconds, the unit must be reset either remotely or by the reset button located on the front panel of the 1Kw driver. It is necessary to wait approximately 15 seconds for the element in K4 to cool before you can expect another three recycles.

Relay K3 performs three functions, the aforementioned closing of K2 when K3 is energized and also to supply 130 V. DC to potentiometer R1 in an overload condition. It also breaks the 230 V. AC which supplies the high voltage contactor coil. In an unenergized condition K3 breaks 130 V. DC to K1 through R1 and maintains coil voltage to the high voltage contactor. Also, the time delay relay K4 has operating voltage removed which should increase the operating life of this relay. K3 is operated by 6 V. AC which is supplied by the unit. One coil terminal is tied common to the 6 V. AC transformer and the other coil terminal is tied in series with a parallel string of overload relay contacts which return to the other side of the 6 V. AC transformer.

Resistor R4 acts as a surge resistor while R2 is merely a bleeder resistor.

The two switches and one push button which control the recycle unit are mounted on the 1KW driver control panel. The operation of the push button acts as a manual reset. It is a normally closed switch, which when open, removes 130 V. DC from the 3.5K resistors in series with the coil and overload potentiometers of the overload relays. These relays then open to again permit operation of the transmitter.

The "local-remote" switch opens the circuit for the remote "on" function, thus placing the transmitter in a local operate condition only.

The "tune-operate" switch performs two functions, in "tune" position it shorts out the coil of K1 in the recycle unit, thus making the unit inoperative. In "operate position", the short is removed from the coil of relay K1. When the 1KW transmitter is used as a driver for a higher power amplifier, the "tune-operate" switch also performs the following functions. It supplies 240 V. AC to the manual push button on the P.A. high voltage control panel when in tune position. In this position the driver and P.A. high voltages must be turned on independently. In "operate" position the short is removed from the coil of K1 and the 240 V. AC is removed from the P.A. high voltage push button on the P.A. Instead 240 V. AC is supplied to one contact of the K809 under drive auxiliary relay, which when closed, turns the P.A. high voltage contactor on.

INSTRUCTIONS FOR OPERATION OF M5675 AMPLIFIER

General Description

The M5675 amplifier covers a frequency range of 88 to 108 mc. This is done without the addition or removal of any padding components in either grid or plate circuits. Power gain of this amplifier is approximately 10. When used as a final output stage, maximum power output is in the vicinity of 50 to 60 watts. The M5675 may also be used to drive following amplifier stages.

The series type of circuit is used in the grid and a conventional parallel type of circuit is used in the plate. This tends to make for less susceptibility of parasitics at higher frequencies than the amplifier is used. Screens of the 6146 amplifier tubes are isolated by chokes rather than RF grounded. This has proven to be more effective at VHF frequencies and eliminates the need for neutralizing. The reader should refer to schematic B-65555 for a better understanding of the circuit.

Tune-up

This particular amplifier should be tuned up for best efficiency and coupled for best transfer of power even if considerably less than full output power is desired. The screen control may then be turned down to reduce output power to the desired level.

To tune the grid circuit, place the negative probe of a voltmeter, into TP401 and ground the positive lead. With drive connected to input receptacle J401, tune C401 (grid tuning) for maximum negative reading on the voltmeter. This voltage may vary all the way from -15 to -45 volts depending on the amount of drive. This reading will drop as soon as screen and plate voltage are applied to the amplifier.

After the grid circuit has been properly tuned, coupling between L401 and L402, L403 should be varied to obtain the maximum negative voltage at TP401 with a minimum of drive. C401 must be retuned each time coupling is changed.

When the input circuit has been properly tuned, plate and screen voltage may be applied to the amplifier and the plate circuit tuned. It is recommended that this be done with the amplifier coupled into a 51 ohm non-reactive load. If plate current is being metered, tune the plate tune control C407 for a dip. Otherwise, tune C407 for maximum power output. Now vary coupling between L404 and L405. Turn amplifier back on and tune C406 for maximum power output along with C407. Several trys may be needed to find the best point of coupling between L404 and L405. Each time the coupling between L404 and L405 is varied, the plate must be retuned along with output coupling capacitor C406.

After tuning has been completed for best power output and efficiency, screen control R405 should be set for the desired power output. In no case should the output circuit be decoupled to reduce output power.

It should be emphasized that this amplifier is easily overdriven. For 50 watts output power approximately 3 watts drive is required. For 15 to 25 watts output power, about 1 watt of driving power is required. If driving power is increased above the required amount, power output of the amplifier will fall off due to high grid leak bias being created. A typical set of reading are given on this amplifier on the following page.

Coupling Amplifier To Another Stage.

When the amplifier is going to be used to drive another amplifier stage, it is suggested that it first be tuned up into a load and then coupled to the grid circuit of the following amplifier stage.

To reduce the possibility of oscillations and/or parasitics, the input circuit of the following stage should be properly coupled and matched to the 51 ohm coaxial line connected to the output of the 50 watt amplifier. This may be done with a micromatch coupling unit. The following grid and input circuit should be adjusted for minimum SWR.

If a micromatch coupling unit is not available, the input coupling and grid tuning of the following stage should be tuned for maximum grid current in that stage.

If the following input circuit is properly matched, plate tuning of the 50 watt amplifier will not change appreciably when switching from a non-reactive load to being coupled to the following amplifier stage.

If the 50 watt amplifier stage was properly tuned up into a load and plate tuning deviates radically from where it was after being coupled into another stage, a major mis-match exists.

If the 50 watt amplifier unit is over-driving the following amplifier, screen control R405 should be adjusted for the desired drive. Do not de-couple the 50 watt amplifier stage.

TYPICAL OPERATIONAL TEST DATA
OBTAINED ON
M5675 AMPLIFIER OPERATING AT 99.1MC

Pwr. Out	65 W.	50 W.	23 W.	17 W.	13 W.
Plt. Current	250 Ma.	215 Ma.	140 Ma.	130 Ma.	110 Ma.
Plt. Voltage	500 volts	520 volts	570 volts	580 volts	590 volts
Screen volts	290 volts	235 volts	150 volts	147 volts	132 volts
Screen Current	12 Ma.	8.5 Ma.	3 Ma.	2.2 Ma.	1.5 Ma.
Cathode volts	68 volts	58 volts	35 volts	33 volts	29 volts
Driving power	6.5 watts	2.5 watts	1 watt	.8 watt	.8 watt
Grid Voltage	-10/-42"	-7/-33"	-8.5/-23"	-6.5/-20"	-3.5/-15"

(Grid voltage measured at TP401. " indicates voltage before applying screen and plate voltage)

Plt.Pwr.Input	107 watts	97 watts	75 watts	72 watts	61 watts
Plt. Dissipation	42 watts	47 watts	52 watts	55 watts	48 watts
Plt. Circuit Efficiency	61%	52%	31%	23.5%	21%

Figures below obtained with no drive.

Plt. Voltage	550 volts	560 volts	580 volts	580 volts	590 volts
Plt. Current	165 Ma.	155 Ma.	125 Ma.	125 Ma.	105 Ma.
Cathode volts	45 volts	40 volts	31 volts	31 volts	27 volts
Plt.Dissipation	83 watts	80 watts	69 watts	69 watts	59 watts

(All readings were made with screen connected to regulated +320 regulated supply)

INSTRUCTION BOOK

FOR

THE M-6095 FM EXCITER

I.B. #888 0648 001

August 1, 1961

Gates Radio Company

Quincy, Illinois

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M6095 EXCITER

(Freq. Range 88 - 108 MC.)

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Proof Of Performance Data Sheet

(This data sheet is located at the very back of the instruction book. It is filled out only when the exciter unit is shipped by itself. When the exciter unit is shipped as an integral part of another unit, this data will be included with the overall data sheet for the transmitter.)

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Drawings at the Back of the Book in the Order Referred to in the Text:

852 5774 001 Schematic, FM Exciter

837 9534 001 Functional Block Diagram Exciter Unit

ES-6170	Standard 75 Microsecond Pre-emphasis Curve
A-4165	Test Set-Up for FM
826 7991 001	Typical Waveforms of Stages V101 thru V106
826 7990 001	Typical Waveforms of Stages V107 thru V112

Tables and Charts Included Within Text of Book That are Helpful in Trouble Shooting:

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NOTE: Complete Tune-up Procedure At Customer Request

SPECIFICATIONS

Power Output:	0 - 10 watts, continuously variable
Frequency:	88 - 108 Mc.
RF Output Impedance:	51-72 ohms
Frequency Stability:	$\pm$ .001%
Type of Oscillator Circuit:	Direct Crystal Control
Type of Modulation:	Phase shift employing pulse techniques
Modulation Capability:	$+$ 100 Kc 100% Modulation equals $\pm$ 75 Kc
Audio Input Impedance:	600 ohms
Audio input level for 100% modulation at 400 cycles:	$+$ 10 dbm, $\pm$ 2 db
Overall Audio Frequency Response:	Within 1 db of standard 75 micro-second pre-emphasis curve or flat $\pm$ 1 db 50 to 15,000 cycles depending on specifications of plug-in audio pad. -30 db at 30 cycles.
Distortion at 100% Modulation:	3% or less, 30 to 50 cycles. 1% or less, 50 to 100 cycles. .5% or less, 100 to 10,000 cycles. 1% or less, 10,000 to 15,000 cycles.
FM noise:	65 db below 100% modulation at 400 cycles or better.
AM noise:	60 db below equivalent 100% amplitude modulation.
Power input:	Approximately 120 watts when exciter is putting out full 10 watts. (1 ampere at 117 volts.) Approximately 6 watts (intermittent) crystal oven circuit.

Tube Complement:	3 - 6201
	7 - 6AU6
	1 - 6AQ5
	3 - 6J6
	1 - 12AX7
	2 - OA2
	1 - GZ34/5AR4
	1 - 6080
	1 - 6360
	3 - 7025

INTRODUCTION

All FM transmitters require a device that will supply an RF driving voltage of sufficient amplitude to drive the succeeding amplifier stage to the required output power level. In addition, this device must have necessary provisions made for frequency modulating the carrier the proper amount.

These requirements are fulfilled by the M6095 exciter unit. The exciter panel is standard 19" wide for rack mounting, height is 14". A rear dust cover is provided that extends 2-1/2" beyond the back of the panel. This dust cover is held on by four acorn nuts easily removed from the front of the panel. The highest unit on the front of the panel is the crystal oven which extends 4-1/2" beyond the panel proper.

The unit is complete with its own power supply. It is light in weight; 21-1/2 lbs, this makes it very easy to remove the unit from the cabinet or rack in which it is mounted and to place it on a bench. All that is needed to operate the unit is an AC cord connected from TB101-7&8 to a 117 V. AC outlet.

INSTALLATION

Generally, when the exciter unit is received at the point of operation it will be mounted in a cabinet along with additional amplifier stages. The unit finds its greatest usage in driving 50 watt and 250 watt amplifier stages. With some additional external metering, the unit becomes a complete 10 watt FM transmitter.

Forced air cooling is not required for the unit. Sufficient ventilation should be allowed to provide normal circulation and up-draft at least for the front of the panel, where all of the tubes are mounted.

External wiring to the unit consists of the following:

1. A shielded, twisted pair that connects to TB101-1 -2-3. The shield should connect to TB101-3 which is ground. These are the audio input terminals. Audio requirements for 100% modulation are approximately +10 DBM, and the input impedance is 600 ohms.

2. Two wires connected to TB101-7&8. These wires are to provide operating voltages for the unit. Requirements are

117 volts, AC at 1 ampere.

3. Two wires to connect to TB101-9&10. This provides operating voltage for the crystal oven. Requirements are 117 volts, AC at about 6 watts intermittent service.

In addition, if the exciter unit is used to supply B+ to some other unit a wire must be connected from TB101-6 to the other unit. An additional 20 to 30 milliamps at +320 volts may be drawn from this terminal when the exciter is transmitting a full 10 watts. If output power from the exciter unit can be reduced to 3 or 4 watts, up to 50 milliamps may be drawn from TB101-6.

The exciter may also be used to supply filament voltage to some other unit. To do this, a wire must be connected from TB101-4 to the other unit. 6.3 volts, AC at about 1-1/2 amps. is available to be drawn from this terminal.

If the power amplifier stage of the exciter unit (V115) is to be externally metered the jumper connecting TB101-5&6 should be removed. A wire should then be connected from TB101-5 to the positive terminal of the external milliammeter and a wire should be connected from TB101-6 to the negative terminal of the milliammeter. The final stage will draw about 65 milliamps when output power is 10 watts. The external milliammeter should have a minimum full scale deflection of 100 milliamps.

PRE-OPERATION

In almost all cases the exciter unit has been properly tuned up to customer frequency at the Gates plant. If all tubes and other components are properly in place, wires connected, etc., the exciter may be placed into operation by turning S101 to the "ON" position. This switch is located in the primary circuit of T103. When it is turned "ON" both the filament voltage and the B+ voltage come on to all tubes. The rectifier tube is of the slow heating indirect cathode type, and positive voltage will not exist for perhaps 20 seconds, after this length of time the exciter power output will come up.

The only adjustments that will have to be made are to tune C169 (output coupling) and C167 (V115 plate tune) for maximum power output into a load, following stage, or antenna. Final adjustment of C167 and C169 should be done only after the exciter has come up to full operating temperature; this will take about 15 minutes after first turning the unit on. Stray capacities of tubes tend to change slightly as the tube warms up and a small change of even 1/4 pf can considerably de-tune a circuit operating in the VHF range.

Frequency adjust control C104 should be set to the value given in the factory test data sheet. Oven pilot lamp A101 will start cycling after the oven heater has been on for about 20 minutes. The crystal oven does not really stabilize until it has been on for about 1 hour. If, after this length of time, the carrier center frequency does not agree with that shown on a frequency monitor of know accuracy, readjust the C104 for proper center frequency. Normal cycling of oven pilot lamp A101 will be"ON" 1/3 and "OFF" 2/3 timeswise for a room temperature of 75° F.

A quick check of the B+ voltage is advisable. This can be done by placing the negative probe of a 20,000 ohms per volt meter into a black test point (TP122 or TP123), and a positive probe into TP121. The voltmeter should read +320 volts DC.

DAILY OPERATION

It is considered good practice to arrange wiring and control circuits so that the crystal oven heater operates independently of the main power switch. If this is done, and the crystal oven remains on all the time, the exciter will be close to center frequency, even from a cold start. Power requirements for the oven are about 6 watt and this only intermittently. On a presumed basis of the oven being "ON" 1/3 of the time, the oven would use only 2 watt of power per hour.

Assuming that the crystal oven is on continuously, then the only thing that needs to be done in the normal days operation is to turn the main power "ON" when starting the broadcasting day and "OFF" when finished. In most cases, this will be accomplished when the low voltage switch is turned on in the transmitter, whether the transmitter be 250, 1000 or 5000 watts.

If the exciter is turned on 10 or 15 minutes before "AIR" time, no other adjustments should be necessary. The exciter will reach 80 to 90% of full power in about 5 minutes and full power in 10 to 15 minutes. This assumes that the unit was fine tuned while thoroughly warmed up.

