TECHNICAL MANUAL

FM-20H3

FM TRANSMITTER

994 6745 001

HARRIS CORPORATION

Broadcast Products Division

T.M. No. 888 1071 001

Revision A: January 1981

MANUAL REVISION HISTORY

MCN OR REV.NO.	MCN OR REV. DATE	ECN NO.	DESCRIPTION OF CHANGE
			Revision A: January 1981
A-1	01/18/82	ENG REQUEST	Add Addendum entitled "Harris Engineering Department Power Distribution Recommendation".

WARNING

THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS. PERSONNEL MUST AT ALL TIMES OBSERVE SAFETY WARNINGS, INSTRUCTIONS AND REGULATIONS.

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers inherent in handling potentially hazardous electrical/electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance and service of this equipment involves risks both to personnel and equipment, and must be performed only by qualified personnel exercising due care. HARRIS CORPORATION shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks.

During installation and operation of this equipment, local building codes and fire protection standards must be observed. The following National Fire Protection Association (NFPA) standards are recommended as reference:

- Automatic Fire Detectors, No. 72E
- Installation, Maintenance, and Use of Portable Fire Extinguishers, No. 10
- Halogenated Fire Extinguishing Agent Systems, No. 12A

WARNING

ALWAYS DISCONNECT POWER BEFORE OPENING COVERS, DOORS, ENCLOSURES, GATES, PANELS OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. NEVER MAKE INTERNAL ADJUSTMENTS, PERFORM MAINTENANCE OR SERVICE WHEN ALONE OR WHEN FATIGUED.

Do not remove, short-circuit or tamper with interlock switches on access covers, doors, enclosures, gates, panels or shields. Keep away from live circuits, know your equipment and don't take chances.

WARNING

IN CASE OF EMERGENCY ENSURE THAT POWER HAS BEEN DISCONNECTED.

WARNING

IF OIL FILLED OR ELECTROLYTIC CAPACITORS ARE UTILIZED IN YOUR EQUIPMENT, AND IF A LEAK OR BULGE IS APPARENT ON THE CAPACITOR CASE WHEN THE UNIT IS OPENED FOR SERVICE OR MAINTENANCE, ALLOW THE UNIT TO COOL DOWN BEFORE ATTEMPTING TO REMOVE THE DEFECTIVE CAPACITOR. DO NOT ATTEMPT TO SERVICE A DEFECTIVE CAPACITOR WHILE IT IS HOT DUE TO THE POSSIBILITY OF A CASE RUPTURE AND SUBSEQUENT INJURY.

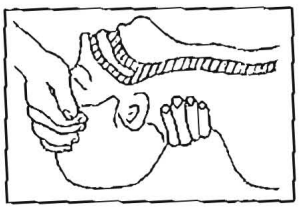
TREATMENT OF ELECTRICAL SHOCK

1. IF VICTIM IS NOT RESPONSIVE FOLLOW THE A-B-CS OF BASIC LIFE SUPPORT.

PLACE VICTIM FLAT ON HIS BACK ON A HARD SURFACE

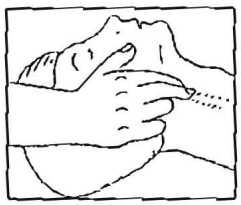
(A) AIRWAY

IF UNCONSCIOUS.
OPEN AIRWAY



LIFT UP NECK
PUSH FOREHEAD BACK
CLEAR OUT MOUTH IF NECESSARY
OBSERVE FOR BREATHING

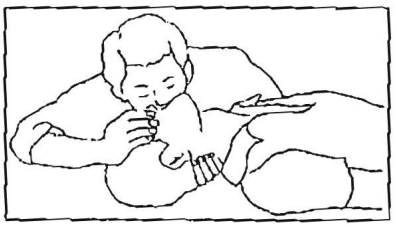
CHECK
CAROTID PULSE



IF PULSE ABSENT,
BEGIN ARTIFICIAL
CIRCULATION

(B) BREATHING

IF NOT BREATHING.
BEGIN ARTIFICIAL BREATHING



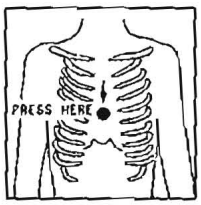
TILT HEAD
PINCH NOSTRILS
MAKE AIRTIGHT SEAL

4 QUICK FULL BREATHS

REMEMBER MOUTH TO MOUTH
RESUSCITATION MUST BE
COMMENCED AS SOON AS POSSIBLE

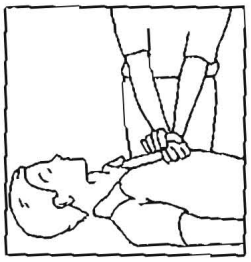
(C) CIRCULATION

DEPRESS STERNUM 1 1/2 TO 2 INCHES



APPROX. RATE OF COMPRESSIONS --80 PER MINUTE
- ONE RESCUER
- 15 COMPRESSIONS
- 2 QUICK BREATHS

APPROX. RATE OF COMPRESSIONS --60 PER MINUTE
- TWO RESCUERS
- 5 COMPRESSIONS
- 1 BREATH



NOTE: DO NOT INTERRUPT RHYTHM OF COMPRESSIONS
WHEN SECOND PERSON IS GIVING BREATH

CALL FOR MEDICAL ASSISTANCE AS SOON AS POSSIBLE.

2. IF VICTIM IS RESPONSIVE.

A. KEEP THEM WARM
B. KEEP THEM AS QUIET AS POSSIBLE
C. LOOSEN THEIR CLOTHING
D. A RECLINING POSITION IS RECOMMENDED

FIRST-AID

Personnel engaged in the installation, operation, maintenance or servicing of this equipment are urged to become familiar with first-aid theory and practices. The following information is not intended to be complete first-aid procedures, it is brief and is only to be used as a reference. It is the duty of all personnel using the equipment to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.

Treatment of Electrical Burns

1. Extensive burned and broken skin

   a. Cover area with clean sheet or cloth. (Cleanest available cloth article.)
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply any salve or ointment.
   c. Treat victim for shock as required.
   d. Arrange transportation to a hospital as quickly as possible.
   e. If arms or legs are affected keep them elevated.

NOTE

If medical help will not be available within an hour and the victim is conscious and not vomiting, give him a weak solution of salt and soda: 1 level teaspoonful of salt and 1/2 level teaspoonful of baking soda to each quart of water (neither hot or cold). Allow victim to sip slowly about 4 ounces (a half of glass) over a period of 15 minutes. Discontinue fluid if vomiting occurs. (Do not give alcohol.)

