RCA

Broadcast Equipment

[redacted]

BTF-20E1
FM Transmitter

ES-560602

[redacted]

IB-8027531

Broadcast Equipment

Instructions

BTF-20E1
FM Transmitter

ES-560602

Commercial Electronic Systems Division/Front and Cooper Streets/Camden, New Jersey, U.S.A., 08102

IB-8027531

EMERGENCY FIRST AID INSTRUCTIONS

WARNING

VOLTAGES THAT ARE DANGEROUS TO LIFE ARE INVOLVED IN THE OPERATION OF THIS ELECTRONIC EQUIPMENT. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE THE EQUIPMENT WITH VOLTAGES APPLIED. DANGEROUS CONDITIONS MAY EXIST IN CIRCUITS WITH POWER CONTROLS IN THE OFF POSITION DUE TO CHARGES RETAINED BY CAPACITORS, ETC. ALWAYS DISCHARGE AND GROUND CIRCUITS PRIOR TO TOUCHING THEM TO AVOID PERSONAL INJURY OR LOSS OF LIFE.

Personnel engaged in the installation, operation, or maintenance of this equipment or similar equipment are urged to become familiar with the following rules both in theory and practice. It is the duty of all operating personnel to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.

RESCUE BREATHING

GENERAL INFORMATION

A. START IMMEDIATELY, SECONDS COUNT

Do not move victim unless absolutely necessary to remove from danger. Do not wait or look for help or stop to loosen clothing. Warm the victim or apply stimulants. The main purpose is to GET AIR INTO THE VICTIM'S LUNGS.

B. WIPE OUT VICTIM'S MOUTH

Wipe out quickly any mucus, food, or any foreign matter in the victim's mouth using your fingers or a cloth wrapped around your fingers.

C. LOOSEN CLOTHING - KEEP WARM

Do this when the victim is breathing by himself or help is available. Keep him quiet as possible and from becoming chilled. Otherwise, treat him for shock.

D. DON'T GIVE UP

Continue emergency rescue breathing without interruption until victim is breathing without help or until all hope of reviving him as determined by a physician is gone.

E. CALL A PHYSICIAN

Have someone summon medical aid since respiratory and other disturbances may develop as a aftermath. A physician is necessary during the recovery period.

PROCEDURE

FIG. A

FIG. B

FIG. C

TILT HEAD BACK - Lift neck and point chin up to open air passage.

EXTEND JAW - Pull or push jaw into jutting out position (Fig. A).

PINCH NOSE - Close nostrils to prevent air leakage, or close mouth when using mouth-to-nose breathing.

BLOW - Seal victim's mouth or nose with your mouth. (Fig. B) Blow until chest rises.

REMOVE MOUTH - Listen for exchange of air; if none, check throat for obstruction. To remove it, place victim in position shown in Fig. C, and slap sharply between shoulder blades.

REPEAT - 12 times per minute for adults; at least 20 times per minute for children.

BURNS

SKIN REDDENED: Apply ice cold water to burned area to prevent burn from going deeper into skin tissue. Cover area with clean sheet or cloth to keep away air. Consult a physician.

SKIN BLISTERED OR FLESH CHARRED: Apply ice cold water to burned area to prevent burn from going deeper into skin tissue. Cover area with clean sheet or cloth to keep away air. Treat victim for shock and take to Hospital.

EXTENSIVE BURN-SKIN BROKEN: Cover area with clean sheet or cloth to keep away air. Treat victim for shock and take to hospital.

