TECHNICAL MANUAL

FM-20H3 20KW FM TRANSMITTER

FOR

994 6746 105 FM-40H3 FM TRANSMITTER

2899-1
9730-8

HARRIS INTERTYPE CORPORATION

GATES®

A DIVISION OF HARRIS-INTERTYPE

WARRANTY

Seller warrants new equipment manufactured by Gates Radio Company against defects in material or workmanship at the time for delivery thereof, that develop under normal use within a period of one year (6 months on moving parts) from the date of shipment, of which Purchaser gives Seller prompt written notice. Other manufacturers' equipment, if any, including electron tubes, and towers shall carry only such manufacturers' standard warranty.

Seller's sole responsbility for any breach of the foregoing provision of this contract, with respect to any equipment or parts not conforming to the warranty or the description herein contained, is at its option, (a) to repair or replace such equipment or parts upon the return thereof f.o.b. Seller's factory within the period aforesaid, or (b) to accept the return thereof f.o.b. Purchaser's point of installation, whereupon Seller shall either (1) issue a credit to Purchaser's account hereunder in an amount equal to an equitable portion of the total contract price, without interest, or (2) if the total contract price has been paid, refund to Purchaser an equitable portion thereof, without interest.

If the Equipment is described as used, it is sold as is and where is. If the contract covers equipment not owned by Seller at this date it is sold subject to Seller's acquisition of possession and title.

Seller assumes no responsibility for design characteristics of special equipment manufactured to specifications supplied by or on behalf of Purchaser.

Seller shall not be liable for any expense whether for repairs, replacements, material, service or otherwise, incurred by Purchaser or modifications made by Purchaser to the Equipment without prior written consent of Seller.

EXCEPT AS SET FORTH HEREIN, AND EXCEPT AS TO TITLE, THERE ARE NO WARRANTIES, OR ANY AFFIRMATIONS OF FACT OR PROMISES BY SELLER, WITH REFERENCE TO THE EQUIPMENT, OR TO MERCHANTABILITY, INFRINGEMENT, OR OTHERWISE, WHICH EXTEND BEYOND THE DESCRIPTION OF THE EQUIPMENT ON THE FACE HEREOF.

RETURNS AND EXCHANGES

Do not return any merchandise without our written approval and Return Authorization. We will provide special shipping instructions and a code number that will assure proper handling and prompt issuance of credit. Please furnish complete details as to circumstances and reasons when requesting return of merchandise. Custom built equipment or merchandise specially ordered for you is not returnable. Where return is at the request of, or for the convenience of the customer, a restocking fee of 15% will be charged. All returned merchandise must be sent freight prepaid and properly insured by the customer. When writing to Gates Radio Company about your order, it will be helpful if you specify the Gates Factory Order Number or Invoice Number.

WARRANTY ADJUSTMENTS

In the event of equipment failure during the warranty period, replacement or repair parts may be provided in accordance with the provisions of the Gates Warranty. In most cases you will be required to return the defective merchandise or part to Gates f.o.b. Quincy, Illinois for replacement or repair. Cost of repair parts or replacement merchandise will be billed to your account at the time of shipment and compensating credit will be issued to offset the charge when the defective items are returned.

MODIFICATIONS

Gates reserves the right to modify the design and specifications of the equipment shown in this catalog without notice or to withdraw any item from sale provided, however, that any modifications shall not adversely affect the performance of the equipment so modified.

ADDENDA

FM-20H3 FM TRANSMITTER

994 6746 105

A terminal board, TB-10 has been installed on the underside of the top of each transmitter cabinet (left, front corner).

Wires from the center cubicle of the FM-40H3 transmitter system should be connected to the terminals of TB10 as designated on drawing 838 9479 001. The drawing also shows the termination of each wire in the center cubicle or the transmitter cabinet.

A blank panel with a terminal board has been installed in the space normally occupied by the TE-3 FM Exciter. The wires usually connected to the exciter are connected to these terminals. A jumper has been added between AFC interlock circuitry wires 30 and 170.

The high voltage control circuitry of each transmitter has been rewired as shown on drawing 838 9522 001.

The following items have been added to each transmitter's high voltage control circuitry.

DS10	Indicates when the recycle relay, K8, was energized.
DS11	Indicates the transmitter automatic switching circuitry is in operation.
K13	Prevents the automatic switching circuitry from turning ON the transmitter if the recycle relay was energized.
K14	Is energized through normally open contacts of the recycle relay. Its contacts control the voltage to the coil of K13 when the automatic switching is in operation.
S20	Will reset relays K13 and K14.
S21	Will energize the automatic switching relay assembly on the side of the center cubicle.
S22	Will de-energize the automatic switching relay assembly on the side of the center cubicle.

TB10 — Terminal board for wire connections to the center cubicle. It is mounted on the underside of the top at the left front corner.

The grid drive relay, K10, has been replaced with a new relay which has 2 form "C" sets of contacts.

Status lights have been installed in each transmitter, however, the LOCKOUT light circuitry has been re-wired per the drawing 838 9522 001.

PARTS LIST

DS10,DS11	406 0388 000	Pilot light
K10	572 0160 000	Relay, 2PDT
K13,K14	574 0224 000	Relay, 4PDT
S20,S21,S22	604 0391 000	Switch, P.B. SPDT
TB10	614 0020 000	Terminal Board
	838 9522 001	Schematic
	852 7534 001	Schematic, Overall FM-20H3

INSTRUCTIONS FOR INSTALLING AND OPERATION

OF

GATES FM-20H3 20KW FM TRANSMITTER

IB-888 1071 001

Gates Radio Company
Quincy, Illinois

TABLE OF CONTENTS

FM-20H3 20KW FM TRANSMITTER

TABLE OF CONTENTS

SECTION 1 - GENERAL DESCRIPTION

1.1 Warranty

This equipment is guaranteed under the Gates Warranty. The terms and conditions are explained in the Gates Warranty which is printed inside the front cover of this manual.

Most Gates manufactured items are guaranteed for one year, with the exception of tubes and moving parts, which are subject to specific warranties based upon hours of usage. The Warranty does not extend to "no charge" service in the field.

1.2 Safety Notice

This equipment employs voltages which are dangerous and may prove fatal if contacted by operating personnel. Extreme caution should be exercised when working with the equipment. Observe safety regulations.

Do not change tubes or make adjustments inside equipment with any voltages ON. While your Gates transmitter is fully interlocked you should not rely on the interlock switches for removing high operating voltages. It is always best to disconnect the primary power at the building wall switch and discharge all capacitors with the grounding stick provided.

1.3 Purpose of Book

This instruction book has been prepared to assist in the installation, operation, and maintenance of the Gates FM-20H3 20KW FM Transmitter.

1.4 Purpose of Equipment

The Gates FM-20H3 is a FM broadcast transmitter with the capability of delivering 20,000 Watts power output to the transmission line. The transmitter is designed for continuous broadcast operation in the 88.1 to 107.9 MHz frequency band. Performance will meet or exceed those specifications required by the Federal Communication Commission for standard FM broadcast service.

1.5 Description

The FM-20H3 transmitter is housed in two cabinets utilizing only ten square feet of floor space. The transmitter cabinet is 42" wide x 32-3/4" deep x 78" high. The high voltage power supply cabinet is 30" x 30" x 49" high, and it may be positioned apart from the transmitter cabinet. Complete access to the interior of both cabinets is possible by doors or removable panels.

Front doors are provided on the transmitter cabinet to offer a pleasing and symmetrical front view appearance. All necessary operational metering is provided by four meters located on the meter panel above the front doors. The following controls are also located on the meter panel.

(a) Filament ON
(b) Filament OFF
(c) Plate ON
(d) Plate OFF
(e) Filament Voltage Meter Switch (IPA or PA)

Controls listed below are located behind the front doors.

(a) VSWR Cal
(b) Pwr Cal
(c) For Pwr-VSWR Cal-VSWR
(d) PA Filament
(e) Multimeter
(f) IPA Screen
(g) PA Screen Raise-Lower
(h) IPA Filament
(i) Remote-Local
(j) IPA O.L.
(k) Recycle
(l) PA Remote Plate Current
(m) PA O.L.
(n) PA Remote Plate Voltage
(o) PA Plate Tuning
(p) PA Output Loading
(q) PA Neutralizing
(r) IPA Plate Tuning
(s) IPA Grid Tuning

1.6 Vacuum Tube Table

Symbol No.	Type	Function
V1	4CX15,000A	Power Amplifier (PA)
V2,V3	4CX250B	Intermediate Power Amplifier (IPA)

1.7 FM-20H3 Technical Data (Monaural)

Power Output	10 to 20 kW
Frequency Range	88.1 to 107.9 MHz
RF Output Impedance	50 Ohms
Output Termination	Standard EIA 3-1/8" flange
Maximum VSWR	1.7:1
Harmonic Attenuation	-80 dB
Frequency Stability	± .001%
Modulation Capability	± 100 kHz
Audio Input Impedance	600 Ohms
Audio Input Level	+ 10 dBm, ± 2 dB
Audio Frequency Response	± 1 dB, 30-15,000 Hz
Audio Distortion	½% or less, 30-15,000 Hz
FM Noise Level	65 dB below 100% FM modulation (400 Hz reference)
AM Noise Level	50 dB below equivalent 100% AM modulation
Power Source Voltage	208/230/240/250 V., 3 phase, 60 Hz
	115 V., 1 phase, 60 Hz
Power Source Variation (Slow)	± 5%
Power Factor	.90
Power Input Requirement	30 kW., 240 V; 300 W. 115 V.
Ambient Temperature Range	-20°C to +45°C
Altitude	7500 feet
Transmitter Cabinet Size	42" wide x 32-3/4" deep x 78" high **
Power Supply Cabinet Size	30" wide x 30" deep x 49" high
Weight (Total)	2000 pounds
Front Door Swing	21"
PA Tube Dissipation (Maximum)	15,000 W., 850 BTU/Minute
Blower Air Flow	1250 c.f.m. @ 6.3 inches of water pressure

* 32-3/4" is overall depth dimension. With rear door, front door handles and meter trim strip removed the minimum depth is 29-3/4"

** R.F. plumbing extends 12-7/8" above cabinet top.

SECTION 2 - INSTALLATION

2.1 Inspection

The FM-20H3 is carefully packed at the Gates plant to ensure safe arrival at its destination. The equipment is packed in a number of heavy cartons and wooden crates. Open the crates and cartons carefully to avoid damaging any of the contents. Remove the packing material and search for possible loose items, such as pilot lights, fuses, loose screws and bolts. A complete visual inspection should be made of the equipment for shipping damage.

If damage should occur during shipment, a damage report should be filed promptly with the transportation company to receive compensation. If a claim is to be filed, the original packing case and material must be preserved. Gates Radio Company is not responsible for damage occurring during shipment. Parts or components shipped to replace the damaged items will be billed to the customer plus transportation expenses, the cost of which should form a portion of your claim to the transportation company.

Make sure all relay contacts are free and in good mechanical condition. Make sure all mechanical connections are tight. Check with a screw driver or a wrench, all mechanical and electrical connections that are mechanically bolted together. All tie downs or blocking used for shipping purposes should be removed. A good overall visual inspection may save time and trouble in placing the transmitter into operating condition.

2.2 Packing Check List

Certain components of the transmitter have been removed for shipment and are packed separately to ensure safe handling. These parts on the FM-20H3 have been kept to a bare minimum and are plug-in units, heavy components or tubes. Refer to the Packing Check List to determine that all these components are on hand.

2.3 Tube Handling and Operating Precautions, 4CX15,000A

Avoid bumping this tube. Due to its large mass, bumping this tube will introduce resultant stresses which may cause internal damage.

Before operating this tube refer to the tune-up and operating procedure given in SECTION 3. It is recommended procedure to adjust the equipment for operation under heavy plate loading conditions, and with only sufficient R.F. drive to provide the required power output and efficiency.

Extreme care should be taken during tune-up as well as in regular service to avoid, even momentarily, operation of this tube under conditions of insufficient plate loading or excessive R.F. drive. These operating conditions, especially at the upper end of the VHF range, will produce excessively high seal and/or bulb temperature and will result in damage to this tube.

In advance of actual placement of the equipment, certain planning should be accomplished. The use of the Installation Drawing will assist in locating the power and audio input holes position of the transmitter.

Either side of the transmitter may be placed against a wall or other equipment. Complete accessibility for maintenance and installation is provided in the FM-20H3 by access from the front or the rear of the transmitter and the high voltage power supply cabinets.

Mount the blower B1 on the shock mounts in the base of the transmitter cabinet directly below the PA enclosure. Install the canvas blower boot around the PA enclosure inlet and push boot up until it is taut. Secure the boot tightly with the boot clamp. Rotate the impeller by hand to check for freedom of movement.

The normal length of the interconnecting cable between the transmitter cabinet and power supply cabinet is 15 feet. Other lengths of 25 or 35 feet are available.

Wire No.	From Power Supply	To Transmitter
122	TB7-1	TB8-1
Gnd.	TB7-2	TB8-2
123	TB7-3	TB8-3
124	TB7-4	TB8-4
125	TB7-5	TB8-5
126	TB7-6	TB8-6
Coax	E5	E4
Coax Shield	Gnd. Stud	Gnd. Stud
#1 AWG wire (3 pieces)	K5	T4 primary

Appropriate primary taps should be used on T4 and T5 (2000 V. Supply) for your 3 phase a.c. input line voltage.

Install the plug-in capacitor C37 in the transmitter bias supply located on the side of the transmitter cabinet.

The R.F. output coupling assembly consists of a silver plated 3-1/8 inch outer conductor with a flange near the center and a inner conductor with brass plugs in each end. The outer conductor also has two monitor coupling loops and an adjustable sleeve. Before installing, remove both monitor coupling loops and loosen the set screws in the adjustable sleeve to temporarily position the sleeve close to the flange.

Remove the output coupling loop that is connected to the output loading capacitor C6.

Insert the R.F. output outer conductor in the hole in the top of the PA enclosure from inside the PA enclosure. The flange will be inside the enclosure and the monitor coupling loop cutouts will be above the top of the cabinet. Secure the outer conductor to the top with bolts.

Insert the inner conductor in the outer conductor from the top. The 1/4 inch stud should be up. Position the notch filter and directional coupler above the output outer conductor and thread the stud of the inner conductor output assembly into the inner conductor of the notch filter. With a crescent wrench tighten the inner conductor from inside the PA enclosure. Slip the filter tee down over the output outer conductor and rotate to final position. DO NOT POSITION ANY R.F. PLUMBING OVER THE PA AIR EXHAUST. Tighten the stainless steel clamp securely around the filter tee and the output outer conductor.

Remount the monitor coupling loops on the outer conductor.

Re-position the output adjustable sleeve to the distance recorded in your test data sheets. This adjustment must be accurate within 1/8 inch as measured from the tube deck to the bottom of the sleeve.

Install the output coupling loop between the output loading capacitor C6 and the inner conductor of the output coupling assembly.

Bolt the low pass filter between the directional coupler and the transmission line to the antenna. SUPPORT MUST BE PROVIDED FOR THE NOTCH FILTER, LOW PASS FILTER AND TRANSMISSION LINE. (See Section 5.4).

Inspect the IPA circuitry for possible shorts or loose connections. DO NOT RE-POSITION ANY STRAPS OR BUSS WIRES SINCE THEY ARE AN INTRICATE PART OF THE ELECTRICAL DESIGN.

The transmitter may or may not have two connecting links from the PA tube to the plate line. Remove the link toward the rear of the transmitter, if used. Observing the tube handling precautions insert V1 (4CX15,000A) in its tube socket. A alignment line on the tube anode should match a line on the tube chimney. Press the tube firmly in the socket. Examine the underneath side of the socket to make sure the tube is properly seated and that the finger-stock is making good contact with the tube conducting rings.

Re-install the second connecting link if used. Place the anode connector clamp around the outside of the link or links and down against the tube chimney. Tighten the clamp firmly, making sure the connecting link or links are between the clamp and the tube anode.

Above 95 MHz the PA coarse tuning per operating frequency is determined by the distance from the bottom of the rotary or adjustable arm portion of the plate line to the PA tube deck. The distance must be within 1/16 inch as recorded in the test data. The arm should be fully extended from the plate line; i.e., the tightening nuts must be at the slot's ends on the arm's swivel points.

Refer to the FM Exciter Installation Instructions for proper module placement in the excitor cabinet.

2.5 Wiring Connection

After the transmitter is physically in place and the components removed for shipment have been re-installed, a.c. power should be brought to the transmitter.

Refer to the Installation drawing.

The conduit or wiring of the power leads should be in agreement with local electric codes and be able to carry the power requirements of the transmitter. Power leads and program leads should not be run in the same conduit or in the same wiring duct. If, due to necessity, the program leads are in close proximity to the power leads, the program leads should be separately shielded.

The 3 phase a.c. input enters the transmitter in the right hand corner of the base and connects to K11, K12 and ceramic stand-off E6. Power source voltage should be either 208, 230, 240, or 250 volts, 60 Hz with approximately a 40 kVA capacity.

If the line voltage is below 208 V. add the dashpot oil to the 3 phase line magnetic overload relays, K11 and K12. (Remove the reservoir cup and fill according to the directions on the oil container.)

The 115 V, 60 Hz single phase a.c. input also enters the transmitter in the right hand corner of the base and connects to F1 and F2. Approximately 500 VA capacity is required.

The audio input line enters the base of the transmitter at the center, approximately 2" from the front. The audio line connects directly to terminal board TB-1 of the FM Exciter. Terminals 1 and 3 are the audio inputs, and terminal 2 is ground or shield connection. If stereo is used, the lines are connected in accordance with the Stereo Generator instructions which is part of the FM Exciter manual.

A good ground at these FM frequencies is mandatory in keeping R.F. currents in nearby audio or monitoring equipment to a minimum. A short length of unshielded wire makes a very efficient antenna. If R.F. is transferred to audio equipment the results can show up as noise or feedback. Gates recommends a single common ground point from the transmitter cabinet to a good grounding system, such as, a water pipe or an actual earthing ground.

2.6 Cooling

The RF amplifiers of the transmitters are forced air cooled. Other components are convection cooled with the aid of fans on the top of the transmitter cabinet and the high voltage power supply cabinet. The temperature rise inside the equipment must not exceed 20°C (68°F) above the room ambient and must not be greater than 60°C (140°F) under any circumstance. *

Heat is a major factor to electronic component deterioration. A good system of removing the heated air from the transmitter and the transmitter room and providing cool air for the air inlet of the transmitter will prolong the life of the transmitter and its components.

Maximum plate dissipation for the 4CX15,000A is 15,000 W (850 BTU/minute), however nominal plate dissipation will be around 6,000 W. (342 BTU/minute). Duct work to the top of the PA enclosure air outlet, if installed, should not cause any back pressure. At no point should the duct work have less of a cross sectional than the opening at the top of the transmitter. Sharp, right angle bends are not permissible. Where a bend is necessary a right angle radius type should be used.

The normal operating air pressure below the PA tube socket is approximately 7½ inch of water. Under this condition the blower is capable of delivering 1130 cubic feet per minute.

There are many installation possibilities. Contact a local heating and cooling contractor for a detailed analysis of your particular installation.

* NOTE: The 20°C temperature rise is not applicable to the PA enclosure inlet and outlet.

SECTION 3 - OPERATION

3.1 Pre-Operation

Before placing the FM-20H3 in operation, check once again the points covered in SECTION 2.

1. Wires connected between transmitter and power supply cabinet.
2. Primary power to the 3 phase input terminals.
3. 115 Volts to the 1 phase fuse block.
4. Program line connected to the exciter.
5. 115 Volts for the FM exciter.
6. Transmitter connected to antenna or a suitable load.

If everything appears to be in order, then you may proceed.

3.2 Test Data

Your equipment has gone through many different kinds of tests at the Gates factory and has operated for several hours on your assigned frequency. This is to ensure correct adjustment and proper setting of all controls. Refer to the test data supplied with your transmitter. This data is attached to the front of the transmitter when shipped.

3.3 Adjustment

Set the dial settings to those recorded on the test data sheet. Switch S19 in the high voltage power supply cabinet to the 4500 V d.c. position.

Primary power may now be applied to the transmitter by pushing the Filament ON button. The light behind the Filament ON button should light.

Put the Filament Voltage switch in the IPA position and adjust the IPA Filament control for 6 V as read on the Filament Voltage meter.

Next, the blower should begin to run and come up to speed. After the blower reaches operating speed, air pressure in the PA enclosure will operate the air switch. Closing of the air switch will turn ON the PA filament. Set the Filament Voltage switch in the PA position and adjust the PA Filament control for 6.3 V as read on the Filament Voltage meter. (See Section 5.6)

Turn the IPA Screen control fully counter-clockwise.

With the PA Screen Raise-Lower control in the Lower position run the motor controlled PA screen voltage rheostats (R43 & R44) to the lowest voltage point (arm at 11 o'clock). The screen voltage rheostats may be inspected by opening the front access door. Remember that a.c. voltages are present on components on the back of the access door.

Check the IPA bias voltage at TB3-5 and TB3-4 (ground) with an external meter and adjust R28 as necessary to obtain the test data sheet measurement. TB3 is located on a shelf directly below the motor controlled PA screen voltage rheostat.

Check the PA bias voltage at TB3-3 and TB3-4 (ground) with an external meter and adjust R29 as necessary to obtain the test data sheet measurement.

Place the Multimeter switch on the access door to the IPA I_g position. If the exciter is RF driving the IPA stage a reading of approximately 10 to 30 mA will be indicated on the Multimeter. Adjust the IPA Grid Tuning for a maximum indication.

Check for an indication (5 mA) on the Multimeter when the Multimeter switch is in the IPA I_k position.

High voltage may now be applied by pushing the High Voltage ON button. The light behind the High Voltage ON button should light. Plate and screen voltage are applied simultaneously to the IPA and PA stages.

Turn the IPA Screen control until 50% scale reading of IPA I_k is indicated on the Multimeter. Resonate the IPA stage by adjusting the IPA Plate Tuning for a dip in the IPA I_k. Increase IPA screen voltage for Test Data IPA I_k reading.
The Power Output meter is the farthest meter on the right on the meter panel. Its function is determined by the For Pwr-VSWR Cal-VSWR switch. You may read:

1. For Pwr (Forward Power).
2. VSWR Cal (VSWR Calibrate) used for meter calibration for maximum scale reading during VSWR measurements.
3. VSWR on the transmission line.

Power output of the transmitter will be noticed if the PA Plate Tuning and PA Output Loading are near their test data readings. The For Pwr-VSWR Cal-VSWR switch will have to be in the For Pwr position.

Increase the PA screen voltage with the PA Screen Raise-Lower switch in the Raise position, until approximately 2 A of PA Plate Current are indicated. Resonate the PA stage by adjusting the PA Plate Tuning control for a dip in the PA plate current.

Adjust the PA Output Loading control for maximum power output (4 to 6 kW).

Check the VSWR on the transmission line. With the For Pwr-VSWR Cal-VSWR switch in the VSWR Cal position adjust the VSWR Cal control fo maximum indication on the Power Output meter (it will be impossible to obtain a full scale calibration reference at 4 to 6 kW power output). Position the switch to the VSWR position for the indication of VSWR on your transmission line. If a large mis-match is present check the antenna or transmission line for possible problems before proceeding with the adjustment.

The low voltage check is now complete. Turn OFF the transmitter and place S19 switch in the high voltage power supply cabinet to the 9000 V d.c. position.

Turn ON the low voltage and lower the PA screen voltage to minimum.

Turn ON the high voltage. Approximately 18 kW power output should be noted.

Adjust PA Plate Tuning for a dip in plate current and the PA Output Loading for the most efficient operation.

Re-adjust the PA Plate Tuning for a plate current dip and then make one additional turn in the direction that causes the power output to increase.

Increase the PA screen voltage for 20 kW power output which should occur when the PA screen current is 75 to 125 mA as indicated on the PA Screen Current meter.

Re-adjust the PA Plate Tuning and PA Output Loading controls as indicated above for maximum power output and the most efficient operation.

If the VSWR of the transmission line is satisfactory refer to the test data sheets for operating condition you may expect. Since the transmitter was checked into a 50 Ohm resistive load at the Gates factory any system with a mis-match will probably change the tuning. Therefore, the recorded test data knob readings may not agree with actual operation.

The PA Screen Raise-Lower control is used to compensate for any a.c. supply voltage variations which cause power output fluctuations.

The overloads are set for 20 kW operation at the Gates factory. The IPA Plate Overload R36 is set for 500 mA of IPA I_k as read on the Multimeter. The PA Plate Overload R39 is set for approximately 3.4 A. PA plate current. The controls are located under a small cover plate on the front access door.

The RF output of the exciter is varied with a output control of the 10 W. amplifier and is explained in the exciter section of this instruction book.

3.4 Maintenance

Maintenance of the FM-20H3 should consist of the following:

1. Keeping the transmitter clean.
2. Changing tubes when emission falls off.
3. Checking mechanical connections and fastenings.
4. Lubricating the blower motor.

Keeping the transmitter clean from the accumulation of dust will reduce failure resulting from arcing, dirty relay contacts, and overheating of chokes, resistors and transformers. Electrostatic fields are "dust catchers". Support insulators in the PA enclosure and other locations are the worse offenders. They must be kept clean and free of all foreign material at all times. If not, arcing may result and the insulator shattered.

The air filter should be clean at all times. The washable air filter used in the back door may be purchased from the Gates Radio Company under Part Number 827-5285-011. However, the filter may be cleaned using warm water and a mild detergent.

Once a month the entire transmitter should be cleaned of dust. The inside of the power amplifier should be thoroughly wiped clean of dust. A small brush, soft rag, and vacuum cleaner can be used very effectively in keeping the equipment clean.

All contactors and relays should be inspected regularly for pitting and dirt. The contacts should be burnished and cleaned if required. The overload relays are telephone type, with sealed contacts and should require little attention.

The bearings for the motor of the PA blower are sealed and normally give long trouble free operation. They are lubricated for approximately 20,000 hours of operation. After this period of operation 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 attached to the upper plug on the bearing. New grease should be applied until clean grease runs out of the drain plug at the bottom. It is suggested the blower be removed for this maintenance.

The PA tube and the IPA tubes should be removed once a month and the fins cleaned of dust. Air may be blown through the fins in the reverse direction, or the anode cleaned with soap and water or denatured alcohol.

This transmitter is a precision electrical device, and as such should be kept clean at all times and free of dust and foreign material. Dust and moisture condensation will lead to possible arc-overs and short conductive paths. A good preventive maintenance schedule is always the best assurance for trouble free transmitter operation.

SECTION 4 - CIRCUIT DESCRIPTION

The FM-20H3 circuits will be described in the following sections:

Power Amplifier (PA)
Intermediate Power Amplifier (IPA)
Exciter
Power Supply
Control Circuits
Metering

See Block Diagram.

4.1 Power Amplifier

The power amplifier of the FM-20H3employs a single 4CX15,000A tetrode in a common cathode amplifier circuit. The plate circuit is inductively tuned by varying a length of inner conductor of a transmission line within the rectangular outer conductor. The plate line is approximately one-half wavelength long, being foreshortened by the output capacity of the tube. The large variable portion of the line is used for coarse or approximate frequency setting and the end of the half-wave line is made variable for fine plate circuit tuning which is controlled from the front panel. The fine frequency control covers approximately 3 MHz at the low end of the FM band and approximately 6 MHz at the higher end of the band. (The large variable portion may not be used below 95 MHz).

Output coupling is accomplished by capacity tuning a coaxial coupler. The coupler inductively couples R.F. power from the amplifier enclosure.

The PA grid circuit is common with the IPA plate circuit. The IPA plate inductance, L6, IPA plate tuning capacitor C24, and the input capacitance of the PA tube form a pi circuit.

Bypassing of the PA screen and filaments is accomplished by using a number of high voltage ceramic capacitors with lead lengths kept as short as possible.

4.2 IPA

The intermediate power amplifier employs two 4CX250B tetrodes in a common cathode circuit. The grid circuit is capacity tuned. The plate circuit is common with the PA grid as previously explained. Screen bypassing is effected with the built-in bypass of the 4CX250B air system socket. The cathode of each IPA tube is bypassed with four ceramic button capacitors. The two 4CX250B's are in parallel.

4.3 Exciter

The FM Exciter is described in detail in the Exciter instruction book.

4.4 Power Supply

Two high voltage power supplies are used in the FM-20H3. The one located in the transmitter cabinet is a 3 phase full wave supply delivering 2000 V. for the IPA plates and with proper voltage dividing provides the IPA and PA screen voltages.

The second supply is located in a separate cabinet. It delivers 4500 or 9000 V. to the plate of the final power amplifier. It is also a 3 phase full wave supply, with rectifiers and all filtering located in the power supply cabinet.

A single phase, full wave bridge circuit supply is used to provide both the IPA and PA bias voltages. The IPA bias voltage is varied by R28 and the PA bias voltage is varied with R29.

Each of these supplies uses silicon rectifiers and has a single section, choke input filter.

4.5 Control Circuits

The control circuits of the FM-20H3 consist of the following:

K1	Primary contactor applies voltage to the IPA filament transformer, bias supply, fans and K2.
K2	Blower contactor applies voltage to the blower.
K3	Auxiliary relay applies holding voltage to the Step/Start contactor K4.
K4	Step-Start contactor applies voltage to transformers T4 and T5 through 1 Ohm resistors R31, R32 and R33. Also the plate contactor K5 is energized through K4 which shorts out the resistors.
K5	Plate contactor applies primary voltage to transformers T4 and T5 after Step-Start function is completed.
K6,K7	IPA and PA Overload relay momentarily interrupts the high voltage control circuit in case of an overload. The overload function is adjustable by R36 (IPA) and R39 (PA).
K8	Recycle relay breaks the holding circuit of the high voltage control circuitry if an IPA or PA overload occurs a number of times. The recycle time of C38 and R35 (adjustable) will determine when K8 will be energized if there is a continuous overload.
K9	PA Screen Raise-Lower Control relay will allow the raising or lowering of the PA screen voltage either at the transmitter or a remote control location.

K10	Underdrive relay must be energized to turn ON the high voltage. IPA grid current caused by RF drive must reach 4 mA or more to energize K10.
K11,K12	AC Line Voltage Overload relay (with S8 and S9) will interrupt the holding circuit for K3 when excessive current is drawn.
S1	Filament ON pushbutton switch applies a momentary voltage to K1.
S2	Filament OFF pushbutton switch which interrupts the holding voltage to K1.
S3	Plate ON pushbutton switch applies a momentary voltage to K3.
S4	Plate OFF pushbutton switch which interrupts the holding voltage to K3.
S5	Local-Remote toggle switch provides selection of either local or remote control of the transmitter turn ON or OFF functions.
S6,S7, S11,S12	Door Interlock plunger switches must be closed to turn ON the high voltage.
S8,S9	Overload switches which must be closed to turn ON the high voltage. They are part of K11 and K12.
S10	Air Pressure switch will close after air pressure in the PA enclosure reaches the proper value. Voltage is then applied to the PA filaments.
S13,S14	Limit switches for motor B2 which drives the PA screen voltage rheostats.
S15	Power Raise-Lower lever switch controls motor B2.
S16	For Pwr-VSWR Cal-VSWR rotary switch used to select desired function as read on Power Output meter.
S17	Filament Voltage lever switch allows selection of the IPA or PA filament voltage on the Filament Voltage meter.
S18	Multimeter rotary switch selects various IPA or PA tube parameters to be monitored on the Multimeter.
S19	High Voltage lever switch in the power supply cabinet used for selection of either 4500 V. or 9000 V. on the plate of the PA tube.

4.6 Metering and Fuse Indicators

All metering of the FM-20H3 is accomplished with four meters located on the cabinet meter panel and three meters on the front access door.

Cabinet meter panel:

Filament Voltage meter will monitor the IPA or PA filament voltage. The selection is determined by the IPA-PA Filament Voltage switch.

Plate Current meter will read the PA plate current. This meter is wired in the ground return path of the high voltage supply.

Plate Voltage meter is wired on the low potential side of the PA meter multiplier resistor.

Power Output meter will indicate power output or VSWR on the transmission line. The meter is associated with the directional coupler DC1. The For. Pwr-VSWR Cal-VSWR switch S16 determine which function will be read.

Front access door:

Multimeter will indicate IPA I_{g1}, IPA I_k, IPA I_{g2} or PA I_{g1}. The selection is determined by the rotary switch S18.

PA Screen Current meter is wired in the high voltage feed (1500 V. d.c.) for the PA screen grid.

A Time Elapsed meter will indicate the total time that the filament voltage is applied to the PA tube.

Fuse indicating lights are connected across various fuses as indicated on the front access door. The 115 V. A.C. fuse lights will only indicate as the Filament ON pushbutton is pushed if either fuse is defective.

SECTION 5 - ADDITIONAL INFORMATION

5.1 Remote Control

Remote Control facilities are built into the FM-20H3 and require only connections to either the Gates RDC-10AC Remote Control Unit or the Gates RDC-200A Remote Control equipment. The connections to the transmitter are made at TB6 located in the base of the cabinet.