2. Less severe burns - (1st & 2nd degree)

   a. Apply cool (not ice cold) compresses using the cleanest available cloth article.
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply salve or ointment.
   c. Apply clean dry dressing if necessary.
   d. Treat victim for shock as required.
   e. Arrange transportation to a hospital as quickly as possible.
   f. If arms or legs are affected keep them elevated.

REFERENCE: ILLINOIS HEART ASSOCIATION

AMERICAN RED CROSS STANDARD FIRST AID AND PERSONAL SAFETY MANUAL (SECOND EDITION)

FM-20H3 20 kW FM TRANSMITTER

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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 20 kW Transmitter.

1.4 Purpose of Equipment

The Gates FM-20H3 is a FM broadcast transmitter with the capability of delivering 21,500 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.

Warning, disconnect primary power prior to servicing.

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

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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	7 to 21.5 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 (See Caution Note, bottom of page) 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	660 c.f.m. @ 4 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.

CAUTION

THIS EQUIPMENT IS DESIGNED FOR CONNECTION TO A CLOSED DELTA THREE PHASE POWER SERVICE

Warning, disconnect primary power prior to servicing.

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 Division 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

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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.

Warning, disconnect primary power prior to servicing.

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.

2.4 Installation

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.

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 Transmitter	To Power Supply
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. (See Caution Note, bottom of page)

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

CAUTION

THIS EQUIPMENT IS DESIGNED FOR CONNECTION TO A CLOSED DELTA THREE PHASE POWER SERVICE

Warning, disconnect primary power prior to servicing.

The R.F. output coupling assembly consists of a silver plated 3-1/8 inch outer conductor with a flange near the center and an 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.

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. If necessary, loosen the set screws in the adjustable sleeve to temporarily position the sleeve close to the flange. 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 1/16 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.)

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

Warning, disconnect primary power prior to servicing.

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. An 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 fingerstock 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 near the top of the tube's anode. 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 exciter 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.

It is recommended to use No. 1 AWG wire or larger and a 125 Ampere circuit breaker or disconnect switch on the 3 phase input source.

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.

Warning, disconnect primary power prior to servicing.

The normal operating air pressure below the PA tube socket is approximately 4 inches of water. Under this condition the blower is capable of delivering 660 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 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. The air switch will not close if the blower rotation is incorrect (see Section 5.6).

Warning, disconnect primary power prior to servicing.

Turn the IPA Screen control fully counterclockwise.

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 for 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 if the tested power output is 20 kW.

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.

Warning, disconnect primary power prior to servicing.

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.

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The RF output of the exciter is varied with an 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.

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 Division 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 lubricated and sealed to provide several years of operation. It is not recommended to lubricate the bearings unless actual maintenance is required on the blower.

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.

Warning, disconnect primary power prior to servicing.

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-20H3 employs 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 at the lower frequencies.)

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.

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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 determines 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.

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5.6 Blower Rotation

On initial turn ON the blower rotation should be checked. As the filament voltage is turned OFF determine the motor rotor rotation as it slows to a stop. The rotation should be counterclockwise as viewed through the air vents at the end of the motor housing. 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.

5. Adding a resistor in series with the IPA plate voltage lead.

6. Changing the 9000 V d.c. power transformer primary configuration from a delta to a wye connection.

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.

HARRIS CORPORATION Broadcast Products Division
123 Hampshire Street Quincy Illinois 62301

ELECTRICAL PARTS LIST

SYMBOL	DESCRIPTION	GATES PART #
B1	Main Blower Assembly/with Motor	432 0137 000
	Motor for B1 208/240 Vac, 3 phase, 50/60 Hz, 3450 RPM normal, 2hp, continous duty	436 0076 000
B2	Tuning Motor, 1 r/min.	436 0013 000
B3, B4	Motor, 1500 RPM, 115 V, 60 Hz	436 0004 000
C4	Cap .01 uF 1 kV	516 0082 000
C5	Neutralizing Cap, Plate	814 3152 001
C6	Cap Variable Vacuum, 10-100 pF, 15 kV	514 0194 000
C7	Cap 500 pF 15 kV	516 0713 000
C8 thru C16	Cap 500 pF 5 kV	516 0205 000
C17 thru C20	Cap 1000 pF 5 kV	516 0206 000
C21	Cap Feedthru 1000 pF 1 kV	516 0361 000
C22	Cap 2200 pF 500 V. 5%	500 088" 000
C23	Cap 100 pF 15 kV	516 0209 000
C24	Cap Variable 6-11 pF	520 0277 000
C25	Cap 500 pF 5 kV	516 0205 000
C26 thru C30	Cap Feedthru 1000 pF, 500 V.	516 0235 000
C31	Cap 40 pF 5000 V.	516 0334 000
C32	Cap Variable 5.2-30 pF	520 0158 000
C33, C34	Cap .01 uF 1 kV	516 0082 000
C35, C36	Cap .001 uF 1 kV	516 0054 000
C38	Cap 15 uF 450 V.	522 0133 000
C39	Cap 8 uF 3000 V.	510 0612 000
C40	Cap 4.5 uF 10 kV	510 0687 000
C41 thru C48	Cap 500 pF 500 V.	516 0250 000
C49	Cap Neut. (Feedthru Stud to Socket XV2)	
C50	Not Used	
C51 thru C54	Cap 1000 pF 5 kV	516 0206 000
C55	Cap (Part of Tube Socket XV2)	

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Warning, disconnect primary power prior to servicing.

ELECTRICAL PARTS LIST

SYMBOL	DESCRIPTION	GATES PART #
C56	Cap (Part of Tube Socket XV3)	
C57	Cap .01 uF 1 kV	516 0082 000
C58, C59	Cap 125 uF, 350 V.	524 0281 000
C60 thru C65	Cap 4300 pF 15 kV	516 0390 000
C66	Cap 500 pF 15 kV	516 0713 000
C67	Cap 200 pF 7.5 kV	516 0210 000
C68, C69	Cap 1000 pF 5 kV	516 0206 000
C70, C71	Cap 500 pF 5 kV	516 0205 000
CR2, CR3	Zener Diode 1N2974	386 0016 000
CR4	Silicon Diode 1N2071	384 0020 000
DC1	Coupler, 40 kW (Part of Notch Filter Ass'y.)	620 0399 000
DS1 thru DS7	Light, Fuse indicating 230 V.	406 0358 000
DS8, DS9	Light, #381	396 0182 000
F1, F2	Fuse 10A 250 V	398 0182 000
F3 thru F5	Fuse 8A 250 V	398 0213 000
F6, F7	Fuse 6A 250 V	398 0181 000
F8	Fuse 1A 250 V	398 0017 000
FL1	Low Pass Filter (88-92 MHz and 98-108 MHz)	994 6172 001
FL1	Low Pass Filter (92-98 MHz)	994 6172 002
FL2	Notch Filter & Coupler Assy	942 4686 001
	Air Filter Washable Type	827 5285 011
J2, J3	Receptacle Type BNC	612 0237 000
J4	Receptacle Type N	612 0233 000