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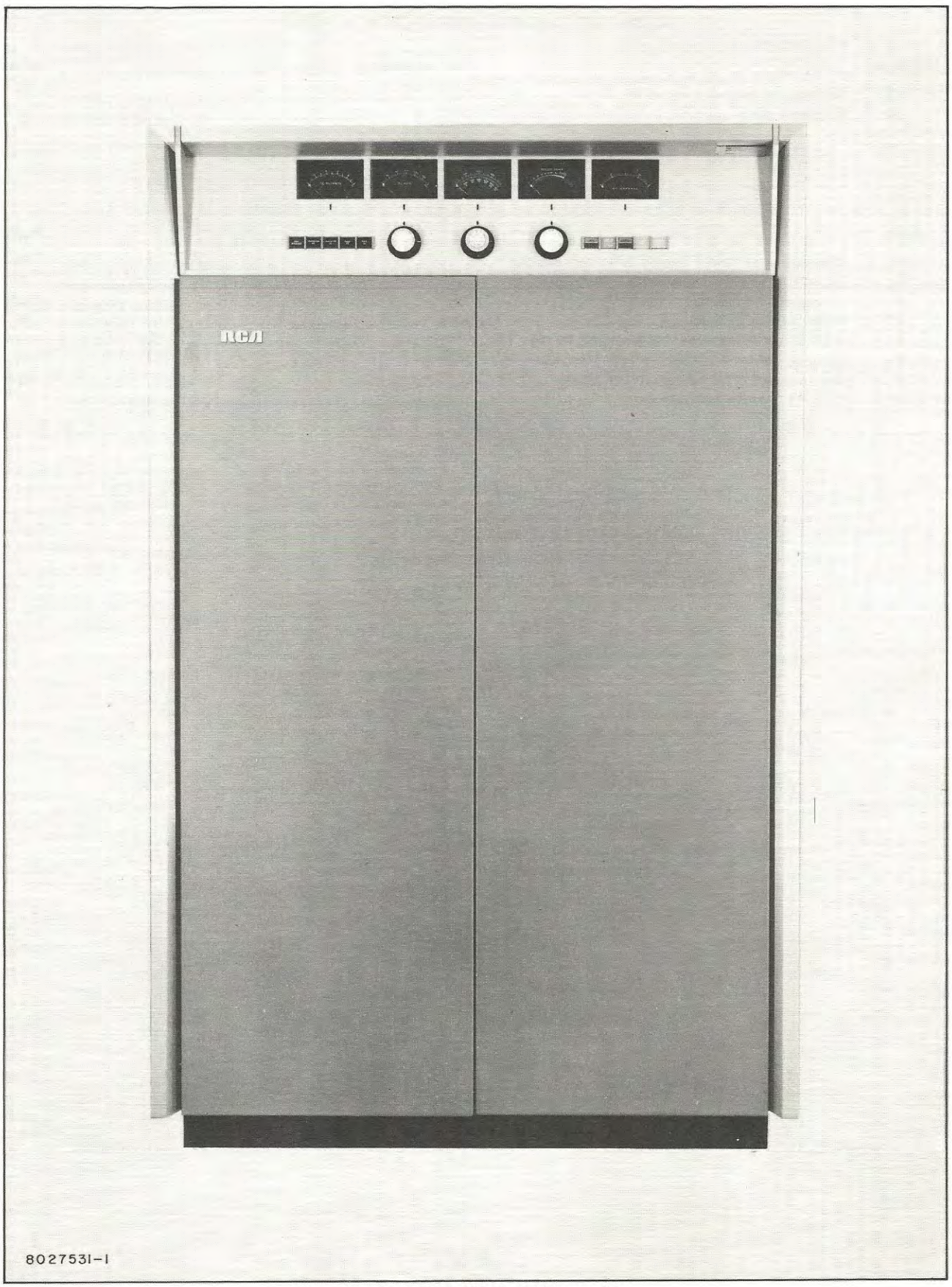


Figure 1. BTF-20E1 20kW FM Transmitter

TECHNICAL SUMMARY

ELECTRICAL SPECIFICATIONS

Type of Emission	F3 and F9
Frequency Range	88 to 108 MHz
Power Output	10 to 20 kW
Output Impedance	50 ohms
Frequency Deviation for 100% Modulation	±75 kHz
Modulation Capability	±100 kHz min.
Carrier Frequency Stability	±1000 Hz max.
Audio Input Impedance	600/150 ohms [1]
Audio Input Level (100% modulation)	+10 ±2 dBm[2]
Audio Frequency Response (30-15,000 Hz)	±1 dB max.[3]
Harmonic Distortion (30-15,000 Hz)	0.5% or less[4]
FM Noise Level (referred to 100% FM modulation)	-65 dB max.
AM Noise Level (referred to carrier voltage)	-50 dB max.
SCA Subcarrier Input Level (30% modulation of carrier)	5 volts max.
SCA Subcarrier Input Impedance	15,000 ohms (approx.)
Pre-Emphasis Network Time Constant	75 or 50 usec, as desired
Main-to-Subchannel Crosstalk	-50 dB[5]
Sub-to-Main Channel Crosstalk	-60 dB[6]

POWER LINE REQUIREMENTS

Transmitter:

Line	240/208 volt, 3 phase, 50/60 Hz
Combined Line Voltage Variation and Regulation	±5%
Power Consumption	36,000 watts (approx.)
Power Factor (approx.)	90%

FM Exciter:

Line	117V/208V/240V ±5% 50/60 Hz
Power Consumption including BTS-1B Stereo Generator and BTX-1B SCA Generator	80 watts

PHYSICAL SPECIFICATIONS

Maximum Altitude	7500 feet
Ambient Temperature Range	-20° to +45°C
Heat Dissipation	16 kW, 910 BTU/MIN, or 4.6 tons of refrigeration

[1] Audio pre-emphasis 75 microseconds (50 microseconds if desired).