The function on the terminal board are:

TB6-1	Filament ON
TB6-2	Filament ON
TB6-3	Plate OFF
TB6-4	Plate ON-OFF
TB6-5	Plate ON
TB6-6	Power Lower
TB6-7	Power Raise
TB6-8	+6 V. d.c. for K9
TB6-9	Ground
TB6-10	PA Plate Voltage metering (controlled by R50)
TB6-11	PA Plate Current metering (controlled by R11)
TB6-12	Power Raise-Lower common
TB6-13	RF Power Output metering (controlled by R6)
TB6-14	Circuit return for RF Power Output metering

5.2 Stereophonic Operation

Provision has been made for the installation of the Gates M6533 Stereo Generator in the FM Exciter. Instructions for audio connections are given in the exciter section of this instruction book.

With the addition of the M6533 Stereo Generator the transmitter is FCC type accepted for stereophonic operation.

5.3 Door Interlock Switches

It is possible to defeat the interlock switches when the door or panels are not in place. Simply pull and slightly rotate the plunger away from the switch until it releases about 1/4 inch.

EXTREME CAUTION SHOULD BE USED WHEN OPERATING THE TRANSMITTER WITH DOORS OR PANELS OFF.

5.4 Low Pass Filter Position

A few transmitter installations may prevent the mounting of the low pass filter to the directional coupler because of space limitations. It is permissible to place the filter some distance (multiples of 1/2 wavelength at operating frequency) from the coupler. Also a 45° or 90° elbow may be used between the low pass filter and the coupler to facilitate the desired installation.

5.5 Blower Location

The blower may be installed outside of the transmitter cabinet (in basements, etc.) and the air ducted to the PA enclosure. It should be pointed out that the air ducting must not be smaller than the PA enclosure inlet and must not have any abrupt changes in cross section area. Any bend should be a radius type. Contact a local heating contractor for ducting recommendations of your installation.

5.6 Blower Rotation

On initial turn ON the blower rotation should be checked. As the filament voltage is turned OFF determine the impellor rotation as it slows to a stop. The rotation should be clockwise as viewed at the blower air inlet. A pair of the 3 phase lines to the blower may be changed to obtain the correct rotation.

5.7 IPA Plate Loading

Varying the position of the strap between the grid of the PA tube and C23 (100 pF) will affect the IPA plate loading. Pushing this strap closer to C23 will increase loading. As the loading is changed slightly the IPA Plate Tuning will have to be adjusted for a dip in IPA I_k which normally should be 400 to 450 mA.

5.8 Power Reduction

Usually the changes required for power reduction are accomplished during final test at the Gates factory.

Lowering the power may consist of one or all of the following changes dependent on the power level.

1. Decreasing the PA screen voltage with the motor controlled rheostats R43 and R44.
2. Changing the PA screen voltage divider which include R45, R46, R47.
3. Increasing the PA bias voltage.
4. Changing the 2000 V d.c. power transformer primary configuration from a delta to a wye connection. Also the PA screen voltage divider may require a variation.

5.9 FM Noise Measurements

1. The blower vibration will cause noise if the shock mounts on the blower mounting base are tightened too securely. The studs should be flush with the top of the nuts.

2. The polarity connection of the 115 V. AC supply to XF1 and XF2 should be connected for minimum noise.

5.10 Second Harmonic Filter

Upon completion of installation of the transmitter a check should be made on the tightness of the Allen set screws at the adjustment end of the second harmonic trap. There are two set screws that secure the short to the center conductor. If these become loose for any reason and light contact is made between the brass short and the center conductor, heating at this point may occur, resulting in possible burning and eventual destruction of the short and other parts of the filter.

A regular check on the tightness of these screws should be made at six month intervals, as part of the preventive maintenance program for the transmitter.

FM HARMONICS IN THE TV BAND

The sharp upsurge in FM broadcasting has in some instances developed unlooked for interference with local TV reception. In every instance this interference is in so-called fringe areas for TV reception and where the strength of the TV signal is weak enough that outside highly directional home TV antennas are necessary. ----- When this condition develops, the TV viewer quickly learns from his service man that the local FM station is the offender. ----- The FM broadcaster is immediately deluged with requests to eliminate the interference. In some instances CATV (Community Antenna Television) systems are also offended as they pick up weak distant TV stations. ------- What is the FM broadcaster's responsibility? Answer: To meet FCC rules and regulations as related to harmonic radiation of his FM equipment but not to guarantee perfect TV reception.

Below is a chart showing the picture and sound frequencies of TV stations between Channels 7-13 inclusive. Channels 2-6 are not shown. FM harmonics do not fall in these Channels. In fact, commercial FM station harmonics will affect only Channels 8 and above ------ look at the chart.

TV Channel	Picture Frequency Band ---Mc---	Sound Frequency
7	175.25 to 179.50	197.75
8	181.25 to 185.50	185.75
9	187.25 to 191.50	191.75
10	193.25 to 197.50	197.75
11	199.25 to 203.50	203.75
12	205.25 to 209.50	209.75
13	211.25 to 215.50	215.75

The frequency range for commercial FM broadcasting is 92.1 Mc to 107.9 Mc: --- To determine the second harmonic of your FM frequency, just multiply your frequency by 2. Example: If your frequency is 99.9 Mc, multiplied by 2 would make a second harmonic of 199.8 Mc. By consulting the above chart, you will note the second harmonic falls in the picture portion of the TV Channel 11.

Correct FM Harmonic Radiation

The FCC stipulates that transmitters of 3000 watts power and over must have a harmonic attenuation of 80 db. For 1000 watts, 73 db., and for 250 watts, 66.9 db. All reputable manufacturers design their FM transmitters to meet or exceed these specifications.

Fringe Area TV Strength Versus FM Harmonics

Let's take a typical FM station that radiates 70,000 microvolts per meter at 1 mile. At 80 db. harmonic attenuation (as called for by FCC), this station will radiate approximately 7 microvolts per meter at 1 mile on the second harmonic. In the case of our Channel 11 example, it is estimated that a fringe area TV station from 60 to 90 miles distance would have a signal strength of from 5 to 25 microvolts per meter. It can then be easily understood that a 7 microvolt signal, well within FCC specifications, would definitely interfere with the TV signal, yet with the FM broadcaster's equipment performing normally.

This is sometimes further aggravated by the FM station being located between the TV station and the TV receivers. In this instance the TV antennas are focussed not only on the TV station but your FM station as well. The home TV antennas are beamed at your legal second harmonic as well as the fringe TV station.

What To Do

When interference occurs, it will develop ragged horizontal lines on the TV picture varying with the FM program content. If the TV sound portion is interfered with (usually not the case), then the FM signal will be heard in addition to the TV sound.

1. It is not up to the FM broadcaster to go on the defensive. He did not put the TV station 75 miles away nor did he select the TV Channel. ---- In most instances the condition is a natural phenomena that neither you, the TV station, nor the FCC can correct.

2. Do not adjust the FM harmonic or "T" notch filters supplied with the FM transmitter. These are factory adjusted and most FM stations do not have the expensive equipment necessary for correct adjustment. Tampering with this calibrated adjustment will probably make the condition worse.

3. Do not rely on TV service men's types of measuring equipment. They are not built to accurately measure harmonics and invariably give erroneous readings that invite the CATV or local service men's association to say "I told you so." Remember it is difficult to radiate harmonics if the equipment is built to suppress the harmonics and it is.

4. In many instances interference may be caused by overloading on the front end of the TV receiver. This problem usually occurs when the receiver is located close to the FM transmitter. This problem can be overcome by installing a trap tuned to the frequency of the FM carrier. The TV service man can and must learn how to do this. In most cases it works, while in some instances, if not properly installed or tuned, it will not completely eliminate the interference. In one case where interference of this type existed, a TV station put traps for the fundamental FM frequency on nearly every TV set in town. Not the FM transmitter.

Summary

The FCC is well acquainted with this nation-wide problem. If TV viewers write FCC, complaining about your FM station, remember the FCC has received a few thousand similar letters. ----- It is not the obligation of the FM broadcaster to assure fringe area reception of a TV station any more than is the obligation of the TV station to assure the FM broadcaster perfect reception in his TV city.

Probably your installation will not have problems as outlined above. If they do exist, don't blame the equipment. Every transmitting device puts out a second harmonic, even the TV stations. The fact that these harmonics legally fall into the spectrum of a TV station many miles distant is coincidental, but not your fault.

Gates Radio Company

PARTS LIST

Symbol No.	Gates Stock No.	Description
B1	432 0137 000	Main Blower, 208-220 V., 60 Hz. 2 HP
	436 0076 000	Replacement Motor for B1
B2	436 0013 000	Tuning Motor, 1 r/min.
B3	436 0004 000	Motor, 1500 RPM, 115 V. 60 Hz
B4		Same as B3
C4	516 0082 000	Cap., .01 uF., 1 kV.
C5	814 3152 001	Neutralizing Cap., Plate
C6	514 0194 000	Cap., Variable Vacuum, 10-100 pF., 15 kV.
C7	516 0233 000	Cap., 500 pF., 30 kV.
C8	516 0205 000	Cap., 500 pF., 5 kV.
C9		Same as C8
C10		Same as C8
C11		Same as C8
C12		Same as C8
C13		Same as C8
C14		Same as C8
C15		Same as C8
C16		Same as C8
C17	516 0206 000	Cap., 1000 pF., 5 kV.
C18		Same as C17
C19		Same as C17
C20		Same as C17
C21	516 0361 000	Cap., Feedthru, 1000 pF., 1 kV.
C22	500 0781 000	Cap., 2200 pF., 500 V.
C23	516 0209 000	Cap., 100 pF., 15 kV.
C24	520 0277 000	Cap., Variable, 6-11 pF.
C25		Same as C8
C26	516 0235 000	Cap., Feedthru, 1000 pF., 500 V.
C27		Same as C26
C28		Same as C26
C29		Same as C26
C30		Same as C26
C31	516 0334 000	Cap., 40 pF., 5000 V.
C32	520 0158 000	Cap., Variable, 5.2-30 pF.
C33		Same as C4
C34		Same as C4
C35	516 0054 000	Cap., .001 uF., 1 kV.
C36		Same as C35
C37	524 0013 000	Cap., 30-30 uF., 525 WV. d.c.
C38	522 0133 000	Cap., 15 uF., 450 V.
C39	510 0682 000	Cap., 8 uF., 3000 V.
C40	510 0681 000 #347	Cap., 4.5 uF., 10 kV. (No brkt.)
C41	516 0250 000	Cap., 500 pF., 500 V.
C42		Same as C41
C43		Same as C41 23.9°
C44		Same as C41
C45		Same as C41
C46		Same as C41
C47		Same as C41
C48		Same as C41

PARTS LIST

Symbol No.	Gates Stock No.	Description
C49		Cap., Neut. (Feedthru Stud to Socket XV2)
C50		Not Used
C51	516 0206 000	Cap., 1000 pF., 5 kV.
C52		Same as C51
C53		Same as C51
C54		Same as C51
C55		Cap., (Part of Tube Socket XV2)
C56		Cap., (Part of Tube Socket XV3)
C57	516 0082 000	Cap., .01 uF., 1 kV.
C58		Not Used
C59		Not Used
C60	516 0390 000	Cap., 4300 pF., 15 kV.
C61		Same as C60
C62		Same as C60
C63		Same as C60
C64		Same as C60
C65		Same as C60
C66		Same as C7
C67	516 0210 000	Cap., 200 pF., 7.5 kV. 4870
C68		Same as C51
C69		Same as C51
C70		Same as C8
CR2	386 0016 000	Zener Diode, 1N2974
CR3		Same as CR2
CR4	384 0020 000	Silicon Diode, 1N2071
DC1	620 0399 000	Coupler, 40 kW (Part of Notch Filter Ass'y.)
DS1	406 0358 000	Light, Fuse indicating, 230 V.
DS2		Same as DS1
DS3		Same as DS1
DS4		Same as DS1
DS5		Same as DS1
DS6		Same as DS1
DS7		Same as DS1
DS8	396 0182 000	Light, #381
DS9		Same as DS8
F1	398 0182 000	Fuse, 10 A. 250 V.
F2		Same as F1
F3	398 0213 000	Fuse, 8 A. 250 V.
F4		Same as F3
F5		Same as F3
F6	398 0181 000	Fuse, 6 A. 250 V.
F7		Same as F6
F8	398 0017 000	Fuse, 1 A. 250 V.
FL1	994 6172 001	Low Pass Filter (88-92 mHz and 98-108 mHz)
FL1	994 6172 002	Low Pass Filter (92-98 mHz)
FL2	942 4686 001	Notch Filter & Coupler Ass'y.
	827 5285 011	Air Filter, Washable Type

Symbol No.	Gates Stock No.	Description
J2	612 0237 000	Receptacle, Type BNC
J3		Same as J2
J4	612 0233 000	Receptacle, Type N
K1	570 0120 000	Primary Contactor, 4 pole, 110 V, 50/60 Hz
	584 0133 000	Replacement Coil for K1
	584 0129 000	Replacement Contact Kit for Single Pole of K1
K2	570 0132 000	Blower Contactor, 3 pole, 208-220 V. 50/60 Hz
	584 0134 000	Replacement Coil for K2
	584 0135 000	Replacement Contact Kit for Single Pole of K2
K3	574 0099 000	Relay, DPDT, 110 V, 60 Hz
	584 0136 000	Replacement Coil for K3
	584 0138 000	Replacement Contact for K3, Upper stationary
	584 0139 000	Replacement Contact for K3, Lower stationary
	584 0140 000	Replacement Contact for K3, Right Hand movable
	584 0141 000	Replacement Contact for K3, Left Hand movable
K4	570 0119 000	Step-Start Contactor, 4 pole, 208-220 V, 50/60 Hz
	584 0142 000	Replacement Coil for K4, (208-220 V. a.c.)
	584 0129 000	Replacement Contact Kit for Single Pole of K4
K5	570 0116 000	Plate Contactor, 3 pole, 220 V, 60 Hz
	584 0143 000	Replacement Coil for K5 (220 V)
	584 0144 000	Replacement Contact Set complete (For K5)
K6	572 0125 000	PA O.L. Relay, 6 V. d.c.
K7	572 0125 000	PA O.L. Relay, 6 V. d.c.
K8	574 0128 000	Recycle Relay, SPDT
K9	572 0066 000	Relay
K10	572 0052 000	IPA Grid Underdrive Relay
K11	582 0003 000	Magnetic Overload Relay, 60-120 A.
K12		Same as K11
	584 0069 000	Replacement Coil for K11 & K12
L1		Not Used
L2	942 5994 001	Plate Line Assembly
L3	927 4249 002	PA R.F. Plate Choke
L4	494 0004 000	Choke, 7 uH
L5	914 9985 001	IPA R.F. Plate Choke
L6		IPA Plate Coil (Det. by Freq.)
L7		Not Used
L8		Not Used
L9		Same as L4
L10	476 0007 000	Choke, 12 H., 75 mA

PARTS LIST

Symbol No.	Gates Stock No.	Description
L11	476 0272 000	Filter Reactor, 2 H., 1 A.
L12	476 0270 000	Reactor, 2 H., 5 A.
L13	914 7670 002	Choke, 2 uH.
L14		Same as L13
L15		Same as L4
L16		Same as L4
M1	630 0124 002	Filament Voltage Meter, 0-10 V. a.c
M2	632 0559 002	Plate Current Meter, 0-5 A. d.c.
M3	632 0569 002	Plate Voltage Meter, 0-10 kV.
M4	632 0667 000	R.F. Output Meter (Power & VSWR)
M5	632 0584 002	Multimeter
M6	632 0585 002	PA Screen Current Meter, 0-200 mA d.c.
M7	636 0016 000	Elapsed Time Meter, 230 V. a.c.
R8	914 9092 001	VSWR Calibration Potentiometer, 10k Ohm (Mod.)
R9	550 0067 000	Power Calibration Potentiometer, 10k Ohm
R10	542 0286 000	Resistor, 5 Ohm, 100 W.
R11	550 0061 000	Potentiometer, 1k Ohm
R12		Not Used
R13	540 0300 000	Resistor, 47 Ohm, 1 W. 5%
R14		Same as R13
R15A	540 0623 000	Resistor, 3.3k Ohm, 2 W. 5%
R15B		Same as R15A
R15C		Same as R15A
R16	540 0563 000	Resistor, 10 Ohm, 2 W. 5%
R17		Same as R16
R18	548 0207 000	Resistor, .22 Ohm, 2 W. 1%
R19	540 0162 000	Resistor, 47 Ohm, 1/2 W. 10%
R20		Same as R19
R21	552 0309 000	IPA Filament Rheostat, 25 Ohm, 25 W.
R22	552 0452 000	PA Filament Rheostat, 10 Ohm, 300 W.
R23		Not Used
R24		Not Used
R25	540 0724 000	Resistor, 47 Ohm, 2 W. 10%
R26		Same as R25
R27	542 0106 000	Resistor, 30k Ohm, 10 W.
R28	914 9092 001	Potentiometer, 10k Ohm, 2 W. (Mod.)
R29	552 0349 000	Rheostat, 10k Ohm, 50 W.
R30	542 0218 000	Resistor, 4000 Ohm, 50 W.
R31	542 0441 000	Resistor, 1 Ohm, 50 W.
R32		Same as R31
R33		Same as R31
R34	540 0628 000	Resistor, 5100 Ohm, 2 W. 5%
R35		Same as R9
R36		Same as R11

PARTS LIST

Symbol No.	Gates Stock No.	Description
R37	542 0055 000	Resistor, 15 Ohm, 10 W.
R38	540 0728 000	Resistor, 100 Ohm, 2 W. 10%
R39	550 0059 000	O.L. Adjust Potentiometer, 500 Ohm
R40	542 0343 000	Resistor, 60K Ohm, 160 W.
R41		Same as R40
R42	552 0347 000	IPA Screen Rheostat, 5K Ohm, 50 W.
(R43 & R44)	552 0790 000	Rheostat, 2 in tandem, 10K Ohm, 150 W.
R45	542 0305 000	Resistor, 20K Ohm, 100 W.
R46	542 0335 000	Resistor, 10K Ohm, 160 W.
R47	542 0333 000	Resistor, 5K Ohm, 160 W.
R48	914 3424 001	Meter Multiplier, 5 Megohm
R49		Same as R48
R50	550 0061 000	Potentiometer, 1K Ohm
R51	542 0346 000	Resistor, 100K Ohm, 160 W.
R52		Same as R51
R53		Same as R51
R54	540 0611 000	Resistor, 1000 Ohm, 2 W. 5%
R55	542 0284 000	Resistor, 3 Ohm, 100 W.
R56	540 0162 000	Resistor, 47 Ohm, 1/2 W. 10%
R57	540 0580 000	Resistor, 51 Ohm, 2 W. 5%
R58	540 0833 000	Resistor, 100 Ohm, 25 W.
R59	542 0081 000	Resistor, 2K Ohm, 10 W.
R60	542 0145 000	Resistor, 10K Ohm, 20 W.
R61		Same as R60
R62		Same as R60
R63	540 0571 000	Resistor, 22 Ohm, 2 W. 5%
R64		Same as R63
R65	540 0568 000	Resistor, 16 Ohm, 2 W. 5%
R66	542 0334 000	Res., 7500 ohm, 160 W.
S1	604 0445 000	Switch, Pushbutton, "Z" contacts
S2		Same as S1
S3		Same as S1
S4		Same as S1
S5	604 0032 000	Remote-Local Switch, DPDT
S6	604 0196 000	Interlock Switch
S7		Same as S6
S8		Not Used
S9		Not Used
S10	604 0310 000	Air Switch
S11	604 0196 000	Interlock Switch
S12		Same as S11
S13	604 0052 000	Limit Switch
S14		Same as S13
S15	602 0056 000	PA Screen Raise-Lower Switch
S16	914 9091 001	RF Output Meter Switch (Mod.)
S17	602 0007 000	Filament Voltage Switch
S18	914 9091 003	Multimeter Switch (Mod.)
S19		Voltage Change Switch (Part of Mechanical)

PARTS LIST

Symbol No.	Gates Stock No.	Description
T1	472 0533 000	Filament Transformer
T2	472 0530 000	Filament Transformer
T3	472 0531 000	Bias Transformer
T4	472 0525 000	Plate Transformer, 9000 V. d.c.
T5	472 0534 000	Plate Transformer, 2000 V. d.c.
TB2		Not Used
TB3	614 0072 000	Terminal Board, 5 terminal
TB4	614 0052 000	Terminal Board, 8 terminal
TB5		Not Used
TB6	614 0104 000	Terminal Board, 14 terminal
TB7	614 0096 000	Terminal Board, 6 terminal
TB8		Same as TB7
V1	374 0097 000	Tube, 4CX15,000A
V2	374 0081 000	Tube, 4CX250B
V3		Same as V2
XC37	404 0016 000	Socket for plug-in Capacitor
XF1-2	404 0014 000	Fuse Block, 2 pole
XF3-4-5	402 0015 000	Fuse Block, 3 pole
XF6-7		Same as XF1-2
XF8	402 0074 000	Fuseholder, indicating
XV1	404 0199 000	Tube Socket
XV2	404 0251 000	Tube Socket 80°a
XV3		Same as XV2
Z1	384 0365 000	H.V. Silicon Rectifier Stack
Z2		Same as Z1
Z3		Same as Z1
Z4	384 0167 000	Intermediate Supply Rectifier
Z5		Same as Z4
Z6		Same as Z4
Z7		Same as Z4
Z8		Same as Z4
Z9		Same as Z4
Z10	384 0154 000	Bias Supply Rectifier Stack

PARTS LIST

M-4845 RF OUTPUT CURRENT EXTENSION KIT

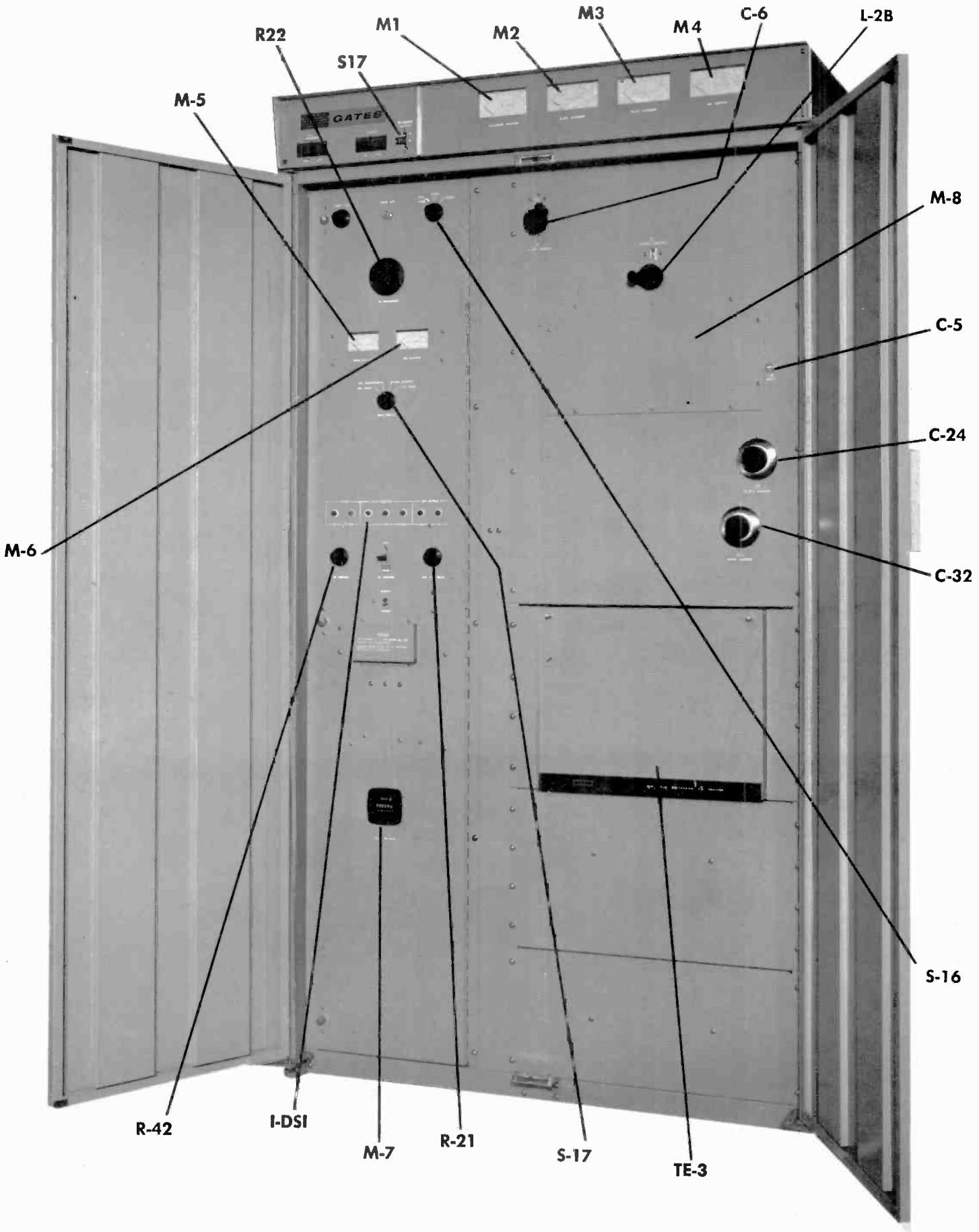
Symbol No.	Gates Stock No.	Description
C1	516 0043 000	Cap., 470 pF., 1 kV.
C2	516 0054 000	Cap., .001 uF., 1 kV.
C3		Same as C2
CR1	384 0195 000	Diode, 1N914
CR2		Same as CR1
J1	612 0237 000	Receptacle, "BNC"
R1	540 0594 000	Res., 200 Ohm, 2 W.
R2		Same as R1
R3		Same as R1
R4		Same as R1
R5		Not Used
R6	550 0067 000	Potentiometer, 10K Ohm
R7	540 0070 000	Res., 7500 Ohm, 1/2 W.
TB1	614 0069 000	Terminal Board, 2 terminal

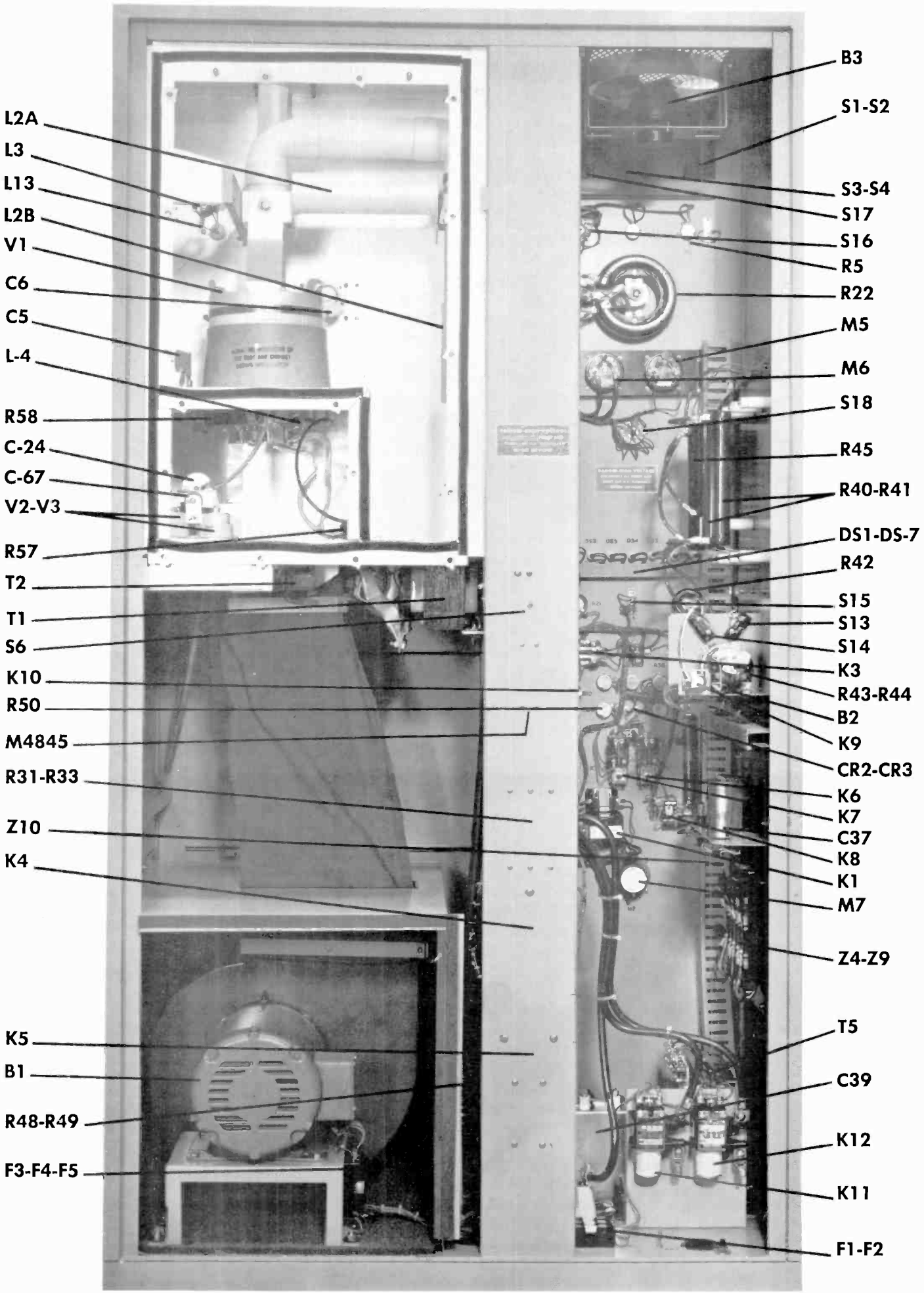
MECHANICAL PARTS

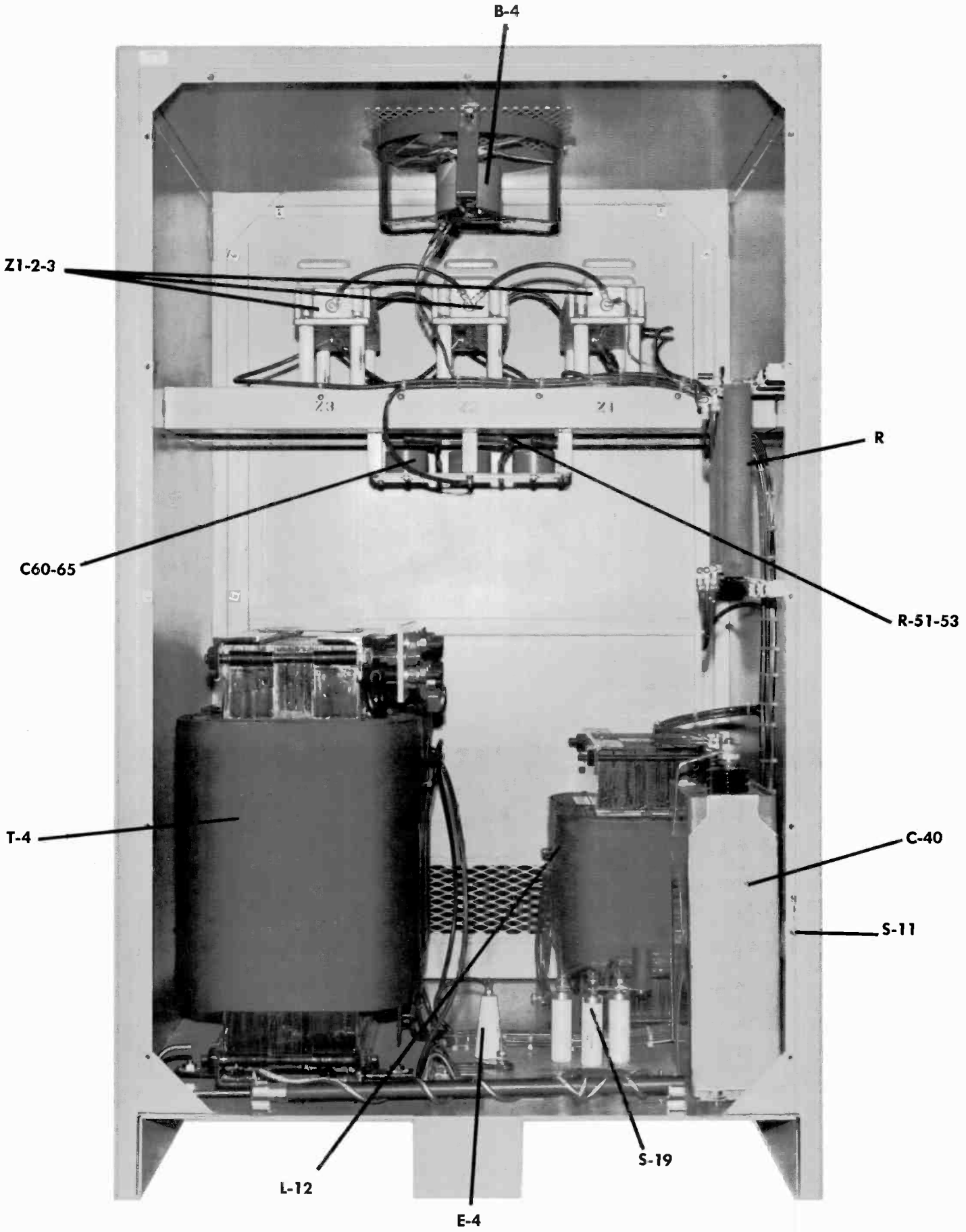
Qty. Used	Gates Stock No.	Description & Usage
2	448 0207 000	Catch , magnetic (Double); Front Doors.
2	404 0073 000	Chimney; IPA Tubes
1	404 0194 000	Chimney; P.A. Tube
2	648 0015 000	Counter; Plate Tuning C6 and Output Loading L2B
1	926 7398 002	Coupling Ass'y. insulated; Plate Line L2A
1	358 0488 000	Coupling, flexible 8 KV; Output Load L2B
4	358 0484 000	Coupling, flexible 4 KV; Rheostat (R43 & R44) and Variable Cap., C24,C32
1	358 0489 000	Coupling, Rigid; Tuning Motor, B2
1	358 0798 000	Drive, Right Angle; Neutralizing C5
1	358 1008 000	Drive, Right Angle; Plate Line P/O L2 -
1	827 5285 014	Filter, Air - 1 x 20 x 37½ Disposable Type; Cabinet
3	926 5727 003	Insulator Ass'y., Feedthru; E1, E2 and Neut.
1	926 5727 004	Insulator Ass'y., Feedthru; E3
2	410 0074 000	Insulator, Conical, 3 in. high; E4, E5
1	410 0173 000	Insulator, Conical, 2-5/8" high; E6
1	926 5727 002	Insulator Ass'y, Feedthru; Neutralizing Cap., C5 in P.A.
3	410 0027 000	Insulator, 1 in. Dia. 3 in. lg; Switch S19
12	410 0021 000	Insulator, 3/4 in. dia. 3 in.lg. Rectifier Z1, Z2 & Z3
6	410 0062 000	Insulator, 3/4 in. Square 2 in. long; Resistors R51, R52, R53
2	410 0018 000	Insulator, 3/4 in. dia. 1½ in. lg; Rheostat R43/44
6	410 0019 000	Insulator, 3/4 in. dia. 2 in lg; Resistors R40, R41,R45