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ELECTRICAL PARTS LIST

SYMBOL	DESCRIPTION	GATES PART #
K1	Primary Contactor, 4 Pole, 110 V 50/60 Hz	570 0120 000
	Replacement Coil for K1	584 0133 000
	Replacement Contact Kit for Single Pole of K1	584 0129 000
K2	Blower Contactor, 3 Pole, 208-220 V 50/60 Hz	570 0132 000
	Replacement Coil for K2	584 0134 000
	Replacement Contact Kit for Single Pole of K2	584 0135 000
K3	Relay, DPDT 110 V 50/60 Hz	574 0099 000
	Replacement Coil for K3	584 0136 000
	Replacement Contact for K3 Upper stationary	584 0138 000
	Replacement Contact for K3 Lower stationary	584 0139 000
	Replacement Contact for K3 Right Hand movable	584 0140 000
	Replacement Contact for K3 Left Hand movable	584 0141 000
K4	Step-Start Contactor 4 Pole 208-220 V 50/60 Hz	570 0119 000
	Replacement Coil for K4 (208-220 V. a.c.)	584 0142 000
	Replacement Contact Kit for Single Pole of K4	584 0129 000
K5	Plate Contactor 3 Pole, 220 V 60 Hz	570 0116 000
	Replacement Coil for K5 (220 V)	584 0143 000
	Replacement Contact Set complete (For K5)	584 0144 000
K6	IPA O.L. Relay 6 V d.c.	572 0125 000
K7	PA O.L. Relay 6 V d.c.	572 0125 000
K8	Recycle Relay SPDT	574 0128 000
K9	Relay, 6V d.c.	572 0066 000
K10	IPA Grid Underdrive Relay	572 0052 000
K11, K12	Magnetic Overload Relay 60-120 A	582 0003 000
	Replacement Coil for K11 & K12	584 0069 000

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Warning, disconnect primary power prior to servicing.

ELECTRICAL PARTS LIST

SYMBOL	DESCRIPTION	GATES PART #
L1	Not Used	
L2	Plate Line Assembly	942 5994 001
L3	PA R.F. Plate Choke	927 4249 002
L4	Choke, 7 uH	494 0004 000
L5	IPA R.F. Plate Choke	914 9985 001
L6	IPA Plate Coil	(Det. by Freq)
L7, L8	Not Used	
L9	Choke, 7 uH	494 0004 000
L10	Choke 12 H 75 mA	476 0007 000
L11	Filter Reactor 2 H, 1A	476 0272 000
L12	Reactor 2 H 5A	476 0270 000
L13, L14	Choke, 2 uH	914 7670 002
L15, L16	Choke, 7 uH	494 0004 000
M1	Filament Voltage Meter 0-10 V a.c.	630 0124 002
M2	Plate Current Meter 0-5 A d.c.	632 0559 002
M3	Plate Voltage Meter 0-10 kV	632 0569 002
M4	R.F. Output Meter (%Power & VSWR)	632 0667 000
M5	Multimeter	632 0584 002
M6	PA Screen Current Meter 0-200 mA d.c.	632 0585 002
M7	Elapsed Time Meter 230 V a.c.	636 0006 000
R8	VSWR Calibration Potentiometer 10K ohm (Mod.)	914 9092 001
R9	Power Calibration Potentiometer 10K ohm 2W	550 0067 000
R10	Res 5 ohm 100 W	542 0286 000
R11	Potentiometer 1K ohm 2W	550 0061 000
R12	Not Used	
R13, R14	Res 47 ohm 1W 5%	540 0300 000
R15A, R15B, R15C	Res 3.3K ohm 2W 5%	540 0623 000

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ELECTRICAL PARTS LIST

SYMBOL	DESCRIPTION	GATES PART #
R16 R17	Res 10 ohm 2W 5%	540 0563 000
R18	Res .22 ohm 2W 1%	548 0207 000
R19, R20	Res 47 ohm ½W 10%	540 0017 000
R21	IPA Filament Rheostat 25 ohm, 25W	552 0309 000
R22	PA Filament Rheostat 10 ohm, 300W	552 0452 000
R23	Res 20K ohm, 10W	542 0103 000
R24	Res 12K ohm,	542 0096 000
R25, R26	Res 47 ohm 2W 10%	540 0724 000
R28	Res., Pot., 7.5K ohm, 12.5W	552 0791 000
R29	Rheostat 10K ohm 50W	552 0349 000
R30	Res 4000 ohm 50W	542 0218 000
R31 thru R33	Res 1 ohm 50W	542 0441 000
R34	Res 5100 ohm 2W 5%	540 0628 000
R35	Potentiometer 10K ohm 2W	550 0067 000
R36	Potentiometer 1K ohm 2W	550 0061 000
R37	Res 15 ohm 10W	542 0055 000
R38	Res 100 ohm 2W 10%	540 0728 000
R39	O.L. Adjust Potentiometer 500 ohm 2W	550 0059 000
R40, R41	Res 60K ohm 160W	542 0343 000
R42	IPA Screen Rheostat 5K ohm 50W	552 0347 000
(R43 & R44)	Rheostat, 2 in tandem 10K ohm 150W	552 0790 000
R45	Res 20K ohm 100W	542 0305 000
R46	Res 10K ohm 160W	542 0335 000
R47	Res 5K ohm 160W	542 0333 000
R48, R49	Meter Multiplier 5 Megohm	914 3424 001
R50	Potentiometer 1K ohm 2W	550 0061 000
R51 thru R53	Res 100K ohm 160W	542 0346 000
R54	Res 1000 ohm 2W 5%	540 0611 000

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ELECTRICAL PARTS LIST

SYMBOL	DESCRIPTION	CATES PART #
R55	Res 3 ohm 100W	542 0284 000
R56	Res 47 ohm ½W 10%	540 0017 000
R57	Res 51 ohm 2W 5%	540 0580 000
R58	Res 100 ohm 25W	540 0833 000
R59	Res 2K ohm 10W	542 0081 000
R60 thru R62	Res 10K ohm 20W	542 0145 000
R63, R64	Res 22 ohm 2W 5%	540 0571 000
R65	Res 16 ohm 2W 5%	540 0568 000
R66	Res 7500 ohm 160W	542 0334 000 36.10
S1 thru S4	Switch Pushbutton "Z" contacts	604 0445 000
S5	Remote-Local Switch DPDT	604 0032 000
S6, S7	Interlock Switch	604 0196 000
S8, S9	Not Used	
S10	Air Switch	604 0310 000
S11, S12	Interlock Switch	604 0196 000
S13, S14	Limit Switch	604 0052 000
S15	PA Screen Raise-Lower Switch	602 0056 000
S16	RF Output Meter Switch (Mod.)	914 9091 001
S17	Filament Voltage Switch	602 0007 000
S18	Multimeter Switch (Mod.)	914 9091 003
S19	Voltage Change Switch	
T1	Filament Transformer	472 0533 000
T2	Filament Transformer	472 0530 000
T3	Bias Transformer	472 0531 000
T4	Plate Transformer 9000 V. d.c.	472 0525 000
T5	Plate Transformer 2000 V. d.c.	472 0534 000

Warning, disconnect primary power prior to servicing.