THEORY OF OPERATION & GENERAL EXPLANATION OF CIRCUITRY.

Of all the known methods used to generate a frequency modulated signal, the one used in this exciter unit is the simplest and most straight forward. Since the signal generation depends upon direct crystal control, the output frequency will be very stable. In addition, tuned circuits will be uncritical in operation and low cost receiving type tubes may be used in the majority of circuits.

V101 is a crystal controlled oscillator. The crystal controlled output of V101 is shaped into a series of sawtooth waveforms by V101 and V102, for application to Modulator #1, V104. The output of Modulator #1, V104, is then again shaped into a sawtooth waveform at crystal frequency for application to Modulator #2.

The reason for two Modulators is to increase the modulating ability of the Exciter at low frequencies. The two modulator stages are driven in parallel from audio stages V116 and V117. V107 through V114 are frequency multiplier stages. V107 through V111 are single ended pentode stages, while V112 through V114 are push-push doublers. V115 is a power amplifier stage, which is capable of producing 10 watts at output frequency of 88 to 108 mcs. The coaxial jumper between J101 and J102 connects frequency multiplier stage V111 to V112, when Multiplex is not in use. When Multiplex is used, the output of J101 feeds into the Multiplex unit and the Multiplex unit feeds back to the input jack, J102.

Stages V116 through V122 make up a conventional regulated power supply with an output voltage of 320 volts. Maximum current to be drawn from this power supply is in the vicinity of 160 milliamps.

This unit has been properly tuned up at the factory. If the customer desires a complete tune-up procedure for the M6095 Exciter unit, it may be obtained by writing to the Gates plant.

GENERAL

If the exciter has been properly tuned up, output power in the vicinity of 10 watts should be obtained. If trouble is experienced along the way in the tune-up procedure, the fault can usually be isolated by referring to typical test point voltages given on a following page. There are five key test points that are indicative of proper operation.

About -35 volts should be obtained at TP106, this indicates that the pulse stages V101 thru V106 are properly operating.

About -2 volts should be obtained at TP108, this indicates that V107 and associated circuitry is working O.K.

Approximately .5 volts RMS RF voltage should be obtained at TP113 and/or TP114, this would indicate that the frequency multiplier stages V107 thru V111 are operating properly.

Around -7 volts should be obtained at TP118, this indicates sufficient driving power to final amplifier stage V115.

If a defect is suspected, but can not be spotted, checking resistance of the various tuning coils L101 thru L115 may locate the trouble.

The proper resistance value of these coils is listed below along with the capacitor values for comparison purposes. The measured resistance should not deviate by more than about 10%. If the accuracy of the voltmeter is not known, a comparison between similar coils can be made. For example, the resistance of L101, L102 and L103 should be the same.

COIL	DC RESISTANCE	CONDENSER VALUE ACROSS COIL
L101,L102,L103	21 ohms	150 mmf.
L104,L105	9.6 ohms	100 mmf.
L106,L107	5.5 ohms	24 mmf.
L108,L109	2.1 ohms	24 mmf.
L110,L111	1 ohm	See Schematic
L112,L114,L115	.12 ohm	See Schematic
L113	.43 ohm	See Schematic

Considerable deviation of resistance from the above given values indicate either the wrong coil, shorted turns, open turns, or a change in value of some other component connected across the coil.

The value of any other parts connected across the coils is to be considered insignificant when compared to the DC resistance of the coil.

COUPLING EXCITER TO A FOLLOWING STAGE

It is preferred that the final amplifier of the exciter be connected to an external dummy load of 51 ohms through a 51 ohm cable while tuning. Tuning the final amplifier in this manner is a good check on its proper operation.

When changing the RF output connection of the exciter from a dummy load to a following amplifier stage an attempt should be made to get a proper match to 51 ohms at the input to the follower amplifier stage.

If the output coupling control, (C169) and plate tune (C167) on the exciter unit, have to be considerably readjusted when coupled into the succeeding amplifier stage, a major mis-match of impedance is to be suspected at the input of the following amplifier stage. This will result in considerable loss of drive to the following stage and cause high standing waves to appear on the inter-connecting coax between the exciter and the following stage.

Most of the amplifier stages that will be used following the M6095 exciter unit will not generally require the full 10 watts of driving power. A 50 watt amplifier stage will require about 2 watts of drive and a 250 watt amplifier about 4 watts of drive.

In no case, should C167 (plate tune) or C169 (output coupling) be de-tuned to reduce output power. This is equivalent to operating V115 in an off-resonant condition and would damage the tube eventually.

Output power can be reduced to almost zero by tuning R167 (output control) to a counterclockwise position. This reduces screen voltage to V115 and, consequently, the plate current which increases efficiency to V115.

In some cases, B+ voltage of 320 volts will be tapped off of TB101-6 to supply screen voltage to a following amplifier stage

The external ≠320 volts should not exceed a drain of about 30 milliamps for continuous operation.

Reducing screen voltage of V115 by adjustment of R167 will drop V115 current drain from about 60 milliamps for 10 watts output to about 25 milliamps for 2 watts output. This extra current may then be used for external purposes.

In summary, when driving an additional amplifier stage from the exciter unit, reduce output by adjustment of R167 and keep C167 and C169 tuned for maximum grid drive in the following stage.

V115 EFFICIENCY

An external jumper is provided on TB101-5&6. An ammeter may be connected in series with this jumper to measure V115 plate current.

B≠ voltage has been previously set at ≠320. Power input to the plate circuit of V115 may be calculated from the ammeter and voltage readings. The voltage drop across R155 must first be calculated. This resistor is in the cathode circuit of V115, its value is 250 ohms.

The formula to use would then read:

$$\text{Power input to plate circuit V115} = I_p \times (E_p - (IR))$$

Where IR is the drop across R155

If, for example, the ammeter reading obtained when connected in series with TB101-5 and 6 was 60 ma. and B≠ to ground was ≠320 V.:

$$\text{Power input V115} = .06 \times (320 - (.06 \times 250))$$

$$= .06 \times (320 - 15)$$

$$= .06 \times 305$$

$$= .813 \text{ watts}$$

Assuming an output power of 10 watts:

$$\text{Plate dissipation V115} = \text{Power input} - \text{Power output}$$

$$= 18.3 - 10$$

$$= 8.3 \text{ watts}$$

$$\text{Efficiency of V115 Stage} = \frac{\text{Power output}}{\text{Power input}}$$

$$= \frac{10}{18.3}$$

$$= 54.8\%$$

These figures can be considered typical. If the output power is not known, an efficiency factor of 55% should be assumed.

TYPICAL DC TEST POINT
VOLTAGES OF M6095 EXCITER UNIT
NO MODULATION. MEASURED WITH
20,000 OHMS/VOLT VOLTMETER

	WITH DRIVE VOLTS	NO DRIVE VOLTS
TP101	-27	0
TP102	+12	+29
TP103	+1	+1.4
TP104	-4	0
TP105	+9.2	+15
TP106	-30	0
TP107	+60	+33
TP108	-3.2	0
TP109	+61	+50
TP110	+72	+34
TP111	+68	+30
TP112	+133	+195
TP113	.46 RMS (H.P. Probe)	0
TP114	.42 RMS (H.P. Probe)	0
TP115	+113	+185
TP116	+140	+235
TP117	+227	+260
TP118	-.6	0
TP119	+157	+187
TP120	+172	+172
TP121	+320	+320

Note: Readings for TP118 and TP119 were obtained with R155 output control full clockwise or maximum output position.

PROOF OF PERFORMANCE

Center Frequency, Noise, Distortion, Response

Proof of performance data as made by the Gates Radio Company on FM transmitters can be likened to listening to the transmitter on a high quality receiver. This tends to "prove-out" the transmitter since measuring and listening equipment is completely external to the transmitter proper and the RF signal is taken from "off-the-air".

Instead of a receiver, an FM monitor of good quality and FCC approved is used. Reference to drawing A-4165 will show the general test set up for making proof of performance measurements.

First off, a sample of the transmitted RF is coupled to the modulation and frequency monitor. This is taken from the antenna, transmission line or from the PA chamber. The method used is determined somewhat by the amount of power needed by the monitor (usually about 1 watt) and by the output power of the transmitter. For low power FM tranamitters up to perhaps 250 watts, a sample of RF may be taken by "tapping" off the output transmission line with a variable condenser in series with the coaxial line going to the monitor. This has the disadvantage though of introducing a slight mismatch back into the transmitter. Usually, it is impossible to obtain enough power to drive the monitor from the antenna without introducing another amplifier ahead of the monitor to raise the receiver signal up to the necessary level. In higher powered transmitters, a monitor loop is usually coupled to the final amplifier section to sample a portion of the transmitted output.

A good quality audio oscillator of 600 ohms output impedance is then connected to the audio input terminals. These are TB101-1,2 and 3 on the exciter unit with terminal #3 being ground. Output level requirements are at least +10 DBM. Since the exciter itself is capable of generating a frequency modulated carrier with distortion ranging as low as .2% the audio oscillator must be in good working order.

A distortion analyzer or meter is connected to the audio output terminals of the monitor. An oscilloscope while being an optional item in making measurements is very helpful in tracing any possible difficulty.

The complete method used to adjust the exciter for proper response, distortion, noise and etc., will now be given as it is done at the Gates factory. Proper proof of performance adjustments at the factory are made only after complete tune-up has been done. After the customer receives the unit, any part of the measurements may be made without undue effect upon other measurements.

All proof of performance measurements should be made with shield covers in place.

SETTING CARRIER FREQUENCY

It is desirable to first set the exciter unit to proper carrier frequency. This should be done first, not only because it is desirable to have the unit on proper frequency, but if the carrier is several thousand cycles off center, undesirable beats may occur within the monitor. This will cause noise readings and may effect apparent frequency response.

Usually, all that is required to place the exciter unit on proper center frequency, is to sample a portion of the RF output with a good frequency standard and adjust C104 (frequency adjust control) until the frequency standard shows proper frequency.

Occasionally, a crystal may be used that can not be set exactly to center frequency by means of C104 alone. Also, a crystal that was originally on proper frequency may drift off the range of C104 due to ageing. When this happens additional frequency adjustment may be made by varying the value of C105. This capacitor controls the amount of feedback to the crystal. Increasing the value of C105 lowers the carrier frequency and decreasing the value of C105 raises the carrier frequency.

With the value of C105 set at the optimum value of 150 PF, varying C104 (frequency adjustment control) from minimum to maximum will cause the center frequency to vary approximately 30,000 cycles. Changing the value of C105 from 150 PF to 50 PF will raise carrier frequency about 10,000 cycles. Changing C105 from 150 PF to 250 PF will lower carrier frequency about 3,000 cycles.

DISTORTION MEASUREMENTS AND ADJUSTMENTS

After the exciter unit has been properly set to carrier frequency distortion adjustments are made. Set the modulator selector switch (S2) in the modulator #2 position. Set the audio oscillator frequency to 30 cycles and modulate the exciter with ≠14 DBM. Next, adjust C119 so that the FM monitor reads 70% modulation. Distortion adjustment control (R126) is then adjusted for best distortion. If R126 is considerably away from the proper adjustment point, it may be impossible to obtain the desired level of modulation or the waveform obtained may be completely torn up. If such is the case, adjust R126 for minimum distortion while modulating somewhat less than 70%, say, about 50%. Then, reset the level on the audio oscillator to ≠14 DBM and adjust C119 and R126 as described above. Then place the modulator selector switch in the modulator #1 position, and follow the procedure just described to adjust modulator #1. In this case, however, the capacitor adjustment is C111 and the distortion adjustment control is R115.

If it is impossible to reduce distortion at 30 cycles, it is advisable to check just the audio portion of the exciter unit and/or the audio oscillator itself. The audio portion of the exciter consisting of tubes V116 and V117 may be checked by running test leads from TP120 and TP122 or TP123 to the input of the distortion analyzer. Distortion as measured at TP120 should be well below .5% at any audio frequency. If distortion from the audio section is O.K. but overall distortion as measured from the monitor is not, then the waveforms of the pulse circuitry should be checked. Typical waveforms of V101 thru V106 are given on drawing 826 7991 001.

100% modulation should occur at an input level of approximately ≠10 DBM from 30 to 1,000 cycles. This input level will cause an RMS audio voltage at TP120 of about 15 volts. If an input level of ≠10 DBM does not generate an RMS voltage of about 15 volts at TP120, then a defect in the audio section may be suspected. If sufficient RMS voltage exists at TP120 and the exciter will not modulate 100%, then a defect in the modulator or previous stage should be suspected.

In any FM system worse distortion occurs at the lowest modulating frequency. In other words, if distortion is 1% at 30 cycles then the distortion can be expected to be better at all higher modulating frequencies. Occasionally, a high distortion figure may result between 10,000 and 15,000 cycles. The fault will not generally lie in the modulator stage, however, it could lie in the audio section.

If high distortion is present at the higher modulating frequencies only, it can usually be traced to one of three causes.

1. High FM or AM noise.

2. Insufficient bandwidth in the frequency multiplier stages.

3. Frequency and modulation monitor not correctly tuned to carrier frequency.

A standard FM monitor contains de-emphasis circuitry that causes lower modulating frequencies of 30 to 1,000 cycles to come out of the monitor with an apparent advantage of around 15 to 17 DB over the audio that is recovered at 15,000 cycles. If noise is down only 40 to 50 DB with respect to 100% modulation at 400 cycles, it will usually not prevent a good distortion reading at a low modulating frequency. However, if frequencies between 10,000 and 15,000 cycles are 15 DB lower in amplitude then 400 cycles, the noise with respect to these frequencies, will only be about 30 DB down. This would correspond to the 3% distortion range on a distortion analyzer. A quick check to determine whether noise is causing an apparent high distortion reading is to remove all modulation from the input to the exciter or transmitter. If the distortion meter needle does not drop appreciably a noise measurement should be made on the exciter.

If bandwidth is insufficient in frequency multiplier stages, some of the higher frequency sidebands will be clipped causing undue distortion. A complete re-tune up is then recommended.

Mis-tuning of the monitor will also cause some clipping of sidebands at higher frequencies. In addition, beat frequencies may be present that show up as noise and prevent a good distortion reading.

Once set, the distortion controls R115, C111, R126 and C119 may not have to be re-set for the life of the the exciter unit. Changing modulator tubes will probably not cause distortion figures to change by more than .1 or .2%. There are exceptions to every rule though.

OVERALL FREQUENCY RESPONSE

If the exciter unit is used in the FM broadcast band of 88 to 108 MC or as the aural exciter unit for TV transmitters, overall frequency response should follow the 75 microsecond curve shown on drawing ES-6170. In other frequency ranges, it may be desirable to have the overall frequency response flat.