MECHANICAL PARTS

Qty. Used	Gates Stock No.	Description & Usage
6	426 0040 000	Isogrommets; Blower Mtg. Bl
6	424 0082 000	Washers for Isogrommets; Blower Mtg. Bl
1	837 9734 001	Support, Mykroy; Plate Line L2
1	838 3893 001	Support, Teflon; Plate Line L2

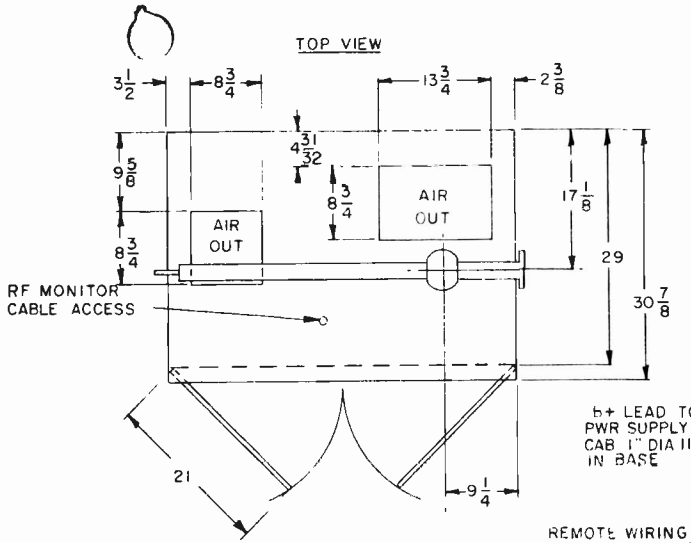

R22
M1
M2
M3
M4
C-6
L-2B
S17
M-5
M-8
C-5
C-24
M-6
C-32
S-16
R-42
I-DSI
M-7
R-21
S-17
TE-3

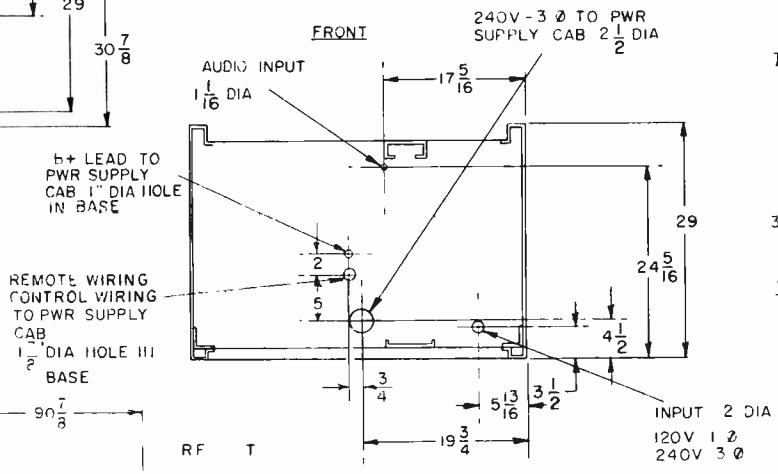

L2A
L3
L13
L2B
V1
C6
C5
L-4
R58
C-24
C-67
V2-V3
R57
T2
T1
S6
K10
R50
M4845
R31-R33
Z10
K4
K5
B1
R48-R49
F3-F4-F5
B3
S1-S2
S3-S4
S17
S16
R5
R22
M5
M6
S18
R45
R40-R41
DS1-DS-7
R42
S15
S13
S14
K3
R43-R44
B2
K9
CR2-CR3
K6
K7
C37
K8
K1
M7
Z4-Z9
T5
C39
K12
K11
F1-F2

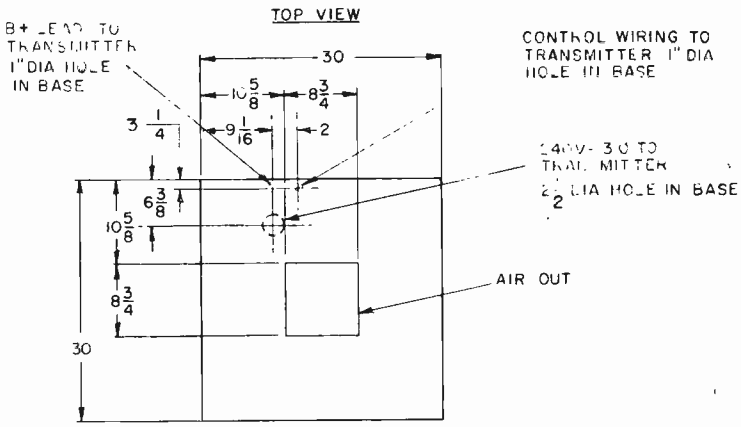

B-4
Z1-2-3
R
C60-65
R-51-53
T-4
C-40
S-11
L-12
S-19
E-4

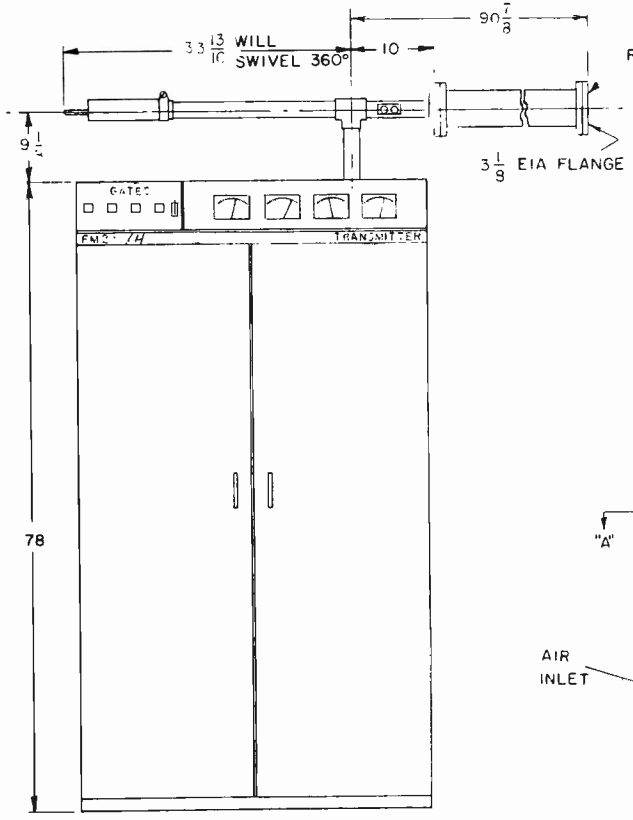
GATES RADIO COMPANY - QUINCY, ILLINOIS
A DIVISION OF HARRIS-INTERTYPE CORPORATION

INSTALLATION DRAWING FM-20G/H3
838 1991 001



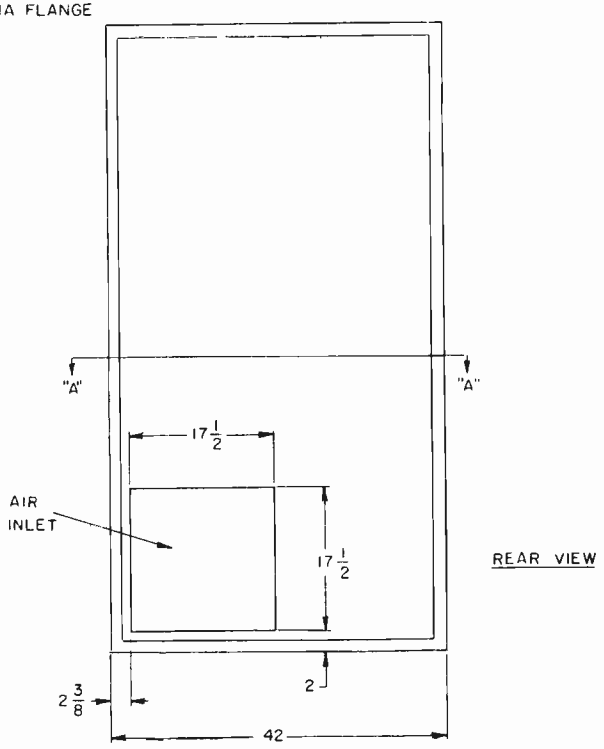




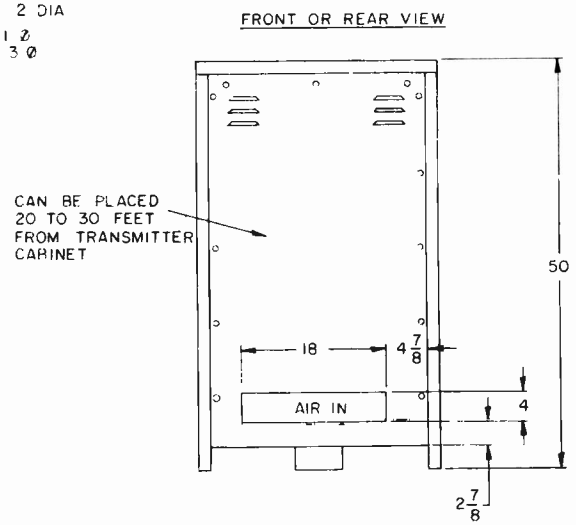


FRONT VIEW

TRANSMITTER CABINET

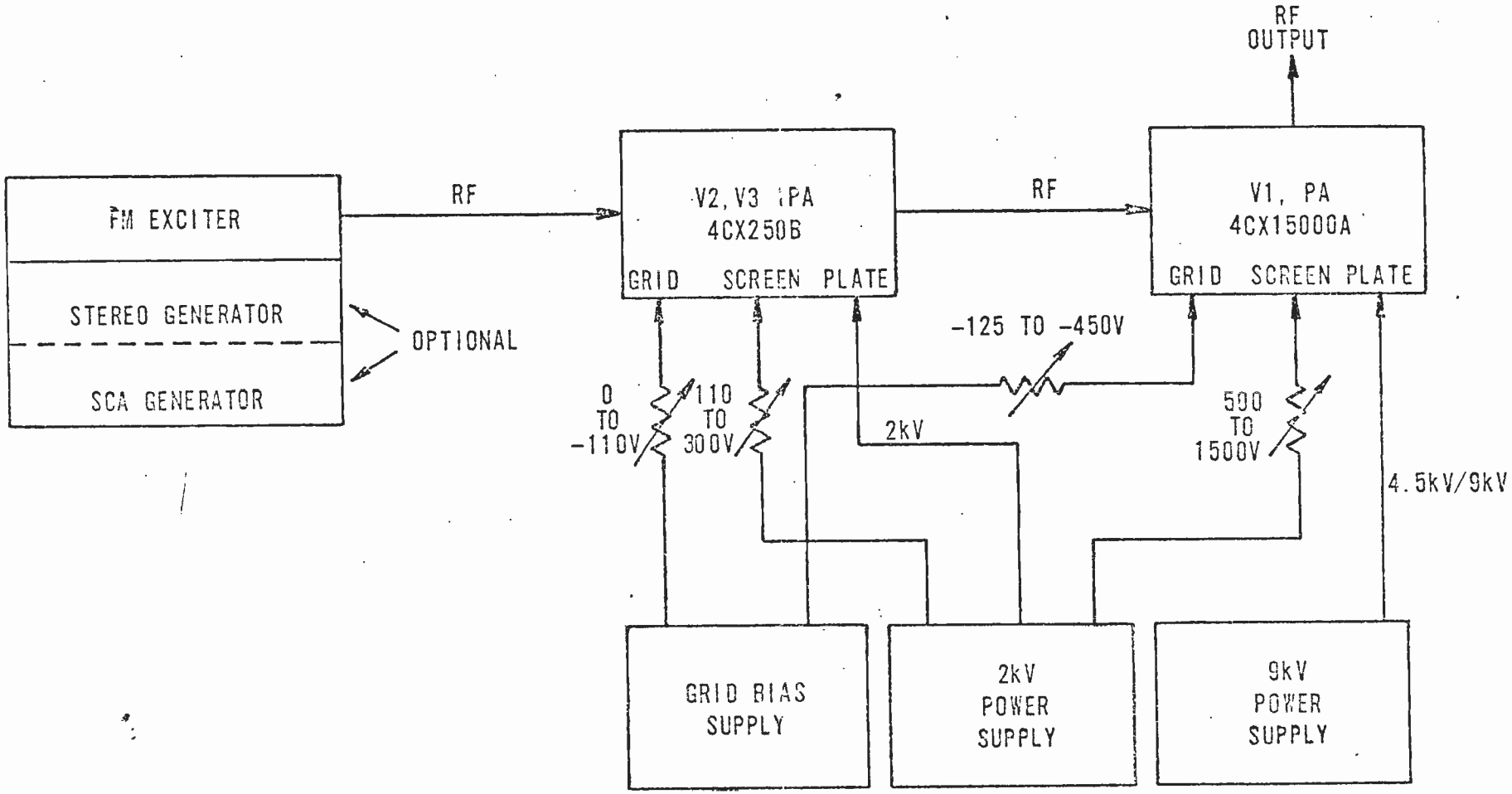


REAR VIEW



H.V. POWER SUPPLY CABINET

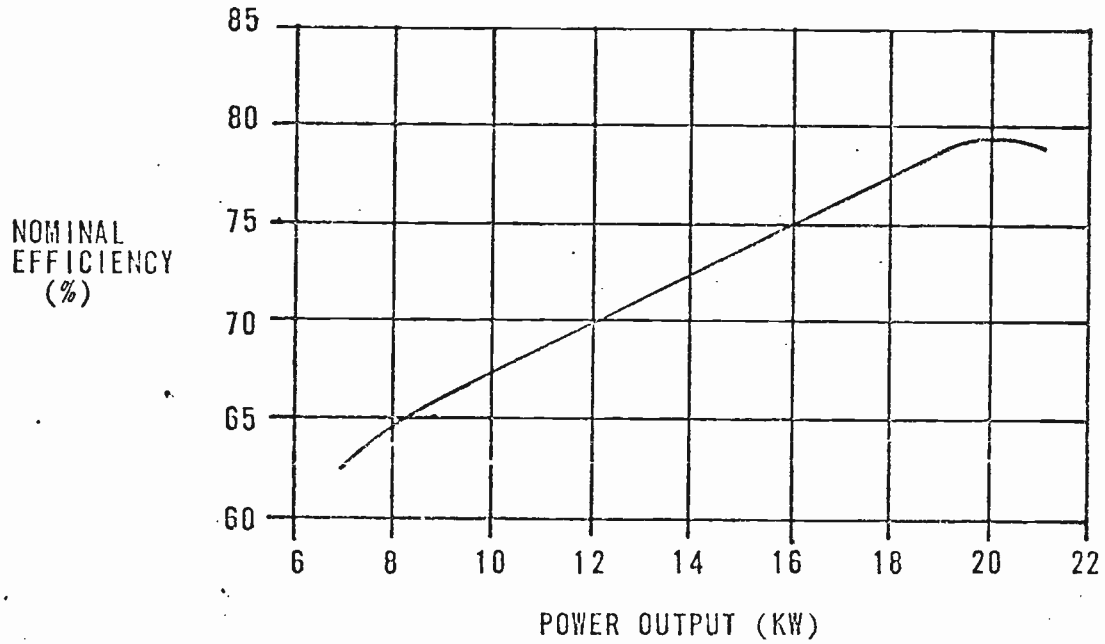
A



QUINCY, ILLINOIS

TITLE BLOCK DIAGRAM
FM-20H2, FM-20H3

DRAWN 2-19-70 S. Lebowitz	F.J. ANDERSON	814 6640 001



REFER TO TRANSMITTERS FACTORY TEST DATA FOR THE EFFICIENCY FACTOR DETERMINED ON FINAL TEST

(REDRAWN, REVISED 2-14-72)

(REVISED 11-12-71)

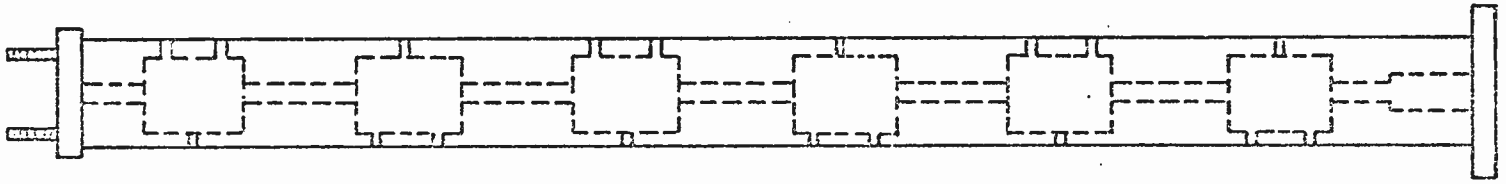
(REVISED 1-15-70)

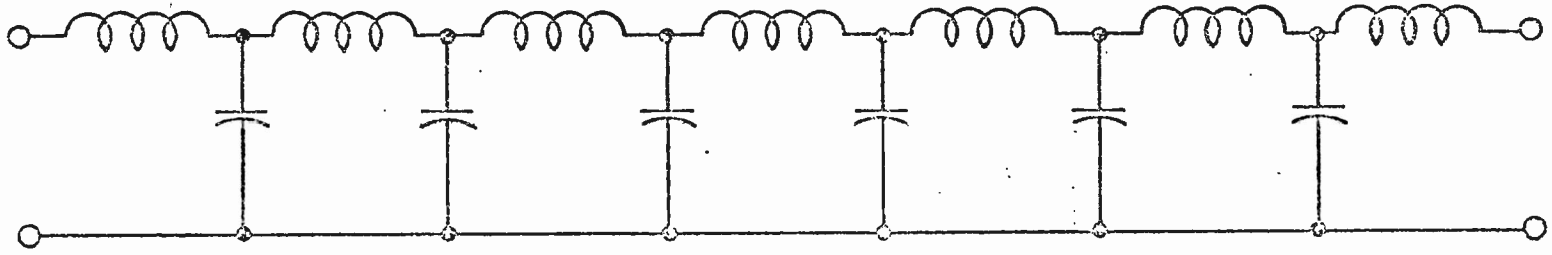
GATES RADIO COMPANY - QUINCY, ILLINOIS
A DIVISION OF HARRIS-INTERTYPE CORPORATION

PA EFFICIENCY CURVE

FM-20G2
FM-20H2, FM-20H3

814 9941 001

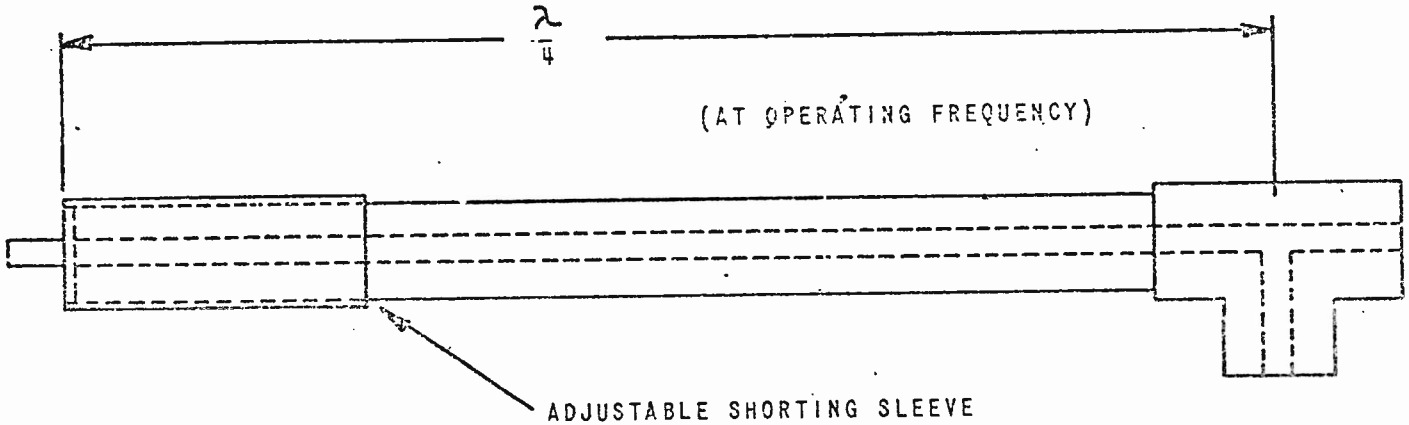


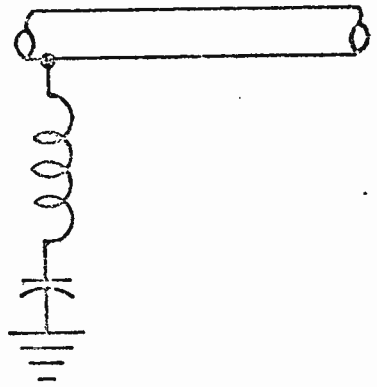


EQUIVALENT CIRCUIT-LOW PASS FILTER

3 1/8" TRANSMISSION LINE, OVERALL LENGTH 72 1/8".

LOW PASS FILTER
FM TRANSMITTERS





APPEARANCE OF NOTCH FILTER
AT SECOND HARMONIC

AT FREQUENCIES BELOW RESONANCE THE "STUB" APPEARS AS AN INDUCTANCE.

AT FREQUENCIES ABOVE RESONANCE THE "STUB" APPEARS AS A CAPACITY.

AT THE SECOND HARMONIC FREQUENCY, THE "STUB" APPEARS AS A SERIES RESONANT CIRCUIT OR DEAD SHORT.

2nd HARMONIC FILTER -
FM TRANSMITTERS

FREQUENCY CHANGE PROCEDURE
HARRIS FM-20K, FM-20H3

This procedure assumes that the transmitter is functional, and that the engineer is familiar with the normal operation and layout of the transmitter, as well as having experience on the test equipment needed. Read and study this procedure before beginning work on the transmitter.

****

BE SURE TO REMOVE ALL PRIMARY POWER BEFORE MAKING ANY INTERNAL ADJUSTMENTS TO THE TRANSMITTER. THERE ARE LETHAL VOLTAGES IN THIS EQUIPMENT.

****

I. Equipment Required:

VOM - Simpson 260 or equivalent
Frequency Counter
Spectrum Analyzer - (To Measure Harmonics to -85 dB up to 1000MHz)
Bird Thru-line watt meter, or equivalent with 25 kw slug.
RF Load - (50 Ohm Capable of 20kw Power)
Metal punch - For frequencies 95.3 MHZ and above, capable of making .218" and .171" diameter holes in .020 copper strap for the new L8 strap.
Metal shears - For frequencies 95.3 MHZ and above, to cut .020" copper strap.
Propane torch and soft solder. (Not needed if the new frequency is between 92 MHZ and 98 MHZ.)
1 x 2 x 12" wooden stick. (Not needed if the new frequency is between 92 MHZ and 98 MHZ.)

II. Parts Required:

A. Output Lowpass Filter

For 92 to 98 Mhz, use filter part no 994-6172-002. No adjustments are required for this filter.

For 88 to 92 Mhz, and 98 to 108 Mhz use 994-6172-001. This filter requires adjustment of the end slugs according to frequency.

B. Anode straps, (2 required)

814-8738-003	88-89.3 and 94.5-100.3 Mhz = 1 1/2" WIDE
814-8738-001	89.5-92.1 and 102.3-108 Mhz = 2 1/4" WIDE
814-8738-004	92.3-94.3 Mhz = 3" WIDE
814-8738-002	100.5-102.1 Mhz = 1 3/4" WIDE
358-0053-000	CLAMP RING

C. Output Coupling Loop

827-9660-001	88-91.9 Mhz
814-8442-001	92.1-103.1 Mhz
814-4138-001	103.1-108 Mhz

D. IPA plate coil L6

939-0189-001	88-91.5 Mhz
838-4547-002	91.7-94.7 Mhz
838-4547-003	94.9-97.9 Mhz
838-4547-004	98.1-101.1 Mhz
838-4547-005	101.3-104.3 Mhz
838-4547-006	104.5-108 Mhz

E. IPA loading strap L8

0.5" wide	88-95.1 Mhz
0.75" wide	95.3-98.9 Mhz
1.0" wide	99.1-102.9 Mhz
1.25" wide	103.1-105.5 Mhz
1.375 wide	105.7-108 Mhz

For L8, the IPA loading strap, order the correct copper strap width per the above chart.

Strap Width	QTY	Part #	Description
0.5" wide	1 ea	814-9522-001	Inductor L8
0.75" wide	1 ft	003-4010-055	1" copper strap
1.00" wide	1 ft	003-4010-055	1" copper strap
1.25" wide	1 ft	003-4010-045	2" copper strap
1.375" wide	1 ft	003-4010-045	2" copper strap

F. Plate Line extension 915-3837-002 is needed below 96.7 Mhz.
Hose Clamp for Plate Line extension is 358-0498-000.

G. IPA Grid Tuning Inductor
1 ft #12 buss wire 254-0006-000.

III. Coarse Setup

A. Second Harmonic Shorting Stub

The second harmonic shorting stub in the output plumbing will need to have the position of the outer sleeve moved according to frequency. The outer conductor can be re-positioned by loosening the set screws and hose clamp, then sliding the outer piece to the desired position.

An initial setting for the second harmonic stub is determined by the formula:

2952 divided by Frequency = Distance from the center of the TEE to the sliding short

Example at 100 MHz: 2952/100 = 29.52 Inches
The second harmonic stub setting can be finalized later when making a measurement of the harmonic output.

Be certain to properly tighten the set screws and clamp after making an adjustment.

B. Output Lowpass Filter (001 version only)

This filter requires some adjustment of the two end slugs according to frequency. See the attached drawing HARMONIC FILTER ASSEMBLY, LOW PASS FILTER, M-6172. With the low pass filter placed on a clean floor with enough room to remove the center conductor, remove one of the end cover and slide the center conductor out of the output conductor. Protect the teflon insulators from ANY dirt contamination with rags or other such protection.

The chart below lists the position of the end slugs measured from the end of the center conductor receivers to the closest edge of the end slugs. Note the difference between the Input and Output ends of the filter. Only the two end cylindrical slugs are adjusted; not the endpieces that are the receiver for the center conductor bullets. The end slugs are held in place by set screws and silver solder which goes the full length of the slug between the slug and the center conductor. Heat the slugs with the propane torch to liquify the solder. This can take a fairly long time due to the thermal mass of the slugs. Do not apply too much heat to the center conductor; it could bend. The wooden stick is used to move the slugs once the solder is liquified. Add more solder if necessary to insure a good joint before allowing the joint to cool.

FREQ	INPUT	OUTPUT
88 to 92	2.125	2.0
98 to 101	2.25	2.375
101 to 103	2.375	2.50
103 to 104	2.50	2.625
104 to 105	2.625	2.75
105 to 107	2.75	2.875
107 to 108	2.875	3.00

C. PA Coarse Tuning Arm

Set the coarse tuning arm to the position noted on a factory test data sheet of the desired frequency. Note that the coarse arm is not used near the low end of the band.

D. Plate Line Extension

Below 96.7 Mhz, install a 915-3837-002 on the bottom of the variable plate line (This is the part which is driven by the front panel Plate Tuning knob).

X E. PA Neutralization

Position the neutralization flag as far from the tube as possible, or the setting indicated by a factory test data sheet on the desired frequency if one was available.

F. HV Supply

Remove the access cover from the HV Power Supply, and set the high voltage select knife switch (S11) to the low voltage position. Fasten the access cover back in place.

G. IPA Grid Inductor

Replace the existing L7 inductor with a 4 inch length of #12 buss wire with the opposite end from C32 connected, but not soldered to the grid lug as this end will have to be moved through the lug in the tune-up process. If you are changing the transmitter to a higher frequency, L7 may simply be shortened, rather than be replaced.

H. IPA Output Loading Strap L8.

If a new L8 is required per chart on page 8, unless the transmitter frequency is 95.1 MHZ or below, L8 must be made from the 020" copper strap provided. See the attached drawing "INDUCTOR - L8 C23 TO PA GRID FM-20H", DWG NO 814-9522-001. This drawing is for the low band only, 88.1 to 95.1 MHZ. To make the proper strap for higher frequencies, cut the new L8 the same length as the strap in the drawing. Punch the holes per the drawing (NOTE: using a drill motor and bit for this operation can be very dangerous). Cut the width of the strap as listed after "L8" on the "PARTS REQUIRED" chart on page 2, step E, of this procedure. Install the new strap in place of the old one between C23 and the PA grid connection on the PA tube socket. Position the new L8 approximately the same as the old L8 was.

L8 is the copper strap connecting from the grid of the PA tubo to capacitor C23. Moving L8 up closer to the PA tube deck will increase the IPA loading, and moving it down from the PA tube deck will decrease the loading. A small movement (1/16 inch) of L8 will change the IPA loading and tuning appreciably. Therefore, be cautious in making this adjustment. Following each adjustment of L8, the IPA screen pot, PA screen pot, and PA loading will need to be turned back to their minimum positions and tuning done again. Otherwise a major arc of the PA cavity could result. Continue to adjust L8 and tune and load the transmitter until the parameters on the Test Data page at the end of this procedure are approximately achieved.

X E. The PA neutralizing flag affects PA grid current and power output. It does not function in the classic sense of neutralization.

In general, the PA grid current increases as the flag is brought nearer to the tube. RF output will generally increase until the grid is saturated, at which point power output would decrease. However, this condition will not necessarily be met.

Be careful not to adjust the flag closer than one inch to the tube. Getting the flag closer than this may result in an arc to the flag.

F. Use a known accurate power measurement device to calibrate the Forward Power meter to 100% at your desired output.

G. Use a spectrum analyzer to verify that the transmitter meets FCC specifications for spurious emissions. Since many spectrum analyzers do not have the dynamic range to measure -80 db, it will probably be necessary to notch out the carrier signal to the analyzer after having established a reference level.

H. If the second harmonic level is out of tolerance, shut the transmitter off and make a small adjustment in the position of the second harmonic shorting stub. Touch up the final tuning if necessary.

TEST DATA SHEET
FM-20K, FM-20H3

NEW FREQUENCY: 107.1 **MHZ** **OLD FREQUENCY:** 94.1 **MHZ**

CAVITY MEASUREMENTS

Distance from the bottom of the PA output coupling sleeve to the PA tube deck is 11 3/16 inches.

Distance from the bottom of the coarse PA plate tuning arm to the PA tube deck is 11 inches.

Distance from the bottom of the fine PA plate tuning inductor slug to the PA enclosure bottom is 12 1/4 inches.

TYPICAL READINGS for 20kw

IPA Cathode Current	420 ma
PA Filament Voltage	6.3 v
PA Grid Current	20-35
IPA Screen I	10-20 ma
PA Screen I	75 ma
PA Plate Current	2.71 A
PA Plate Voltage	9200 V
RF output	20000 W
PA Grid Bias (external meter TB-3, HV off)	-438 V
IPA Control Grid at TB-3 (HV off	-76 V
IPA Screen Voltage at R42	280 V
PA Screen Voltage at M6	800 V
Efficiency	80 %

IV. Exciter:

Since the type of exciter used is independent from the transmitter, the exciter frequency change is covered by a separate procedure. Refer to the technical manual or the required procedure for specific instructions.

V. IPA GRID TUNING

A. Install a watt meter between the output of the exciter and the input of the transmitter so you can look at forward and reflected power.

B. Preset C32 (IPA grid tuning) to "65" on the dial and leave it there until the grid match is completed. C32 should be about 1/2 mesh.