ELECTRICAL PARTS LIST

SYMBOL	DESCRIPTION	CATES PART #
TB2	Not Used	
TB3	Terminal Board 5 Terminal	614 0072 000
TB4	Terminal Board 8 Terminal	614 0052 000
TB5	Not Used	
TB6	Terminal Board 14 Terminal	614 0104 000
TB7, TB8	Terminal Board 6 Terminal	614 0096 000
V1	Tube 4CX15,000A	374 0097 000
V2, V3	Tube 4CX250B	374 0081 000
XC58, XC59	Socket, Twist Lock	530 0044 000
XF1, XF2	Fuse Block 2 Pole	404 0014 000
XF3 thru XF5	Fuse Block 3 Pole	402 0015 000
XF6, XF7	Fuse Block 2 Pole	404 0014 000
XF8	Fuseholder indicating	402 0074 000
XV1	Tube Socket	404 0199 000
XV2, XV3	Tube Socket	404 0251 000
Z1 thru Z3	H.V. Silicon Rectifier Stack	384 0365 000
Z4 thru Z9	Intermediate Supply Rectifier	384 0167 000
Z10	Bias Supply Rectifier Stack	384 0154 000

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ELECTRICAL PARTS LIST

M-4845 RF OUTPUT CURRENT EXTENSION KIT

SYMBOL	DESCRIPTION	GATES PART #	SYMBOL	DESCRIPTION	GATES PART #
C1	Cap 470 pF 1 kV	516 0043 000	R1 thru R4	Res 200 ohm 2W 5%	540 0594 000
C2, C3	Cap .001 uF 1 kV	516 0054 000	R5	Not Used	
			R6	Potentiometer 10K ohm 2W	550 0067 000
CR1, CR2	Diode, 1N914	384 0195 000	R7	Res 7500 ohm ½W 5%	540 0070 000
J1	Receptacle "BNC"	612 0237 000	TB1	Terminal Board 2 Terminal	614 0069 000

MECHANICAL PARTS LIST

SYMBOL	DESCRIPTION	GATES PART #	SYMBOL	DESCRIPTION	GATES PART #
	Chimney IPA Tubes	404 0073 000			
	Chimney PA Tube	404 0194 000			
	Coupling Assy. insulated Plate Line L2A	926 7398 002			