Several methods of making frequency response measurements using an FM monitor are available. Two will be described; the simplest is to set the audio frequency at about mid-range, say 5000 cycles, and modulate the exciter the proper amount, in this case the proper modulation level would be 35%. Keeping the input audio level constant, the frequency may then be adjusted upward to 15,000 cycles and then downward to 30 cycles. Using this method the response will seldom rise above the curve and makes it easy to calculate the percent or decibel error. For example, if at 15,000 cycles modulation the modulation monitor reads only 80% modulation, it can be quickly seen from the drawing ES-6170 that the response is 2 DB below the normal curve. The same reasoning may be applied to the low end of the curve. If the input attenuator is calibrated in small steps, it is also possible to determine the amount that the audio input has to be increased to bring the monitor up to the required percentage of modulation at any modulating frequency.

Another method of measuring frequency response involves keeping the percentage of modulation constant as read on the monitor. To use this method the audio oscillator output must be accurately calibrated. To start with, the carrier should be modulated 100% at 400 cycles, changing the audio frequency from about 30 cycles to 400 cycles should not change the percentage of modulation appreciably. If the modulating frequency is raised upward, say to 5,000 cycles, the input level must be reduced to keep the percent of modulation at 100%. For 5,000 cycles the amount of reduction should be 8.2 DB. For 15,000 cycles the amount of reduction of input level should be 16.9 DB. Recording the amount of reduction of the input level versus modulating frequency and reversing the sign of polarity, will give the curve and frequency response. This can then be compared to the curve of drawing ES-6170.

The second suggested method is particularly useful when response measurements are being made at 25 and 50% modulation levels, or when a standard FM monitor is being used to measure response of an exciter being used to generate the aural carrier for a TV transmitter where normal 100% modulation is ±25 KC. This will correspond to 33-1/3% modulation on a standard FM monitor for the FM broadcast band of 88 to 108 MC.

Seldom will any difficulty be encountered in coming close to the standard 75 microsecond curve between 400 and 10,000 cycles. Generally, if troubles develop with response it will show up as being 2 or 3 db down at 15,000 cycles. A frequency compensating capacitor has been incorporated in the audio amplifier section to take care of just such a contingency. C170 affects response between 10,000 and 15,000 cycles. Increasing the value of C170 raised the frequency response between 10 and 15,000 cycles. Decreasing the value of C170 drops frequency response between 10 and 15,000 cycles.

Stagger tuning L103 will also help response at 15,000 cycles a DB or so, when this is done a voltmeter should be connected to TP108 and the amount of staggering of L103 should not reduce the negative voltage observed by more than .5 volts.

FM NOISE

FM noise is measured with respect to 100% modulation at 400 cycles. To make this measurement, modulate the exciter 100% at 400 cycles and set a reference level on the distortion analyzer. Remove all modulation and read the FM noise on the appropriate scale. FM noise of the exciter unit can be expected to approach 70 DB or better.

If FM noise is high the audio section is the most logical place to start looking. Removal of the last audio tube V117 is a quick way of checking if the trouble is in the audio. The next best bet is the power supply. Hum and noise voltage of the power supply should be between 85 and 90 DB down with respect to +320 volts DC. If these two places fail to show any defect the noise is probably originating from the pulse circuits V101 thru V106. Stages after V106 are unlikely to cause FM noise.

AM NOISE

AM noise is measured or referenced with respect to 100% amplitude modulated wave. This AM noise usually consists of 60 or 120 cycle hum superimposed upon the carrier. There are several ways of making this measurement. Some FM monitors have a provision for making this measurement. This measurement should be made with no modulation present.

AM noise as measured from the exciter unit is usually so low as to be difficult to measure. It will generally be better than

70 DB. If AM noise is high, it can actually originate in most any stage. However, if, upon analyzing the type of noise, it is found to have a basic 120 cycle component the power supply should be suspected. If the noise appears to be mostly a 60 cycle component a heater to cathode leak in any stage should be suspected. A loose connection in any stage will cause the AM noise to rise when the exciter cabinet is jarred. A point often overlooked when making AM noise measurements is the sampling loop or device. For example; if the RF sampling loop is mounted in a PA chamber where blower vibration is apt to occur, this vibration will show up as high AM noise, if the sampling loop is not securely mounted.

TYPICAL PROOF OF PERFORMANCE READINGS

If the exciter unit has been shipped as an individual unit the complete test data sheet will probably have been filled out and included in this section. If the exciter unit is part of a high power transmitter the test data sheet is included with the overall instruction book. A set of typical readings for proof of performance is given below:

Carrier Frequency, O.K.

	Distortion at 100% modulation	Response with reference to standard 75 micro-second pre-emphasis curve
30 cycles	1.75	-1.7 DB
50 cycles	.85	- .2
100 cycles	.56	+ .5
400 cycles	.47	+ .8
1000 cycles	.42	+ .8
2500 cycles	.38	+ .5
5000 cycles	.34	+ .4
7500 cycles	.58	+ .3
10,000 cycles	.58	+ .1

15,000 cycles	.48	- 1

FM Noise: -68 DB

AM Noise: Better Than -70 DB

MAINTENANCE

Since moving parts are at a minimum in the exciter unit routine maintenance is a simple procedure. The few moving parts that are used, such as, variable capacitors, potentiometers and variable inductors will perhaps stay set in one position for the life of the exciter unit. The one exception to this would be C103 the frequency adjust control.

Because routine maintenance is used to prevent trouble and not start it, it is not deemed advisable to poke and pull at every component part at a pre-arranged time. Tubes are the most likely components to go bad. A routine testing of all of the tubes at least once every six months is recommended.

One of the best ways to foretell trouble is by test point voltages. These are recorded on the factory test data sheet. When the exciter is first received and placed into operation, it is advisable to go over these test point voltages and record the reading obtained. The test point voltages should then be checked weekly or monthly. A substantial variation from the original recorded value would indicate a failing tube or other component in that circuit. These voltage measurements should always be made with the same meter since a normal 10% variation from one meter to the next may be expected.

An occasional check on the noise, distortion and response with a test set up such as shown in drawing A-4165 will probably reveal an eminent failure of one of the audio stages or one of the pulse stages V101 thru V106.

When tubes are checked and replaced, it is wise to replace them in their original sockets. If V113, V114 or V115 is changed, it may be necessary to retune associated circuitry for best performance.

TROUBLE SHOOTING

It would be impossible to list every failure and possible cure that might occur in the exciter unit. The same thing may be said of any other piece of electronic gear. However, 90 to 95% of all failures can perhaps be predicted with a few possible clues listed that may help in locating the defect.

Failures or difficulties that may occur in the exciter unit can be divided into two broad categories.

1. Problems associated with carrier only.

2. Problems associated with modulation of carrier.

Problems associated with carrier only can be sub-divided into several groups.

A. No carrier (no power output)

B. Low Carrier (power output low)

C. Intermittent carrier

D. Oscillation

E. Carrier off frequency

Problems associated with carrier only will now be discussed and possible remedies and trouble shooting hints suggested.

NO CARRIER

Of the many problems that can occur, this perhaps is the most serious and yet the easiest defect to find. When this happens, a tube has usually gone completely dead. A comparison of test point voltages with those given at the end of the complete tune-up procedure, test data sheet or voltages recorded when the unit was working properly should reveal the defective stage. The difference in test point voltages with and without drive is in the most cases quite pronounced. When a tube has gone completely sour or dead, voltages noted at test points located in the plate circuit of that particular tube will rise up to the full plate voltage of +320 volts. If the tube is drawing excessive current, the voltage noted at the test point will be extremely low. A failure of any circuit from oscillator stage to power amplifier stage will, of course, cause loss of carrier. The power supply itself should not be overlooked.

To quickly isolate the trouble to a single general area the following procedure could be followed.

1. Check to see if B/ voltage exists at TP121.

2. Check the negative voltage at TP106, a reading of about -35 volts here indicates V101 thru V106 are operating properly.

3. Check negative voltage at TP108. A negative reading here from -2 to -3 volts indicates that the grid of V108 is receiving drive from previous stages.

4. Check RF voltage at TP113 and/or TP114. An RF voltage here of about .5 volts RMS indicates that there is sufficient drive up to this point.

5. Check negative grid voltage of V115 at TP118. A reading of at least -5 volts here indicates plenty of drive and that the grid circuit of V115 is operating.

Should all of the suggested methods fail to locate the trouble a more thorough check will have to be made. Reference to voltages listed on the schematic diagram 852 5774 001 and to waveform measurements on diagrams 826 7991 001 and 826 7990 001 in the back of the book may help. Approximate RF voltage measurements are also included at the end of this section.

LOW CARRIER

The same general routine used to track down the stage causing a carrier failure can be used to check for a low carrier. Tracing down the fault for a low carrier can be more elusive though because voltages will not deviate as much from normal. Low carrier levels are usually caused by a tube with low emission. A slight mis-tuning somewhere along the frequency multiplier chain can cause low output. Reference to the RF voltage chart at the end of this section may be of additional help.

INTERMITTENT CARRIER

An intermittent carrier can be very difficult to track down because about the time test equipment is set up to find the trouble, it disappears. A recommended method finding this is to start at the final stage (V115) and place a meter probe into TP119. Then tap on the chassis or whatever else it takes to cause the intermittent condition. Working back toward the crystal from stage to stage and test point to test point; a point should be reached where a test point voltage does not vary. This should be the last properly operating stage. Immediately following the point where the test point voltage is not varying. An intermittent carrier can be caused by most anything. A bad tube, capacitor, resistor or loose connection or an intermittent short.

OSCILLATION

It is an almost unheard of condition for a frequency multiplier stage to oscillate since frequencies found in the grid circuit are different from frequencies found in the plate circuit. It is within the realm of possibility, however. If an oscillation should occur, it will probably be traced to the final amplifier stage, V115. This stage is self neutralizing and will probably not cause any trouble as long as the shields over the coils are tightly in place and all connections are tight.

A condition somewhat akin to oscillation has been noted while using pulse circuitry similar to that in this exciter unit. A leaky capacitor or intermittent connection in the pulse circuitry can cause the frequency multiplier stages to "fire" off at their resonant frequency. This oscillation will be damped and only occurs momentarily but may be aggravating.

CARRIER OFF FREQUENCY

When the carrier is consistently too far removed from proper center frequency, the trouble can be traced directly to the oscillator stage. This could be due to the oven thermostat sticking and causing the crystal to overheat or could be due to the oven not heating at all. If the thermostat is sticking, pilot lamp A101 will be on all the time provided it is not burned out. If the oven is not heating at all, the pilot lamp should not light.

Some crystals will age and drift off frequency after a length of time. Replacement of the crystal is the only solution here. A change of value of almost any component in the oscillator stage V101 could also cause the carrier frequency to deviate.

Problems associated with modulation of the carrier will now be discussed and some possible remedies and trouble shooting hints suggested. Under this category, sub-division might be as follows:

A. High Distortion

B. Imporper Frequency Response

C. Will not Modulate at all

D. High FM Noise

E. High AM Noise

When it is known that any of the above listed faults exist, it will save time to first isolate the trouble to either the audio stages or the rest of the exciter unit. It is easy to check the output of the audio stages by connecting a ground lead from a black test point and a "hot" lead from TP120. These two leads can then be run to the input of a distortion analyzer. If these leads are very long, they should be shielded or they may pick up external hum and noise.

HIGH DISTORTION

When high distortion is present, it can usually be divided into three categories.

1. Distortion high throughout the audio spectrum 30 to 15,000 cycles.

2. Distortion high at low frequencies only.

3. Distortion high at high frequencies only.

When distortion is high through the audio spectrum of 30 to 15,000 cycles the fault is apt to lie in the audio stages of V116 and V117. It is wise to check these stages anyway when modulation difficulties are experienced. A failure of any component in the audio stages could cause the distortion to rise. Checking voltages against the schematic should show the difficulty. Changing a tube will usually cure the trouble.

It is characteristic of an FM system that the greatest difficulty in attempting to modulate occurs at the low frequencies. When the overall distortion is high between 30 and 400 cycles only, the trouble will usually be found in either one or both of the modulator stages or in the pulse circuitry just preceding them. A check of the waveform in stages V101 thru V106 is advisable. These can be checked against drawing 826 7991 001.

These waveforms were made on a calibrated scope type 524AD Tektronix, if a calibrated scope is not available an ordinary scope may be calibrated approximately by the following method: Peak-to-peak waveforms are always 2.8 times the RMS value of a sine wave. The hot scope lead can be connected to a hot filament wire which should have an AC voltage present of about 6.3 volts AC. The peak-to-peak value would then be 17 or 18 volts. The scope can then be calibrated accordingly by setting a reference point on the scope screen.

The two most important waveforms to check are those at TP102 and TP105. With pin 7 of V103 disconnected, the waveform at TP102 should be a good saw-tooth with an amplitude of 25 to 30 volts peak-to-peak. The leading edge should be linear with no rounding off. When pin 7 of V103 is connected and the bias properly set the waveform will be cut approximately in the middle horizontally.

With V106 removed the waveform at TP105 should be a good saw-tooth with an amplitude of about 25 to 30 volts peak-to-peak. The leading edge should be linear with no rounding off. When V106 is inserted and the bias properly set the waveform will be cut approximately in the middle horizontally.

IMPROPER FREQUENCY RESPONSE

If the frequency response is not correct, the audio section should again be checked for proper response. The frequency response as noted at TP120 should be approximately the desired overall frequency response. It usually will be 2 DB or so high at both extremes of the audio spectrum.

Should the frequency response noted at TP120 prove to be O.K., but overall frequency response be down at 15,000 cycles, it will usually be caused by too narrow a bandwidth or mis-tuning of some of the low frequency multiplier stages, L101 thru L107. L101 thru L103 are most apt to cause this difficulty. Improper tuning of the modulation and frequency monitor can also affect apparent frequency response.

A change in the components associated with the modulator stages can cause poor low frequency response, this is especially true of C112, C121, R114, R113, R115, R126 and R127.

WILL NOT MODULATE AT ALL

This condition will probably resolve down to a dead audio stage.

FM NOISE

If FM noise exists the audio stages can be quickly eliminated by pulling V117 from its socket. Noise in the audio stage can be caused by a heater to cathode leak or a filament wire lying near a grid connection. Hum from the power supply or improper regulation of the power supply can cause noise in the audio stages.

If the noise is not located in the audio stages, the next most probable suspect is the pulse stages of V101 thru V106. An amplitude variation in these stages will cause a frequency modulated noise component. This could be caused by a heater to cathode leak or failure of a stage to properly limit. Hum from the power supply could also cause this difficulty. Modulation at a 60 cycle rate can also be caused in the crystal circuit by induction from the crystal heater.

AM NOISE

AM noise is one fault that will not usually be traced to the audio stages because an amplitude variation in the audio stages causes an FM noise component to appear. While this type of difficulty can occur in most any stage except the audio stages, it is most apt to prevail in one of the frequency multiplier stages and usually near the higher frequency end of the multiplier chain. Hum in B+ coming from the power supply, heater to cathode leakage or an intermittent connection can cause this defect. Hum from heater to cathode leakage will show itself as a 60 cycle component and power supply hum as a 120 cycle component.