C. Turn on the filaments and exciter power, and adjust the IPA bias voltage control, R28 for a negative 50 volts, measured at TB3-5.

D. Set the exciter output for 8 watts.

E. Adjust the length, physical shape, and position of L7, as well as the placement of resistors R63 and R64 along L7 to get minimum reflected power to the exciter. This will probably require a lot of trial and error to get a feel for this adjustment, and to get it right.

Throughout this adjustment, be aware that the cover plate on the under side of the IPA section affects the IPA grid match. Make sure the cover plate is in place and the filaments are on when checking the grid match because this will have a significant effect on its operation.

Once you get the IPA grid matched, you should have 0.5 Watt or less reflected power to the exciter with 10 watts forward power.

F. Remove power from the transmitter, solder all connections on L7, but do not trim the excess wire off of L7. Replace the bottom cover, and apply power.

G. With just the filaments on, adjust the IPA bias voltage control R28 for 20 mA grid current with 10 watts out of the exciter. Verify that a good IPA grid match has been maintained.

7267

VI. Half Voltage Tune Up

A. With filament voltage on, adjust the PA bias voltage control R29 for maximum negative voltage (approx -440V), measured at TB3-3.

B. Lower the PA screen voltage (raise/lower control) all the way.

C. Turn the IPA screen potentiometer fully counterclockwise.

D. Adjust the PA loading control fully counterclockwise.

E. Apply Plate voltage.

F. Slowly bring the IPA screen up until you have 200mA of IPA cathode current.

G. Adjust C24 (IPA plate tuning) for a dip in the cathode current. Check to make sure C24 is in range! If you do not get a dip within the range of C24, then L6 may be incorrect.

H. At this time, you should also see an up scale reading on the PA Plate Current meter.

I. Adjust the PA Plate Tune control for a dip in the PA Plate Current meter as well as a peak reading on the Output Power meter.

If the Plate current does not dip within the range of the control, it will be necessary to adjust the position of the Coarse Plate Tuning arm.

If the Plate Tuning is going toward a dip in Plate current with the fine tuning slider at the bottom of its range (fully extended), the coarse arm will have to be moved upward. So that you do not over shoot the adjustment, move the coarse arm in about 1/4" increments, then readjust the Plate Tuning for a dip in Plate Current.

Conversely, if the Plate Tuning is going toward a dip in plate current with the fine tuning slider at the top of its range, the coarse arm will have to be moved downward. So that you do not over shoot the adjustment, move the coarse arm in about 1/4" increments, then readjust the Plate Tuning for a dip in Plate Current.

NOTES
1. C9 THRU C16 AND C55 AND C56 LOCATED IN TUBE SOCKET
2. [83] INDICATES A WIRE NUMBER
3. TB6-2 INDICATES A TERMINAL BOARD NUMBER
4. [7] INDICATES A JUMPER
5. ⊘ INDICATES A SCREWDRIVER ADJUSTMENT
6. RESISTANCE VALUES ARE IN OHMS
7. ALL RELAYS AND SWITCHES SHOWN IN NORMAL READY TO START POSITION
8. VALUE OF R15 MAY VARY WITH FREQUENCY
9. DISTRIBUTED CAPACITY

TB1
1 LEFT STEREO
2 OR
3 MONO AUDIO INPUT
4 RIGHT STEREO
5 OR
6 41kHz AUDIO INPUT
7
8 115V AC POWER INPUT
9 AFC INTERLOCK [170] S7
10 [38] TB7-3
11 67kHz
12 AUDIO
13 INPUT
14 REMOTE CONTROL OF STEREO MONO MODE
15
16
17
18
19
20

J1 RF OUTPUT

FM EXCITER

TB6 REMOTE CONTROL BOARD
S5A REMOTE [116] 1 FILAMENT ON
K1 L2 [79] 2
K8 NC [52] 3 OFF
S4 BK [51] 4 PLATE ON
S5B REMOTE [117] 5
TB4 5 [61] 6 LOWER
TB4 6 [62] 7 RAISE
TB4 7 [63] 8 +5V
TB4 8 [64] 9 EP
CR3 [89] 10 IP
CR2 [111] 11
K1 L1 [83] 12 RAISE LOWER COM
TB1+ [120] 13 P6
TB1- [121] 14

W4845
C1 470pF
CR1 1N914
CR2 1N914
C2 .001 uF
R6 10K OUTPUT CONTROL
C3 .001 uF
R7 7.5K
R1 200
R2 200
R3 200
R4 200
TB1 + [120] TB6 13
TB1 - [121] TB6 14

3 1/8" EIA FLANGE
50 OHM
FL1
FL2
OC1
YEL
RED
PWR CAL ⊘ R9 10K
R8 10K VSWR CAL
VSWR CAL
FOR PWR
S16 A B
C4 .01uF
M4 Po
[113]
[112]

PA OUTPUT LOADING C6 10-100 pF
L1
L2A
L2B
PA PLATE TUNING
C5 82 NEUT
C23 100pF
L3 L13 L14
C7 500pF
L8
L15 L16
C8 500pF
C66 500pF
NOTE 1 C9 10-500pF
.10 100uF
V1 4CX15000A
C87 200pF
L6
C24 6-30 pF PA PLATE TUNING
L4 7uH
R58 100
SEE NOTE 9
R57 51
L5
C53 C52 C54 C51 C20 C17 C68 C69 C19 C18
C17 20 AND C51 54 C68 C69 1000pF
C35 .001uF M6
C21 .001uF
L9 1uH
C30 .001uF C27 .001uF C29 .001uF C28 .001uF C26 .001uF
RF ENCLOSURE
C25 500pF
T2
T1
R10 5
R1 1K
REMOTE Ip
CR2
TB6 11
R22 10
PA FILAMENT
S17 C57 .01uF
DS9 (PART OF S1)
DS10 (PART OF S3)
W1 KS PLATE
R20 47
R19 47
S18
C33 .01uF
MULTIMETER W5
S18 POSITION MULTIMETER FUNCTION
1 IPA GRID
2 IPA CATHODE
3 IPA SCREEN
4 PA GRID

J4
E7
C22 2000pF
R63 22
R64 22
L7
R15A 3.3K
R15B 3.3K
R15C 3.3K
C32 5-30 pF IPA GRID TUNING
C31 40pF
C49 NEUT
C55 NOTE 1
V2 4CX250B
V3 4CX250B
R14 47
R65 16
R13 47
C41 .44 500pF
R16 10
R17 10
C45 .48 500pF
C56 NOTE 1
E1 E2 E3

IPA FILAMENT
R21 25
GRID DRIVE
K10
R56
T3
R25 47
Z10
R26 47
.10
C37 30uF
C37A 30uF
R27 30K
R28 10K
IPA BIAS
R29 10K
R30 4K
TB3-1 TB3-2 TB3-5 TB3-4 TB3-3
TB4-8 TB4-3
[137]
[140]
[86]
[54]
[55]
[104]
[106]
[105]
[107]
[108]
[109]
[110]
[101]
[165]
[164]
[161]
[65]
[67]
[66]
[45]
[100]
[111]
[99]
[94]
[103]

ELAPSED TIME M7 [161]
[160]

TB4
[119] LOWER S15 RAISE TB6 6
[59] 2
[60] 3
[61] 4
[62] 5 TB6 7
[63] 6 TB6 8
[64] 7 TB6 9
LOWER RED S13 COM
RAISE S14 BRN
R2

S1 FILAMENT ON N.O.
S2 FILAMENT OFF N.C.
LOCAL REMOTE S5A
TB6 1
TB6 2
B3
K1 FILAMENT
DS2 F1 10A
DS1 F1 10A
115V AC INPUT 1 PHASE
[152] [153] [84] [83] [82] [95] [154] [156]
T1 T2 T3 T4
L1 L2 L3 L4
[28] [52] [54] [56] [57] [58] [34] [35] [37] [38] [39] [77] [75] [76] [77] [76] [87]
[79] [80] [74] [78] [90] [79] [81] [35]

DS4 F4 8A
B1
S10 AIR
F5 8A F6 8A
K2 BLOWER
DS3 DS5
[23] [24] [68] [141] [73] [42] [71] [72] [65] [70] [69] [88] [43] [44] [147] [148] [26]

R31 R32 R33
K4 STEP START
[18] [25] [19] [86] [87] [88] [20] [21] [22] [50] [47]

K12 230V
K11 AC INPUT 3 PHASE
E6
K5 PLATE
AUXILIARY CONTACTS OF K5 ARE USED FOR DS10
[16] [17] [18] [46] [47] [48]

JUMPER FOR LOCAL OPERATION
TB6-3 TB6-4
K8 RECYCLE
R34 1K
C38 16uF
CR4
R35 10K RECYCLE
K7
R38 100
PA OVERLOAD
IPA CATHODE OVERLOAD R36 1K
IPA OVERLOAD DS6
PA PLATE OVERLOAD
R39 500
C36 .001
M2
R37 15
DS7
F7 8A F8 8A
[156] [157] [158] [159] [150]
[91] [92] [93] [31] [42]
[118] [119] [43] [44] [45]

REAR DOOR S6 [33]
FRONT DOOR S7 [32]
S2 PLATE ON N.O. [42]
S4 PLATE OFF N.C. [40]
S5B REMOTE LOCAL
TB6 5 [117]
K3
[41] [7] [41] [40] [51]

S8 S9 [34]
FM EXCITER TB1-9 TB1-10 [170]
TB6-10 REMOTE ED [89]
CR3
R50 1K
[27]

T4
R15 [15]
Z4 Z6 Z8 Z5 Z7 Z9
C39 1uF
R40 60K R41 60K
R42 5K IPA SCREEN [103]
R59 2K
R44 10K R46 10K R66 7.5K R47 5K R45 20K
[6] [5] [14] [4] [3] [2] [1] [8]

HIGH VOLTAGE SUPPLY CABINET
[188] [22] [23] [24] [25] [26] [27]
S11 INTERLOCK S12
B4
R60 C60 C61 R62 C62 C63 C64 C65 R61
Z1 Z2 Z3
900DV S19
450DV
L11 2H
C40 4.5uF
R51 100K R52 100K R53 100K R54 1K
R49 5MEG R48 5MEG
C34 .01uF
T5
E4 E5
[13] [95]

GATES RADIO COMPANY - QUINCY, ILLINOIS
A DIVISION OF HARRIS-INTERTYPE CORPORATION

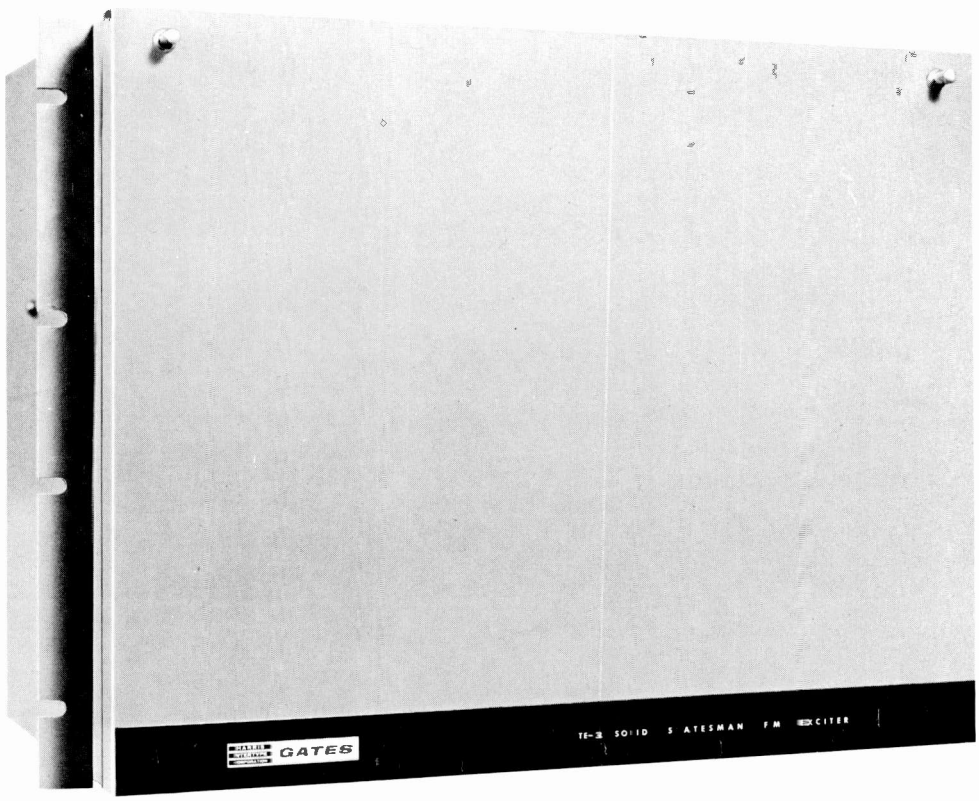
SCHEMATIC, OVERALL
FM-20H3 TRANSMITTER
852 6553 001

TECHNICAL MANUAL

TE-3
SOLID STATESMAN FM EXCITER

HARRIS INTERTYPE CORPORATION

GATES®



TE-3
SOLID STATESMAN
FM EXCITER

TECHNICAL MANUAL

TE-3 FM EXCITER

INTRODUCTION

This Technical Manual provides the necessary information for the application, installation, operation, adjustment and maintenance of the TE-3 Exciter.

Price: $15.00

888 1042 001

TABLE OF CONTENTS

SECTION 1 - DESCRIPTION

1.1 GENERAL

The TE-3 Exciter consists of five basic, interconnected, modular units; Power Supply, Power Amplifier, Modulated Oscillator, Automatic Frequency Control, and Audio Section. See Fig. 1.1.

The frequency range of the exciter is from 87.5 MHz to 108 MHz and it is factory tuned to the customer specified frequency.

The exciter is completely self-contained. The oscillator of the exciter operates at the carrier output frequency eliminating frequency multipliers. This insures improved carrier stability and excellent frequency response when the power level is increased in conjunction with high power transmitters. The output power of the exciter is 10 to 15 watts.

1.2 OPTIONAL EQUIPMENT

The TE-3 exciter has provisions for three optional plug in modules; two SCA Generators, and one Stereo Generator. Figure 1.1 shows the TE-3 with Stereo Generator and SCA Generator installed.

1.3 TECHNICAL CHARACTERISTICS

1.3.1 MECHANICAL:

Width:	19" (Fits standard rack mount)	
Height:	14"	
Depth:	12 ¼"	
Weight:	(Uncrated)	52 lbs. (monaural only)
		3 lbs. (SCA generator)
		6 lbs. (stereo generator)
Finish:	Beige	

Semiconductors used throughout.

1.3.2 ELECTRICAL: (Monaural Operation)

Frequency Range:	87.5 to 108 MHz
Power Output:	10 Watts
RF Harmonics:	Suppression meets or exceeds all FCC requirements
RF Output Impedance:	50 ohms (BNC connector)
Frequency Stability:	.001% or better
Modulation Capability:	Capable of ±100 kHz (±75 kHz=100% modulation)
Audio Input Impedance:	600 ohms balanced
Audio Input Level:	+10 dBm ±2 dB for 100% modulation at 400 Hz

Audio Frequency Response:	Standard 75 microsecond FCC pre-emphasis curve, ±1 dB, 30-15,000 Hz
Distortion:	.5%, 30 to 15,000 Hz
FM Noise:	65 dB below 100% modulation (ref. 400 Hz)
AM Noise:	70 dB below reference carrier AM modulated 100%
Temperature:	-20° to +50° C
Altitude:	7,500 feet
Power Requirements:	117 V AC, single phase, 60 Hz, 85 watts

1.3.3 ELECTRICAL: (Stereophonic Operation)

Pilot Oscillator:	Crystal controlled
Pilot Stability:	19 kHz ±1 Hz, 0° to 50° C
Audio Input Impedance (Left and Right):	600 ohms balanced
Audio Input Level: (Left and Right):	+10 dBm ±1 dB for 100% modulation at 400 Hz
Audio Frequency Response (Left and Right):	Standard 75 microsecond, FCC pre-emphasis curve, ±1 dB, 50-15,000 Hz
Distortion (Left and Right):	1% or less, 50-15,000 Hz
FM Noise (Left and Right):	60 dB (minimum) below 100% modulation (ref. 400 Hz)
Stereo Separation (Left to Right or Right to Left Channel):	35 dB (minimum) 50 to 15,000 Hz
Sub-Carrier Suppression (With or without modulation present):	42 dB (minimum) below 90% modulation
* Crosstalk (Main channel to sub-channel or sub-channel to main channel):	42 dB (minimum) below 90% modulaton, 50-15,000 Hz
Sub-Carrier 2nd Harmonic Suppression (76 kHz):	60 dB or better below 100% modulation

NOTE: Stereophonic measurements to be made with an FCC approved monitor.

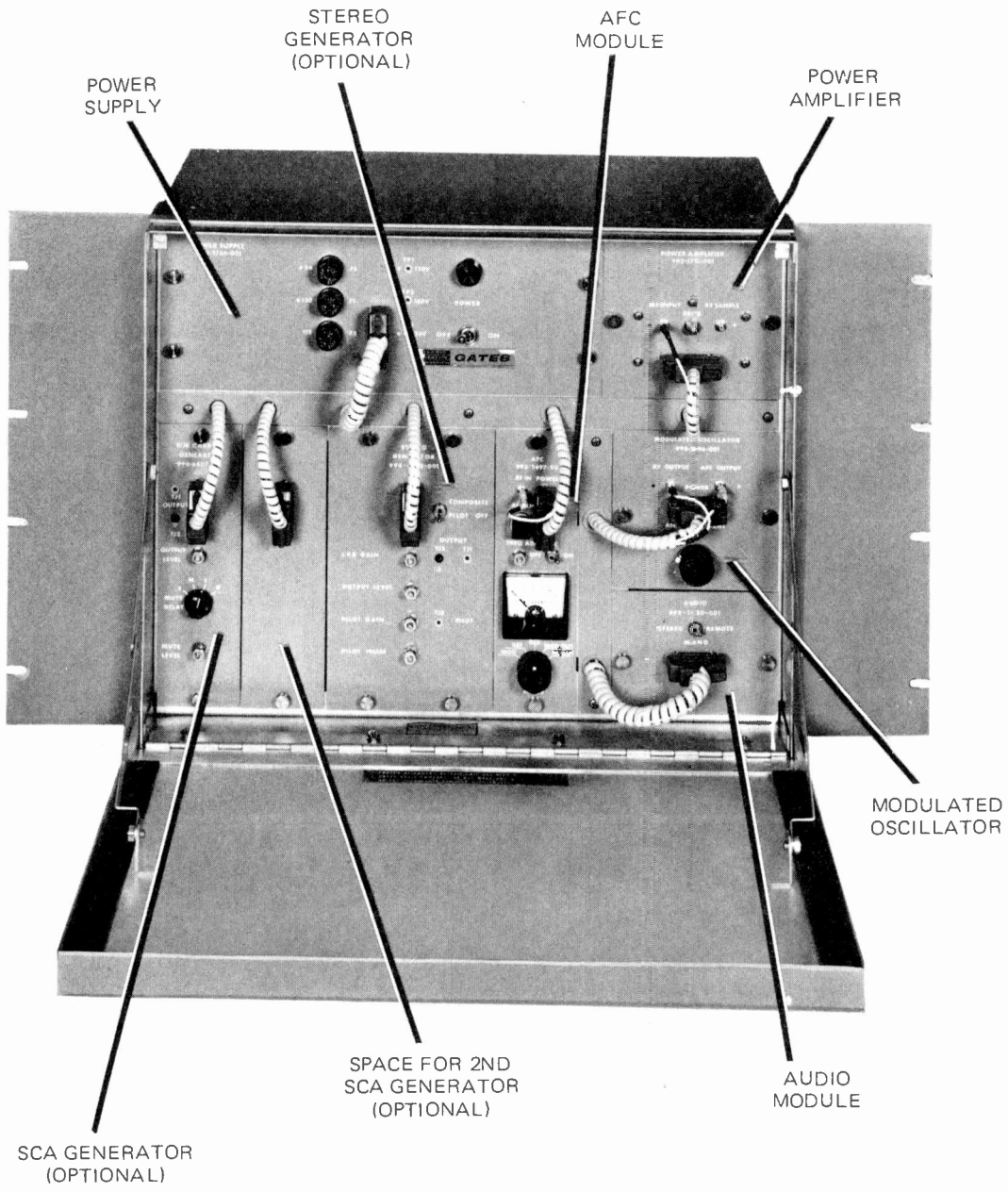
* Measurement to be made using an L=R signal for sub-channel crosstalk and an L=-R signal for main channel crosstalk.

1.3.4 ELECTRICAL: (SCA Operation)

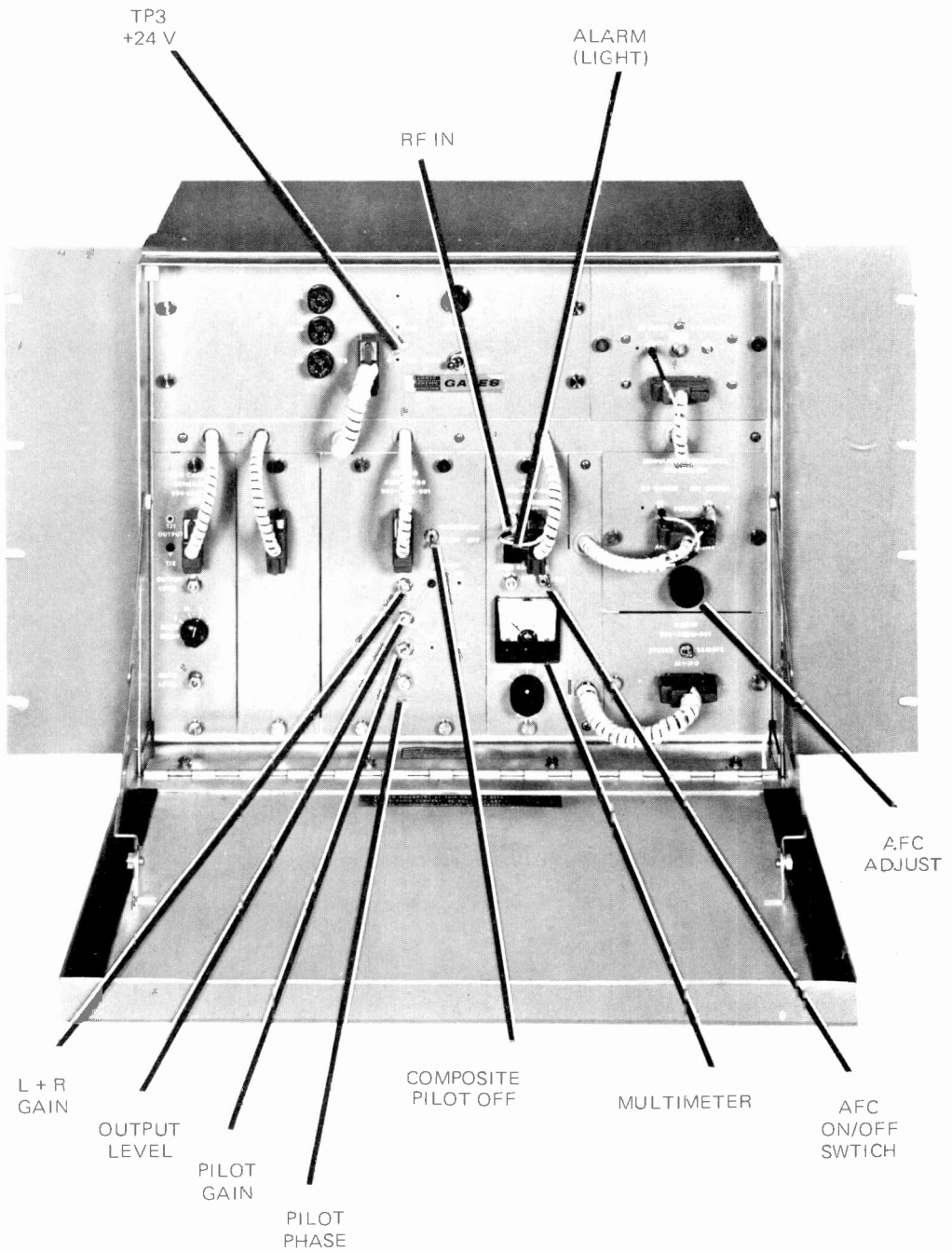
Frequency:	Any SCA channel between 25 and 75 kHz
Frequency Stability:	±500 Hz
Oscillator Type:	Two Colpitts heterodyned to produce desired output frequency
Modulation:	Direct FM
Modulation Capability:	Capable of ±7.5 kHz (±5 kHz considered 100% modulation)
Audio Input Impedance:	600 ohms balanced
Audio Input Level:	+8 dBm, ±3 dB for 100% modulation at 400 Hz
Audio Frequency Response:	41 kHz and 67 kHz, 50 microsecond, modified pre-emphasis 67 kHz response modified for proper operation when used with stereo to conform to FCC specs
Distortion:	1.5% (or better) 30-7,000 Hz
FM Noise (Main channel not modulated):	55 dB minimum (ref. 100% modulation 400 Hz)
Crosstalk (Sub-channel to main channel and stereophonic sub-channel):	-60 dB or better
** Crosstalk (Main channel to sub-channel):	50 dB below 100% modulation (ref. 400 Hz) with main channel modulated 70% by frequencies 30-15,000 Hz

** Crosstalk measurements to be made from an FCC approved monitor using 75 microsecond de-emphasis.

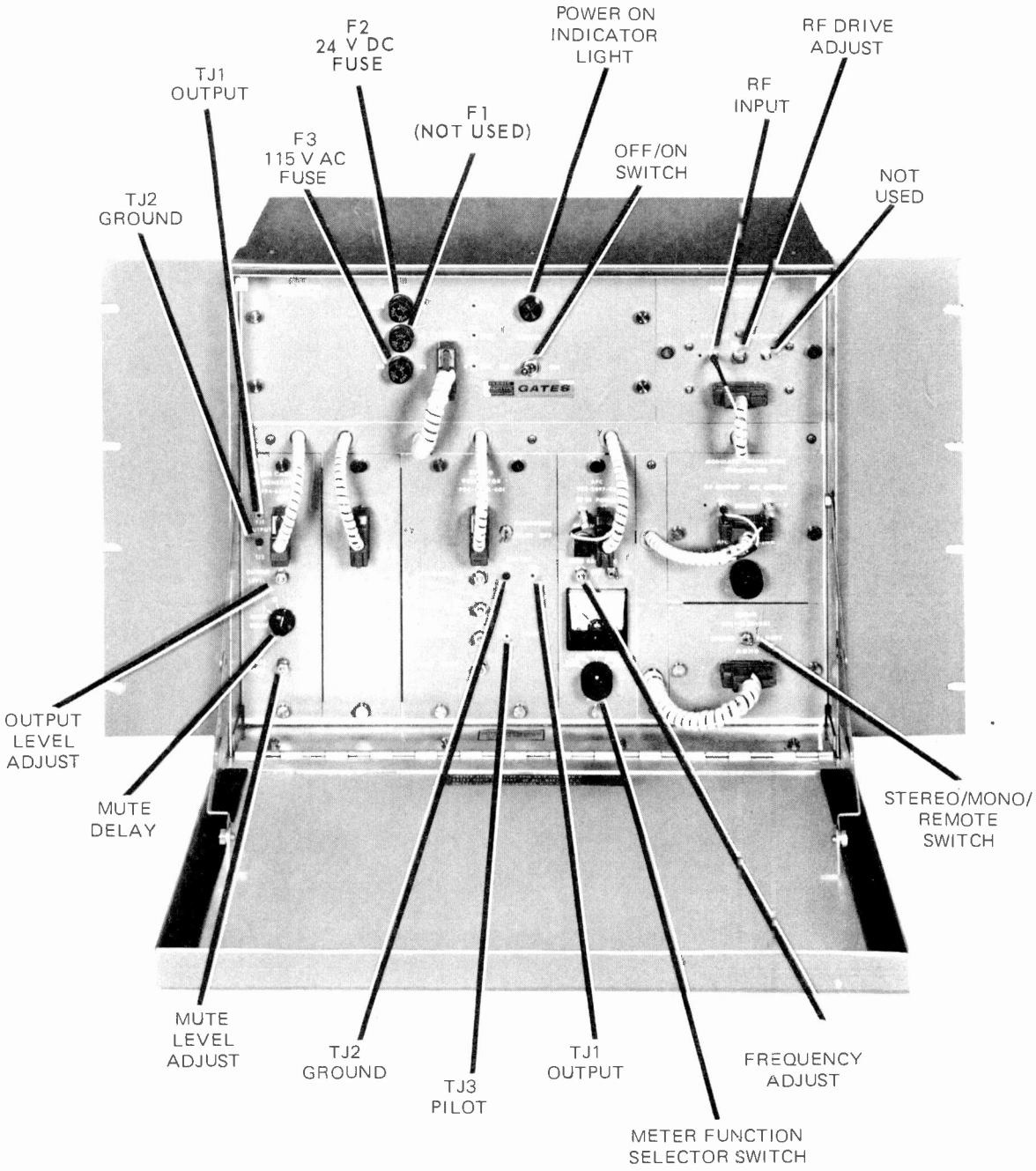
Automatic Mute Level:	Variable from 0 to 40 dB below 100% modulation
Remote Control:	Exciter is internally equipped to be locally or remotely switched from monaural to stereo operation. On monaural operation, normal right audio input connections are switched to the 41 kHz SCA position, if used. Remote functions are accomplished by a single set of external relay contacts, (closure required for stereo operation). An external relay must provide a holding function.



FRONT
VIEW
FIG. 1.1



FRONT
VIEW
FIG. 1.2



FRONT
VIEW
FIG. 1.3

SECTION 2 - INSTALLATION

2.1 DAMAGE CLAIM INFORMATION

In case of damage, notify the delivering carrier at once. After he has approved the damage report order new part(s) from Gates Radio Company, using the parts list for description and individual identification.

2.2 UNPACKING AND INSPECTION

The container and packing should be removed only after a careful examination of the outside of the carton for indications of possible mishandling.

Retain packing material until installation is complete and the TE-3 is placed in operation.

2.3 UNPACKING CHECK LIST

When the TE-3 is shipped as a separate unit, the following items are furnished and packed separately:

EQUIPMENT	GATES PART NO.
Basic	
TE-3 Cabinet	992 1726 001
Modulated Oscillator (Module)	992 2696 001
Audio Unit (Module)	992 1830 001
AFC Control (Module)	992 2697 001
Power Amplifier (Module)	992 1715 001
Technical Manual	888 1042 001
Optional	
SCA Generator 1 or 2 Modules(s)	994 6507 001
Stereo Generator (Module)	994 6533 001

2.4 MECHANICAL DETAILS

The modular design assures easy access to all parts during inspection, routine maintenance and repair. Each module may be released from the chassis by means of thumb screws, and operated external to the chassis.

The exciter output may be connected into a dummy load, antenna, or a following amplifier stage.

2.5 POWER REQUIREMENTS & CONNECTION

A 117 V AC, 60 Hz, single phase, 85 watt, fuse or circuit breaker protected, power source is required. No additional equipment is necessary for operation.

Connect the input power to terminals 7 & 8 of TB1. See Fig. 2.1.

When the AC input is 117 VAC, the black and green/black primary leads of the transformer T1 should be used. If the AC input voltage is less than 105 VAC, the black and white/black primary leads should be used. If the AC input voltage is greater than 125 VAC, the black and white primary leads should be used.

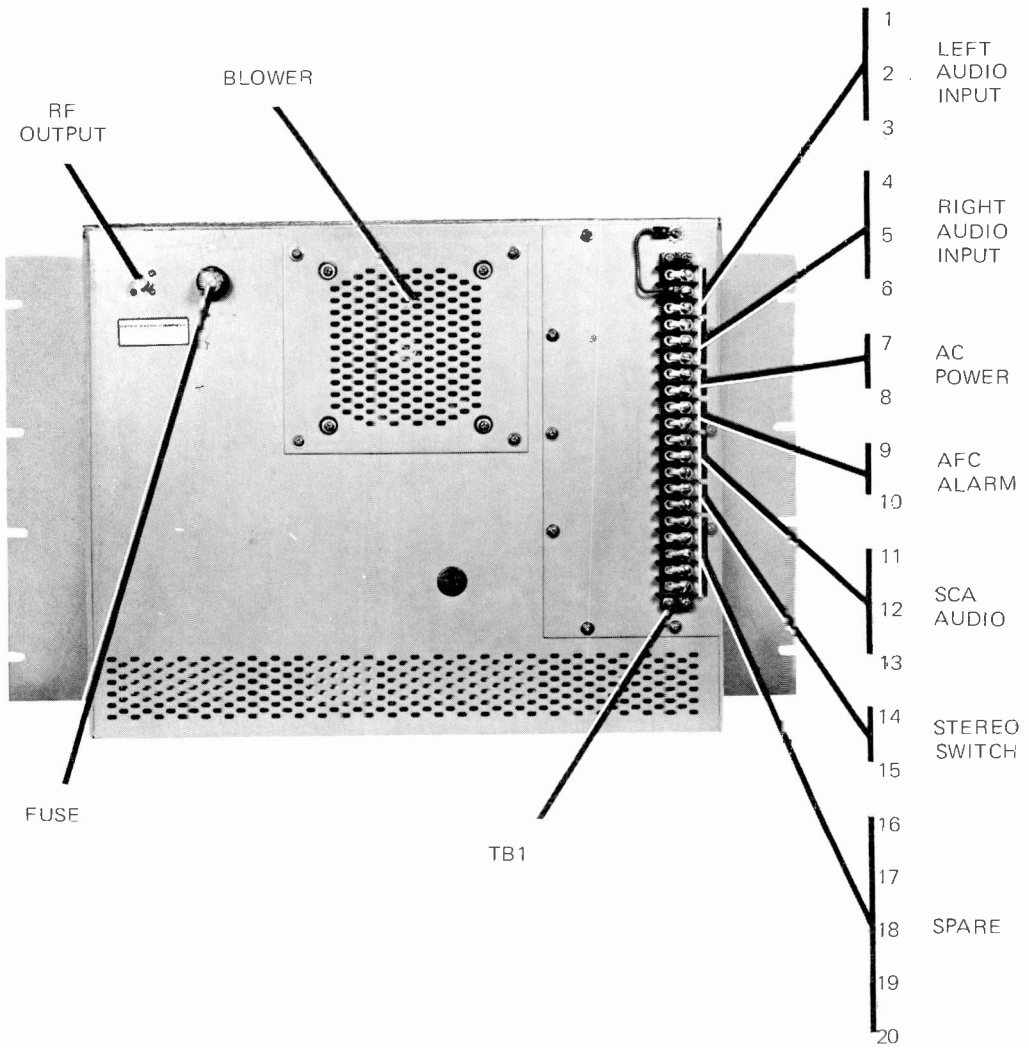
2.6 R.F. OUTPUT CONNECTION

The R.F. connection to the exciter is a BNC connector (J1) on the rear of the unit. See Fig. 2.1. Use coaxial cable type RG58A/U.