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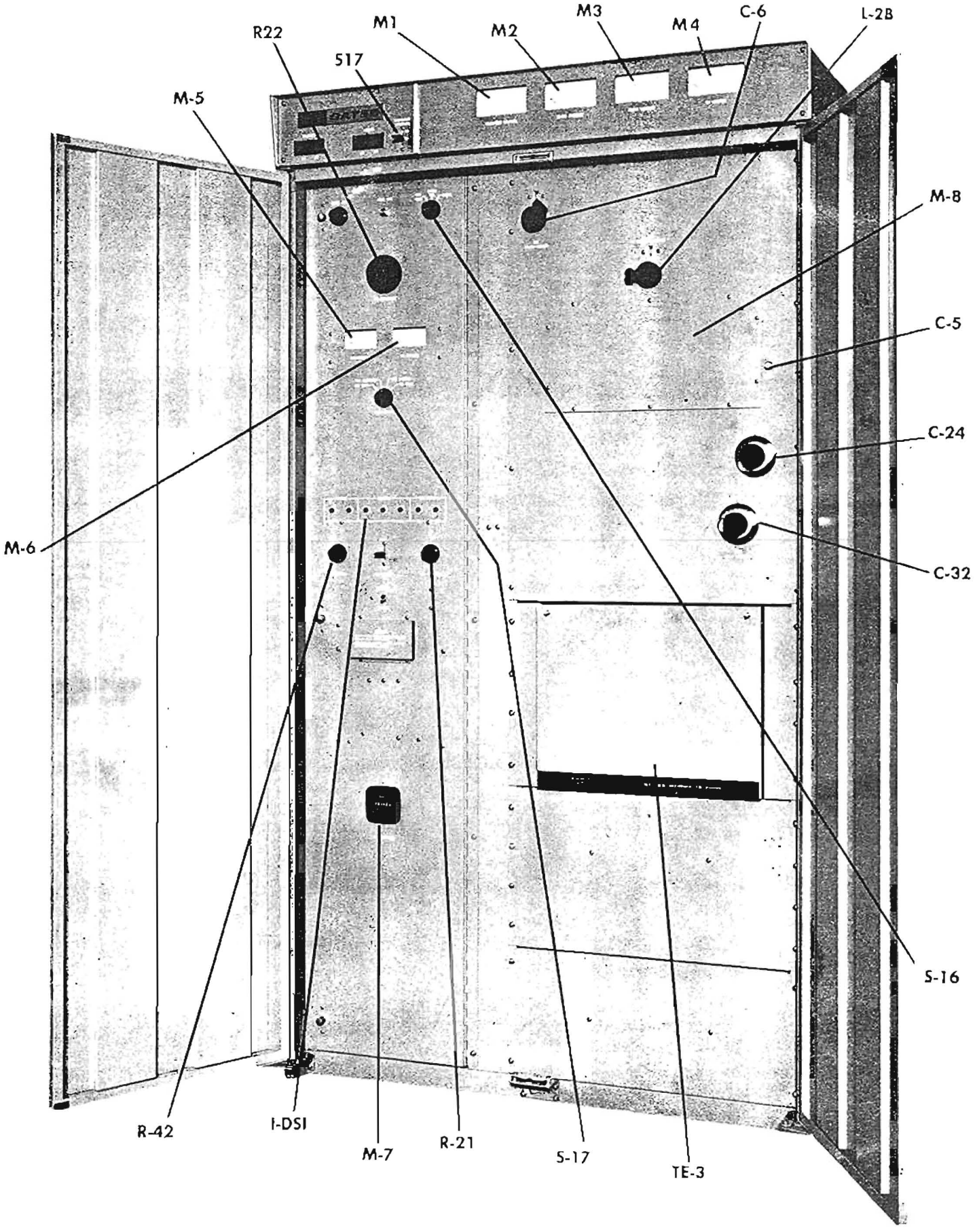
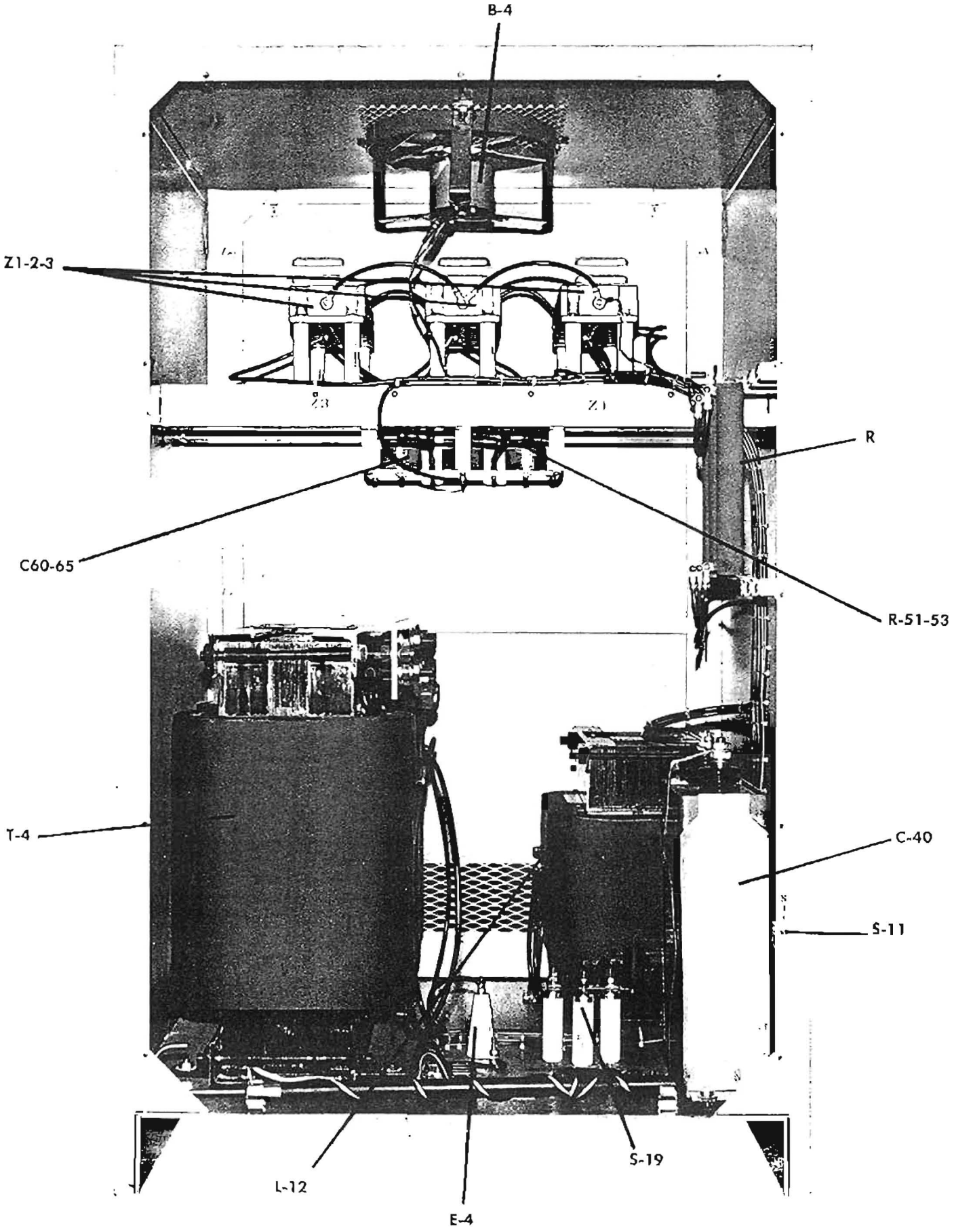
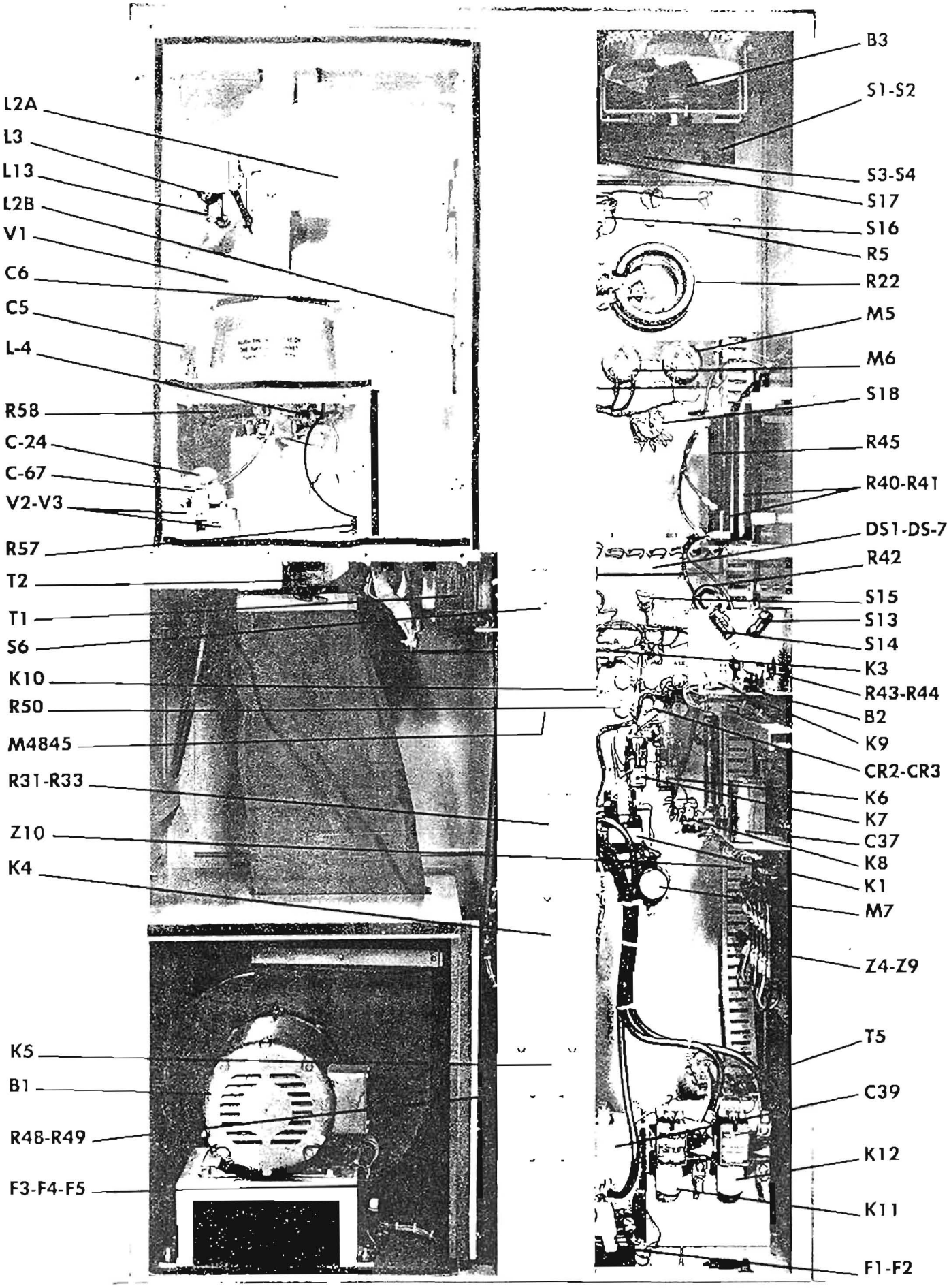
Warning, disconnect primary power prior to servicing.