All Values Are RMS

Location	Reading
Pin 5, V107	13.5 V.
Junction C130,C131,L102	8.2 V.
Pin 1, V108	6.0 V.
Pin 5, V108	18.0 V.
Pin 1, V109	5.2 V.
Pin 5, V109	29.0 V.
Pin 1, V110	4.7 V.
Pin 5, V110	29.0 V.
Pin 1, V111	6.6 V.
Pin 5, V111	34.0 V.
J101, TP113	.47 V.
J102, TP114	.51 V.
Pin 5, V112	6.2 V.
Pin 6, V112	6.4 V.
Pin 1 & 2, V112	21.0 V.
Pin 5, V113	9.0 V.
Pin 6, V113	10.5 V.
Pin 1 & 2, V113	23.0 V.
Pin 5, V114	9.0 V.
Pin 6, V114	9.5 V.
Pin 1 & 2, V114	26.0 V.
Pin 1 & 3, V115	19.0 V.
Pin 6 & 8, V115	150 V.

PARTS LIST

Symbol No.	Gates Drawing No.	Description
A101	396 0045 000	Lamp, 6-8 V. #47
C101, C102, C103, C171	506 0005 000	Cap., 0.1 uf., 200 V.(W) D.C.
C104	520 0301 000	Cap., Variable, 5-100 uuf.
C105	516 0193 000	Cap., 150 uuf., 600 V. (W) D.C.
C106, C123, C147, C148, C155, C157, C189	516 0054 000	Cap., .001 uf., 1000 V.(W) D.C.
C107	516 0185 000	Cap., 50 uuf., 600 V.(W) D.C.
C108, C114	516 0191 000	Cap., 100 uuf., 600 V.(W) D.C.
C109, C120, C127, C128, C129, C132, C133, C134, C173	516 0082 000	Cap., .01 uf., 1 KV.
C110, C118, C135, C137, C138, C139, C141, C142, C143, C146	516 0074 000	Cap., .005 uf., 1000 V.(W) D.C.
C111, C119	520 0292 000	Cap., Variable, 50-400 uuf.
C112, C121	506 0009 000	Cap., 2 uf., 200 V.(W) D.C.
C113, C149, C156	516 0173 000	Cap., 10 uuf., 600 W.V. D.C.
C155, C116	506 0017 000	Cap., 1 uf., 400 V. (W) D.C.
C122, C130, C131	516 0175 000	Cap., 15 uuf., 600 V.(W) D.C.
C136, C158	516 0172 000	Cap., 5 uuf., 600 V.(W) D.C.
C140, C144, C145	502 0183 000	Cap., 1 uuf., ±2.5 mmf. 500 V. (W) D.C.
C150, C152	516 0252 000	Cap., 330 uuf., 600V.(W) D.C.
C151, C153	516 0179 000	Cap., 25 uuf., 600V.(W) D.C.
C154	506 0016 000	Cap., 0.5 uf., 400V.(W) D.C.
C159, C160, C161, C163, C165, C166, C188, C190, C191	516 0043 000	Cap., 470 uuf., 1KV (W) D.C.
C162, C169	520 0112 000	Cap., Variable 2.7-19.6 uuf.
C164, C167	520 0169 000	Cap., Variable 2.4-10.8 uuf.
C168		Cap., 500 uuf., 500 W V. D.C.

Symbol No.	Gates Drawing No.	Description
C174, C175, C176, C177, C178, C179, C185, C186, C187	516 0319 000	Cap., 1000 uuf., 500V.(W) D.C.
C170	516 0195 000	Cap., 200 uuf., 600V.(W) DC
C171	506 0014 000	~~D.C.~~ Cap. .1 uf 400W (W) DC
C172	516 0067 000	Cap., .003 uf., 1000V.(W) D.C.
C180	522 0133 000	Cap., 16 uf., 450V.(W) D.C.
C181, C182	524 0013 000	Cap., 30/30 uf., 525 V.(W) D.C.
C183, C184	506 0012 000	Cap., .03 uf., 400V.(W) D.C.
F101	398 0079 000	Fuse, Slo-blo, 1-1/2 amp.
F102	398 0011 000	Fuse, 1/4 amp.
HR101	558 0016 000	Crystal Oven, 6.3 V. 60° C.
J101, J102	612 0237 000	Receptacle, UG-290A/U
J103	612 0232 000	Receptacle, UG-58/U
L101	913 1104 001	Freq. Mult. Coil Assy.
L102, L103	913 1105 001	Freq. Mult. Coil Assy.
L104	913 1106 001	Freq. Mult. Coil Assy.
L105	913 1107 001	Freq. Mult. Coil Assy.
L106, L107	913 1108 001	Freq. Mult. Coil Assy.
L108, L109	913 1109 001	Freq. Mult. Coil Assy.
L110, L111	913 1110 001	Freq. Mult. Coil Assy.
L112, L115	492 0025 000	Coil, 2-3.7 uh.
L113	492 0027 000	Coil, 3.4-7 uh.
L114	492 0024 000	Coil, Var. w/Brass Slug
L116	813 1112 001	Plate Coil for V114
L117	813 1113 001	Grid Coil for V115
L118	813 1114 001	Plate Coil for V115
L119		Output Coupling Coil for V115 (Pt. of 6360 output coil Assy)
L120		R.F. choke, 3.3 uh.
L122, L123, L126, L127, L128	494 0004 000	R.F. Choke
L121	476 0013 000	Choke, 6 hy,@ 160 ma., 165 ohm.
L124, L125	913 1116 001	Parasitic Suppressor

Symbol No.	Gates Drawing No.	Description
P101,P102		Plug, UG-88/U
P103	620 0122 000	Adaptor, UG-27/U
R101,R178, R179	540 0218 000	Res., 2.2 meg., 1/2W., 10%
R102	540 0476 000	Res., 4700 ohm, 1W., 10%
R103	540 0644 000	Res., 24K ohm, 2W., 5%
R104	540 0758 000	Res., 33K ohm, 2 W., 10%
R183	540 0213 000	Res., 820K ohm, 1/2W., 10%
R185	540 0188 000	Res., 6800 ohm, 1/2W., 10%
R186,R187, R190,R191	540 0171 000	Res., 270 ohm, 1/2W., 10%
R188,R189	540 0160 000	Res., 33 ohm, 1/2W., 10%
R192	913 2346 001	Resistor Assy. 0.1 ohm
S101	604 0001 000	Toggle Switch
S102	602 0005 000	Switch, 3 pos., 2 pole
T101	472 0088 000	Heater Transformer, Pri. 115 V., 50/60 Cy., Sec. 6.3 V. C.T. @ 1.2 Amp.
T102	478 0144 000	Audio Input Transformer
T103	472 0248 000	Power Transformer
TB101	614 0054 000	Terminal Board
TP101 thru TP121	612 0312 000	Test Point Jack
TP122,TP123	612 0311 000	Test Point Jack
V101,V102, V105	370 0229 000	Tube, 7025.
V103,V104, V106	370 0028 000	Tube, 6201.
V107,V108,V109, V110,V111,V121	370 0040 000	Tube, 6AU6.
V112,V113, V114	370 0082 000	Tube, 6J6
V115	374 0054 000	Tube, 6360
V116	370 0116 000	Tube, ECC83/12AX7
V117	370 0170 000	Tube, 6AQ5
V118	370 0133 000	Tube, GZ34/5AR4
V119	370 0158 000	Tube, 6080
V120,V122	370 0001 000	Tube, 0A2

Symbol No.	Gates Drawing No.	Description
XA101	406 0057 000	Pilot Light Assembly
XC181,XC182, XV118,XV119	404 0016 000	Socket, 8 pin
XF101,XF102	402 0021 000	Fuseholder
XHR 101	404 0068 000	Socket, 8 pin
XV101,XV102, XV103,XV104, XV105,XV106, XV115,XV116	404 0042 000	Socket, 9 pin miniature
XV107,XV108, XV109,XV110, XV111,XV113, XV114,XV117, XV120	404 0038 000	Socket, 7 pin miniature
Y101		Crystal in T9D Holder

WARRANTY

This equipment is warranted by Gates Radio Company of Quincy, Illinois to be free from defects in workmanship and material and will be repaired or replaced in accordance with the terms and conditions set forth below:

1. Gates Radio Company believes that the purchaser has every right to expect first-class quality, materials and workmanship and has created rigid inspection and test procedures to that end, and excellent packing methods to assure arrival of equipment in good condition at destination.

2. Gates Radio Company will endeavor to make emergency shipments at the earliest possible time giving consideration to all conditions.

3. Gates Radio Company warrants new equipment of its manufacture for one (1) year, (six (6) months on moving parts), against breakage or failure of parts due to imperfection of workmanship or material, its obligation being limited to repair or replacement of defective parts upon return thereof f.o.b. Gates Radio Company's factory, within the applicable period of time stated. Electron tubes shall bear only the warranty of the manufacturer thereof in effect at the time of the shipment to the purchaser. Other manufacturers' equipment covered by a purchaser's order will carry only such manufacturers' standard warranty. These warranty periods commence from the date of invoice and continue in effect as to all notices, alleging a defect covered by this warranty, received by Gates Radio Company prior to the expiration of the applicable warranty period.

The following will illustrate features of the Gates Radio Company warranty:

Transmitter Parts: The main power or plate transformer, modulation transformer, modulation reactor, main tank variable condensers all bear the one (1) year warranty mentioned above.

Moving Parts: As stated above, these are warranted for a period of six (6) months.

Electron Tubes: As stated, electron tubes will bear such warranty, if any, as provided by the manufacturer at the time of their shipment. Gates Radio Company will make such adjustments with purchasers as given to Gates Radio Company by the tube manufacturer.

All other component parts (except as otherwise stated): Warranted for one (1) year.

Abuse: Damage resulting from abuse, an Act of God, or by fire, wind, rain, hail, in transportation, or by reason of any other cause or condition, except normal usage, is not covered by this warranty.

4. Operational warranty - Gates Radio Company warrants that any new transmitter of its manufacture, when properly installed by purchaser and connected with a suitable electrical load, will deliver the specified radio frequency power output at the output terminal(s) of the transmitter, but Gates Radio Company makes no warranty or representation as to the coverage or range of such apparatus. If a transmitter

does not so perform, or in the event that any equipment sold by Gates Radio Company does not conform to any written statement in a contract of sale relative to its operating characteristics or capabilities, the sale liability of Gates Radio Company shall be, at the option of Gates Radio Company, either to demonstrate the operation of the equipment in conformance with its warranty, or to replace it with equipment conforming to its warranty, or to accept its return, f.o.b. purchaser's point of installation and refund to purchaser all payments made on the equipment, without interest. Gates Radio Company shall have no responsibility to the purchaser under a warranty with respect to operation of equipment unless purchaser shall give Gates Radio Company a written notice, within one (1) month after arrival of equipment at purchaser's shipping point, that the equipment does not conform to such warranty.

5. Any item alleged by a purchaser to be defective, and not in conformance with a warranty of Gates Radio Company shall not be returned to Gates Radio Company until after written permission has been first obtained from the Gates Radio Company home office for such return. Where a replacement part must be supplied under a warranty before the defective part can be returned for inspection, as might be required to determine the cause of a defect, purchaser will be invoiced in full for such part, and if it is determined that an adjustment in favor of the purchaser is required, a credit for an adjustment will be given by Gates Radio Company upon its receipt and inspection of a part so returned.

6. All shipments by Gates Radio Company under a warranty will be f.o.b. Quincy, Illinois or f.o.b. the applicable Gates Radio Company shipping point.

7. Gates Radio Company is not responsible for the loss of, or damage to, equipment during transportation or for injuries to persons or damage to property arising out of the use or operation of Gates equipment. If damage or loss during transportation occurs, or if the equipment supplied by Gates Radio Company is otherwise damaged, Gates will endeavor to make shipment of replacement parts at the earliest possible time giving consideration to all conditions. It is the responsibility of a purchaser to file any claim for loss or damage in transit with the transportation company and Gates will cooperate in the preparation of such claims to the extent feasible when so requested.

8. Gates Radio Company, in fulfilling its obligations under its warranties, shall not be responsible for delays in deliveries due to depleted stock, floods, wars, strikes, power failures, transportation delays, or failure of suppliers to deliver, acts of God, or for any condition beyond the control of Gates that may cause a delayed delivery.

9. This warranty may not be transferred by the original purchaser and no party, except the original purchaser, whether by operation of law or otherwise, shall have or acquire any rights against Gates Radio Company by virtue of this warranty.

10. Gates Radio Company reserves the right to modify or rescind, without notice, any warranty herein except that such modification or rescission shall not affect a warranty in effect on equipment at the time of its shipment. In the event of a conflict between a warranty in a proposal and acceptance and a warranty herein, the warranty in the proposal and acceptance shall prevail.