[2] Level measured at input jack J1 with 400 Hz tone applied.

[3] Audio frequency response referred to 50 or 75 microsecond pre-emphasis curve.

[4] Distortion includes all harmonics up to 30 kHz and is measured following a standard 50 or 75 microsecond de-emphasis network.

[5] Relative to ±6.0 kHz deviation of the subcarrier by a 400 Hz tone, main channel modulated 70% by 30 to 15,000 Hz tones and 30% by subcarrier, using a narrowband detector.

[6] Relative to ±75 kHz deviation of the main carrier by a 400 Hz tone, subcarrier modulated ±6.0 kHz by 30 to 6000 Hz tones, main carrier modulated 30% by subcarrier, using a narrowband detector.

TECHNICAL SUMMARY (Continued)

Dimensions:

Transmitter:

Width	48-1/4"
Height	77"
Depth	33-1/8"

Power Supply:

Width	32"
Height	49"
Depth	23"

Weight:

Transmitter	1425 lbs. (approx.)
Power Supply	1025 lbs. (approx.)

LIST OF EQUIPMENT

BTF-20E1 20kW FM TRANSMITTER
ES-560602

Quantity	Description	Reference
1	Basic Transmitter	MI-560507
1	Power Determining Kit	MI-560510
1	Blower (do not use on 50 Hz above 3000 ft. altitude)	MI-560347-1
1	Rectifier	MI-560340-2
1	Plate Transformer	MI-560341-1
1	Power Supply	MI-560342-3
1	Set of Side Panels	MI-560373
1	Installation Material	MI-560515
1	Harmonic Filter, selected as follows:	
	88 to 108 MHz – Unpressurized	MI-561506
	88 to 108 MHz – Pressurized	MI-561507
**	BTE-15A Exciter System, Mono	ES-560631
**	BTE-15A Exciter System, Mono and 1 SCA	ES-560632
**	BTE-15A Exciter System, Mono and 2 SCA	ES-560633
**	BTE-15A Exciter System, Stereo	ES-560634
**	BTE-15A Exciter System, Stereo and 1 SCA	ES-560635
**	BTE-15A Exciter System, Stereo and 2 SCA	ES-560636
1	Set of Operating Tubes	ES-560609
*	Set of Spare Tubes (100%)	ES-560609
1	Nameplate	MI-28180A
*	Touch Up Finish Kit	MI-27660C
1	Blower Mounting Kit	MI-560517
1	Frequency Determining Parts, for customer's assigned frequency as follows:	
	ES NUMBER — FREQUENCY	
	ES-560272-1 — 88.1 TO 89.9 MHz	
	ES-560272-2 — 90.1 TO 91.9 MHz	
	ES-560272-3 — 92.1 TO 93.9 MHz	
	ES-560272-4 — 94.1 TO 95.9 MHz	
	ES-560272-5 — 96.1 TO 97.9 MHz	
	ES-560272-6 — 98.1 TO 99.9 MHz	
	ES-560272-7 — 100.1 TO 101.9 MHz	
	ES-560272-8 — 102.1 TO 103.9 MHz	
	ES-560272-9 — 104.1 TO 105.9 MHz	
	ES-560272-10 — 106.1 TO 107.9 MHz	
2	Instruction Book	IB-8027531
2	Instruction Book for BTE-15A FM Exciter	IB-8027524

*Supplied if and as specified on sales order.
**Supply one ES as specified on sales order.

OPTIONAL ACCESSORY EQUIPMENT

Description	Reference
Set of Spare Semiconductors for BTE-15A FM Exciter	MI-560718
Spare Crystal for BTE-15A FM Exciter (Specify channel frequency)	MI-560717-*
BTE-15A FM Exciter	MI-560712
BTS-1B Stereo Generator	MI-560713
Type BTX-1B Subcarrier Generator (Specify SCA Frequency)	MI-560714
5-kHz Filter (required when transmitting stereo and SCA)	MI-560721
Type BTR-11B Remote Control System	MI-27537/ 27538-A
Type BTG-10AL/AR Automatic Logging Equipment	ES-561486/ 561489
Type BW-75A FM Monitor	MI-560735
Type BW-85A FM Stereo Monitor	MI-560740
Type BW-95A SCA and Modulation Monitor	MI-560745

TUBE COMPLEMENT

Symbol	Type	Function
1V101	7203/4CX250B	Driver
1V103	7203/4CX250B	Driver
1V102	4CX15,000A	Power Amplifier

NOTE: Refer to BTE-15A FM Exciter Instruction Book, IB-8027524, for the exciter semi-conductor complement.