R22
M1
M2
M3
M4
C-6
L-2B
517
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


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


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

HARRIS ENGINEERING DEPARTMENT
POWER DISTRIBUTION RECOMMENDATION

Radio and Television transmitters using three-phase power must operate with the line-to-line voltages well balanced. Operation with the incoming line-to-line voltages substantially unbalanced will increase the ripple from the three-phase power supplies, primarily at twice the power line frequency, and thus increase the hum of the transmitter. Unbalanced line voltages result in unbalanced currents in the windings of the three-phase transformers, and in unbalanced currents in the windings of three-phase motors.

Three-phase motors should be run with line voltage balance within 1%; a 3-1/2 percent line voltage unbalanced will produce a temperature rise approximately 25% above normal in the winding carrying the greater of the unbalanced currents, while a 5% unbalance will produce a temperature rise approximately 50% greater than normal.

The regulation of a three-phase open delta transformer bank is much poorer than that of a closed delta bank.[1] The closed delta bank is symmetrical; the open delta is not; so the regulation in each of the three phases differs widely, and the effect of this may be an appreciable line voltage unbalance. The regulation of a closed delta is symmetrical on each phase.

Depending upon the impedances of the two transformers making up the open delta this appreciable line voltage unbalance may be great enough to impair satisfactory operation of the transmitter. HARRIS customers have experienced this with open delta distribution, and when the third transformer was added for closed delta service, the problem disappeared.

Transient overvoltages with open delta distribution can cause transmitter damage, particularly to the silicon rectifiers used in the main HV power supply. This is sometimes troublesome when the open delta transformers are at the end of a long overhead open wire distribution system. Several HARRIS

1. "Transformer Engineering" - Blume, Boyajian, Camilli, Lennox, Minneci, & Montsinger (John Wiley & Sons). 2nd 1967.

customers, upon following the HARRIS recommendation and adding the third transformer, have found the difficulty gone.

Although the above argument specifically calls out Closed Delta distribution, a WYE distribution also uses three transformers, and is symmetric, avoiding the difficulties arrising from the non-symmetrical configuration of the Open Delta distribution.

WYE TYPE POWER DISTRIBUTION

In large segments of the world the power distribution is four-wire WYE. Single phase service is derived between the neutral of the WYE distribution and any one of the three other wires.

Three-phase main power supply transformers for small transmitters - 10 kilowatts or less - in the United States are generally operated from three-phase lines in the 210 to 250 volt range, line to line. HARRIS has adopted the practice of specifying three-phase transformers for transmitters of this class with three separate primaries, each having appropriate taps to accommodate the several nominal voltages in this range. For service in the United States these primaries are connected in Delta.

For service in those parts of the world in which the power distribution is four-wire WYE in the 360 to 415-volt range these three primaries are connected tin WYE, with each primary tapped for the line to neutral voltage. The neutral point of the three primaries of the transformer within the transformer within the transmitter is solidly connected to the power distribution system neutral, to provide a path for zero sequence currents, as well as any harmonic currents which might flow due to the rectification of the secondary voltages.

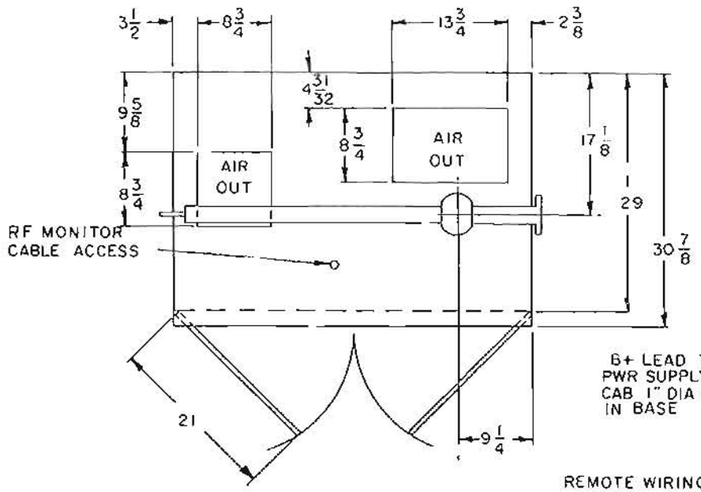
The line-to-line voltage is equal to the line to neutral voltage multiplied by the square root of three (1.732 approximately), nominally.

Typical system voltages: (Nominal)

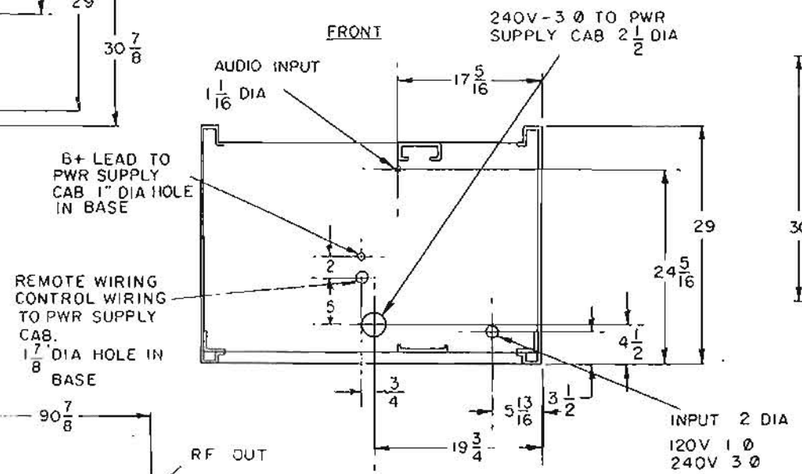
LINE TO NEUTRAL (single phase)	LINE TO LINE (three phase)
210 volts	364 volts
220 volts	380 volts
230 volts	400 volts
240 volts	415 volts
250 volts	433 volts

In summary, either a closed delta or WYE distribution system is satisfactory for HARRIS transmitter.