11. This warranty shall be applicable to all standard Gates catalog items sold on or after March 1, 1960.

12/13/61

Gates Radio Company
Quincy, Illinois

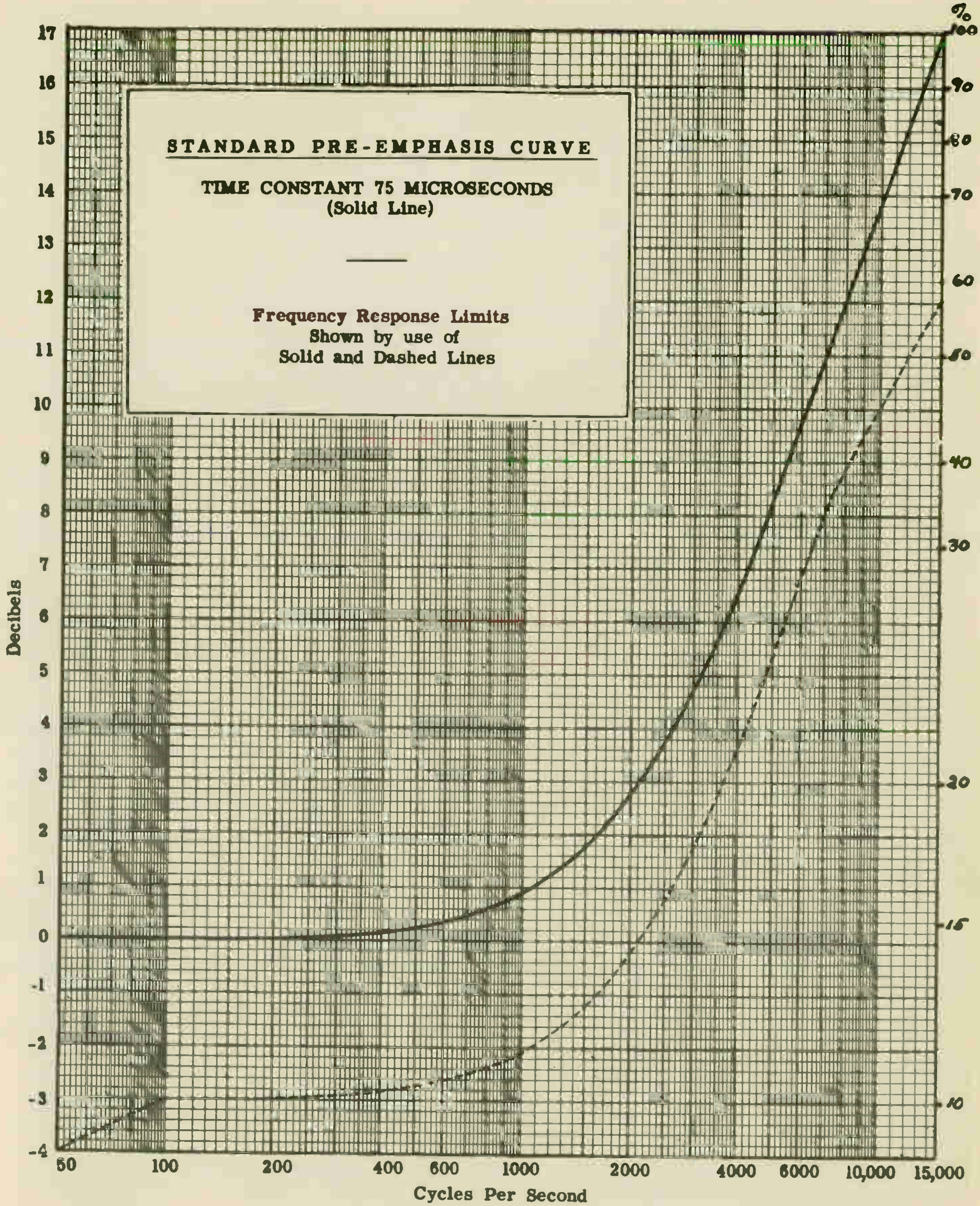
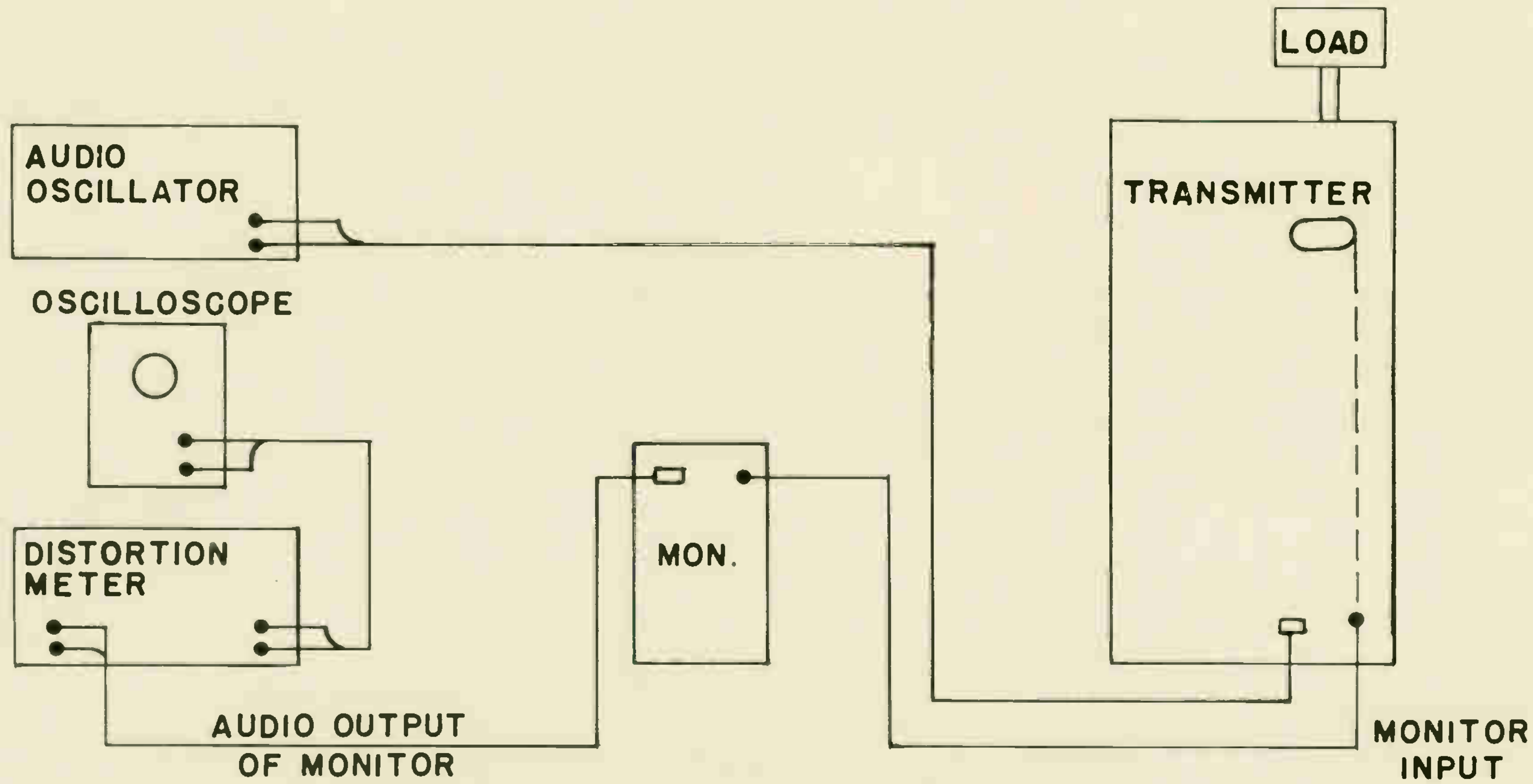
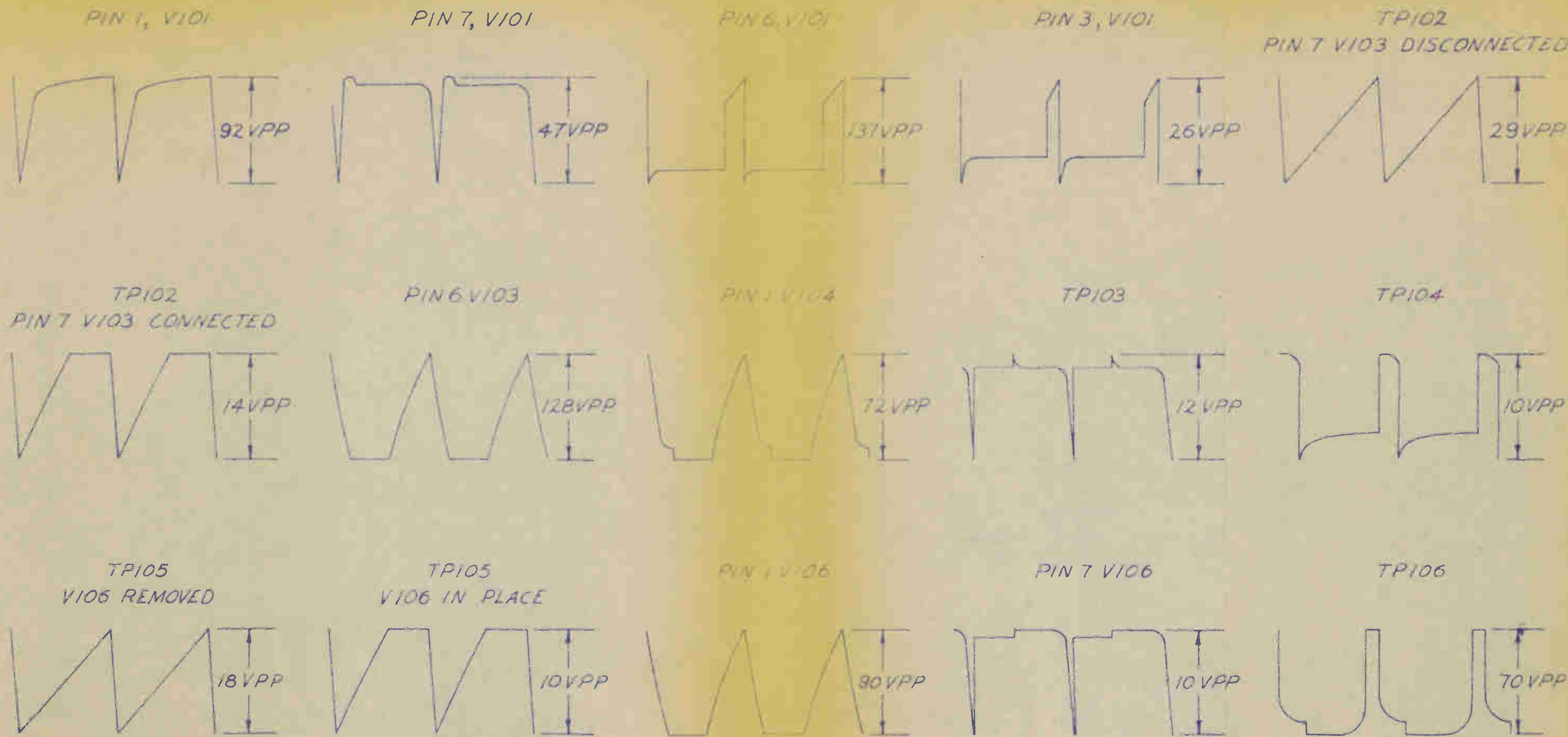


FIGURE 12

ES-6170



REDRAWN CJN 12-31-58	REDRAWN WLS 1-7-56	GATES RADIO COMPANY QUINCY, ILLINOIS	
		TEST SETUP FOR F.M.	
		DR. CRB	A-4165
		CH. BEP	ENG BEP

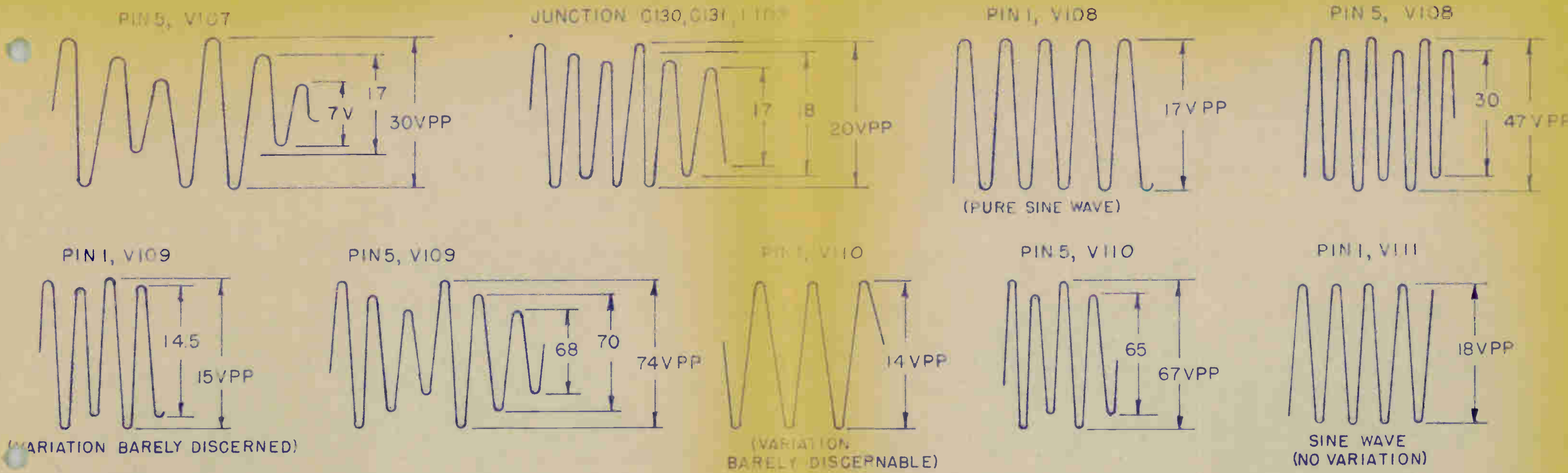


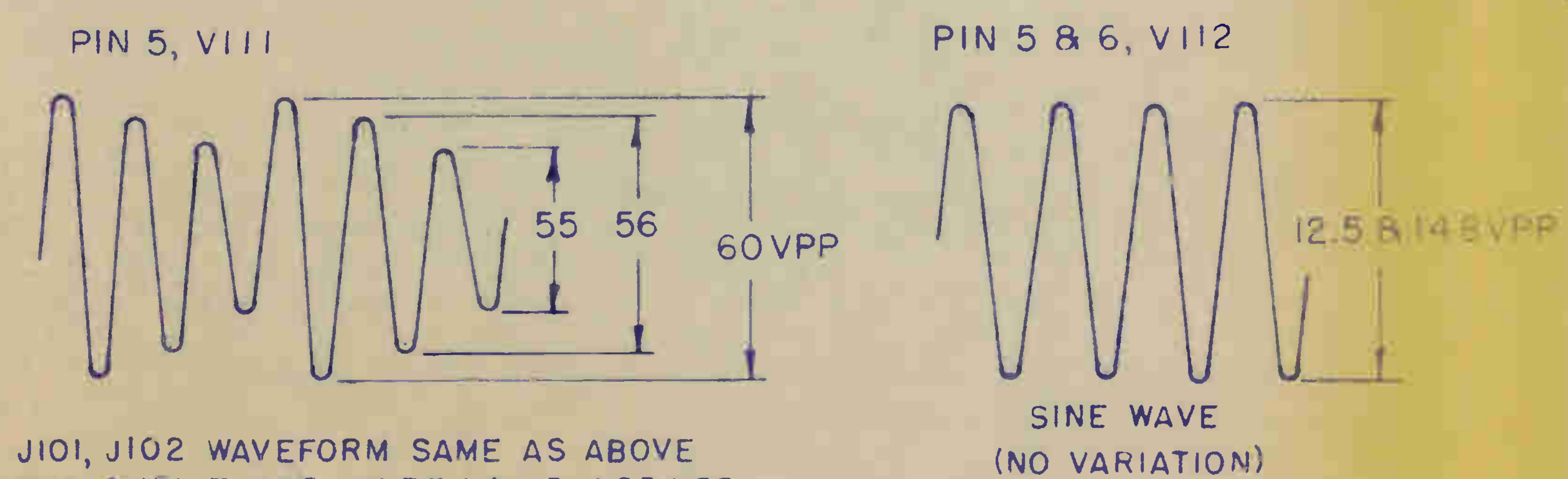
NOTE:

THE ABOVE PP WAVEFORM MEASUREMENTS WERE MADE WITH A MODEL 524 AD TEXTRONIX SCOPE. AN UNCALABRATED SCOPE MAY BE CALIBRATED BY USING FILAMENT VOLTAGE TO SET A REFERENCE. PEAK TO PEAK VOLTAGE EQUALS 2.8 X RMS VALUE. 6.3 VAC = 17.5 VPP.