2.7 ADDITIONAL CONNECTIONS - See Fig. 2.1

Additonal connections are located on the terminal board TB1 on the rear of the exciter. They are as follows:

1–2–3:	Left Audio Input	(2 is shield)
4–5–6:	Right Audio Input or SCA	(5 is shield)
7–8:	AC Input	
9–10:	AFC Alarm	(N.C.)
11–12–13:	SCA Audio	(12 is shield)
14–15:	Stereo-Mono Switch	
16–17–18–19–20:	Spare	



REAR
VIEW
FIG. 2.1

SECTION 3 - OPERATION & ADJUSTMENT

3.1 FRONT PANEL CONTROLS

The following table gives the identification and function of the front panel controls, (See Fig. 1.1 for basic modules).

TABLE 3.1
FUSES & TEST POINTS
LOCATION AND IDENTIFICATION

IDENTIFICATION	TYPE	FUNCTION
Power Supply		
F2	3 Amp Fuse	Protect +24 Volt circuits
F3	2 Amp Fuse	Protect 115 V AC circuits
S1	Toggle Switch	Energize/De-energize unit
A1	Green Light	Indicates unit energized
Power Amplifier		
R11	Potentiometer	DRIVE Adjust
Modulated Oscillator		
R29	Knob controlled Pot.	AFC Adjust
Audio Unit		
	Toggle Switch	STEREO/MONO/REMOTE SELECT
AFC Unit		
S1	Toggle Switch	AFC - ON/OFF
R48	Potentiometer	FREQ. ADJUST
M1	DC Microammeter	Indicates indexed function
S2	5 position knob controlled switch	Indicates meter function
Stereo Generator		
S1	Toggle Switch	COMPOSITE/PILOT OFF
TJ1	Jack (Test)	COMPOSITE OUTPUT
TJ2	Jack (Test)	GROUND
R68	Potentiometer	L + R GAIN Adjust
R53	Potentiometer	OUTPUT LEVEL Adjust
R27	Potentiometer	PILOT GAIN Adjust
R24	Potentiometer	PILOT PHASE Adjust
SCA Generator		
TJ1	Jack (Test)	OUTPUT
TJ2	Jack (Test)	GROUND
R30	Potentiometer	OUTPUT LEVEL Adjust
S1	4 position knob	MUTE DELAY Select
R32	Potentiometer	MUTE LEVEL Adjust

3.2 TURN ON PROCEDURE

INITIAL

Connect input, output, and power leads as outlined in Section 2.

Turn on main power switch S-1 on the power supply and allow approximately thirty seconds warmup. Set the AFC "OFF/ON" switch to the "ON" position. The red "Alarm" lamp should be extinguished.

NOTE: If it is not, slowly rotate the "AFC Adjust" control on the modulator until it is extinguished.

Adjust the "DRIVE" control on the Power Amplifier for required output.

Select stereo or mono operation with the toggle switch on the audio unit.

After approximately 30 minutes adjust the frequency by rotating R-48 "FREQ ADJ" on the AFC unit for correct frequency as read on a frequency monitor or counter.

The TE-3 is now ready for operation.

NOTE: In routine operation it is recommended that the TE-3 be left on at all times.

3.3 MODULATED OSCILLATOR ADJUSTMENT - See Fig. 4.3

The front panel control "AFC ADJUSTMENT" is a vernier frequency adjustment. Two additional factory adjustments, coarse frequency adjustment (L3) and the modulator bias adjustment (R6) are located on the shock mounted chassis.

Turn the "AFC ADJUSTMENT" control to a mid-range position and turn the meter switch on the AFC unit to the "AFC" position. Turn the AFC switch to "ON".

NOTE: Within a few seconds the "Alarm" lamp should extinguish and the AFC meter should read on scale.

Adjust the "AFC ADJUSTMENT" on the modulated oscillator for a reading between 29 and 31 on the AFC meter.

NOTE: The recommended operating range of the "AFC" position of the meter switch is from 22 to 35. Operation within this range will assure that the modulated oscillator is always within the capture range of the automatic frequency control unit. This will assure that the automatic frequency control will regain a locked condition after a power failure or other interruption of power.

3.4 ALARM CIRCUITS ADJUSTMENT

The operation of the AFC alarm system may be verified in the following manner.

Momentarily disconnect the RF connector from the "AFC" input jack on the modulated oscillator. Note that the "ALARM" lamp lights immediately. Re-insert the connector and note that the lamp extinguishes within a few seconds.

Note that the AFC meter is in the "AFC" position and rotate the "AFC ADJUSTMENT" fully counterclockwise. Note that the meter reading has decreased to approximately 15. Momentarily turn the "AFC" switch off and on. Note that the "ALARM" lamp illuminates and the meter returns to mid-scale. Rotate the "AFC ADJUSTMENT" clockwise until the "ALARM" lamp is extinguished. Set the "AFC ADJUSTMENT" for a reading between 29 and 31 on the AFC meter.

3.5 AFC MULTIMETER

POSITION	INDICATION
"Mod"	Output of Modulator Frequency Divider Chain. Nominal Reading: 35-45
"Ref"	Output of Reference Frequency Divider Chain. Nominal Reading: 35-45
"AFC"	AFC Buss Voltage Nominal Reading: 25-35
"Mod Out"	Power Output of Modulator. Nominal Reading: Refer to Final Test Data supplied with exciter.
"PA Out"	Power Output of Exciter. Nominal Reading: Refer to Final Test Data supplied with exciter.

SECTION 4 - THEORY OF OPERATION

4.1 GENERAL

The TE-3 Exciter is self-contained with capabilities in excess of minimum FCC specifications.

Each exciter is factory tested on the customer's frequency and satisfactory operation is verified.

4.2 POWER SUPPLY - See Fig. 7.3 Schematic & Fig. 4.1 Photograph

The power supply consists of a two section unit. The two sections supply a regulated 24 DC volts and a regulated 150 DC volts respectively. Both sections receive AC voltage from a common power transformer.

NOTE: The 150 volt section is not used in the TE-3.

In the 24 volt supply, the AC voltage supplied by transformer T1, is rectified by diodes CR6 through CR9. The rectified voltage is applied to filter section C3, C4, and R7. Q4 is a series control transistor that regulates the 24 volt supply. A sample of the output voltage is compared with a reference voltage in Q7. The reference voltage is supplied by temperature compensated diodes CR10 and CR11. Any change in the output voltage is amplified by Q5 and Q6. This amplified output causes series control Q4 to return the output voltage to the value set by R11.

NOTE: The output voltages will remain relatively constant over a temperature range of -20 to +70° C. The output voltages will remain constant as the line voltage is varied from 85 to 115% of normal 117 volt AC supply. Normal load variations will cause no voltage change in these supplies.

4.3 POWER AMPLIFIER - See Fig. 7.6 Schematic & Fig. 4.2 Photograph

The power amplifier is a four stage amplifier. Transistors Q1, Q2, and Q3 are single stage amplifiers. Q4 and Q5 are paralleled to obtain the desired output level.

Maximum power is 10 to 15 watts. Power output is determined by the setting of R11, the input drive control. Transformers T1 and T2, along with the associated capacitors C4 and C7 match the output impedance of these stages to the low input impedance of the following stages. Inductors L1, L2, and capacitors C14 and C15 match the output impedance of Q3 to the low impedance of Q4 and Q5. The output circuit of Q4 and Q5 is a modified Pi type of circuit consisting of L5, L6, and C19 and C20.

4.4 AUDIO UNIT - See Fig. 7.7 Schematic & Fig. 4.5 Photograph

The audio unit supplies the modulated oscillator with all main channel modulation (excluding SCA). When the function switch is in the "MONO" position, left audio input is filtered and pre-emphasized and applied directly to the modulated oscillator unit. The composite stereo signal including the pilot is completely removed from the modulation input of the modulated oscillator.

If the function switch is in the "STEREO" position, left and right audio inputs are filtered, pre-emphasized and applied to a resistive matrix. They then connect to the stereo generator. The composite stereo signal including pilot returns through the audio unit for application to the modulation input of the modualted oscillator.

Left audio input circuitry consists of three fundamental types of circuits. First, is a 19 kHz notch filter consisting of L1 and C1.

Resistors R1 through R5 and capacitors C2, C3, C4 along with inductor L2 form a 75 microsecond pre-emphasis section.

The primary and secondary impedance of T1 is 600 ohms. Right audio input circuitry is exactly identical to left audio input circuitry.

When selector switch S1 is in the STEREO position, output of the left pre-emphasis section is connected to the primary of T1. The secondary of T1 connects into the matrix consisting of R13 through R18. At the same time, right audio input signals are routed through the right 19 kHz filter, pre-emphasis network and T2. The secondary of T2 is also connected into the resistive matrix.

Output of the matrix then produces the L−R and L + R signals for application to the signal unit of the stereo generator. At the same time the composite signal along with the 19 kHz pilot is connected through the relay to the input terminals of the modulated oscillator.

When S1 is placed in the MONO position, audio input signals connected to the left audio input, again pass through a 19 kHz notch filter and the left pre-emphasis network. There the signal terminates in R11. R11 may be adjusted to produce the desired modulation level for a given level of audio input.

Also with S1 in the MONO position the normal right stereo input terminals are connected through relay contacts K1 for application to the input of a 41 kHz sub-carrier generator unit if it is used. The 41 kHz SCA (if used) is muted when audio is not applied.

The stereo generator is completely bypassed when S1 is in the MONO position and no stereo signals (or pilot) can modulate the main carrier.

When S1 is in the REMOTE position the mono to stereo functions may be performed by the contacts of a remote control relay. This relay must perform a holding function.

4.5 MODULATED OSCILLATOR - See Fig. 7.4 Schematic & Fig. 4.3 Photograph

The modulated oscillator accepts monaural, composite stereo, and SCA signals and generates a stable, low distortion, frequency modulated signal in the standard FM broadcast band of 87.5 to 108 MHz.

The modulated oscillator consists of three sections; a stable oscillator, a buffer amplifier, and a power supply regulator.

There are four inputs to the modulated oscillator; baseband for monaural or composite stereo, two isolated SCA inputs, and an automatic frequency control input.

Three outputs from the modulated oscillator are as follows: An RF output of approximately 500 millivolts into a fifty ohm load for automatic frequency control (J-2). An RF output of 20 milliwatts to drive a power amplifier (J-3) and a DC output proportional to the RF output level that provides a convenient means of monitoring the RF output of the modulator (J1-9).

4.5.1 OSCILLATOR

The oscillator is a modified "CLAPP" circuit operating at the assigned carrier frequency at a power level of approximately 150 milliwatts.

The oscillator frequency is adjusted by L3 and R29. L3 is an internal coarse frequency adjustment used to set the oscillator frequency within the adjustment range of the vernier frequency adjustment R29.

NOTE: L3 is factory adjusted and should not be reset in the field.

Resistor R29 is a ten turn potentiometer located on the front panel. See Fig. 1.1. R29 provides a reverse bias voltage to CR3, a voltage variable capacitor, used as an electrically adjustable frequency control. A DC control voltage from the automatic frequency control unit maintains the electrical adjustment and is the frequency controlling element in the system.

Diodes CR1 and CR2 are connected to the oscillator tank circuit and are biased to the linear region by resistor R6, the "Modulator Bias" control. See Fig. 4.3.

Modulation from the audio unit, or SCA generators, or stereo generator is applied to the junction of diodes CR1 and CR2.

4.5.2 BUFFER AMPLIFIER

A broadband matching network consisting of L4 and C12 matches the collector circuit of the oscillator transistor Q1 to the attenuator network, R13, R14, and R15. The attenuator provides a nonreactive load and isolation for the signal. Transistor Q2 amplifies the oscillator output to approximately 500 milliwatts.

A broadband low pass filter comprised of C23, C24, and L6 matches the collector circuit of Q2 to the output attenuator, R20, R21, and R22.

The attenuator network reduces the output level of the buffer stage to a level sufficient to drive the power amplifier and provides additional isolation for the oscillator circuit.

A sample of the RF output of the buffer stage is directed to the automatic frequency control system. An additional sample of the RF output is rectified by diode CR8. The DC voltage derived from diode CR8 is used to provide a meter reading on the AFC unit proportional to the RF output of the modulated oscillator.

NOTE: The oscillator and buffer transistors are low noise silicon "overlay" transistors designed specifically for VHF oscillator and amplifier applications.

4.5.3 POWER SUPPLY REGULATOR

The power supply regulator is a conventional pass transistor type using a zener, regulated reference voltage applied to the base of Q3. The reference voltage is temperature compensated by diode CR7.

4.6 AUTOMATIC FREQUENCY CONTROL UNIT

See Fig. 7.5 Schematic & Fig. 4.4 Photograph

The automatic frequency control unit is designed to operate in conjunction with the modulated oscillator to provide a stable, automatically controlled, FM broadcast signal in the standard FM broadcast band of 87.5 to 108 MHz.

The automatic frequency control unit is divided into five sections: Reference oscillator, frequency dividers, phase detector, power supply regulator, and alarm circuitry.

The AFC unit operates on the principle of the phase locked loop. The input signal frequency from the modulated oscillator is phase locked to an internal crystal controlled reference.

The AFC unit is energized from the FM exciter main frame with 24 V DC at 300 milliamps. In addition, 500 millivolts of RF at the carrier frequency is necessary for operation.

A multimeter is incorporated (see Fig. 1.2), to monitor five parameters associated with the AFC unit, the modulated oscillator, and the power amplifier. A red pilot light will indicate any malfunctions and a front panel switch disables the AFC unit during initial tune-up and in case of malfunction.

Exact center frequency adjustment is assured by a vernier frequency control.

4.6.1 REFERENCE OSCILLATOR

The reference oscillator is a standard crystal controlled oscillator utilizing an integrated circuit, Z12. The oscillator frequency is adjusted with capacitor C27 and diode CR10.

The first two transistors of the integrated circuit Z12 form an emitter coupled amplifier and the third transistor is a buffer amplifier to isolate the load from the crystal oscillator. The crystal is a high stability unit enclosed in a temperature controlled oven. The oven temperature is maintained at 60^{o} C by the closed loop system consisting of integrated circuit Z13, a differential amplifier, thermistor RT1, transistor Q6, and resistor R38. R38 is used as the oven heater element. The oven temperature is evaluated by thermistor RT1. The output of RT1 controls the bias voltage at the base of Z13B. The bias voltage is compared with the reference setting at the base of Z13A and the difference between the two voltages is amplified and applied to the base of control transistor Q5. Q5 regulates the current through the heater resistor R38 and controls the oven temperature.

4.6.2 FREQUENCY DIVIDERS

Two frequency divider systems are incorporated in the AFC unit, one for the modulated oscillator output and one for the reference oscillator output.

Three outputs from the modulated oscillator are as follows: An RF output of approximately 500 millivolts into a fifty ohm load for automatic frequency control (J-2). An RF output of 20 milliwatts to drive a power amplifier (J-3) and a DC output proportional to the RF output level that provides a convenient means of monitoring the RF output of the modulator (J1-9).

4.5.1 OSCILLATOR

The oscillator is a modified "CLAPP" circuit operating at the assigned carrier frequency at a power level of approximately 150 milliwatts.

The oscillator frequency is adjusted by L3 and R29. L3 is an internal coarse frequency adjustment used to set the oscillator frequency within the adjustment range of the vernier frequency adjustment R29.

NOTE: L3 is factory adjusted and should not be reset in the field.

Resistor R29 is a ten turn potentiometer located on the front panel. See Fig. 1.1. R29 provides a reverse bias voltage to CR3, a voltage variable capacitor, used as an electrically adjustable frequency control. A DC control voltage from the automatic frequency control unit maintains the electrical adjustment and is the frequency controlling element in the system.

Diodes CR1 and CR2 are connected to the oscillator tank circuit and are biased to the linear region by resistor R6, the "Modulator Bias" control. See Fig. 4.3.

Modulation from the audio unit, or SCA generators, or stereo generator is applied to the junction of diodes CR1 and CR2.

4.5.2 BUFFER AMPLIFIER

A broadband matching network consisting of L4 and C12 matches the collector circuit of the oscillator transistor Q1 to the attenuator network, R13, R14, and R15. The attenuator provides a nonreactive load and isolation for the signal. Transistor Q2 amplifies the oscillator output to approximately 500 milliwatts.

A broadband low pass filter comprised of C23, C24, and L6 matches the collector circuit of Q2 to the output attenuator, R20, R21, and R22.

The attenuator network reduces the output level of the buffer stage to a level sufficient to drive the power amplifier and provides additional isolation for the oscillator circuit.

A sample of the RF output of the buffer stage is directed to the automatic frequency control system. An additional sample of the RF output is rectified by diode CR8. The DC voltage derived from diode CR8 is used to provide a meter reading on the AFC unit proportional to the RF output of the modulated oscillator.

NOTE: The oscillator and buffer transistors are low noise silicon "overlay" transistors designed specifically for VHF oscillator and amplifier applications.

4.5.3 POWER SUPPLY REGULATOR

The power supply regulator is a conventional pass transistor type using a zener, regulated reference voltage applied to the base of Q3. The reference voltage is temperature compensated by diode CR7.

4.6 AUTOMATIC FREQUENCY CONTROL UNIT

See Fig. 7.5 Schematic & Fig. 4.4 Photograph

The automatic frequency control unit is designed to operate in conjunction with the modulated oscillator to provide a stable, automatically controlled, FM broadcast signal in the standard FM broadcast band of 87.5 to 108 MHz.

The automatic frequency control unit is divided into five sections: Reference oscillator, frequency dividers, phase detector, power supply regulator, and alarm circuitry.

The AFC unit operates on the principle of the phase locked loop. The input signal frequency from the modulated oscillator is phase locked to an internal crystal controlled reference.

The AFC unit is energized from the FM exciter main frame with 24 V DC at 300 milliamps. In addition, 500 millivolts of RF at the carrier frequency is necessary for operation.

A multimeter is incorporated (see Fig. 1.2), to monitor five parameters associated with the AFC unit, the modulated oscillator, and the power amplifier. A red pilot light will indicate any malfunctions and a front panel switch disables the AFC unit during initial tune-up and in case of malfunction.

Exact center frequency adjustment is assured by a vernier frequency control.

4.6.1 REFERENCE OSCILLATOR

The reference oscillator is a standard crystal controlled oscillator utilizing an integrated circuit, Z12. The oscillator frequency is adjusted with capacitor C27 and diode CR10.

The first two transistors of the integrated circuit Z12 form an emitter coupled amplifier and the third transistor is a buffer amplifier to isolate the load from the crystal oscillator. The crystal is a high stability unit enclosed in a temperature controlled oven. The oven temperature is maintained at 60^{O} C by the closed loop system consisting of integrated circuit Z13, a differential amplifier, thermistor RT1, transistor Q6, and resistor R38. R38 is used as the oven heater element. The oven temperature is evaluated by thermistor RT1. The output of RT1 controls the bias voltage at the base of Z13B. The bias voltage is compared with the reference setting at the base of Z13A and the difference between the two voltages is amplified and applied to the base of control transistor Q5. Q5 regulates the current through the heater resistor R38 and controls the oven temperature.

4.6.2 FREQUENCY DIVIDERS

Two frequency divider systems are incorporated in the AFC unit, one for the modulated oscillator output and one for the reference oscillator output.

The modulated oscillator divider consists of integrated circuits Z1 through Z7 and divides the input frequency by 16,384. This is necessary to eliminate the phase shift in the incoming signal caused by the frequency modulation. The large division ratio permits full range modulation from twenty hertz upward without upsetting the phase detector function.

All of the integrated circuits are bi-stable multi-vibrators or "Flip Flops". The resultant output of either side of the flip flops is a frequency one half of the input frequency. The output at test point TP1 is 1/16th of the incoming frequency.

Transistor Q1 is a buffer amplifier used to isolate and amplify the output of Z4 to a level sufficient to drive Z5. Integrated circuits Z5, Z6, Z8, and Z9 divide each incoming signal by sixteen. Integrated circuit Z7 divides the incoming signal by four.

The reference oscillator frequency divider consists of integrated circuits Z8 and Z9 and divides the frequency of the reference oscillator by 256. This is done in order to operate the crystal in the most stable range.

4.6.3 PHASE DETECTOR

The phase detector consists of integrated circuit Z10. The IC is a flip-flop circuit with the toggle input connected to the reference oscillator frequency divider which keys alternate sides of the flip-flop. The resultant output of the phase detector is a square wave with a duty cycle of fifty percent. The output of the modulated oscillator frequency dividers is also a square wave. This signal is differentiated by capacitor C9 and resistor R5 to form a sharp pulse. The pulse is used to "set" the flip-flop Z10.

NOTE: If the frequencies at the input of the phase detector are exactly equal, the output of the phase detector will be a square wave with a duty cycle proportional to the relative phase of the two input signals.

The square wave output of the phase detector is amplified by transistor Q2 to a level of approximately twenty volts peak to peak. The signal is then filtered by resistors R9 and R10 and capacitors C13 and C14 to remove the reference frequency component of the signal. The amplitude of the remaining DC component is then proportional to the phase difference of the input signals and is used to control the modulated oscillator frequency.

4.6.4 ALARM CIRCUITS

Five circuits are monitored by the alarm circuits, three directly and two indirectly. The alarm output, indicating functional failures, is displayed on the front panel by indicator lamp DS-1. The alarm output is also available in the form of normally open and normally closed relay contacts through the power connector.

The circuits directly monitored by the alarm system are the reference and modulated oscillator frequency dividers and the "out of lock" condition. The circuits indirectly monitored are the reference oscillator output and the modulated oscillator output through their respective dividers.

The output of the reference frequency dividers is detected and converted to a DC voltage by diodes CR1 and CR2. The detected voltage is amplified by Z11C and Z11D.

NOTE: Both amplifier stages are biased in a saturated condition or cut off.

In normal operation both stages are saturated and there is no output from Z11D. If a failure occurs in this section, the voltage at the collector of Z11D will increase toward five volts. Diode CR5 will conduct, turning on Z14B and Q3. When Q3 conducts, alarm lamp DS-1 illuminates and relay K1 is energized. This action disables the associated transmitter.

The modulated oscillator and its associated frequency dividers are monitored in an identical manner by Z11A and Z11B and their associated components.

An "out of lock" condition exists when the modulated oscillator is operating at a frequency outside the lock in range of the phase detector and the automatic frequency control circuit. When this condition occurs the phase detector output will contain a large AC component in addition to the normal comparison frequency and DC component. The AC component is directly proportional to the frequency error between the two signals. The AC component is amplified by Z14A and detected by diodes CR11 and CR12. The resultant DC voltage turns on Z14B and Q3 in a manner identical to the presentation in the previous section.

The comparison frequency present in the normal output of the phase detector is removed by the filtering action of R27, R28, C20, and C21.

NOTE: The frequency response of the amplifier is such that it will not respond to all signals outside the capture range of the phase detector.

4.7 STEREO GENERATOR

A 19 kHz pilot signal is generated by a crystal controlled oscillator Q1 for the composite stereo. Q2 isolates this signal and the 19 kHz signal is applied to the 19 kHz tuned amplifier stage Q3. The secondary of transformer T1 is connected to a push-pull doubler circuit consisting of transistors Q4 and Q5.

This stage in conjunction with transformer T2 generates a 38 kHz signal. The 38 kHz signal is applied to the balanced sub-carrier modulator circuit consisting of transformers T3 and T4 and diodes CR1 through CR4.

An L-R input signal from the audio unit is also applied to the balanced sub-carrier modulator.

An L-R double sideband suppressed carrier signal appears at the output of T4. Harmonics of this signal are reduced by forward biasing of diodes CR1 through CR4 and by adjusting the harmonic null control R37. Sub-carrier null control R48 balances out the residual 38 kHz sub-carrier to a level of approximately -45 dB.

NOTE: Second harmonics of the double sideband signal fall into the band pass of the normal 67 kHz SCA signal. If these second harmonic signals are not attenuated, crosstalk from the stereo signal will interfere with the sub-carrier channel.

The L+R input signal from the audio unit is combined with the L-R double sideband signal at the junction of C22, R53, and R60. A circuit consisting of L3 through L6 and capacitors C29 and C30 adjusts the time delay of the L+R input to match the L-R signal. A composite stereo signal appears at the junction of C22, R53, and R60. This signal is applied to the emitter follower Q12 from the output level control R53.

The composite stereo signal is amplified by Q13 and applied to the base of emitter follower Q14.

The total composite signal with 10% 19 kHz pilot signal appears at the emitter of Q14.

A pilot signal from terminal 4 of transformer T1 is applied to emitter follower Q6. Maximum separation is maintained by the adjustment of the pilot phase by the phase control between Q6 and emitter follower Q7. A pilot gain control is incorporated at the emitter of transistor Q7. The pilot signal is added to the composite output by connecting R27 to the emitter resistor of Q14.

The second harmonic signal from R53 via Q8 is amplified and inverted by Q9. This signal is applied to emitter follower Q10 and from Q10 to the amplifier Q13, thus cancelling the harmonics.

NOTE: Crosstalk null control R33 cancels any remaining cross-talk.

4.8 SUB-CARRIER GENERATOR

The sub-carrier generator generates the sub-carrier frequencies (41 or 67 kHz) by utilizing two self-excited oscillators.

Q1 and Q2 are the individual Colpitts oscillators. Q1 oscillates at 900 kHz and Q2 oscillates at 941 or 967 kHz.

The outputs from Q1 and Q2 are mixed by diodes CR1 and CR2. Filter network L5, C13, and C14 remove all undesired frequencies.

The sub-carrier frequency is amplified by Q3 and applied to a tunable low pass filter. The filter consists of L6, L7, L8, C19, C20, C21, and C22, and removes all harmonics of the sub-carrier frequency.

By variation of the base bias voltage the oscillators are frequency modulated at an audio rate. The audio modulation is applied to the oscillators Q1 and Q2 by the push-pull audio transformer T1.

NOTE: An audio shaping network is connected prior to the primary of T1. The network is adjusted so that the audio response will increase several dB at 5 kHz with respect to the 400 Hz reference. The response will roll-off above 5 kHz.

When this generator is used as a 67 kHz sub-carrier unit for use with stereo, capacitors C1 and C2 are disconnected. The circuit then functions as a de-emphasis circuit. The roll-off is above 3 kHz to avoid generating side bands that would interfere with the stereo signal.

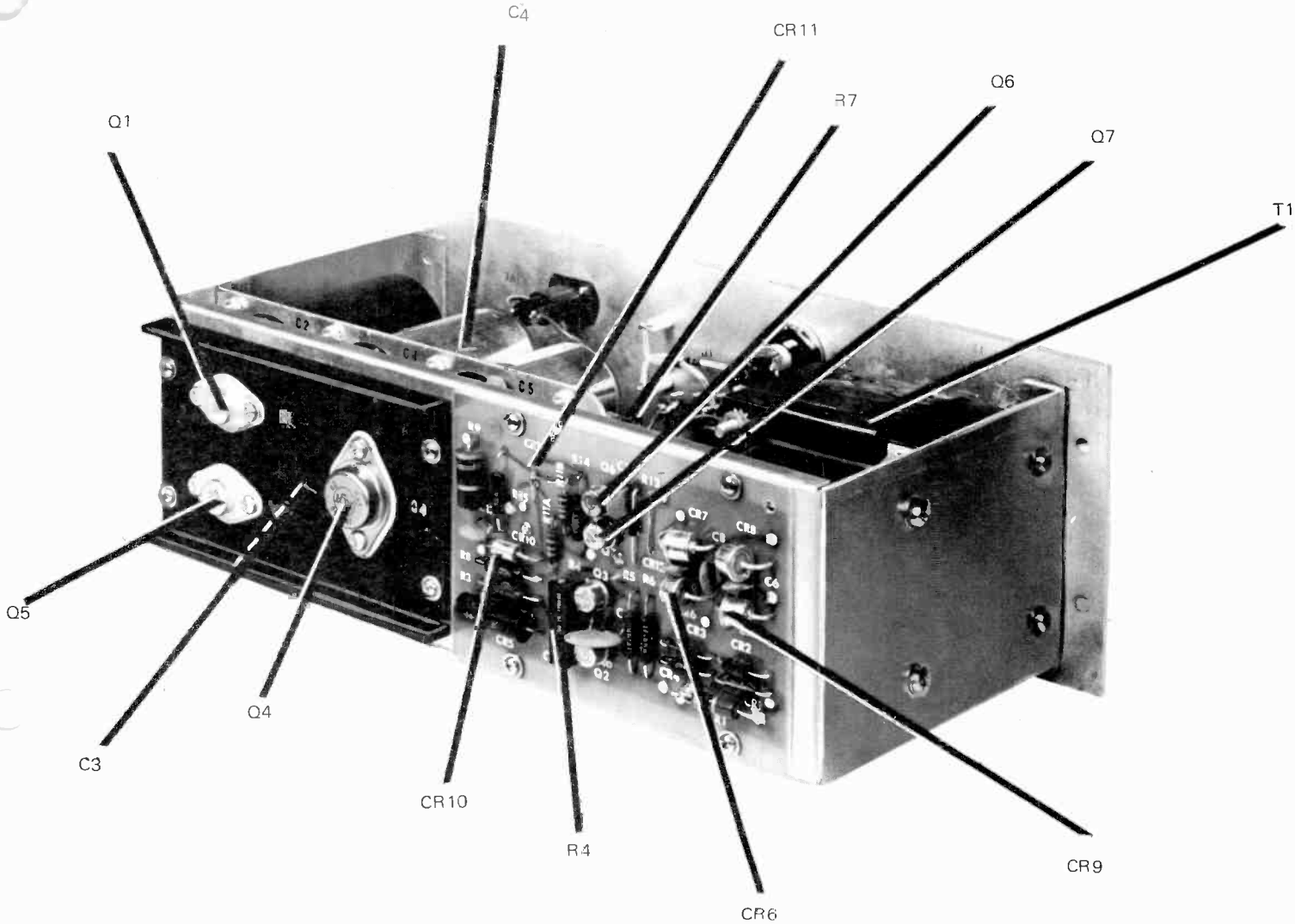
A portion of the audio input is applied to a muting circuit consisting of Q4, Q5, Q6, and Q7. Q4 and Q5 amplify and square the input audio. The resulting square wave signal is rectified by diodes CR3 and CR4.

When audio is applied to Q6 the DC level at the base of Q6 and the bias of Q7 keeps Q6 and Q7 from conducting.