TOP VIEW

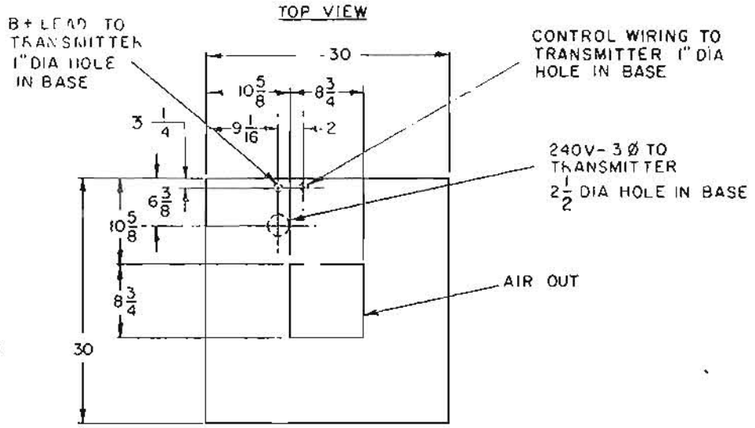


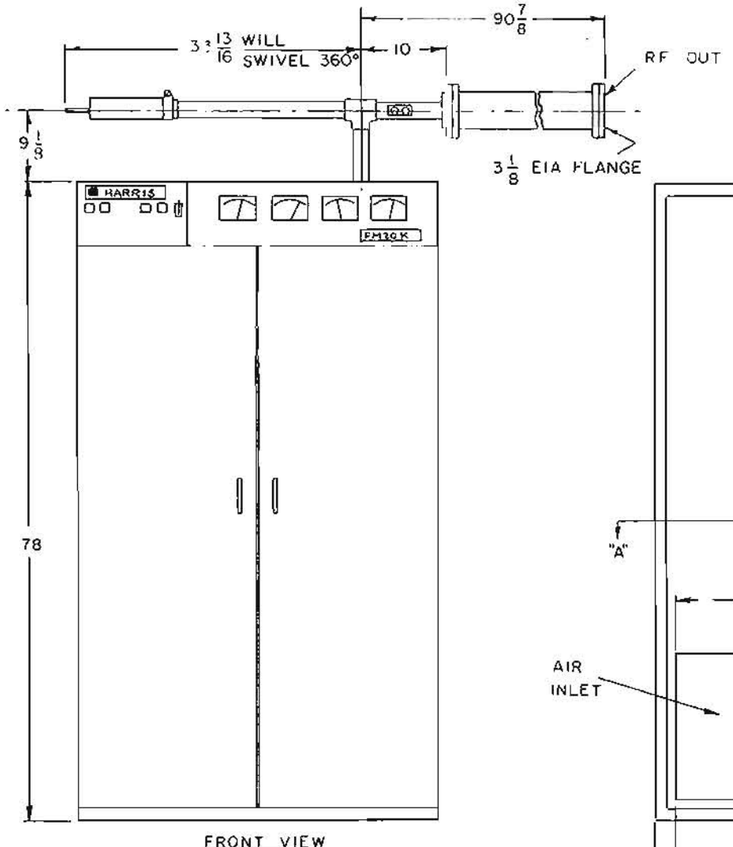
FRONT



SECTION "A" - "A"