TYPICAL WAVEFORMS OF STAGES V101 THROUGH V106 OF THE M6095 EXCITER

826 7991 001





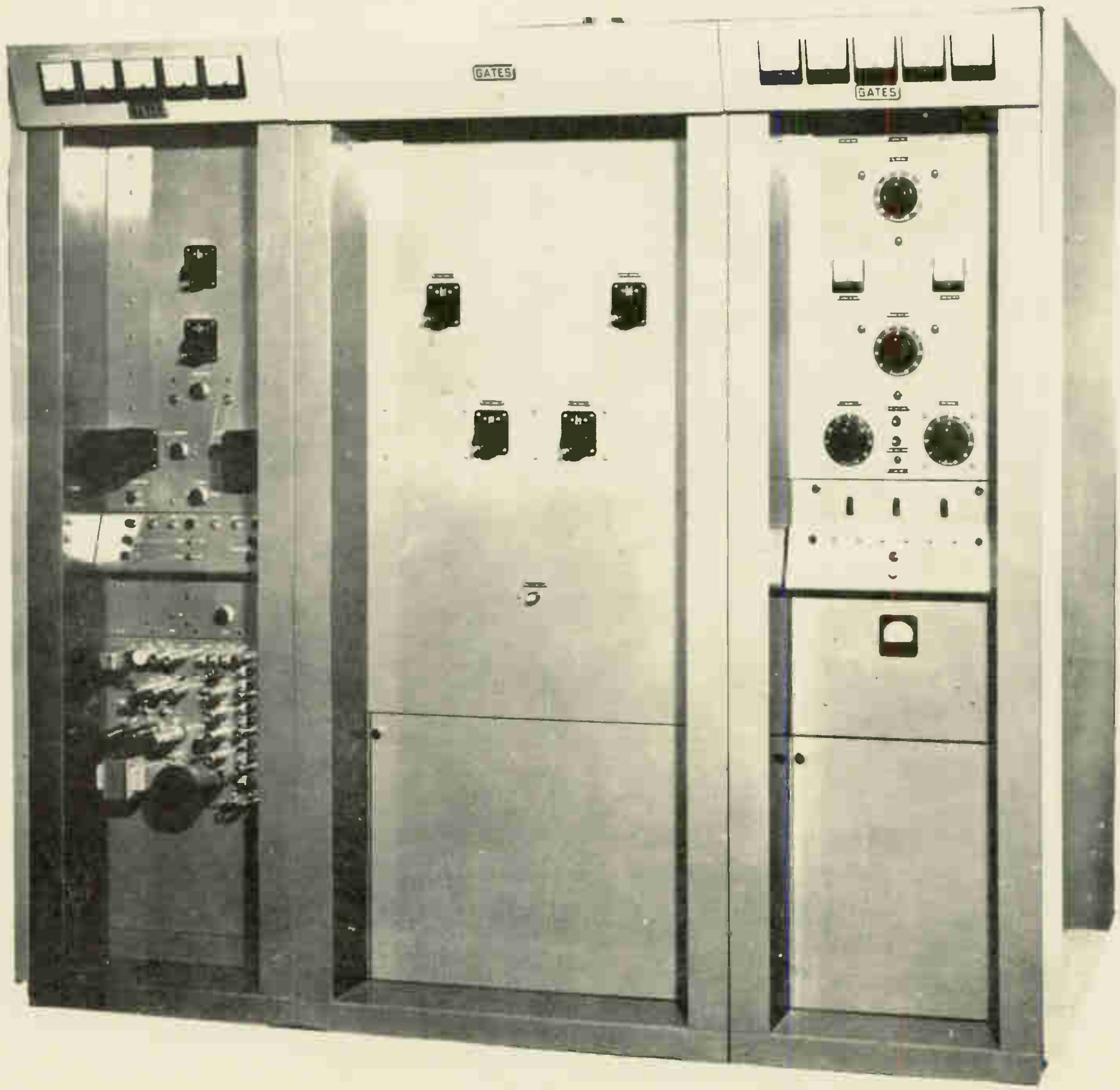
J101, J102 WAVEFORM SAME AS ABOVE BUT AMPLITUDES WERE 1.4, 1.3, 1.25 VPP RESPT.

NOTE: TO MAKE THE WAVEFORM MEASUREMENTS SHOWN ON THIS DRAWING, A MODEL 524AD TEXTRONIX SCOPE WAS USED. AN ATTENUATOR PROBE WAS USED WHICH REDUCED CAPACITY. FREQUENCY OF THE UNIT UNDER TEST WAS 88.1 MC. IN EACH CASE THE STAGE UNDER TEST HAD TO BE RETURNED WHEN THE PROBE WAS CONNECTED. IT MAY BE IMPOSSIBLE TO RE-RESONATE THE CIRCUIT UNDER TEST IF THE EXCITER IS TUNED UP NEAR THE HIGH END OF THE BAND.

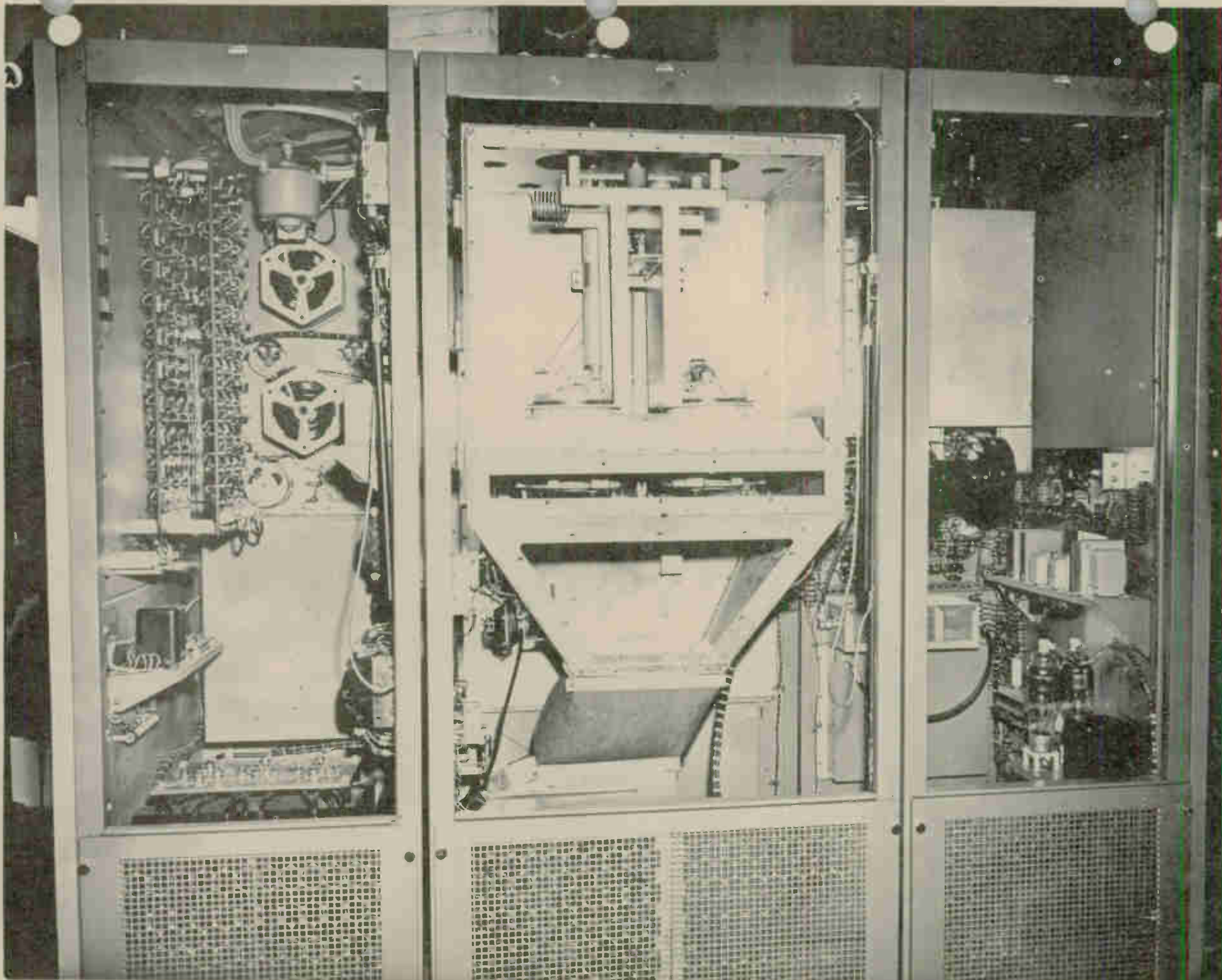
IF AN UNCALIBRATED SCOPE IS USED, IT MAY BE CALIBRATED BY USING FILAMENT VOLTAGE TO SET A REFERENCE. PEAK TO PEAK VOLTAGE EQUALS 2.8 X RMS VALUE. 6.3 VAC THEN EQUALS 17.5 VPP.
IT WAS IMPOSSIBLE TO SYNC SCOPE AFTER V112.

TYPICAL WAVEFORMS OF STAGES
V107 THROUGH V112. M6095 EXCITER

826 7990 001



800 0184 002



800 0202 001

GATES RADIO COMPANY
QUINCY, ILLINOIS

A-35549

SCALE

LIST OF PARTS

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

TUBE DATA 4-400A

Class "C" Maximum CCS Ratings (per tube)

DC Plate Voltage	4000 max. volts
DC Screen Voltage	600 max. volts
DC Plate Current	350 max. MA.
Plate Dissipation	400 max. watts
Screen Dissipation	35 max. watts
Grid Dissipation	10 max. watts
Filament voltage	5.0 ±5% volts
Filament current	14.5 amp.

AIR COOLING DATA

Plate Dissipation	400 watts
Min. air flow (cu.ft/min)	14
Inlet pressure (inches of water)	.25
Max. Base Seal (°C)	200°
Max. Plate Seal (°C)	220°

STATUS

DEVELOPMENT	PRODUCTION
MECH. CHK.	
PROJ. ENG.	

CH. BY
DATE
DR. BY
DATE
MTL.
ENG.
FIN.

TITLE TUBE DATA 4-400A

UNLESS OTHERWISE SPECIFIED ALL TOLERANCES PER GATES SPEC.

A-35549

GATES RADIO COMPANY QUINCY, ILLINOIS		A SCALE

LIST OF PARTS

QTY.	QTY.	QTY.	QTY.	ITEM	REFERENCE	PT. OR G.N.	FIN.	DESCRIPTION	MAT'L

Radio Frequency Power Amplifier (60 - 110 Mc)

Maximum Ratings:

D.C. Plate Voltage - 6500 volts

D.C. Screen Voltage - 1500 volts

D.C. Plate Current - 2.5 amps.

Plate Dissipation - 10,000 watts

Screen Dissipation - 250 watts

Grid Dissipation - 75 watts

Filament Voltage - 7.5 volts ±5%

Filament Current - 75 amps.

Cooling: To maintain tube seal temperature at 200°C. at 50°C. ambient air temperature.

Plate Dissipation	CFM (Sea Level)	Inches of Water Pressure
4000 watts	100	0.3
6000 watts	190	0.8
8000 watts	290	1.5
10,000 watts	400	2.5

STATUS

DEVELOPMENT	PRODUCTION

CH. BY / DATE — MTL.
DR. BY / DATE — ENG. J.B. — FIN.

TITLE: TUBE DATA, 4CX10,000D

UNLESS OTHERWISE SPECIFIED ALL TOLERANCES PER GATES SPEC. — A

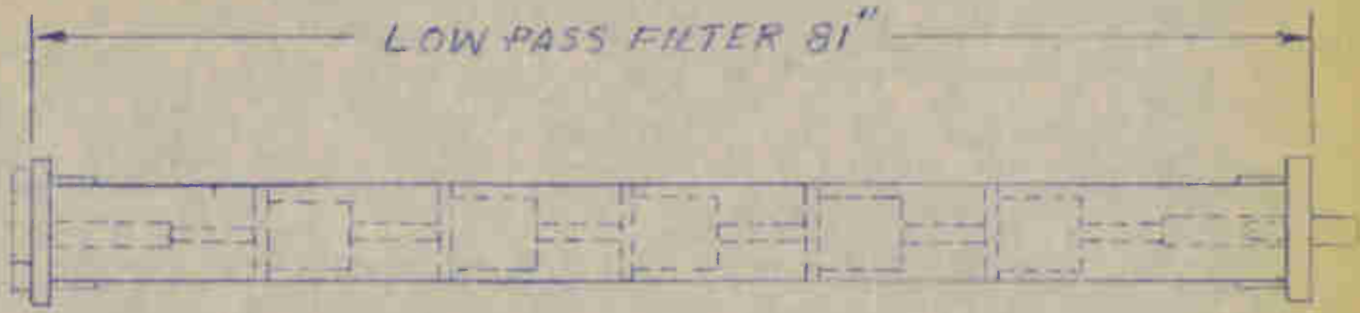
GATES RADIO COMPANY
QUINCY, ILLINOIS

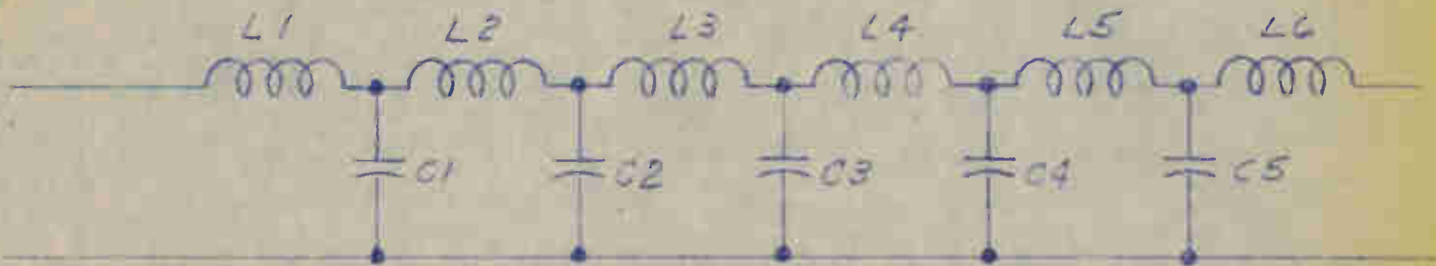
813 6243 001

SCALE NTS

LIST OF PARTS

104 QTY.	103 QTY.	102 QTY.	101 QTY.	ITEM	REFERENCE	PT. OR G.N.	FIN.	DESCRIPTION	MATL.





EQUIVALENT CIRCUIT - LOW PASS FILTER

NOTE: 6 1/8" TRANSMISSION LINE
INPUT & OUTPUT 3 1/8" EIA FLANGE

STATUS	
DEVELOPMENT	PRODUCTION
MECH. ENG.	
PROJ. ENGR. JB	
APPROVAL FOR PRODUCTION BY	

5/10

CH. BY / DATE	MTL.	TITLE SCHEMATIC HARMONIC FILTER FOR FM 10KW-20 KW. XMTR.	UNLESS OTHERWISE SPECIFIED ALL TOLERANCES PER GATES SPEC.
DR. BY / DATE	ENG. / FIN.		813 6243 001

GATES RADIO COMPANY
QUINCY, ILLINOIS

A 34515

SCALE

LIST OF PARTS

104 QTY.	103 QTY.	102 QTY.	101 QTY.	GR. NO. ITEM	REFERENCE	PT. OR G.N.	FIN.	DESCRIPTION	MATL.

STATUS	
DEVELOPMENT	PRODUCTION

ECN 8535 1
ANC 2-15-61

CH. BY	MTL.	TITLE SCHEMATIC - REMOTE FILAMENT METERING KIT M6092	UNLESS OTHERWISE SPECIFIED ALL TOLERANCES PER GATES SPEC.
DATE			
DR. BY	ENG.	FIN.	A 34515
DATE			

TRANSFORMER SPECIFICATIONS

TRANSFORMER CLASSIFICATION

Power Transformer

SPECIFICATIONS ARE TO RETMA STANDARDS UNLESS OTHERWISE NOTED.