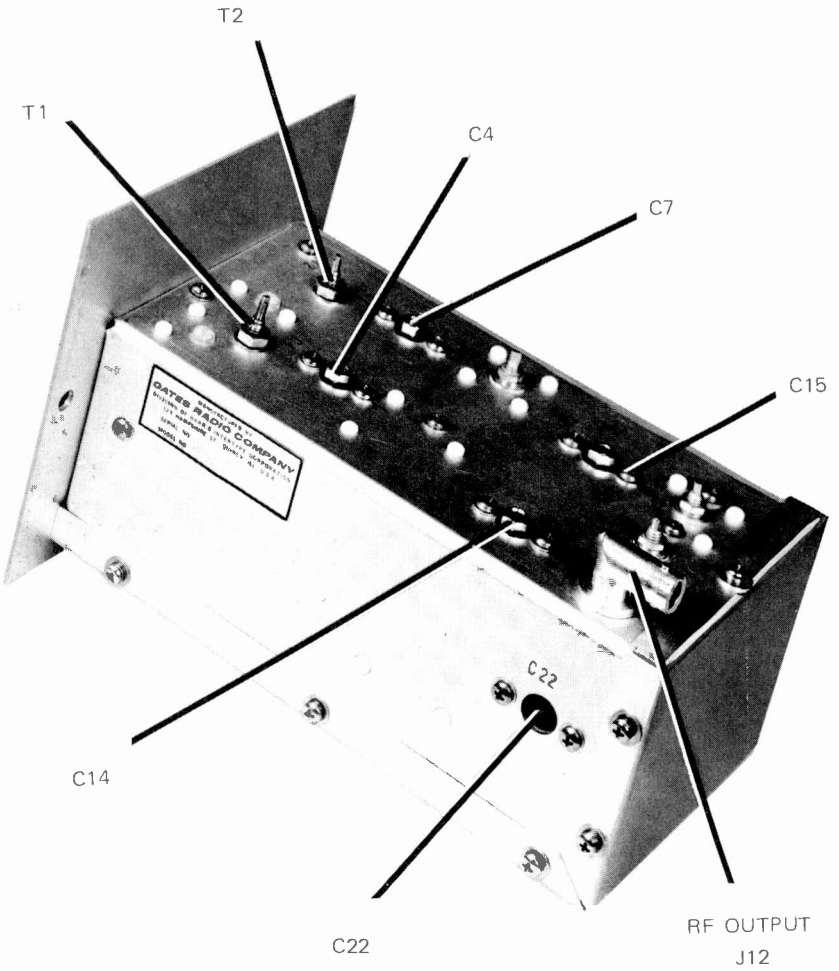
When audio input is removed, Q6 and Q7, conduct causing the impedance from the junction of C17 and C18 to chassis ground to drop to a few ohms. This causes the sub-carrier output to be attenuated approximately 50 to 60 dB.

NOTE: The length of time between sub-carrier shut off and when the audio is removed from Q4 is determined by a capacitor network at the base of Q6 in conjunction with the mute time constant switch S1.

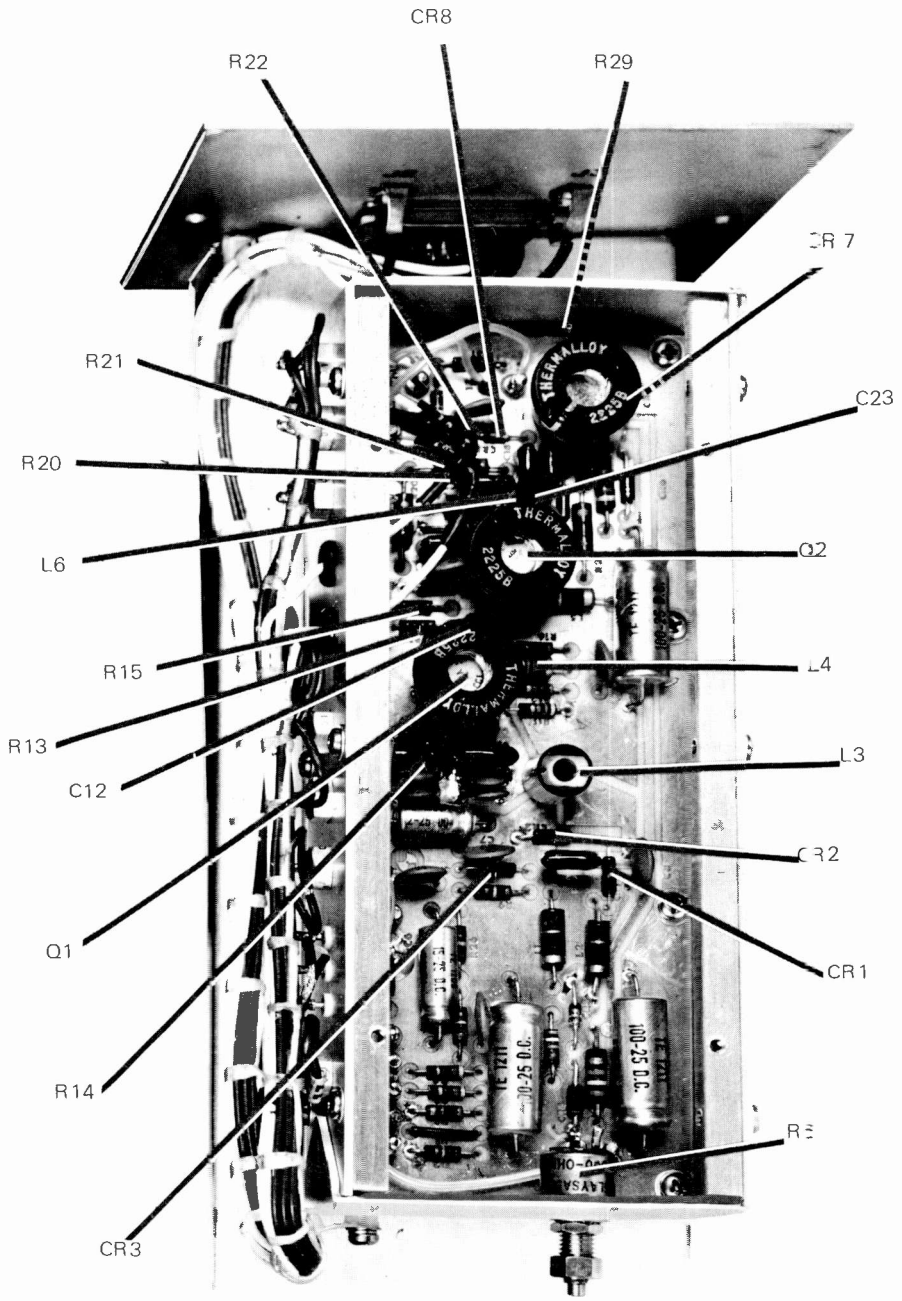
The Mute Level control, R32, determines the audio level required to turn OFF the sub-carrier.



INTERNAL VIEW
POWER SUPPLY
FIG. 4.1

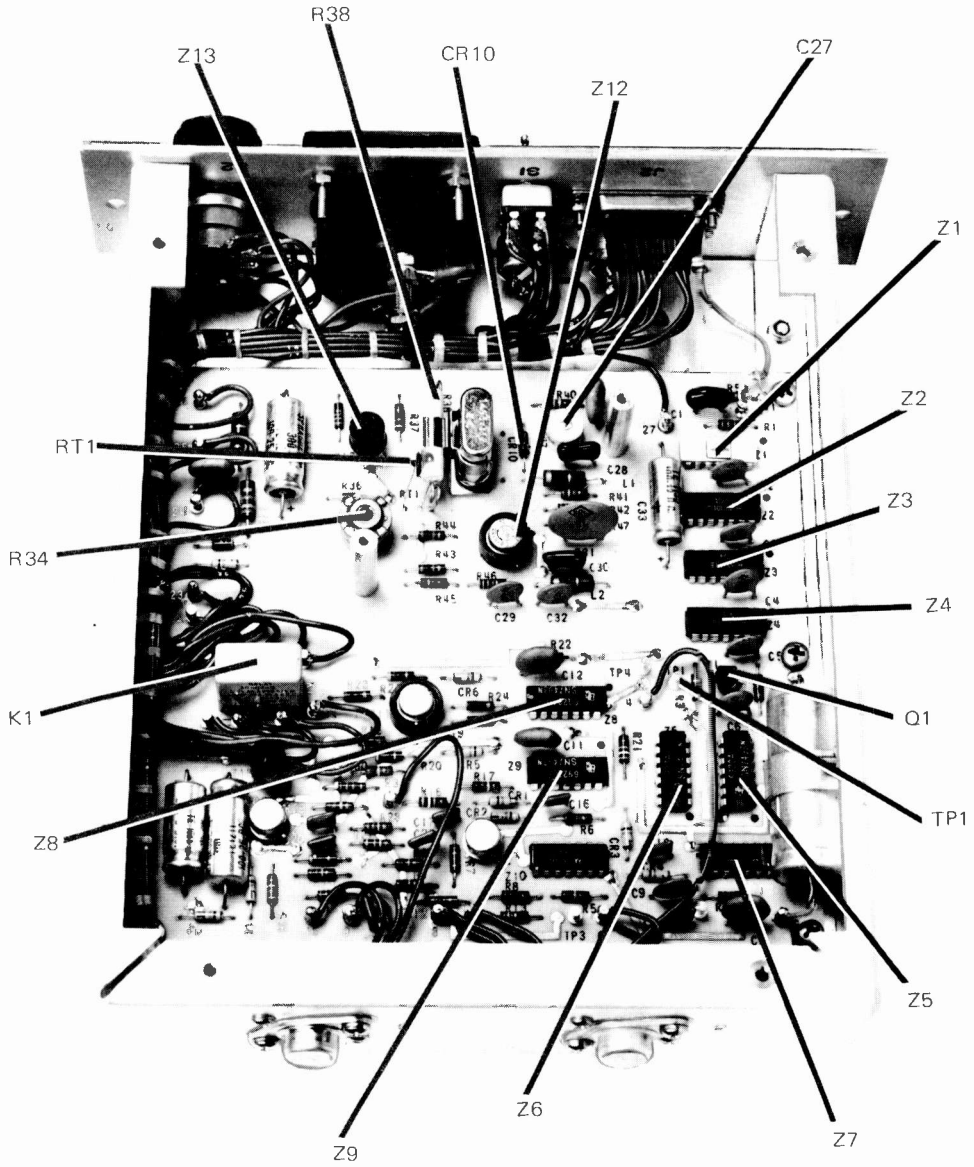


POWER AMPLIFIER
FIG. 4.2

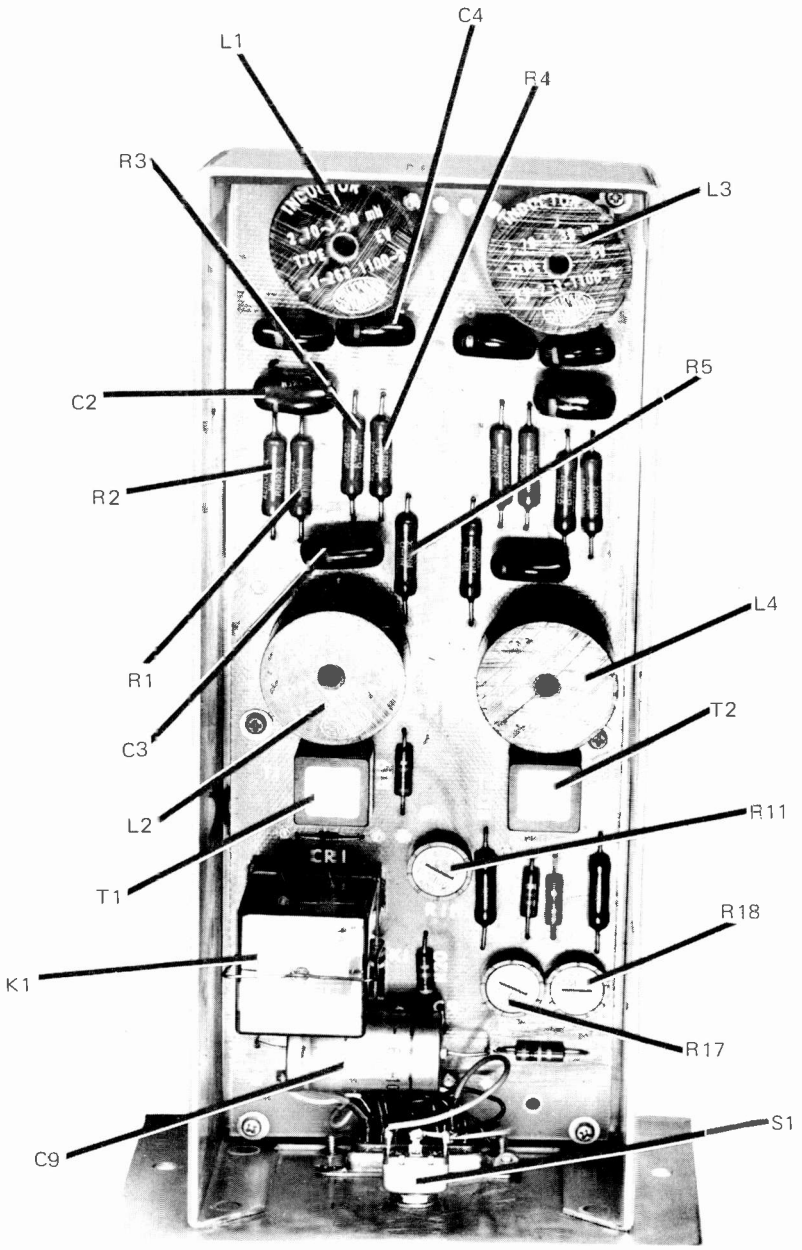


INTERNAL VIEW
MODULATED OSCILLATOR

FIG. 4.3

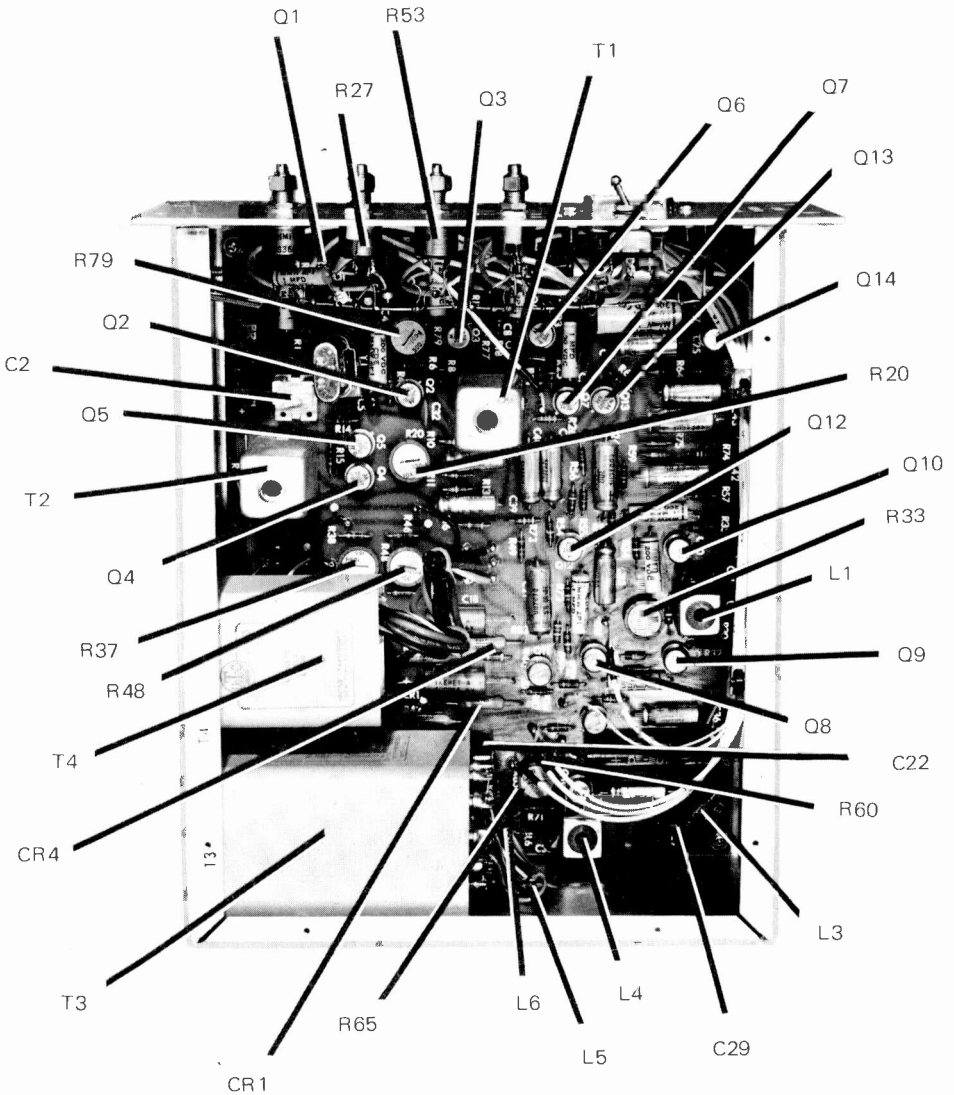


INTERNAL VIEW
(OVEN COVER REMOVED)
AFC UNIT
FIG. 4.4

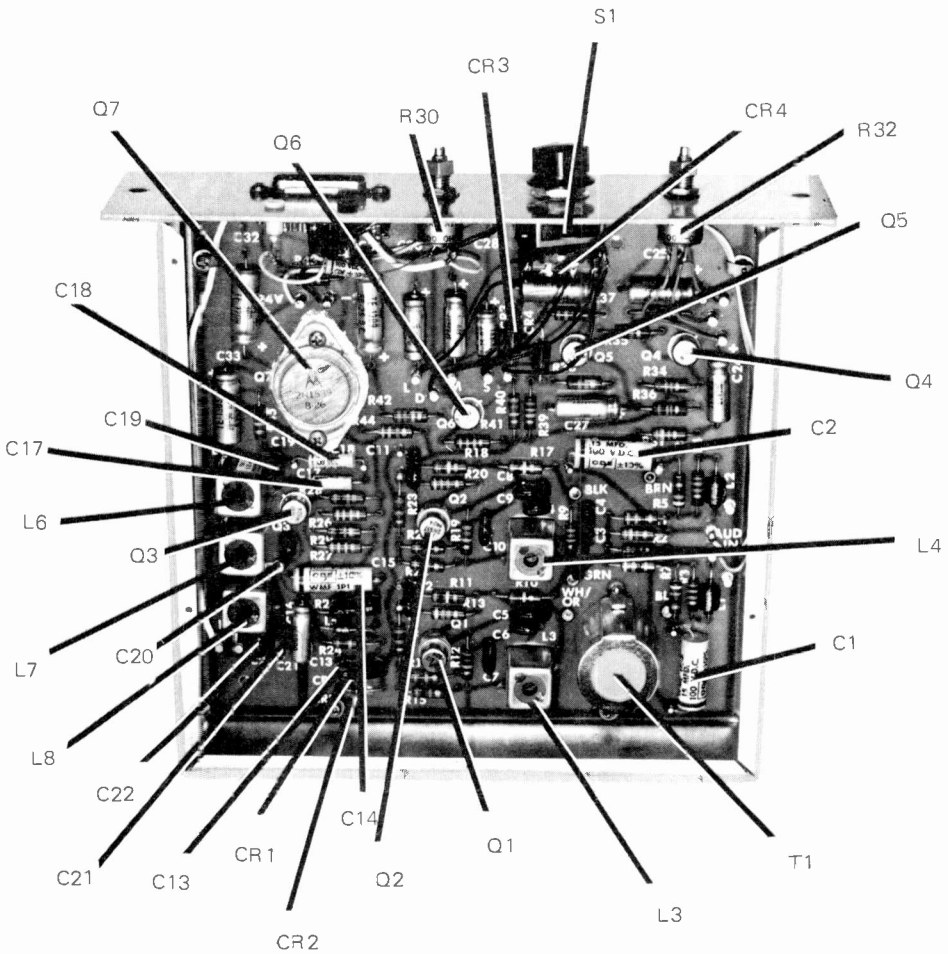


INTERNAL VIEW
AUDIO UNIT

FIG. 4 - 5



INTERNAL VIEW
STEREO GENERATOR
FIG. 4 - 6



INTERNAL VIEW
SCA GENERATOR
FIG. 4 - 7

SECTION 5 - TROUBLESHOOTING

5.1 GENERAL

Each individual unit is thoroughly tested on the customer frequency before shipment. If any unit fails to operate properly, insure that all connectors fit properly into the respective receptacles on each individual module.

Isolate a problem to an individual module by referring to the overall block diagram Fig. 7.1. Refer to the appropriate schematic of the module in question.

5.2 NO CARRIER OUTPUT

Check that the power supply is providing 24 V DC. If the pilot lamp on the power supply is extinguished, insure that S1 on the power supply is "ON". Determine the condition of the 117 V AC connections at the terminals on the rear of the exciter. Check the condition of F3, the 117 volt fuse on the power supply. Check fuse F1 located on the rear of the cabinet.

If the pilot lamp on the power supply lights; check F2, the 24 V fuse on the power supply.

If the power supply is providing the proper voltages, check the output coax of the exciter for a short or open circuit.

Determine if the modulated oscillator is providing output by listening to an FM Receiver tuned to the operating frequency. Check the output level of the modulated oscillator as read on the AFC meter.

If the modulated oscillator is functioning properly and is providing power output to the 10 watt amplifier, trace the RF signal through the amplifier stages and compare AC and DC voltages with the schematic values.

5.3 CARRIER OFF FREQUENCY

Measure the "Locked" and "Unlocked" frequency. If the frequency is further away from the correct value when the AFC defeat switch is on, the fault is probably in the AFC unit. Determine if the fine frequency control knob has been misadjusted. Check the power supply voltages.

If the AFC unit isn't functioning, the AFC switch may be turned off and the modulated oscillator tuned to carrier frequency and operated temporarily without AFC.

NOTE: Drift must be checked at short intervals when operating in this mode.

NOTE: Some types of frequency monitors will display a nearly "ON FREQUENCY" reading when the carrier is several hundred kHz off frequency. The correct frequency is the point where the AFC "Locks" instead of kicking the frequency monitor off scale.

5.4 HIGH DISTORTION

Units other than the transmitter will usually be responsible for high distortion; especially the console, amplifier, limiters, and audio lines. There are no active elements present in the exciter at audio frequencies.

5.5 HIGH NOISE

First establish the noise as to type. If the noise is 120 Hz ripple, check the power supply. Disconnect the audio lines. If the noise originates from the audio lines, check that the center tap of the audio output transformer of the audio equipment is not grounded. In a remote controlled system, check all isolation devices. Determine if the modulated oscillator is causing the noise by disconnecting the audio unit and any SCA generators used.

5.6 EXCESSIVE CROSSTALK (Main & Stereo Channel to SCA Channel)

Determine if crosstalk is present on the audio input lines. The most common cause of high crosstalk is in the detector and IF strip of the SCA monitor or SCA receiver. Determine if high crosstalk is present on more than one receiver.

NOTE: Crosstalk may occur in improperly tuned stages in either the transmitter or receiver. The tuned stages of the exciter amplifier are very broad and should not cause trouble.

5.7 POOR STEREO SEPARATION

Check the wave form at the output of the stereo generator and at the output of the monitor or receiver detector. Determine if the pilot is on and is modulating the main carrier 8 to 10%. Check the pilot phase.

5.8 POWER AMPLIFIER TUNING

All internal adjustments are tuned for maximum power output. R11, the input "DRIVE" control on the front panel is then set for the desired power output.

5.9 AUDIO UNIT ALIGNMENT - See Fig. 4.5

S1 is placed in the "Mono" position to adjust the audio unit.

A 400 Hz, +10 dBm signal is applied to the left audio input. Adjust R11 for 100% carrier modulation.

A "Left=Right" signal of 400 Hz is applied to the left and right audio inputs and S1 is switched to the stereo mode. Adjust R18 for a minimum 400 Hz signal level at J11-10 (L-R out).

A "Left=Minus Right" signal of 400 Hz is then connected into the left and right audio inputs. Switch S1 to the stereo mode position and adjust R17 for a minimum 400 Hz signal level at J11-6 (L+R out).

Apply a 19 kHz audio signal to the left audio input terminal and adjust L1 for a minimum 19 kHz output signal at J11-6 (L+R out). Apply a 19 kHz audio signal to the right audio input terminal and adjust L3 for a minimum 19 kHz output signal at J11-6 (L+R out). Adjust L2 and L4 for a 16.8 dB increase in output level at 15 kHz as compared to a 400 Hz reference signal. Measure this signal at J11-6 (L+R out).

Connect the L=R and L=R signals into the exciter input terminals. Adjust L1 through L4 for minimum L+R to L-R crosstalk at 15 kHz. Measure at the L-R and L+R terminals of the matrix.

5.10 STEREO GENERATOR ALIGNMENT - See Fig. 4.6

C2 is adjusted to set the pilot frequency as observed on a frequency counter or monitor.

R20, the doubler balance control, is adjusted for minimum 19 kHz ripple on the composite output signal, This adjustment is performed without a pilot signal.

The sub-carrier null control, R48, is adjusted for a minimum 38 kHz output. Harmonic null control, R37 is adjusted for minimum second harmonic output from the balanced modulator.

NOTE: The adjustment of R48 and R37 may be observed on an approved stereo monitor, wave analyzer, or ultrasonic display.

R53, the output level control, is adjusted to modulate the main carrier 90% with a 400 Hz left or right audio input signal of +10 dBm. This level excludes the pilot.

L1 is tuned to the second harmonic of the 38 kHz double sideband signal and R33, the crosstalk null control, is adjusted to cancel out the 76 kHz component remaining at the output of the stereo generator.

The pilot gain control R27 is adjusted to modulate the main carrier 10%. The pilot phase control, R24 is adjusted for best separation as read on a stereo monitor.

5.11 SUB–CARRIER GENERATOR SETTING - See Fig. 4.7

The first SCA generator adjustments consist of tuning the output filter so that there are essentially no harmonics of the sub-carrier present in the output of the SCA generator.

L6 and L8 are adjusted for maximum attenuation of the second harmonic of the SCA frequency. L7 is adjusted to minimize ripple over the sub-carrier passband.

NOTE: The passband is considered to be the sub-carrier frequency $\pm$15 kHz.

L3 is adjusted for an approximate output frequency of 900 kHz and L4 for approximately 900 kHz plus the sub-carrier frequency. The L4 frequency is generally 941 or 967 kHz. L3 or L4 is then fine tuned for the exact SCA frequency.

NOTE: The SCA frequency must be compared to a frequency standard. A non-metallic tool with narrow screwdriver type blade is necessary for this adjustment.

The output level control, R30, is set to modulate the main carrier at the required level.

The Mute Level control, R32, is adjusted to turn off the sub-carrier output if the audio input signal disappears.

NOTE: Optimum setting is 30 to 40 dB below 100% modulation of the sub-carrier.

Connect an audio signal at 400 Hz to the proper SCA input terminals of the exciter and modulate the sub-carrier 100%. Reduce the level of the audio input 30 or 40 dB and adjust R32 so the sub-carrier output disappears.

NOTE: S1, the mute delay, is adjusted to whatever muting speed is desired after the audio is removed from the input.

SECTION 6 - PARTS LIST

6.1 - CHASSIS

SYMBOL	DESCRIPTION	GATES PART NO.
B1	Fan 115 V AC 50/60 Hz	430 0037 000
F1	Fuse 4 Amp 250 V Type AGC	398 0021 000
J1	Panel Jack, BNC UG291/U	612 0418 000
P12	Plug BNC UG88/U	610 0238 000
Y1	Crystal, NE6A (Freq. Determined by Customer)	444 000
XF1	Fuse Holder	402 0074 000
	RF Weather Strip	358 0834 000
	Shock Mount	426 0003 000

6.2 - POWER SUPPLY

SYMBOL	DESCRIPTION	GATES PART NO.
A1	Lamp 3W 120 V	396 0163 000
C1	Cap 200 uF 250 V	524 0125 000
C2	Same as C1	
C3	Cap 1000 uF 50 V	524 0104 000
C4	Same as C3	
C5	Cap 500 uF 50 V	524 0094 000
C6	Cap 470 pF 1 kV	516 0043 000
C7	Same as C6	
C8 thru C14	Cap .01 uF 50 V	516 0375 000
C15	Cap 2 uF 200 V	506 0085 000
C16	Cap .01 uF 1 kV	516 0082 000
C17	Same as C16	
CR1 thru CR4	Diode 1N2070	384 0019 000
CR5	Zener Diode 1N4061	386 0189 000
CR6 thru CR9	Diode 1N4720	384 0165 000
CR10	Zener Diode 1N3582	386 0047 000
CR11	Diode 1N914	384 0134 000
CR12	Zener Diode 1N4749A	386 0077 000
CR13	Same as CR11	
F1	Fuse 3/10A 250 V AGC	398 0012 000
F2	Fise 3A 250 V MTH	398 0020 000
F3	Fuse 2A 250 V AGC	398 0019 000

SECTION 6 - PARTS LIST - CONT'D.

6.2 - POWER SUPPLY - CONT'D.

SYMBOL	DESCRIPTION	GATES PART NO.
J1	Panel Connector	610 0419 000
Q1	Transistor 2N3054	380 0041 000
Q2	Transistor 2N4036	380 0045 000
Q3	Transistor 2N3440	380 0058 000
Q4	Transistor 2N3055	380 0043 000
Q5	Transistor 2N3054	380 0041 000
Q6	Transistor 40319	380 0044 000
Q7	Transistor 2N697	380 0098 000
R1	Res 10 ohms 1 W 5%	540 0284 000
R2	Res 30 ohms 2 W 5%	540 0574 000
R3	Res 2.2 K ohms 3 W 1%	548 0189 000
R4	Pot 1 K ohm ½ W	552 0775 000
R5	Res 17.5 K ohms 3 W 1%	548 0190 000
R6	Same as R5	
R7	Res 2 ohms 25 W	542 0438 000
R8	Res 1 K ohm 3 W 1%	548 0192 000
R9	Res 68 ohms 2 W 5%	540 0583 000
R10	Not Used in Power Supply	
R11A	Res 510 ohms	540 0042 000
R11B	Same as R11-A	
R12	Not Used in Power Supply	
R13	Not Used in Power Supply	
R14	Res 1.6 K ohms 3 W 1%	548 0197 000
R15	Same as R8	
R16 thru R18	Res 10 K ohms ¼ W 5%	540 0936 000
S1	Switch Toggle SPST, 6A, 125 V	604 0005 000
T1	Transformer Power	472 0536 000
XA1	Lamp Socket (Less Lens)	406 0367 000
XF1 thru XF3	Fuseholder	402 0013 000
XQ1	Not Used in Power Supply	
XQ2 thru XQ3	Transipad for TO-5 Case	404 0198 000
XQ4 thru XQ5	Not Used in Power Supply	
XQ6 thru XQ7	Same as XQ2	
	Heat Sink	814 3250 701
	Lens, Green	406 0378 000

6.3 - 10 W POWER AMPLIFIER

SYMBOL	DESCRIPTION	GATES PART NO.
C1 thru C3	Cap .001 uF 1 kV	516 0054 000
C4	Cap Var 3.9 to 50 pF	520 0116 000
C5	Same as C1	
C6	Same as C1	
C7	Same as C4	
C8	Not Used	
C9	Same as C1	
C10	Same as C1	
C11	Cap 3.9 uF, 35 V	526 0012 000
C12	Not Used	
C13	Cap 22 pF 500 V	500 0809 000
C14	Same as C4	
C15	Same as C4	
C16	Same as C13	
C17	Cap .01 uF, 1 kV	516 0082 000
C18	Same as C1	
C19	Cap 82 pF 500 V	500 0823 000
C20	Cap 30 pF 500 V	500 0812 000
C21	Same as C1	
C22	Cap Var 1.5 to 9.1 pF	520 0341 000
C23 thru C24	Not Used in Power Amplifier	
C25	Same as C1	
CR1	Diode 1N914	384 0134 000
FL1 thru FL2	Filter	484 0065 000

SYMBOL	DESCRIPTION	GATES PART NO.
J1	Not Used in Power Amplifier	
J2	Panel Connector	610 0419 000
J3 thru J4	Receptacle Panel Male, 50 ohms	620 0355 000
J5 thru J11	Not Used in Power Amplifier	
J12	Right Angle Receptacle	612 0403 000
L1	Inductor	814 9577 001
L2	Inductor	814 9578 001
L3	RF Choke .68 uH	494 0164 000
L4	Same as L3	
L5	Inductor	814 3244 001
L6	Same as L5	
Q1	Transistor PT3134A	380 0036 000
Q2	Transistor PT3134B	380 0037 000
Q3	Transistor PT3134C	380 0038 000
Q4 thru Q5	Transistor PT3134E (Matched Pair)	380 0039 000
	Transistor Kit PT3134 (Containing Q1 thru Q5)	380 0040 000
R1	Res 1.1 K ohms ½ W 5%	540 0050 000
R2	Res 11 K ohms ½ W 5%	540 0074 000
R3	Res 56 ohms ½ W 5%	540 0019 000
R4	Res 470 ohms ½ W 10%	540 0174 000
R5	Res 2.7 K ohms ½ W 10%	540 0183 000

6.3 - 10 W POWER AMPLIFIER - CONT'D.

SYMBOL	DESCRIPTION	GATES PART NO.
R6	Res 33 ohms 1 W 5%	540 0296 000
R7	Same as R4	
R8	Res 2.2 K ohms ½ W 10%	540 0182 000
R9	Res 27 ohms ½ W 5%	540 0011 000
R10	Same as R9	
R11	Pot 100 ohms ½ W	550 0001 000
R12	Res 1 K ohm ½ W 5%	540 0049 000
R13	Res 4.7 K ohms ½ W 5%	540 0065 000
R14	Res 47 K ohms ½ W 5%	540 0089 000
T1	Transformer Bifilar	914 3246 001
T2	Transformer Bifilar	914 3247 001
XQ1 thru XQ2	Heat Sink (For TO-5 Case)	404 0196 000

6.4 - AUDIO UNIT

SYMBOL	DESCRIPTION	GATES PART NO.
C1	Cap .025 uF 100 V	508 0308 000
C2 thru C4	Cap .03 uF 100 V	508 0307 000
C5	Same as C1	
C6 thru C8	Same as C2	
C9	Cap 1000 uF 16 V	522 0391 000
C10	Cap .005 uF, 1 kV	516 0074 000
CR1	Diode 1N914	384 0134 000
J1 thru J10	Not Used in Audio Unit	
J11	Panel Connector	610 0419 000
K1	Relay	572 0134 000
L1 thru L4	Inductor 2.7 to 3.3 mH	492 0328 000
R1 thru R4	Res 270 ohms ½ W 1%	548 0139 000
R5	Res 110 ohms ½ W 1%	548 0217 000
R6 thru R9	Same as R1	
R10	Same as R5	
R11	Trim Pot 500 ohms 1 W	552 0800 000

SECTION 6 - PARTS LIST - CONT'D.