INSTALLATION MATERIAL

Item	Qty	Description	Reference
1	2	Arm Assembly (Tuning)	887449-501
2	2	Trimmer Adjusting Tool	86183-502
3	1	Lamp Changing Tool	8535851-1
4	1 set	Wire #14 AWG Black 500 ft.	990820-99
5	1 set	Wire 2/0 Black 15 ft.	2010751-9
6	1 set	Wire #14 AWG 15 kV White 50 ft.	2010853-141
7	1 set	Strap, Copper 1-1/2 – in. Wide, 30 ft. Long	8812985-6
8	1	Connector Coaxial	1510020-103

RECOMMENDED TEST EQUIPMENT

Description	RCA Reference	Other Reference
PA Dummy Load and Thruline Wattmeter	MI-19267-L/H	
Exciter Dummy Load and Wattmeter 0-15/60 Watts		Bird Electronic Corp. Model 611
Audio Generator		Hewlett-Packard Model 206A
Distortion and Noise Meter		Hewlett-Packard Model 331A/334A
Oscilloscope		Tektronix Model 535A/535B
AM Noise Measuring Adapter		McMartin Model AM25
Reducer Cone (3-1/8" dia. coaxial line to type N connector)	MI-19113-C58	
Vacuum Tube Voltmeter (VoltOhmyst)	WV-98C	
Grid-Dip Meter		Measurements Corp. Model 59
One 6 foot length of RG-8/U Cable with type N connectors		

DESCRIPTION

GENERAL

The RCA Type BTF-20E1 20 KW FM Broadcast Transmitter is designed for high-power operation in the standard FM band, 88 to 108 MHz, and is specifically engineered for multiplex service transmission. Except for the high-voltage power supply, the transmitter is housed in a single, modern-styled cabinet.

The BTF-20E1 transmitter employs a compact, self-contained exciter in a circuit that uses capacitive diodes as modulators of an oscillator to produce direct FM. An automatic frequency control (AFC) circuit maintains oscillator frequency to close tolerance. The exciter is well suited for multiplex and stereo as specified by the FCC by virtue of its wide frequency response and extreme stability.

A new feature of the transmitter is the built-in manometer which indicates air filter efficiency and warns of reduced cooling-air supply to the power tubes.

CONSTRUCTION

The BTF-20E1 transmitter is housed in a single, double-door cabinet, in a two-tone blue textured vinyl finish, set off with an aluminum meter panel and trim. Maximum accessibility is afforded by swing-doors on the front and rear of the cabinet. All operating controls and meters used for rapid check of transmitter functions are located on a panel above the front doors. A separate unitized high-voltage power supply may be located anywhere in the FM station.

The BTE-15A FM Exciter (refer to IB-8027524) is mounted on a single chassis and includes a modular stero generator (when specified) and either one or two SCA generators (when specified). The exciter is all solid-state and includes two multimeters for convenience in operating and servicing. The stereo generator module, the SCA generator modules and RF exciter modules are easily removable for servicing or adjustment.

The pushbutton controls located on the panel just above the front doors of the transmitter include: TRANSMITTER ON/OFF, PLATE ON/OFF, OVERLOAD RESET, and POWER RAISE/LOWER. A cabinet disconnect switch, low voltage circuit breaker, filament circuit breaker, and control circuit breaker are located behind the left-hand door. The main and low-power circuit breakers are located on the front of the separate high-voltage power supply cabinet. When servicing the BTF-20E1, operation of the DISCONNECT switch removes all voltages from the transmitter cabinet except the BTE-15A ac supply voltage at terminals 1TB1-13 and 1TB1-14. Personnel are protected by fully interlocked rear doors, in addition to an interlocked door at the front of the rf unit (which contains the driver and PA stages).