PRIMARY— 208, 230, 240 Volt. 3 Phase Delta. 50/60 cycle

SECONDARY— WYE connected with neutral terminal.
D.C. from 20 ohm filter to be 6500 volts.
Current in load to be 5.5 A., D.C.
continuous. Voltage variation from
1.5 amps. to 5.5 A. to be 5% or less.
Rectifiers to be full wave mercury
vapor tubes.

SHIELDING— None

TYPE OF CONNECTIONS— Primary: Stud Terminals
Secondary: Coil Studs.

HIPOT TEST (ALL VOLTAGES ARE RMS)

COIL TO COIL— 16,000 volts

PRIMARY TO CORE AND CASE— 4,000 volts

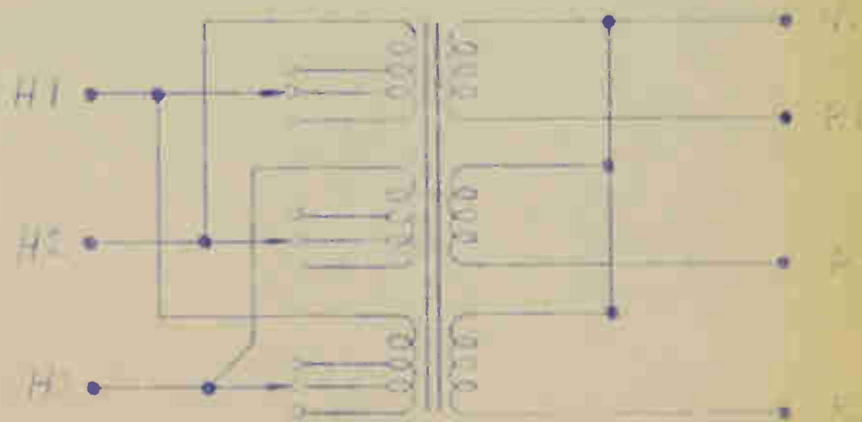
SECONDARY TO CORE AND CASE— 16,000 volts

TEMPERATURE RISE—

ADDITIONAL INFORMATION

May be open frame construction
Dry type construction
Space limited, physical size to be
as small as ratings will permit.
Finish with non-nutrient varnish.

For Case dimensions
see Sheet Two.



[illegible]-61 [illegible]
changed current
rating from
5 A. to 5.5A

OUTLINE

SCHEMATIC

Identical Units Electrically

Sheet 1 of 2

Manufacturers Part No.	Date— 10/12/60	First Made For—	Gates Radio Company Specification Number
[illegible]	Eng.— [illegible]	[illegible] FM Amplifier	[illegible]

TRANSFORMER SPECIFICATIONS

TRANSFORMER CLASSIFICATION	SPECIFICATIONS ARE TO RETMA STANDARDS UNLESS OTHERWISE NOTED.
FILTER REACTOR	

PRIMARY— 2 henries minimum at 5.5 A. D.C.
15 ohms or less D.C. resistance.

SECONDARY—

SHIELDING— None

TYPE OF CONNECTIONS— Coil Studs.

HIPOT TEST (ALL VOLTAGES ARE RMS)

COIL TO COIL—

PRIMARY TO CORE AND CASE—

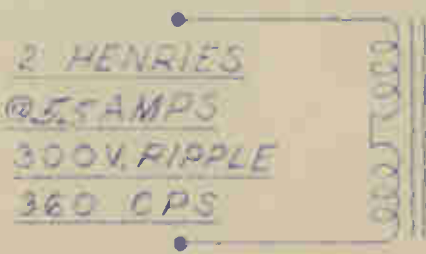
SECONDARY TO CORE AND CASE— 16,000 volts

TEMPERATURE RISE—

ADDITIONAL INFORMATION

H.V. Filter, 6500 volts D.C.
Dry type construction.
Space is limited, physical size to
be as small as the ratings will permit.
Open type construction may be used.
Continuous duty.
Finish with non-nutrient varnish.

For Case Dimensions
see Sheet Two.



7-24-61 S.V.
Changed current
rating from
5 A. to 5.5A.

OUTLINE

SCHEMATIC

Identical Units Electrically

Sheet 1 of 2

Manufacturer's Part No.	Date— 10-12-60	First Made For—	Gates Radio Company Specification Number
[illegible]	Eng.— J.C.	[illegible] FM Amplifier	[illegible]

TRANSFORMER SPECIFICATIONS

TRANSFORMER DESIGNATION	SPECIFICATIONS ARE TO RETMA STANDARDS UNLESS OTHERWISE NOTED.
FILAMENT TRANSFORMER	

PRIMARY— 208, 230, 240 volts, [illegible] cycle

SECONDARY— Two separate windings,
7.5 volts at 85 amps. with center tap.

SHIELDING— None

TYPE OF CONNECTIONS— Pri: Barrier Strip
Sec: Coil Studs

HIPOT TEST (ALL VOLTAGES ARE RMS)

COIL TO COIL— 2000 volts

PRIMARY TO CORE AND CASE— 2000 volts

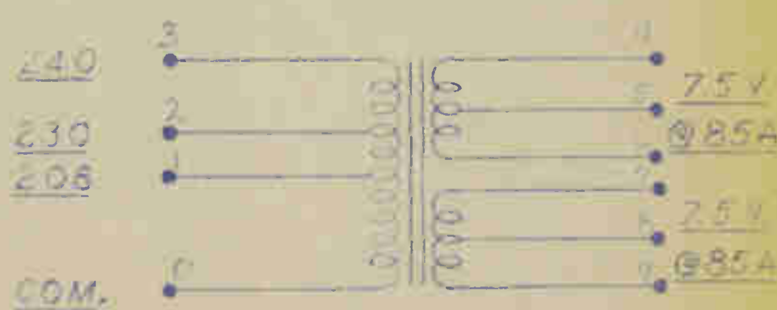
SECONDARY TO CORE AND CASE— 2000 volts

TEMPERATURE RISE—

ADDITIONAL INFORMATION

Dry type construction
For Eimac type 4CX5000A tubes.
Similar to Electro Engineering
E-11601 filament transformer.
For continuous service.
Finish with non-nutrient varnish.

For Case Dimensions -
See Sheet 2.



OUTLINE SCHEMATIC

Identical Units Electrically

Manufacturer's Part No.	Date [illegible]	First Made For—	Gates Radio Company Specification Number
[illegible]	[illegible]	[illegible] FM Amplifier	[illegible]

TRANSFORMER SPECIFICATIONS

TRANSFORMER CLASSIFICATION	SPECIFICATIONS ARE TO RETMA STANDARDS UNLESS OTHERWISE NOTED
POWER TRANSFORMER	

PRIMARY— 208, 230, 240 V. A.C. 50/60 Cycle

SECONDARY— No C.T. - D.C. from low impedance filter to be 1500 Volts. Current in load to be 500 MA. Rectifier to be full-wave bridge type using silicon rectifiers.

SHIELDING— None

TYPE OF CONNECTIONS— Primary (barrier strip)
Sec. (10-32 Studs)

HIPOT TEST (ALL VOLTAGES ARE RMS)

COIL TO COIL— 7500 Volts

PRIMARY TO CORE AND CASE— 2,000 Volts

SECONDARY TO CORE AND CASE— 7,500 Volts

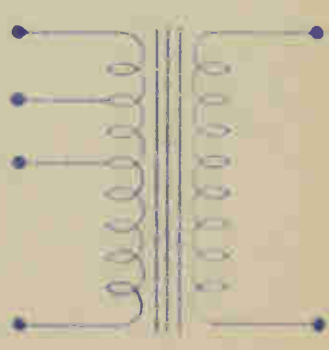
TEMPERATURE RISE—

ADDITIONAL INFORMATION

May be open frame construction.
Dry type construction.
Space limited, physical size to be as small as rating will permit.

Finish with non-nutrient varnish.

For Case Dimensions see sheet two.



OUTLINE SCHEMATIC

Identical Units Electrically

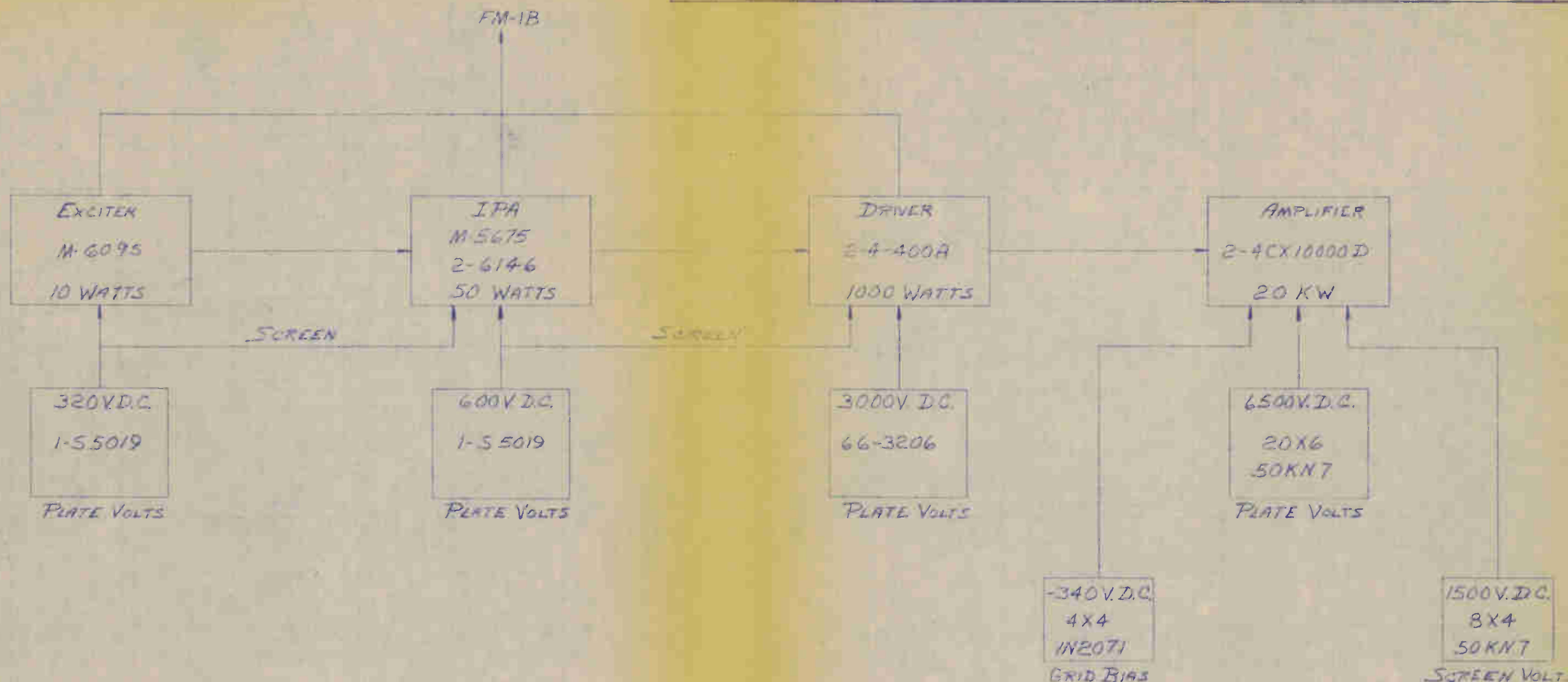
Manufacturers Part No.	Date— [illegible]	First Made For—	Gates Radio Company Specification Number
[illegible]	Eng.— J.B.	[illegible]	[illegible]