6.4 - AUDIO UNIT - CONT'D.

SYMBOL	DESCRIPTION	GATES PART NO.
R12	Res 10 K ohms ½ W 5%	540 0073 000
R13	Res 600 ohms ½ W 1%	548 0218 000
R14	Same as R13	
R15	Res 560 ohms ½ W 5%	540 0043 000
R16	Same as R15	
R17	Trim Pot 100 ohms 1 W	552 0797 000
R18	Same as R17	
R19	Res 750 ohms ½ W 5%	540 0046 000
R20	Res 300 ohms ½ W 5%	540 0036 000
S1	Switch SPDT Center Off	604 0336 000
T1 thru T2	Input Transformer (Matched Pair)	914 8783 001
XK1	Relay Socket	404 0209 000

6.5 - MODULATED OSCILLATOR

SYMBOL	DESCRIPTION	GATES PART NO.
C1	Cap 100 uF 25 V	522 0246 000
C2	Cap .001 uF 1 kV	516 0054 000
C3	Same as C2	
C4	Not Used in Modulated Oscillator	
C5	Cap 27 pF 500 V (88-98 MHz)	500 0811 000
C5	Cap 18 pF 500 V (98-108 MHz)	500 0807 000
C6	Cap 15 uF 25 V	522 0240 000
C7	Same as C2	
C8	Same as C2	
C9	Cap 2 uF 25 V	522 0233 000
C10A	Cap 47 pF	516 0459 000
C10B	Cap 47 pF 500 V (88-98 MHz)	516 0459 000
C10B	Cap 47 pF 500 V (98-108 MHz)	500 0817 000
C10C	Cap 68 pF 500 V (88-98 MHz)	500 0821 000
C11A	Same as C10A	
C11B	Cap 47 pF 500 V (88-98 MHz)	516 0459 000
C11B	Cap 47 pF 500 V (98-108 MHz)	500 0817 000
C11C	Same as C10C	
C12	Cap 18 pF 500 V	500 0807 000
C13 thru C15	Same as C2	
C16	Cap 3 pF 500 V	500 0802 000
C17	Same as C2	
C18	Cap 5 pF 500 V	500 0803 000

6.5 - MODULATED OSCILLATOR - CONT'D.

SYMBOL	DESCRIPTION	GATES PART NO.
C19	Same as C1	
C20	Same as C1	
C21	Same as C2	
C22	Cap 100 uF 25 V	522 0246 000
C23	Cap 22 pF 500 V	500 0809 000
C24	Cap 39 pF 500 V	500 0815 000
C25 thru C31	Cap 1000 pF 500 V	516 0319 000
CR1 thru CR3	Diode Varicap MV1650	528 0010 000
CR4	Diode Zener 1N4747A	386 0100 000
CR5	Diode 1N914	384 0134 000
CR6	Diode Zener 1N4744A	386 0082 000
CR7	Same as CR5	
CR8	Same as CR5	
J1	Connector, Power	610 0419 000
J2	Receptacle, Coax	620 0355 000
J3	Same as J2	
L1	Inductor 10 uH	494 0231 000
L2	Same as L1	
L3	Inductor Variable	492 0366 000
L4	Inductor .47 uH	494 0230 000
L5	Same as L1	
L6	Inductor .1 uH	494 0229 000
Q1	Transistor 2N5109	380 0114 000
Q2	Same as Q1	
Q3	Transistor 2N3053	380 0049 000
R1	Not Used in Modulated Oscillator	
R2	Res 10 K ohms ¼ W 5%	540 0936 000
R3	Res 4.7 K ohms ¼ W 5%	540 0928 000
R4	Same as R3	
R5	Res 2.2 K ohms ¼ W 5%	540 0920 000
R6	Pot 10 K ohms ½ W	550 0009 000
R7	Res 39 K ohms ¼ W 5%	540 0950 000
R8	Res 68 K ohms ¼ W 5%	540 0956 000
R9	Res 100 K ohms ¼ W 5%	540 0960 000
R10	Res 100 ohms ¼ W 5%	540 0888 000
R11	Res 470 ohms ¼ W 5%	540 0904 000
R12	Same as R5	
R13	Res 15 ohms ¼ W 5%	540 0868 000
R14	Res 68 ohms ¼ W 5%	540 0884 000
R15	Same as R13	
R16	Res 1.5 K ohms ¼ W 5%	540 0916 000
R17	Res 270 ohms ¼ W 5%	540 0898 000
R18	Res 15 ohms ½ W 5%	540 0005 000
R19	Res 1 K ohm ¼ W 5%	540 0912 000
R20	Res 27 ohms ½ W 5%	540 0011 000

6.5 - MODULATED OSCILLATOR - CONT'D.

SYMBOL	DESCRIPTION	GATES PART NO.
R21	Same as R20	
R22	Res 39 ohms ¼ W 5%	540 0015 000
R23	Res 39 K ohms ¼ W 5%	540 0950 000
R24	Res 470 ohms ½ W 5%	540 0041 000
R25	Res 10 ohms ½ W 5%	540 0001 000
R26	Same as R2	
R27	Same as R9	
R28	Res 180 ohms ½ W 5%	540 0031 000
R29	Pot 5 K ohms 3 W	552 0818 000
R30	Res 6.8 K ohms ½ W 5%	540 0069 000
R31	Res 22 K ohms ¼ W 5%	540 0944 000
XQ1 thru XQ3	Socket, Transistor	404 0281 000

6.6 - AFC UNIT

SYMBOL	DESCRIPTION	GATES PART NO.
C1	Cap 220 pF 500 V	500 0754 000
C2 thru C6	Cap .001 uF 1 kV	516 0054 000
C7	Cap .05 uF 100 V	516 0435 000
C8	Not Used in AFC Unit	
C9	Same as C2	
C10	Not Used in AFC Unit	
C11	Cap .05 uF 100 V	516 0435 000
C12	Same as C11	
C13	Cap .22 uF 100 V	516 0475 000
C14	Same as C13	
C15	Cap 100 uF 50 V	522 0394 000
C16 thru C22	Cap .1 uF 100V	516 0453 000
C23	Cap 100 uF 25 V	522 0246 000
C24	Cap 250 uF 3 V	522 0164 000
C25	Same as C23	
C26	Same as C7	
C27	Cap Variable 2.5 to 11 pF	518 0047 000
C28	Cap 120 pF 500 V	500 0826 000
C29	Same as C2	
C30	Cap 82 pF 500 V	500 0823 000
C31	Cap .01 uF 1 kV	516 0081 000
C32	Same as C2	
C33	Cap 100 uF 12 V	522 0210 000
C34	Cap 1000 uF 10 V	522 0422 000
CR1 thru CR7	Diode 1N914	384 0318 000
CR8	Diode Zener 1N4733A	386 0135 000
CR9	Same as CR1	
CR10	Varicap MV1626	528 0017 000

SECTION 6 - PARTS LIST - CONT'D.

6.6 - AFC UNIT - CONT'D.

SYMBOL	DESCRIPTION	GATES PART NO.
CR11	Same as CR1	
CR12	Same as CR1	
DS1	Lamp	396 0060 000
J1	Connector, Coax	620 0355 000
J2	Connector, Power	610 0419 000
K1	Relay, DPDT 26.5 V.	578 0010 000
L1 thru L3	Inductor 100 uH	494 0233 000
M1	Meter 0-50 uA DC	632 0663 000
Q1	Transistor 2N3702	380 0087 000
Q2	Transistor 2N3053	380 0049 000
Q3	Transistor 2N4037	380 0146 000
Q4	Transistor 2N3054	380 0041 000
Q5	Transistor 2N3740	380 0066 000
R1	Res 82 ohms ¼ W 5%	540 0886 000
R2	Res 100 ohms ¼ W 5%	540 0888 000
R3	Res 470 ohms ¼ W 5%	540 0904 000
R4	Res 2.2 K ohm ¼ W 5%	540 0920 000
R5	Res 10 K ohm ¼ W 5%	540 0936 000
R6	Res 1.5 K ohms ¼ W 5%	540 0916 000
R7	Same as R4	
R8	Same as R2	
R9	Same as R5	
R10	Same as R5	
R11	Res 330 K ohms ¼ W 5%	540 0972 000
R12	Same as R6	
R13	Res 1.3 K ohms ¼ W 5%	540 0915 000
R14	Res 22 K ohms ¼ W 5%	540 0944 000
R15	Not Used in AFC Unit	
R16	Res 39 K ohms ¼ W 5%	540 0950 000
R17	Res 220 K ohms ¼ W 5%	540 0968 000
R18	Res 1 K ohm ¼ W 5%	540 0912 000
R19	Same as R18	
R20	Res 4.7 K ohms ¼ W 5%	540 0928 000
R21	Same as R16	
R22	Same as R17	
R23	Same as R18	
R24	Same as R18	
R25	Same as R20	
R26	Res 47 K ohms ¼ W 5%	540 0952 000

6.6 - AFC UNIT - CONT'D.

SYMBOL	DESCRIPTION	GATES PART NO.
R27	Same as R26	
R28	Same as R14	
R29	Same as R17	
R30	Same as R5	
R31	Same as R4	
R32	Res 220 ohms ¼ W 5%	540 0896 000
R33	Same as R20	
R34	Pot 5 K ohms	550 0257 000
R35	Res 2.7 K ohms ¼ W 5%	540 0922 000
R36	Same as R26	
R37	Res 3.3 K ohms ¼ W 5%	540 0924 000
R38	Res 50 ohms 5 W	542 1143 000
R39	Res 680 ohms ½ W 5%	540 0045 000
R40	Same as R26	
R41	Res 6.8 K ohms ¼ W 5%	540 0932 000
R42	Same as R37	
R43	Same as R2	
R44	Same as R2	
R45	Same as R41	
R46	Same as R37	
R47	Same as R3	
R48	Pot 10 K ohms (Locking)	550 0007 000
R49	Res 10 K ohms ¼ W 5%	540 0936 000
R50	Res 51 ohms ¼ W 5%	540 0881 000
R51	Same as R3	
RT1	Thermistor 45TG-2	559 0002 000

SYMBOL	DESCRIPTION	GATES PART NO.
S1	Switch Toggle DPDT	604 0320 000
S2	Switch SP 5 Pos	600 0477 000
XDS1	Socket, Lamp	406 0376 000
	Lens, Red	406 0374 000
XQ1	Not Used in AFC Unit	
XQ2	Transipad for TO-5 Case	404 0193 000
XQ3	Same as XQ2	
XQ4	Socket, Transistor	404 0206 000
XQ5	Same as XQ4	
XY1	Socket, Crystal	404 0132 000
Z1	Integrated Circuit MC-1027P	382 0032 000
Z2 thru Z4	Integrated Circuit MC-1013L	382 0033 000
Z5	Integrated Circuit SN7493N	382 0034 000
Z6	Same as Z5	
Z7	Integrated Circuit MC-853P	382 0035 000
Z8	Same as Z5	
Z9	Same as Z5	
Z10	Integrated Circuit MC-848P	382 0016 000
Z11	Integrated Circuit CA-3018	382 0018 000
Z12	Same as Z11	
Z13	Differential Amp TD—101	382 0020 000
Z14	Same as Z13	

6.7 - FILTER ASSEMBLY

SYMBOL	DESCRIPTION	GATES PART NO.
C1 thru C20	Cap .001 uF 500 V	516 0319 000
C21 thru C24	Cap .025 uF 500 V ±20%	516 0393 000
TB1	Terminal Board	614 0087 000
L1 thru L6	Choke 100 uH	494 0233 000
L7 thru L10	Coil	814 4837 001
L11 thru L20	Choke 3.3 uH	494 0110 000

6.8 - ISOLATION PAD, 3 dB

SYMBOL	DESCRIPTION	GATES PART NO.
J5	Receptacle "BNC"	612 0237 000
J6	Receptacle "N"	612 0233 000
R1	Res 300 ohm 7 W	546 0229 000
R2	Res 20 ohm 5 W	546 0230 000
R3	Same as R1	

6.9 - STEREO GENERATOR

SYMBOL	DESCRIPTION	GATES PART NO.
C1	Cap 100 uF 50 V	522 0322 000
C2	Cap Var 2-27 pF	520 0342 000
C3	Cap .008 uF 600 V	508 0291 000
C4	Cap .1 uF 200 V	506 0088 000
C5	Cap 100 pF 500 V	500 0877 000
C6	Same as C4	
C7	Cap 5 uF 50 V	522 0251 000
C8	Same as C4	
C9	Cap 2000 pF 500 V	500 0845 000
C10 thru C13	Same as C4	
C14	Cap 2500 pF 500 V	500 0879 000
C15	Not Used in Stereo Generator	
C16	Cap 15 uF 25 V	522 0240 000
C17 thru C20	Cap 1000 uF 6 V	526 0058 000
C21	Cap 20 uF 50 V	522 0256 000
C22	Cap 250 uF 15 V	522 0336 000
C23	Same as C16	
C24	Cap 50 uF 25 V	522 0244 000
C25	Cap 35 uF 25 V	522 0243 000
C26	Not Used in Stereo Generator	
C27	Cap 1 uF 200 V	506 0087 000
C28	Cap .01 uF 200 V	506 0001 000
C29	Cap 470 pF 300 V	500 0835 000
C30	Same as C29	
C31	Cap 1000 uF 25 V	522 0306 000
C32	Cap 1000 pF 1 kV	516 0054 000
C33 thru C34	Not Used in Stereo Generator	
C35	Same as C16	
C36	Same as C16	
C37	Same as C1	
C38	Same as C4	
C39 thru C41	Same as C16	
C42	Same as C24	
C43	Same as C24	
C44	Same as C16	
C45	Cap 1000 uF 16 V	522 0391 000
C46	Cap 470 pF 300 V	500 0835 000
C47	Cap .1 uF 200 V	506 0088 000
C48	Cap .50 pF 500 V	500 0818 000
CR1 thru CR4	Diode Quad Assy	915 0064 001
J7	Panel Connector	610 0419 000
L1	Adjustable RF Coil 1.3 - 3 mH	492 0331 000
L2	Not Used in Stereo Generator	
L3	RF Choke 300 uH	494 0153 000
L4	Adjustable RF Coil .65 - 1.3 mH	492 0332 000

6.9 - STEREO GENERATOR - CONT'D.

SYMBOL	DESCRIPTION	GATES PART NO.
L5	Same as L1	
L6	Same as L3	
Q1	Transistor, FET	380 0060 000
Q2 thru Q16	Transistor 2N697	380 0098 000
R1	Res 5.1 Megohms ¼ W 5%	540 1001 000
R2	Res 10 K ohms ¼ W 5%	540 0936 000
R3	Res 15 K ohms ¼ W 5%	540 0940 000
R4	Res 470 K ohms ¼ W 5%	540 0976 000
R5	Res 390 ohms ¼ W 5%	540 0902 000
R6	Res 620 ohms ¼ W 5%	540 0907 000
R7	Res 8.2 K ohms ¼ W 5%	540 0934 000
R8	Res 100 K ohms ¼ W 5%	540 0960 000
R9	Res 1 K ohm ¼ W 5%	540 0912 000
R10	Same as R2	
R11	Same as R2	
R12	Res 2.2 K ohms ¼ W 5%	540 0920 000
R13	Same as R8	
R14	Res 100 ohms ¼ W 5%	540 0888 000
R15	Same as R14	
R16	Res 4.7 K ohms ¼ W 5%	540 0928 000
R17	Res 2.4 K ohms ½ W 1%	548 0211 000
R18	Res 150 K ohms ¼ W 5%	540 0964 000
R19	Res 51 K ohms ¼ W 5%	540 0953 000
R20	Pot 10 K ohms 1 W	552 0795 000
R21	Same as R8	
R22	Res 2 K ohms ¼ W 5%	540 0919 000
R23	Res 510 ohms ¼ W 5%	540 0905 000
R24	Pot 50 K ohms ½ W	550 0009 000
R25	Same as R8	
R26	Res 3.3 K ohms ¼ W 5%	540 0924 000
R27	Pot 5 K ohms ½ W	550 0006 000
R28	Same as R8	
R29	Same as R22	
R30	Same as R4	
R31	Same as R8	
R32	Res 22 K ohms ¼ W 5%	540 0944 000
R33	Pot 5 K ohms 1 W	552 0796 000
R34	Same as R8	
R35	Same as R22	
R36	Res 200 ohms ¼ W 5%	540 0895 000
R37	Pot 100 ohms 1 W	552 0797 000
R38	Same as R36	
R39	Res 5.1 K ohms ¼ W 5%	540 0929 000
R40	Res 9.1 K ohms ¼ W 5%	540 0935 000

6.9 - STEREO GENERATOR - CONT'D.

SYMBOL	DESCRIPTION	GATES PART NO.
R41 thru R44	Res 4.75 K ohms ½ W 1%	548 0199 000
R45	Not Used in Stereo Generator	
R46	Res 10 ohms ¼ W 5%	540 0864 000
R47	Same as R46	
R48	Same as R37	
R49	Same as R9	
R50	Same as R4	
R51	Same as R22	
R52	Same as R23	
R53	Same as R27	
R54	Same as R8	
R55	Res 1.5 K ohms ¼ W 5%	540 0916 000
R56	Res 240 ohms ¼ W 5%	540 0897 000
R57	Same as R22	
R58	Same as R3	
R59	Res 120 K ohms ¼ W 5%	540 0962 000
R60	Same as R23	
R61	Same as R2	
R62	Same as R23	
R63	Res Assembly	915 3312 001
R64	Same as R8	
R65	Pot Trim 1 K ohm 1 W	552 0802 000
R66	Same as R9	
R67	Same as R4	
R68	Pot 1 K ohm ½ W	550 0004 000
R69	Same as R9	
R70	Same as R4	
R71	Same as R9	
R72	Same as R2	
R73	Same as R4	
R74	Same as R59	
R75	Same as R12	
R76	Same as R4	
R77	Same as R12	
R78	Res 10 Megohms ¼ W 5%	540 1008 000
R79	Res 500 ohms 1 W	552 0800 000
R80	Res 1200 ohms ¼ W 5%	540 0914 000
R81	Res 10 K ohms ¼ W 5%	540 0936 000
R82 thru R85	Res 100 ohms ½ W 1%	548 0049 000
R86	Same as R19	
R87	Same as R19	
R88	Res 100 ohms ½ W 5%	540 0025 000
RT1	Thermistor 1 K ohm	559 0006 000
S1	Switch Subminiature Toggle, SPDT	604 0366 000
T1	Transformer 19 kHz	478 0269 000
T2	Transformer 38 kHz	478 0270 000
T3	Transformer	478 0026 000
T4	Transformer	478 0220 000

SECTION 6 - PARTS LIST - CONT'D.

6.9 - STEREO GENERATOR - CONT'D.

SYMBOL	DESCRIPTION	GATES PART NO.
TJ1	Test Point Jack White	612 0312 000
TJ2	Test Point Jack Black	612 0311 000
TJ3	Same as TJ1	
XQ1	Transipad	404 0197 000
XQ2 thru XQ16	Transipad	404 0198 000
XY1	Crystal Socket	404 0132 000
Y1	Crystal 19 kHz	444 1129 000

SECTION 6 - PARTS LIST - CONT'D.

6.10 - SCA GENERATOR

SYMBOL	DESCRIPTION	GATES PART NO.
C1	Cap .15 uF Mylar 100 V	508 0286 000
C2	Same as C1	
C3 thru C5	Cap 100 pF 100 V	500 0844 000
C6	Cap 220 pF 500 V	500 0873 000
C7	Cap 62 pF 500 V 5%	500 0820 000
C8	Same as C3	
C9	Same as C6	
C10	Same as C7	
C11	Cap 100 pF 500 V	500 0759 000
C12	Same as C11	
C13	Cap 1500 pF 500 V	500 0878 000
C14	Same as C13	
C15	Cap .1 uF Mylar 100 V	508 0278 000
C16	Cap 15 uF 25 V	522 0240 000
C17	Cap .01 uF Mylar 100 V	508 0298 000
C18	Same as C17	
C19	Cap 250 pF 500 V	500 0831 000
C20	Cap 330 pF 100 V	500 0874 000
C21	Same as C20	
C22	Same as C19	
C23	Cap .01 uF Mylar 100 V	508 0298 000
C24	Cap 25 uF 6 V	522 0178 000
C25	Same as C24	
C26	Cap 100 uF 12 V	522 0210 000
C27	Same as C16	
C28	Cap 2 uF 25 V	522 0233 000
C29	Same as C16	
C30	Cap 25 uF 25 V	522 0242 000
C31	Cap 50 uF 25 V	522 0244 000
C32	Same as C31	
C33	Cap 20 uF 50 V	522 0256 000
CR1	Diode 1N270	384 0128 000
CR2	Same as CR1	
CR3	Rectifier 1N2069	384 0018 000
CR4	Same as CR3	
J5	Receptacle	610 0419 000
L1	Choke 4.7 mH	494 0175 000
L2	Same as L1	
L3	Choke Adjustable .28 - .65 mH	492 0321 000
L4	Same as L3	
L5	Choke 2.2 mH	494 0165 000
L6	Coil Adjustable 8 - 20 mH	492 0322 000
L7	Coil Adjustable 15 - 40 mH	492 0323 000
L8	Same as L6	
Q1 thru Q6	Transistor 2N697	380 0098 000
Q7	Transistor 2N1539	380 0016 000

SECTION 6 - PARTS LIST - CONT'D.

SCA GENERATOR - CONT'D.

SYMBOL	DESCRIPTION	GATES PART NO.
R1	Res 1.8 K ohms ½ W 5%	540 0055 000
R2	Res 1.5 K ohms ½ W 5%	540 0053 000
R3	Res 270 ohms ½ W 5%	540 0035 000
R4	Same as R3	
R5 thru R8	Res 47 ohms ½ W 5%	540 0017 000
R9	Res 62 K ohms ½ W 5%	540 0092 000
R10	Res 51 K ohms ½ W 5%	540 0090 000
R11	Res 100 K ohms ½ W 5%	540 0097 000
R12	Res 82 K ohms ½ W 5%	540 0095 000
R13	Res 4.7 K ohms ½ W 5%	540 0065 000
R14	Res 10 K ohms ½ W 5%	540 0073 000
R15	Res 1 K ohm ½ W 5%	540 0049 000
R16	Res 100 ohms ½ W 5%	540 0025 000
R17	Same as R10	
R18	Same as R11	
R19	Same as R12	
R20	Same as R13	
R21	Same as R14	
R22	Same as R15	
R23	Same as R16	
R24	Same as R14	
R25	Same as R14	
R26	Res 33 K ohms ½ W 5%	540 0085 000

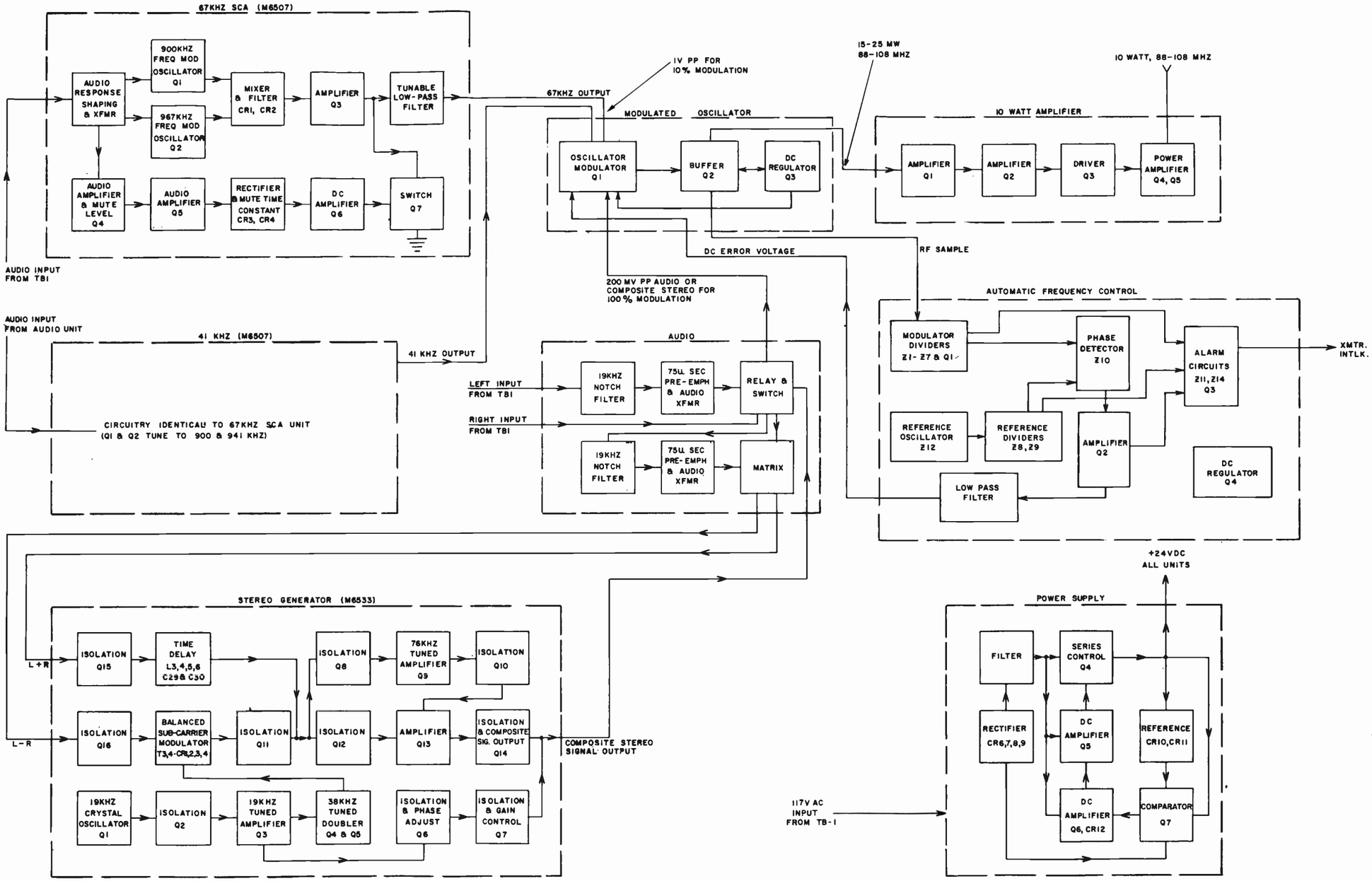
SYMBOL	DESCRIPTION	GATES PART NO.
R27	Same as R26	
R28	Res 2 K ohms ½ W 5%	540 0056 000
R29	Same as R28	
R30	Pot Min 10 K ohm ½ W Linear Taper	550 0007 000
R31	Res 6.8 K ohms ½ W 5%	540 0069 000
R32	Same as R30	
R33	Res 120 K ohms ½ W 5%	540 0099 000
R34	Res 5.1 K ohms ½ W 5%	540 0066 000
R35	Same as R28	
R36	Res 1.1 K ohms ½ W 5%	540 0050 000
R37	Res 680 ohms ½ W 5%	540 0045 000
R38	Res 510 ohms	540 0042 000
R39	Res 16 K ohms ½ W 5%	540 0078 000
R40	Same as R12	
R41	Same as R26	
R42	Res 12 K ohms ½ W 5%	540 0075 000
R43	Same as R28	
R44	Res 3.3 K ohms ½ W 5%	540 0061 000
R45	Same as R14	
S1	Switch 4 Pos. Modified	600 0421 000

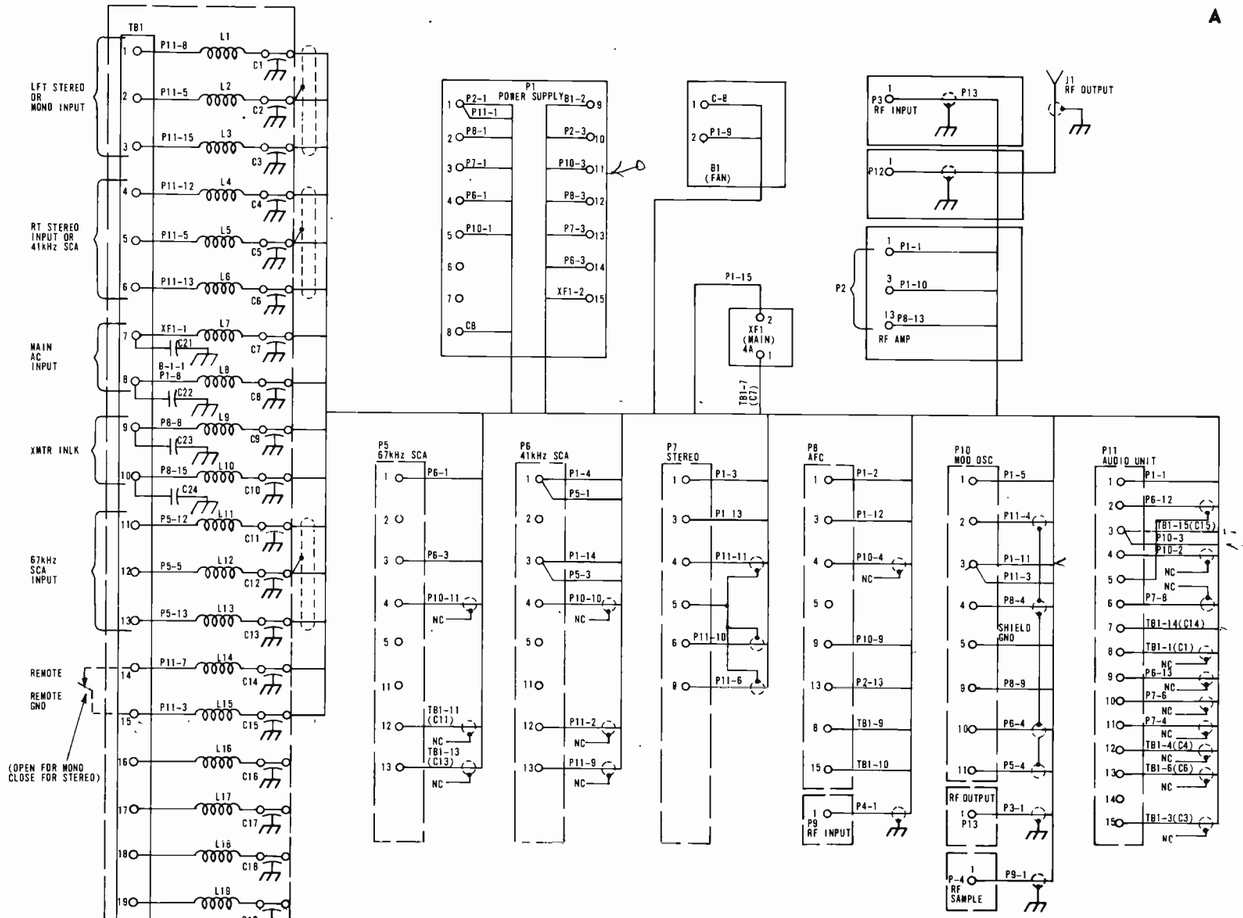
SCA GENERATOR - CONT'D.