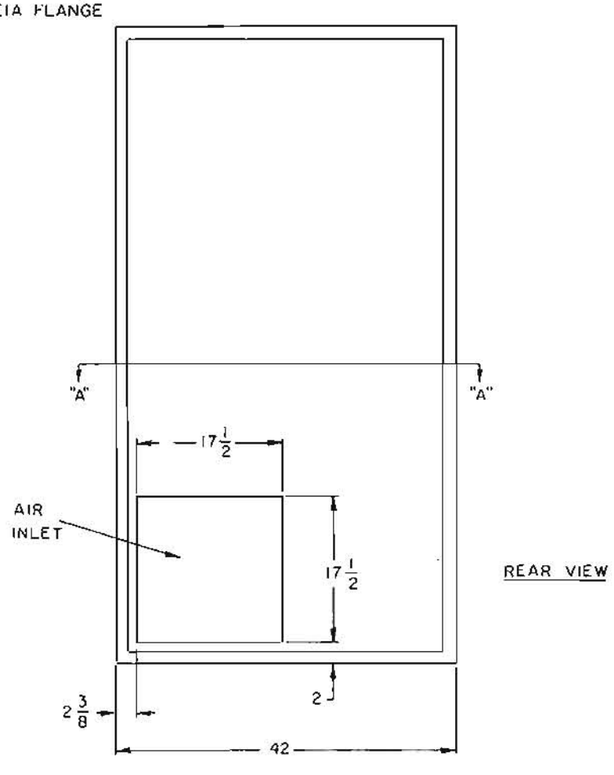
TOP VIEW





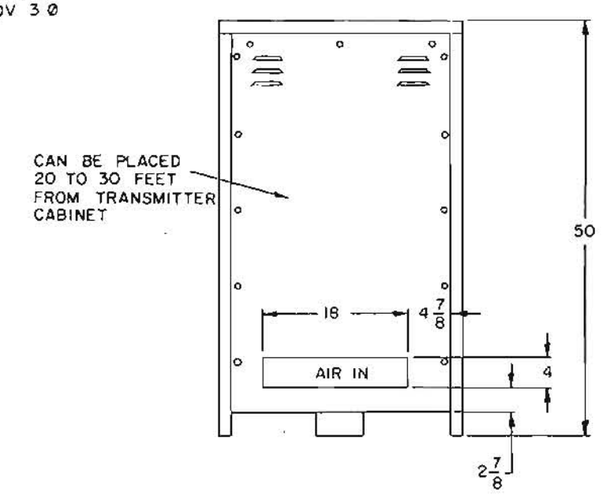
FRONT VIEW

TRANSMITTER CABINET



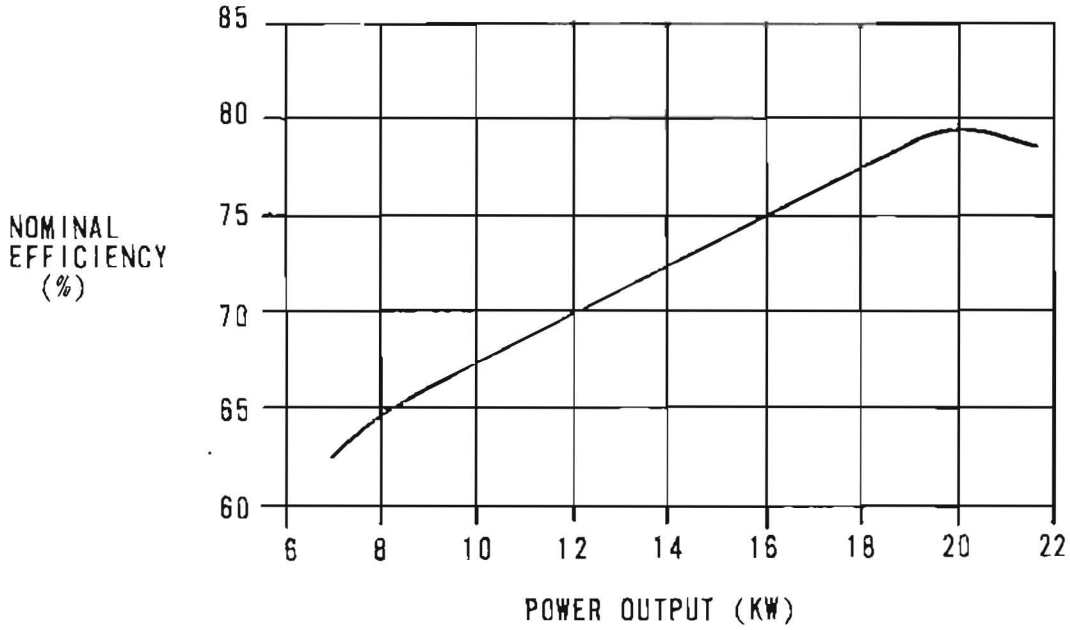
REAR VIEW

FRONT OR REAR VIEW



H.V. POWER SUPPLY CABINET

INSTALLATION DETAILS
838 1991 001



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

(REDRAWN, REVISED 2-14-72)

(REVISED 11-12-71)

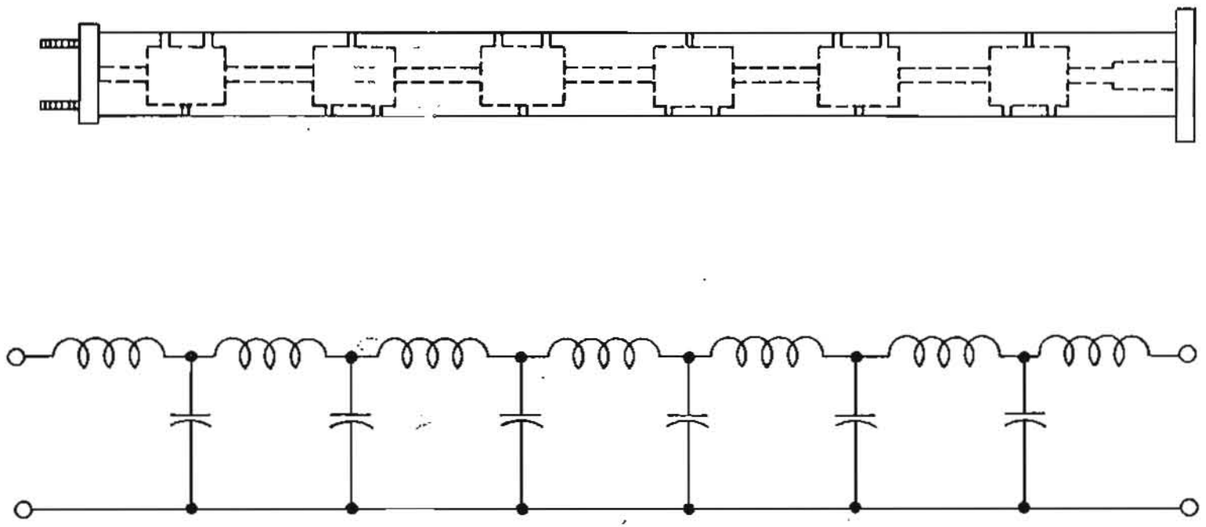
(REVISED 1-15-70)

PA EFFICIENCY CURVE

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

P.A. EFFICIENCY CURVE
814 9941 001

WARNING: Disconnect primary power prior to servicing.

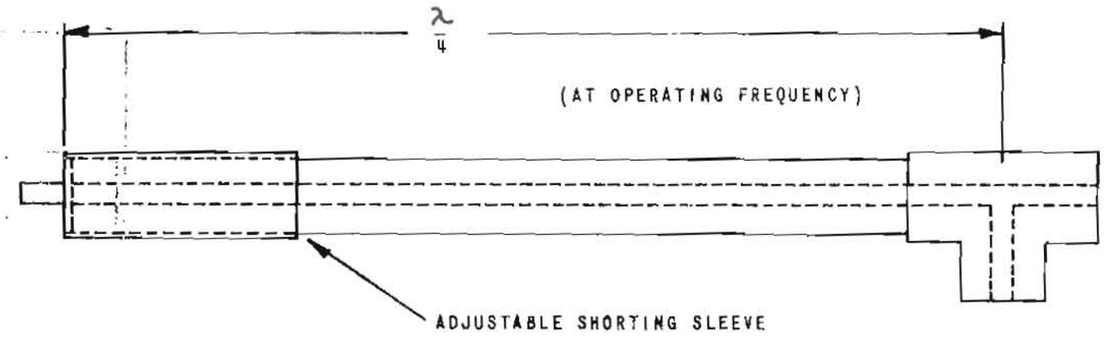


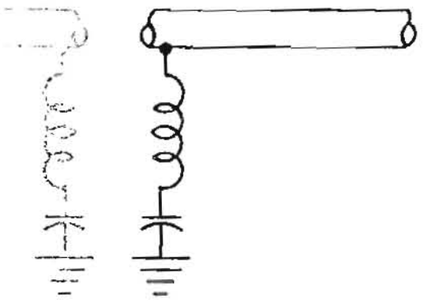
15 EQUIVALENT CIRCUIT-LOW PASS FILTER

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

LOW PASS FILTER
FM TRANSMITTERS

LOW PASS FILTER
814 8556 001





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

2ND HARMONIC FILTER
814 8554 001