GATES RADIO COMPANY
QUINCY, ILLINOIS

SCALE

LIST OF PARTS

105 QTY.	106 QTY.	104 QTY.	103 QTY.	102 QTY.	101 QTY.	ITEM	REFERENCE	PT. or G.N.	FIN.	DESCRIPTION	MATERIAL



STATUS

DEVELOPMENT	PRODUCTION

TITLE **BLOCK DIAGRAM FM 20/15 TRANSMITTER**

MTL. — FIN. —

DR. BY | CH. BY | ENG | SHEET OF

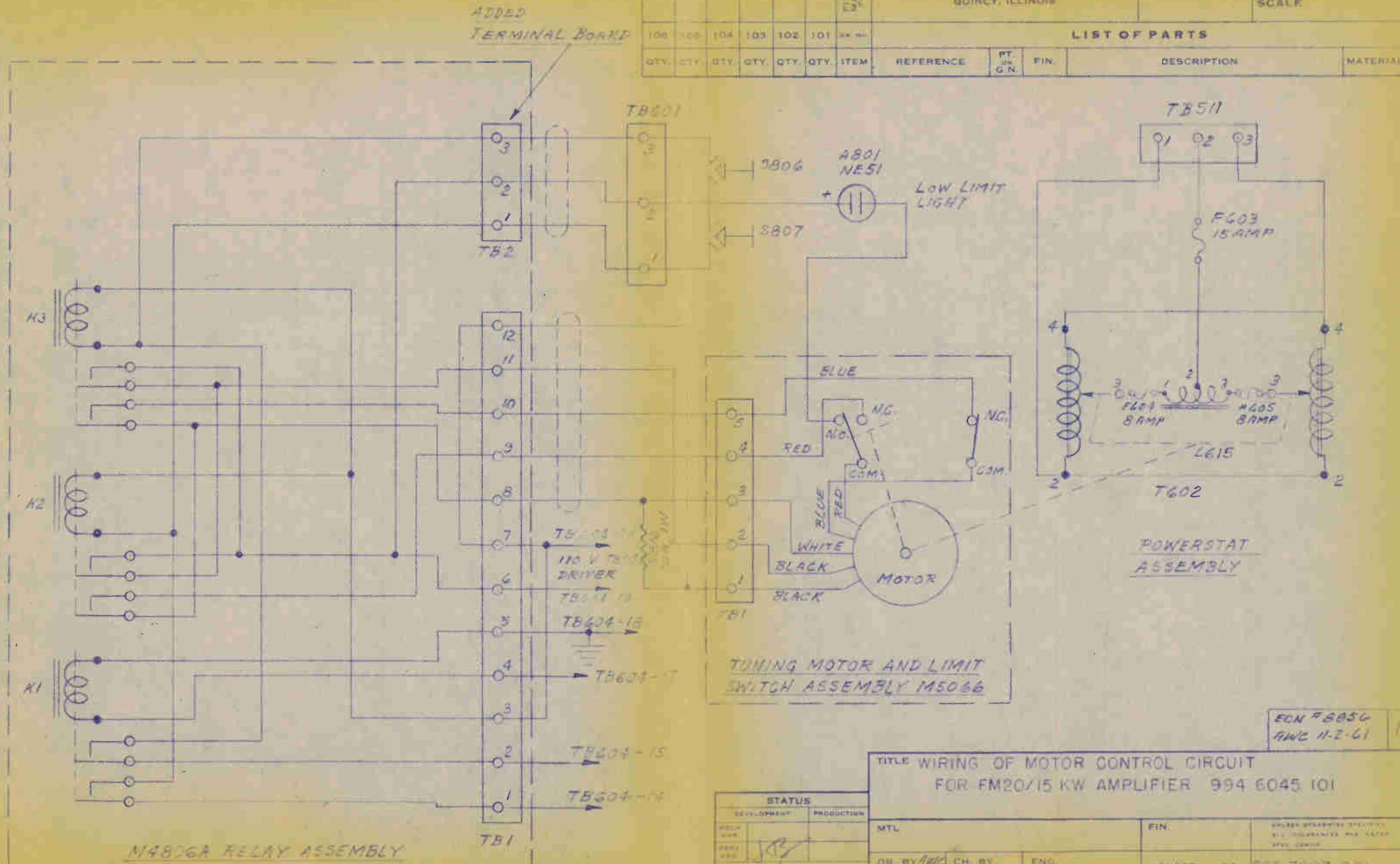
926-7807-001

GATES RADIO COMPANY
QUINCY, ILLINOIS

SCALE

QTY. 106	QTY. 105	QTY. 104	QTY. 103	QTY. 102	QTY. 101	ITEM	REFERENCE	PT. ON G.N.	FIN.	DESCRIPTION	MATERIAL

LIST OF PARTS



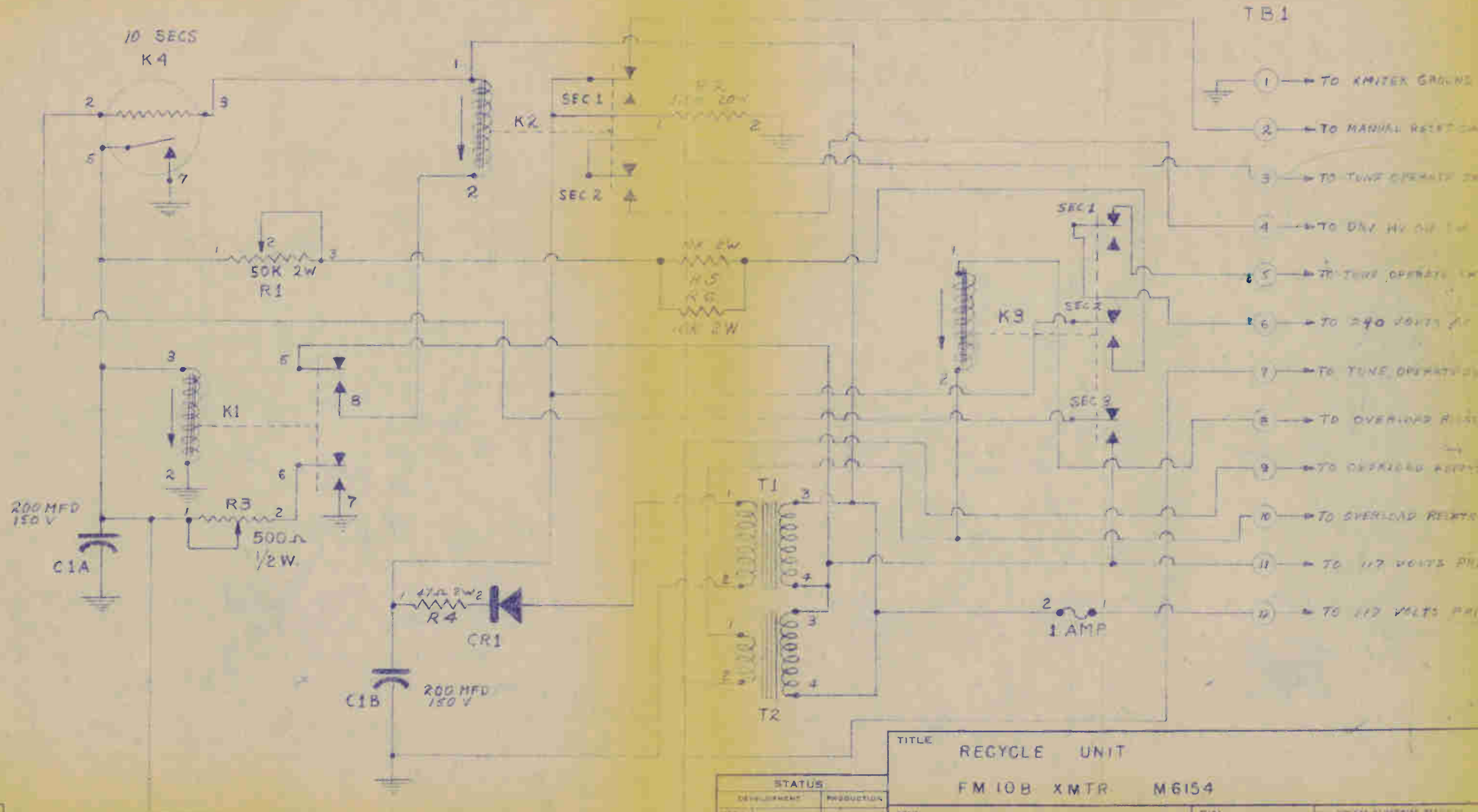
TITLE WIRING OF MOTOR CONTROL CIRCUIT FOR FM20/15 KW AMPLIFIER 994 6045 101

STATUS: DEVELOPMENT | PRODUCTION

MTL. | FIN.

DR. BY AWC CH. BY | ENG. | SHEET OF | 820 7887 001

						DWG. SIZE	GATES RADIO COMPANY QUINCY, ILLINOIS			B-67314 SCALE
106	105	104	103	102	101		LIST OF PARTS			
QTY.	QTY.	QTY.	QTY.	QTY.	QTY.	ITEM	REFERENCE	PT. or G.N.	FIN.	DESCRIPTION	MATERIAL



ECN 8661 5-29-61 AWC	2
ECN 8559	1

STATUS	
DEVELOPMENT	PRODUCTION

TITLE

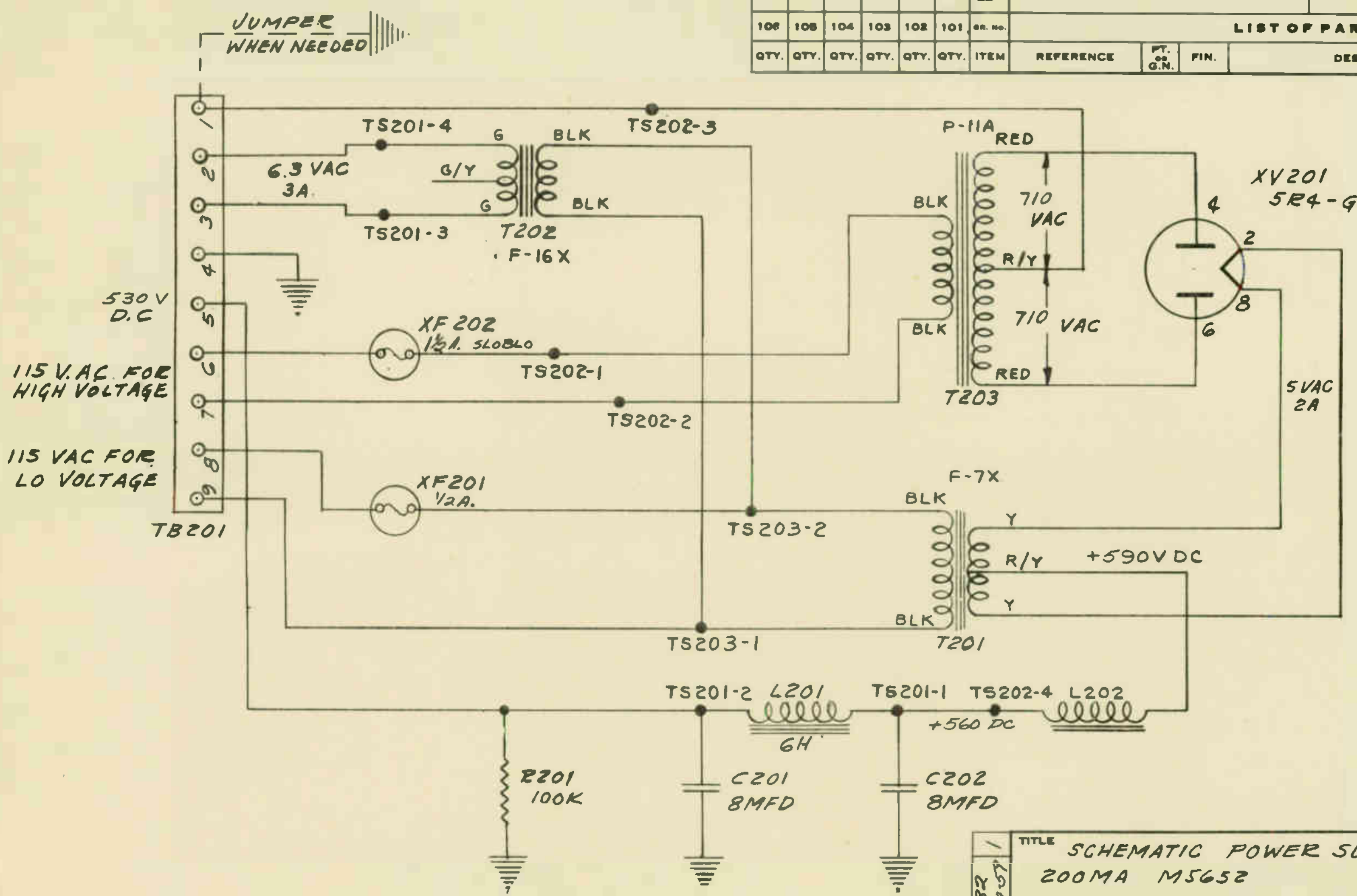
RECYCLE UNIT

FM 10B XMTR M6154

MTL | FIN.

DR. BY | CH. BY | SHEET 1 OF 1 | B-67314

							GATES RADIO COMPANY QUINCY, ILLINOIS		B-65503
						FIRST MADE FOR			SCALE
106	105	104	103	102	101	GR. NO.	LIST OF PARTS		
QTY.	QTY.	QTY.	QTY.	QTY.	QTY.	ITEM	REFERENCE	PT. OR G.N.	FIN.	DESCRIPTION	MATERIAL



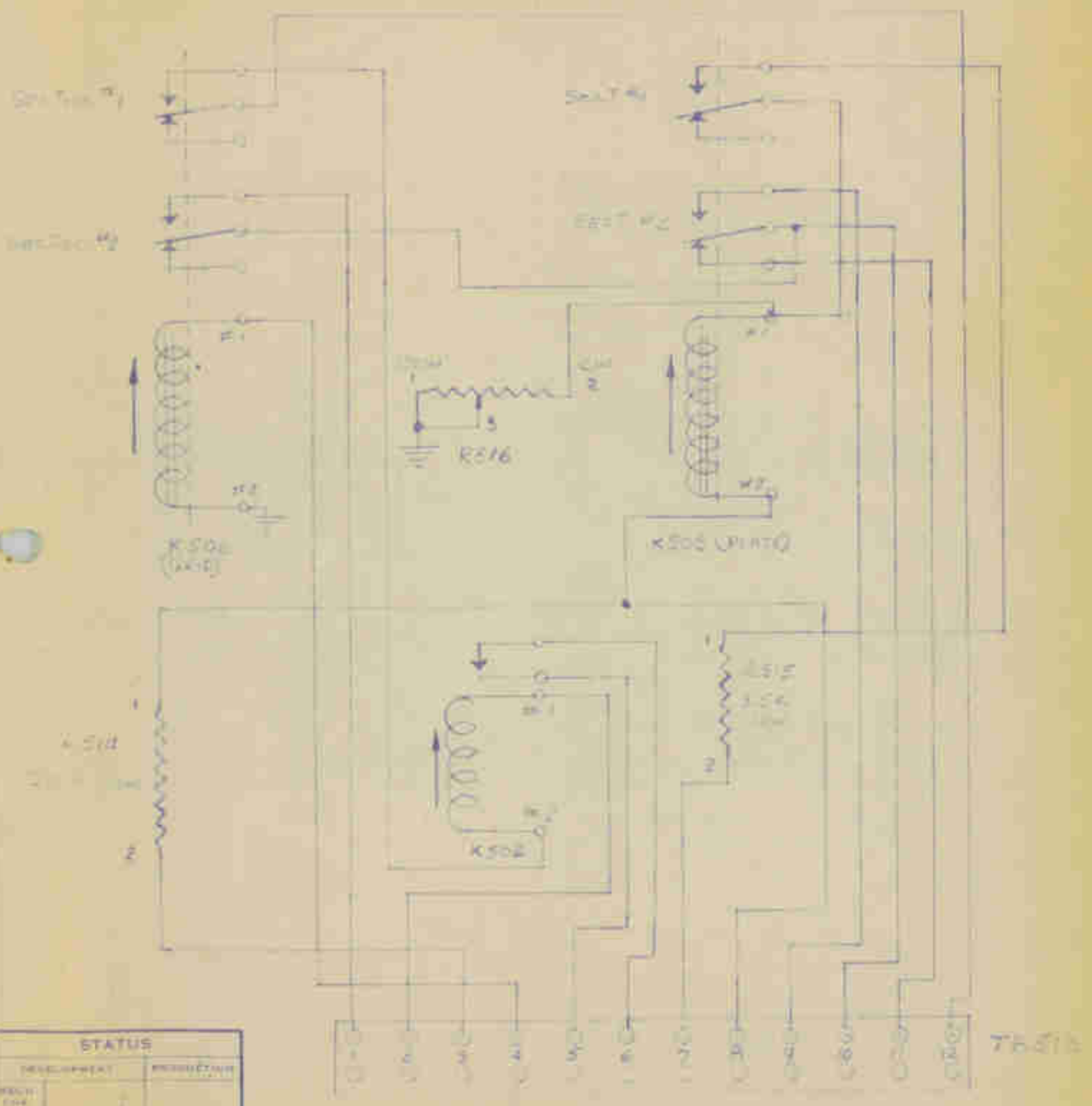
1	TITLE SCHEMATIC POWER SUPPLY 500V. 200MA M5652		
ECN 7782 RD. 8-1959	MTL.	FIN.	UNLESS OTHERWISE SPECIFIED, ALL TOLERANCES PER GATES SPEC. G5M105.
	DR. BY AWC DATE 4-21-58	CH. BY DATE	ENG. DATE	B-65503

GATES RADIO COMPANY
QUINCY, ILLINOIS

SCALE

LIST OF PARTS

104 QTY.	103 QTY.	102 QTY.	101 QTY.	CH. NO. ITEM	REFERENCE	PT. OR G.N.	FIN.	DESCRIPTION	MATL.



STATUS

DEVELOPMENT	PRODUCTION

CH. BY
DATE

MTL.

CH. BY
DATE

ENG.

FIN.

TITLE

UNLESS OTHERWISE SPECIFIED ALL TOLERANCES PER GATES SPEC.