Six easy-to-read front panel meters are provided. Two of the meters indicate PA plate voltage and plate current. A third meter reads ac line voltage and supplies a logging indication of driver and PA filament voltages. The multimeter, 1M2, reads grid current, screen current, and screen voltage for both the driver and the PA stage, and cathode current for the driver stage. Reflectometer meter 1M5 reads transmitter power output in percent. 1M5 is actually a meter-relay which activates the "carrier-off" protection circuits incorporated in this transmitter. Reflected power meter 1M7 incorporates a dual scale so that any reflected energy in the output transmission line may be evaluated in terms of VSWR or in terms of percent of incident power. 1M7 is also an optic meter relay.

Cooling air is supplied to the driver and PA stages by means of a blower mounted below the rf unit. Heavy acoustic insulation reduces blower noise to a minimum. A manometer mounted in the front of the transmitter indicates the efficiency of the filter at the inlet to the blower. This device senses the relative air pressure at the fan side of the filter in inches of water. Properly monitored, the manometer indicates when filter clogging has reduced the volume of cooling air supplied to the power tubes.

CIRCUITS

FM Exciter

The BTE-15A FM Exciter system consists of a main frame (chassis), an rf exciter module, a stereo generator module (when used), and one or two SCA generator modules (when used). All circuitry is solid-state.

The frequency modulated oscillator operates at carrier frequency. A buffer stage and a three stage rf power amplifier raises the power level to 15 watts.

The carrier center frequency is precisely controlled through the use of a phase locked AFC circuit which employs integrated circuit frequency dividers. No tuned circuits or adjustments are required with the circuitry used.

An "off-frequency" detector circuit operates a relay which removes transmitter high voltage when the transmitter center frequency error exceeds a preset limit. DOOR INTERLOCKS tallylight 1DS5 will also be extinguished.

Refer to BTE-15A FM Exciter Instruction Book, IB-8027524, for detailed information.

Driver Stage

A block diagram of the BTF-20E1 is shown in figure 2. Two simplified, single-ended amplifiers (operating class "C") follow the exciter. The driver stage consists of two ceramic 7203/4CX250B tetrodes operated in paral-

lel, while the final power amplifier is a type 4CX15,000A tube, which supplies up to 20 KW of power to the antenna feed line. The driver stage is tuned by pi-network input and output circuits. Variable vacuum capacitors are used to tune the rf tank circuits.

Power Amplifier

The power amplifier also used pi-network circuitry. However, the tuning of this stage is accomplished by variable inductors operating at ground potential. The output tube is designed for very high power gain with little drive. The power output is controlled by means of a motor-driven variable transformer connected in the primary of the low-voltage plate power supply for the driver amplifier. The same variable transformer controls the driver and PA screen voltages. A separate grid bias supply, which uses semiconductor rectifiers, provides fixed bias for both the PA and driver stage. An air pressure interlock (1S21) automatically removes power from filament and high voltage circuits when cooling air pressure drops below a preset value (set at factory). The pressure at which power is removed may be varied by means of an adjusting screw provided on the air interlock switch.

Power Circuits

Power circuits are protected by magnetically-tripped circuit breakers in addition to overload relays. An interlocked system prevents turn-on of plate power until all filaments have heated and the exciter has reached a proper operation condition. In addition, a latching relay automatically re-applies power to the transmitter once before locking-out in the event of brief overloads or power interruptions. The overload relays are reset by illuminated pushbutton switches on the front panel. Separate tally-light indicators are provided for overloads in the driver, power amplifier, low-voltage rectifier, carrier-off, and transmission line VSWR monitoring/ protective circuits.

DOOR INTERLOCKS tally-light 1DS5 will light when all interlocks are closed and the transmitter center frequency is within limits.

Rheostat 1R38 makes possible adjustment of driver screen voltage from the front of the transmitter separately (that is, without simultaneous adjustment of other amplifier tube electrode voltages).

Resistors 1R106 and 1R107, together with associated lengths of tubing, form broadly tuned dipoles which dampen VHF resonances in the PA tank circuit.

DC overload relays 1K1, 1K2 and 1K4 act to remove transmitter high voltage and screen voltage in the event of an over-current condition in the high voltage supply, the low voltage supply, or the rf driver stage. Relays 1K5, 1K6, 1K7, 1K18 and 1K19 act as holding relays and maintain tally-lights illuminated after the cause of an overload is removed so that remedial action may be taken, if required. Tally-lights are extinguished upon operation of the OVERLOAD RESET pushbutton 1S17.

Circuit breakers 2S1, 2S2, 1S5, 1S6 and 1S18 provide protection against ac overload conditions. Item 1S4 is not a circuit breaker; it is a switch, supplied to enable the operator to switch off all ac power to the Basic Transmitter rack, MI-560507.