SYMBOL	DESCRIPTION	GATES PART NO.
T1	Transformer Input	478 0145 000
TJ1	Test Point Jack White	612 0312 000
TJ2	Test Point Jack Black	612 0311 000

SYMBOL	DESCRIPTION	GATES PART NO.
XQ1	Transistor Socket	404 0066 000
XQ2	Same as XQ1	
XQ3 thru XQ6	Transipad for TO-5 Case	404 0198 000

SECTION 7 - DRAWINGS

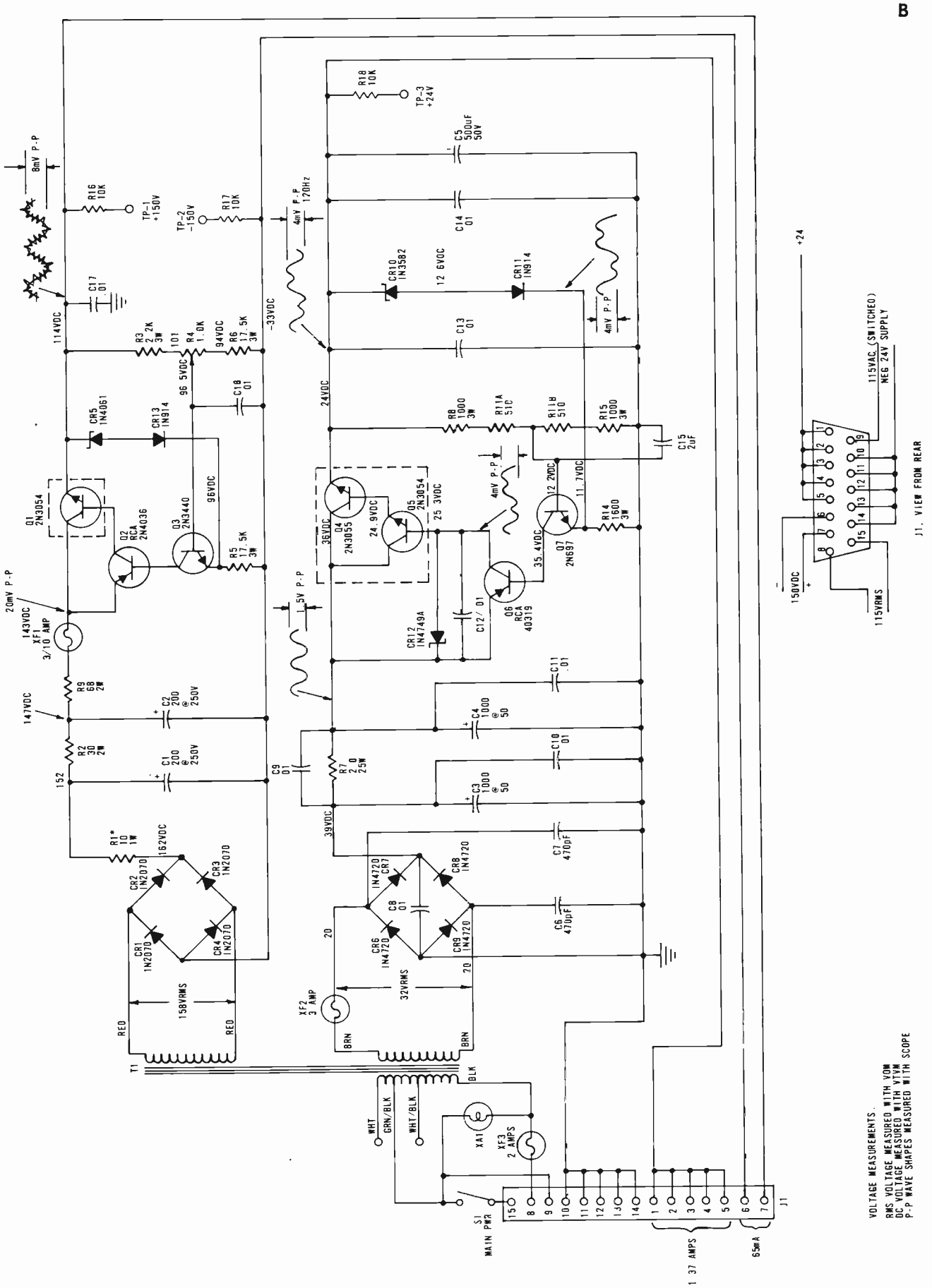

67KHZ SCA (M6507)
900KHZ FREQ MOD OSCILLATOR Q1
967KHZ FREQ MOD OSCILLATOR Q2
AUDIO RESPONSE SHAPING & XFMR
MIXER & FILTER CR1, CR2
AMPLIFIER Q3
TUNABLE LOW-PASS FILTER
AUDIO AMPLIFIER & MUTE LEVEL Q4
AUDIO AMPLIFIER Q5
RECTIFIER & MUTE TIME CONSTANT CR3, CR4
DC AMPLIFIER Q6
SWITCH Q7
AUDIO INPUT FROM TB1
67KHZ OUTPUT
1V PP FOR 10% MODULATION
MODULATED OSCILLATOR
OSCILLATOR MODULATOR Q1
BUFFER Q2
DC REGULATOR Q3
15-25 MW 88-108 MHZ
10 WATT, 88-108 MHZ
10 WATT AMPLIFIER
AMPLIFIER Q1
AMPLIFIER Q2
DRIVER Q3
POWER AMPLIFIER Q4, Q5
DC ERROR VOLTAGE
RF SAMPLE
200 MV PP AUDIO OR COMPOSITE STEREO FOR 100% MODULATION
AUTOMATIC FREQUENCY CONTROL
MODULATOR DIVIDERS Z1-Z7 & Q1
PHASE DETECTOR Z10
ALARM CIRCUITS Z11, Z14 Q3
XMTR. INTLK.
REFERENCE OSCILLATOR Z12
REFERENCE DIVIDERS Z8, Z9
AMPLIFIER Q2
DC REGULATOR Q4
LOW PASS FILTER
AUDIO INPUT FROM AUDIO UNIT
41 KHZ (M6507)
41 KHZ OUTPUT
CIRCUITRY IDENTICAL TO 67KHZ SCA UNIT (Q1 & Q2 TUNE TO 900 & 941 KHZ)
AUDIO
LEFT INPUT FROM TB1
RIGHT INPUT FROM TB1
19KHZ NOTCH FILTER
75 µ SEC PRE-EMPH & AUDIO XFMR
RELAY & SWITCH
MATRIX
+24VDC ALL UNITS
POWER SUPPLY
FILTER
SERIES CONTROL Q4
RECTIFIER CR6,7,8,9
DC AMPLIFIER Q5
REFERENCE CR10, CR11
DC AMPLIFIER Q6, CR12
COMPARATOR Q7
117V AC INPUT FROM TB-1
STEREO GENERATOR (M6533)
L+R
L-R
ISOLATION Q15
ISOLATION Q16
TIME DELAY L3,4,5,6 C29 & C30
BALANCED SUB-CARRIER MODULATOR T3,4-CR1,2,3,4
ISOLATION Q11
ISOLATION Q8
ISOLATION Q12
76KHZ TUNED AMPLIFIER Q9
AMPLIFIER Q13
ISOLATION Q10
ISOLATION & COMPOSITE SIG. OUTPUT Q14
COMPOSITE STEREO SIGNAL OUTPUT
19KHZ CRYSTAL OSCILLATOR Q1
ISOLATION Q2
19KHZ TUNED AMPLIFIER Q3
38KHZ TUNED DOUBLER Q4 & Q5
ISOLATION & PHASE ADJUST Q6
ISOLATION & GAIN CONTROL Q7



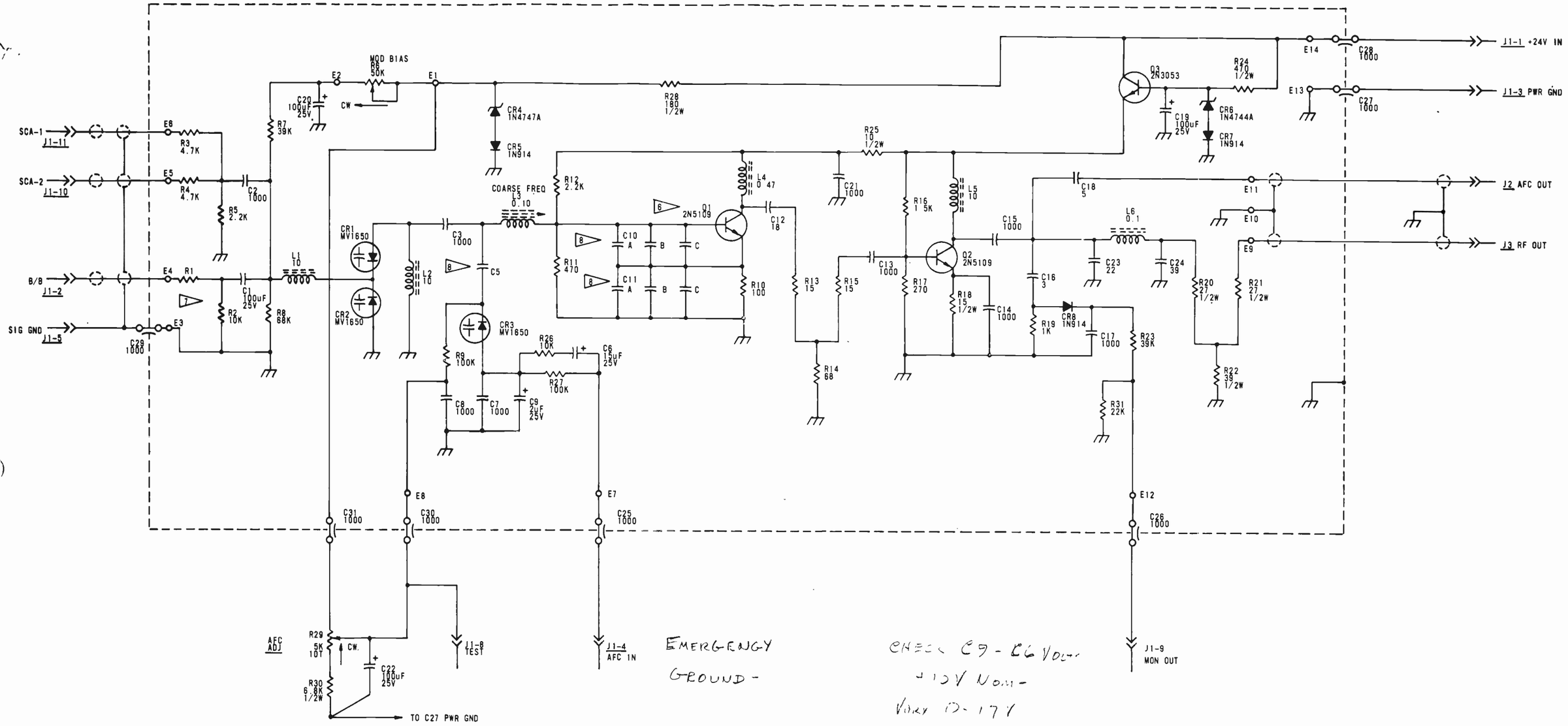
GATES DIVISION
HARRIS-INTERTYPE CORPORATION
123 HAMPSHIRE STREET • QUINCY, ILLINOIS 62301 U.S.A.

838 4199 001

INTERCONNECTING DIAGRAM
FIG. 7.2



POWER SUPPLY
FIG. 7.3
838 1955 001



EMERGENCY GROUND -

CHECK C9 - 2.6 VOLTS
+12V NOM -
VARY 10-17V

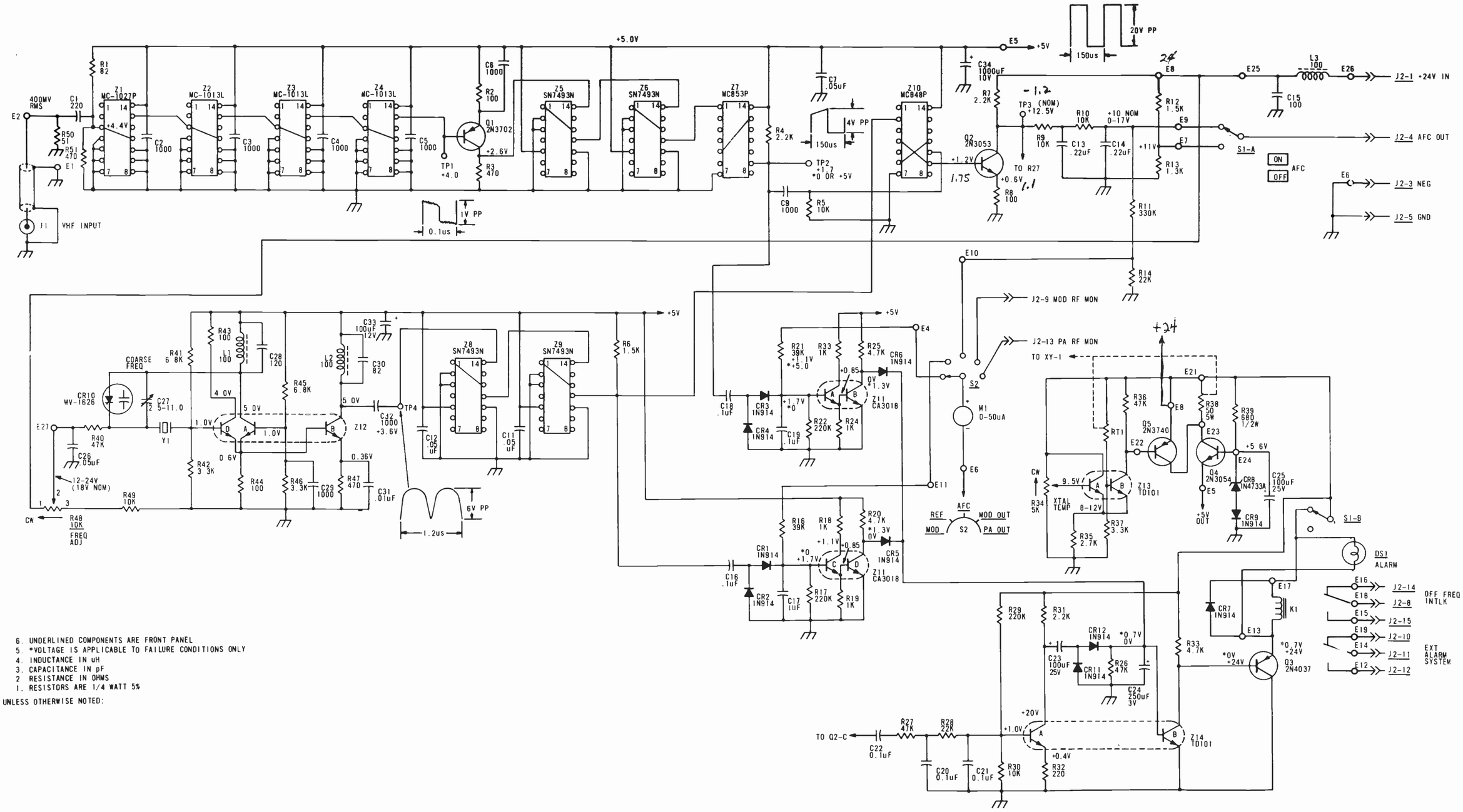
8	FREQ RANGE	C10 A	B	C	C11 A	B	C	C5
	88-100 MHz	47 N750	47 N750	68 5%	47 N750	47 N750	68 5%	27pF 5%
	98-108 MHz	47 N750	47 5%	NOT USED	47 N750	47 5%	NOT USED	18pF 5%

6 SEE CHART

7 R1 IS NOT USED IN STD MODEL TE-3 EXCITER

8 Q1 MAY BE SELECTED FOR MINIMUM NOISE AND/OR DISTORTION

UNLESS OTHERWISE NOTED:
5. UNDERLINED COMPONENTS ON FRONT PANEL
4. INDUCTANCE IN uH
3. CAPACITANCE IN pF
2. RESISTANCE IN OHMS
1. RESISTORS ARE 1/4 WATT 5%

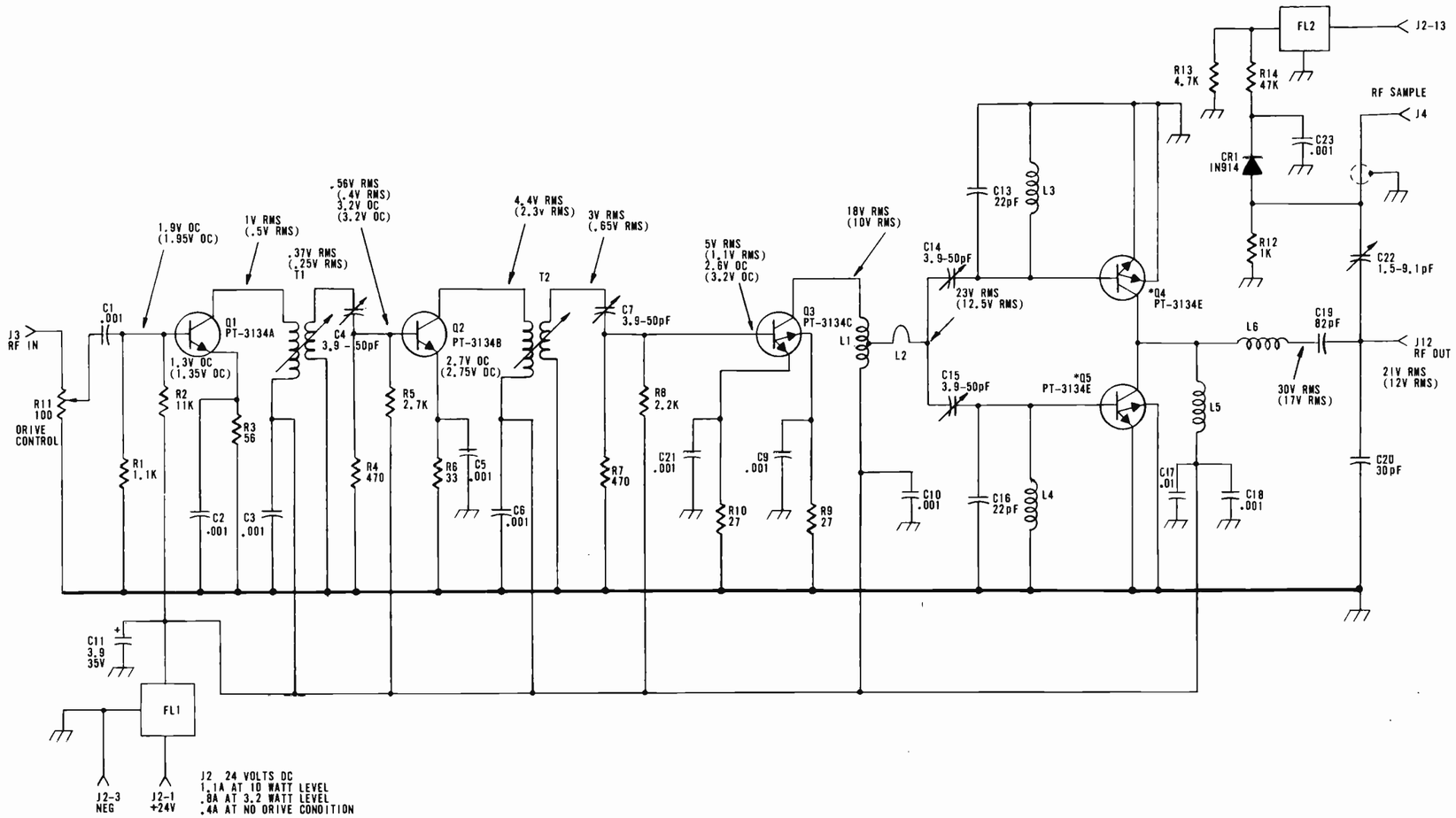


6. UNDERLINED COMPONENTS ARE FRONT PANEL
5. *VOLTAGE IS APPLICABLE TO FAILURE CONDITIONS ONLY
4. INDUCTANCE IN uH
3. CAPACITANCE IN pF
2. RESISTANCE IN OHMS
1. RESISTORS ARE 1/4 WATT 5%

UNLESS OTHERWISE NOTED:

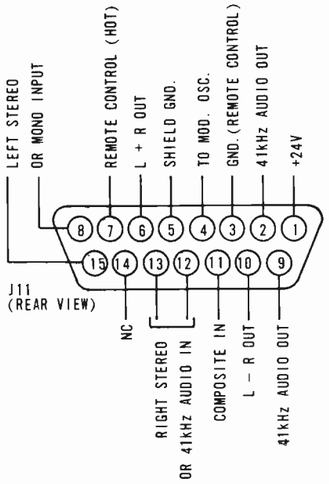
GATES DIVISION
HARRIS-INTERTYPE CORPORATION
123 HAMPSHIRE STREET • QUINCY, ILLINOIS 62301 U.S.A.

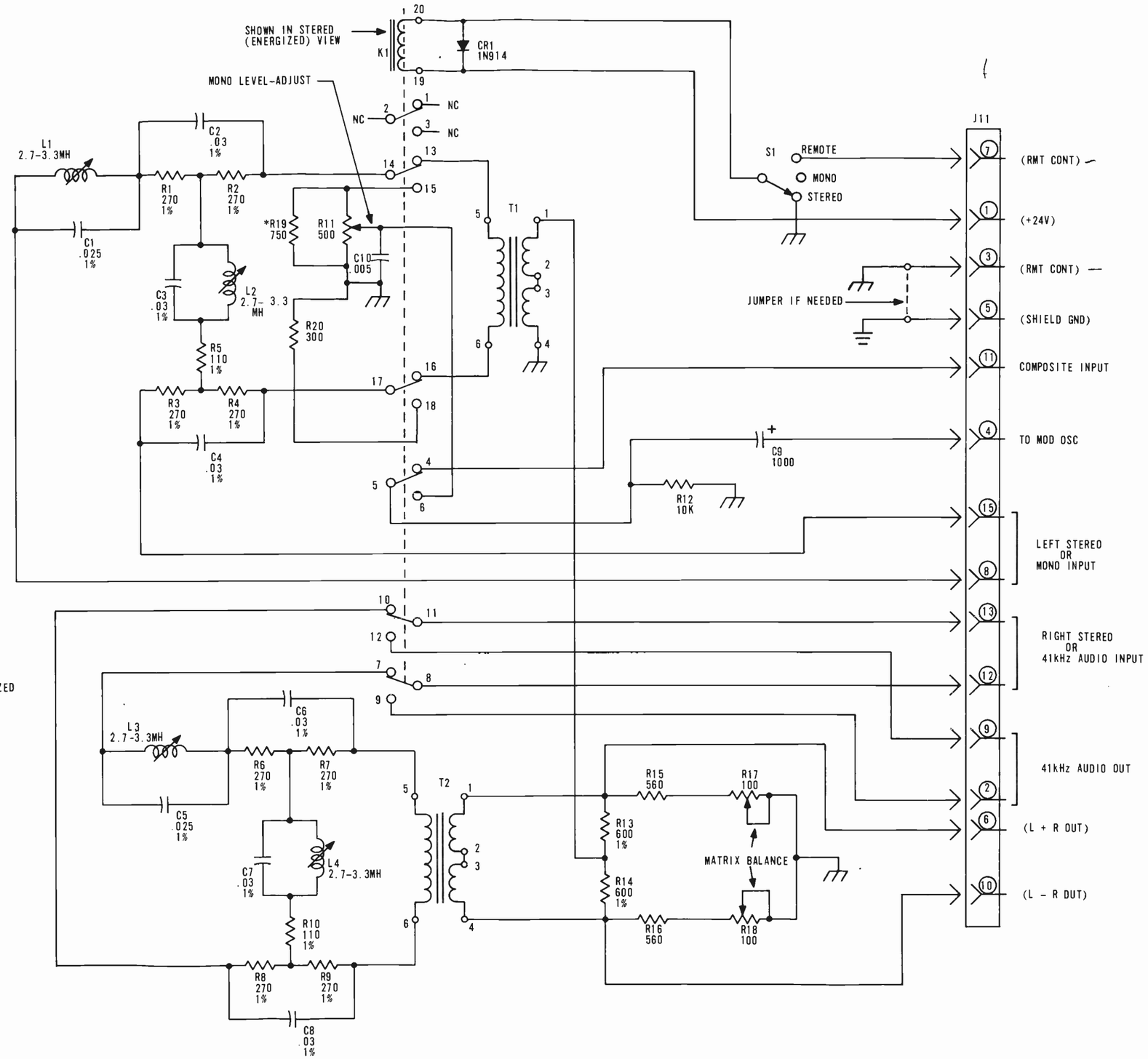
AUTOMATIC FREQ. CONTROL
FIG. 7.5 842 5828 001



NOTE:

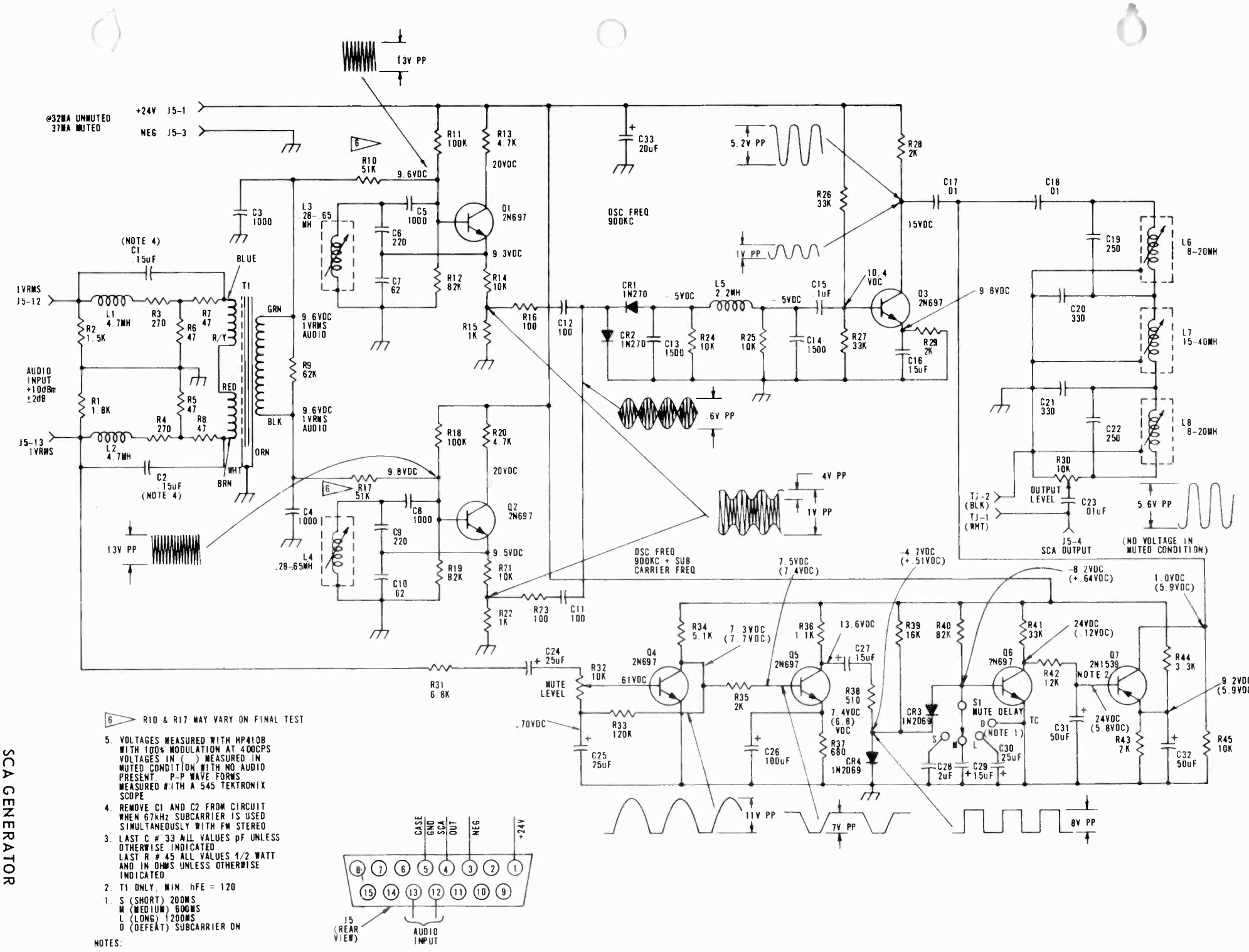
ALL CAPACITORS IN uF UNLESS OTHERWISE STATED
VOLTAGE MEASUREMENTS WITH HP-410B VTVM USING
RF PROBE FOR RMS VALUES
VOLTAGES IN (--) ARE AT 3W OUTPUT LEVEL
OTHERWISE 10W OUT
*Q4 & Q5 ARE A MATCHED PAIR



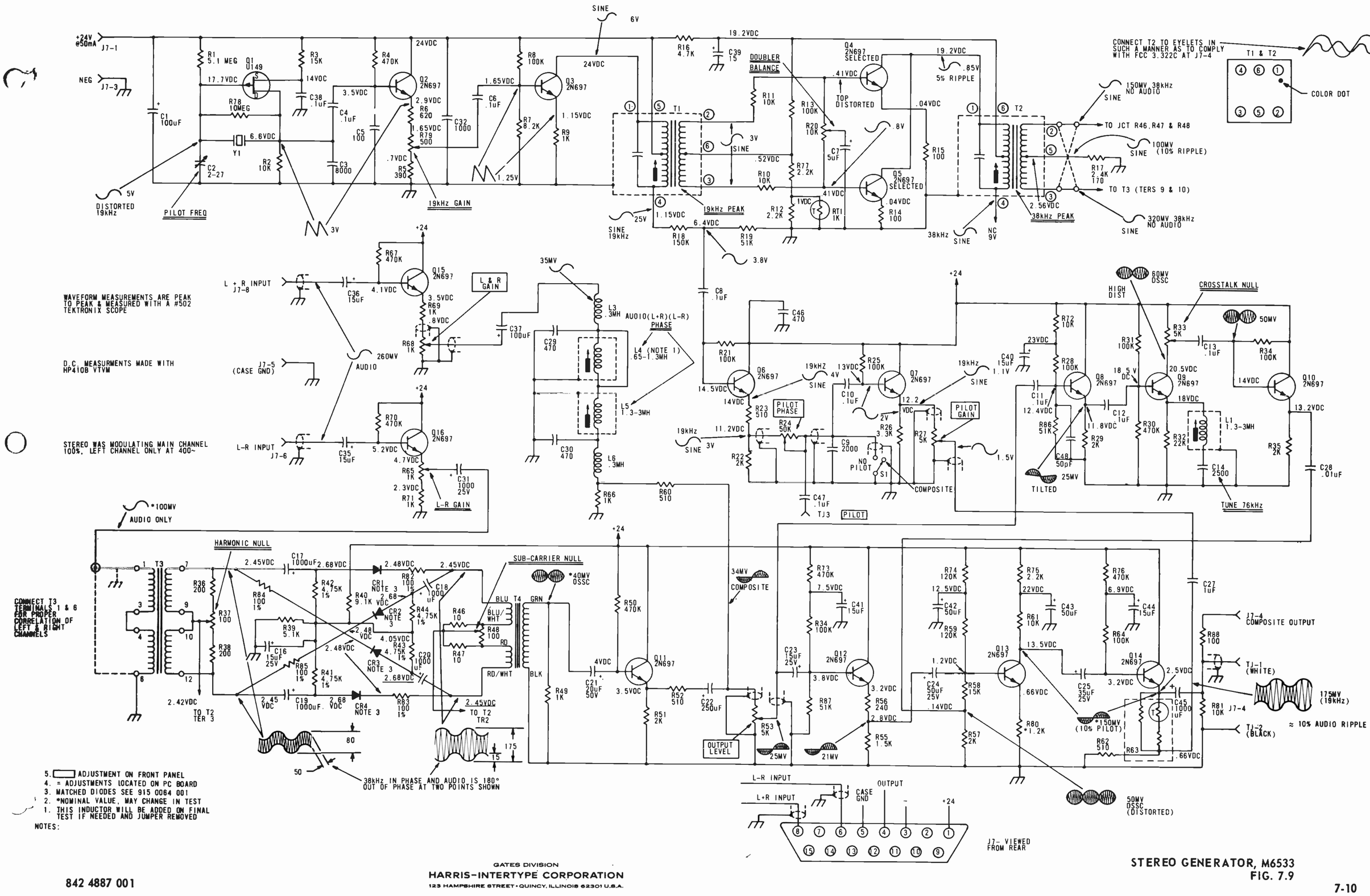


5. *NOMINAL VALUE, DETERMINED ON FINAL TEST
4. INDUCTANCE IN uH
3. CAPACITANCE IN uF
2. RESISTANCE IN OHMS
1. RESISTORS ARE 1/2 WATT 5%

UNLESS OTHERWISE NOTED:



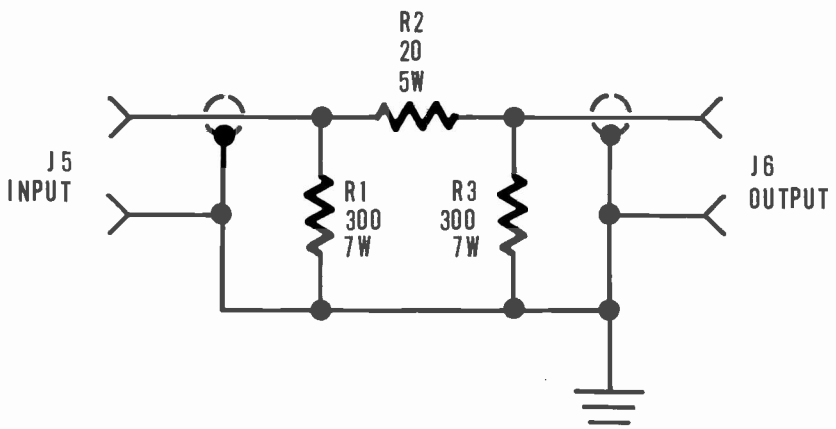
SCA GENERATOR
FIG. 7.8



842 4887 001

GATES DIVISION
HARRIS-INTERTYPE CORPORATION
123 HAMPSHIRE STREET • QUINCY, ILLINOIS 62301 U.S.A.

STEREO GENERATOR, M6533
FIG. 7.9


R2
20
5W
J5
INPUT
R1
300
7W
R3
300
7W
J6
OUTPUT

HARRIS
INTERTYPE
CORPORATION

GATES®

A DIVISION OF HARRIS-INTERTYPE

123 HAMPSHIRE ST. • QUINCY, ILLINOIS • 62301 • U.S.A.