Overcurrent protection of the blower motor is supplied by an overcurrent relay which is supplied as part of blower contactor 1K15. The trip current value is adjustable. In addition, a thermal overload relay (1K22) is used which will de-energize the transmitter low voltage supply in event of medium impedance, but sustained, overloads. Circuit breaker 1S6 affords fast acting protection against short circuit conditions in low voltage supply circuitry.

Protective circuitry is also provided which will remove transmitter plate and screen voltages in the event that:

1. Transmission line VSWR exceeds a preset value, which can be varied by the operator or

2. Power output drops below a preset precentage of nominal, the trip point also selected by the operator.

This affords positive protection against transmitter damage which would be caused by arcing in the transmitter rf circuits or output transmission line, or by a defective antenna. However, the protection circuit must be disabled temporarily in order to calibrate the REFLECTOMETER and reflected power meters.

CAUTION

After calibration or tune-up is carried out, it is mandatory that the reflectometer switch 1S3 be set to the normal position and left at this setting permanently. In any other position of 1S3 the protection circuit is disabled and the transmitter may be subjected to serious damage.

A directional coupler, designated 1Z8, is used in the coaxial line between the exciter unit and the driver stage grid circuit. This directional coupler, used with exciter multimeter M1, makes possible monitoring of reflected power from the driver stage grid circuit. The driver grid circuit may then be adjusted for lowest possible VSWR. in the interstage coaxial line.

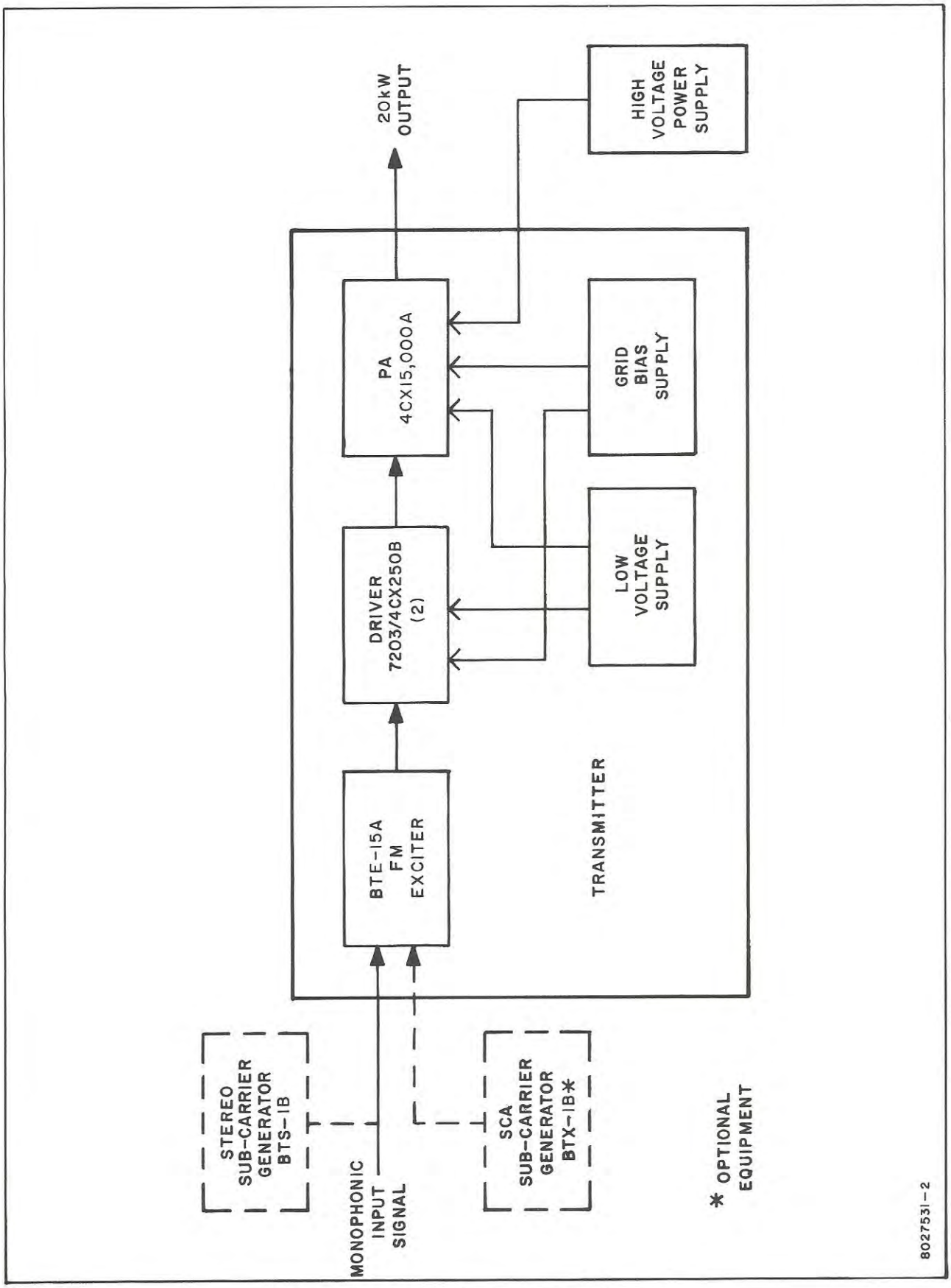


Figure 2. BTF-20E1 Simplified Block Diagram

Optical Meter-Relay Protection Circuits

The "carrier-off" and output transmission line VSWR protection circuitry utilize two optical meter-relays (1M5 and 1M7) in conjunction with a special dual control module (1Z6). The meter relays do not employ contacts. A major advantage of the optical relay is its increased reliability due to the elimination of meter (relay) contacts and the use of solid state electronics in the control module. The optical meter-relay permits positive control of transmitter overload circuitry with very small input energy levels to the meter movement, while providing visual indication of the magnitude of the input signal and easy adjustment of the set point value. Each instrument consists of a precision D'Arsonval meter mechanism with a vane or shutter mounted on the moving element. At set point, the vane shuts off the light (from an internal lamp) to a photo-conductive cell. The resulting change in cell resistance is utilized in external control circuits (partly situated in control module 1Z6, partly in the transmitter control circuits proper) to achieve the desired control action.

The circuitry is fail-safe, i.e., failure of the internal lamp will also shut off the light to the photo-conductive cell and ultimately remove transmitter power. However, lamp failure should not be a problem since the lamps used have a conservatively rated life exceeding 10,000 hours.

The operation of the meter-relay protection circuitry may be explained as follows (refer to figure 36, BTF-20E1 Schematic Diagram and figure 28, 1Z6 Control Module Schematic Diagram). If transmitter power output falls below the set point value, or if output transmission line VSWR rises above the set point value, the optical meter-relay involved activates and operates a relay in control module 1Z6. Two relays are incorporated in the control module – one is controlled by the REFLECTOMETER 1M5, the other by reflected power meter 1M7. Each control module relay has two sets of contacts – one set operates the transmitter overload circuitry, removing transmitter plate and screen voltages – while the other energizes a status light so that the cause of the overload is made apparent. A holding relay (1K18 or 1K19) keeps the overload status light energized until overload reset pushbutton switch 1S17 is depressed.

The module is actuated by a resistance change in the "photo-resistor" arm of an ac bridge within the meter-relay circuitry. Each meter-relay contains a photocell. When light is cut off from the photocell (by a vane attached to the meter movement) at "set-point", the photocell resistance increases sharply. The bridge output phase then reverses, causing the anode and gate voltages of SCR1 (or SCR2) to rise and fall in phase. This "turns on" the SCR and energizes the control relay in series with the SCR. The control relay contacts are connected to turn off the transmitter high voltage.

Two such circuits are employed in each control module. The module also supplies regulated power for the optical meter-relay lamps.

If SINGLE-MULTIPLE switch is set to the MULTIPLE position, the transmitter control circuitry will automatically restore transmitter plate and screen voltages. If the overload condition persists, plate and screen voltages will again be removed. No further recycling will occur until manual reset is carried out by operation of PLATE ON switch 1S9 (or until remotely reset in remotely controlled stations). In the SINGLE position, no recycling will occur. In this case, overload circuits may be reset using either PLATE ON switch 1S9 or OVERLOAD RESET switch 1S17.

Time delay relay 1K20, used in conjunction with auxiliary relay 1K21, disables the added protective circuitry for approximately seven seconds following application of transmitter high voltage. This allows transmitter power output to stabilize at the operating value and prevents spurious operation of the protective circuitry as a result of starting transients.

It will be noted that control voltage (115 volts ac) is fed to control module terminal 1Z6-6 through a normally closed contact of the control module (terminals 1Z6-16 and 1Z6-15). This configuration is used to prevent spurious tripping of the "carrier off" protective circuitry each time the transmitter high voltage is switched off.

CAUTION

It is recommended that the protection circuitry (optical meter-relays) be checked weekly to be certain the protection is operative. Vary the set point adjustment on each optical meter-relay to induce an overload; then reset to normal setting.

Operation of the optical meter-relay protective circuitry is controlled by REFLECTOMETER switch 1S3. This switch functions as follows:

1S3 set to the NORMAL position:

REFLECTOMETER: meter 1M5 indicates transmitter power output in percent. Reflected power meter 1M7 indicates reflected transmission line power in percent of nominal (forward) transmitter power output. A direct-reading VSWR scale is also included. The transmitter "carrier-off" and VSWR protective circuits are effective in this position.

This is the *normal* operating position.

1S3 set to the DISABLE position:

Conditions are the same as described for the

NORMAL position, except that the "carrier-off" and VSWR protective circuitry is *disabled* in this position. This position is used for transmitter tuning and adjustment.

1S3 set to the VSWR CAL position:

REFLECTOMETER meter 1M5 is switched out of the circuit and reads zero. Reflected power meter 1M7 is connected through VSWR calibration control 1R10 to the directional coupler which responds to incident power. "Carrier-off" and VSWR protective circuitry is disabled in this position. This position is used for *calibration* of the reflected power meter.

CAUTION

REFLECTOMETER switch 1S3 must be set to the NORMAL position at all times except during transmitter tuning and adjustments. If this precaution is not observed, damage to the transmitter may occur.

Remote metering connections are provided at terminal board 1TB1, with remote power output connection to be made at 1TB1-11 and 1TB1-12. Directional coupler 1Z7 samples output transmission line incident energy and supplies a dc output for remote power monitoring purposes.

The BTF-20E1 is furnished with a 6-1/8 inch diameter harmonic filter as standard equipment to keep spurious emissions to a minimum. The filter consists of a series of transmission line elements with a uniform outer diameter conductor, a stepped inner conductor, and a shunt stub. The conductors are fabricated of a high-grade copper alloy. Attenuation of all harmonic radiation above channel limits is accomplished in an "M-derived" section, and a series of "constant-K" T-sections. This design provides a broad passband with a sharp high-frequency cut-off and excellent attenuation of frequencies above the passband.

Two versions are available. One, designated as MI--561506, is not pressurized. The other, MI-561507, is pressurized to allow mounting beyond the gas stop.

Remote Control

Remote control provisions are included in the transmitter and terminals are provided for use with remote control units such as the type BTR-11B (or BTR-20D/20DT) and BTG-10AL/AR Automatic Logging Equipment. Additional terminals are provided for remote control of TRANSMITTER ON, TRANSMITTER OFF, PLATE ON, PLATE OFF, POWER RAISE, POWER LOWER, and OVERLOAD RESET functions. Remote metering connections for final amplifier plate current, plate voltage, and power output are also provided.

INSTALLATION

GENERAL

Basic steps in the installation of the BTF-20E1 transmitter consist of planning the equipment layout and making provisions for transmitter room power and light, transmission line runs and connections to the equipment. The units can then be unpacked, assembled and wired as specified in these instructions. Space for items not supplied, such as auxiliary input equipment, or line dehydrating units, should not be overlooked in the planning. Before locating the transmitter, reference should be made to the instruction books supplied with these equipments.

NOTE: The instructions contained in this book are not intended to supersede applicable local codes. On points where conflict is evident, the local code should be followed.

A harmonic filter is supplied with the BTF-20E1 transmitter, and is designed to effectively attenuate second through seventh harmonic radiations from FM transmitters. (Normally an unpressurized filter is supplied; however, a pressurized filter is available.) The filter is constructed of coaxial transmission lines and is the reflective type, i.e., the rejected energy is not absorbed. The filter is inserted in the transmission line at the top of the transmitter.

In selecting a location for the transmitter, care should be taken to allow sufficient space for the filter which is approximately 11 feet in length.

The room in which the transmitter is installed should be well ventilated and provided with an abundant supply of clean, dry air. The maximum ambient temperature for proper operation is given in the Technical Summary. If an air-exhaust hood and duct arrangement is to be used with the transmitter, it should be designed and assembled so that minimum back pressure is developed. An exhaust fan with a minimum capacity of 5000 CFM should be used in the exhaust system. A transmitter room lay-out can be prepared by reference to the floor plan diagram, figure 3, which gives the overall dimensions of the equipment. A minimum clearance of 24

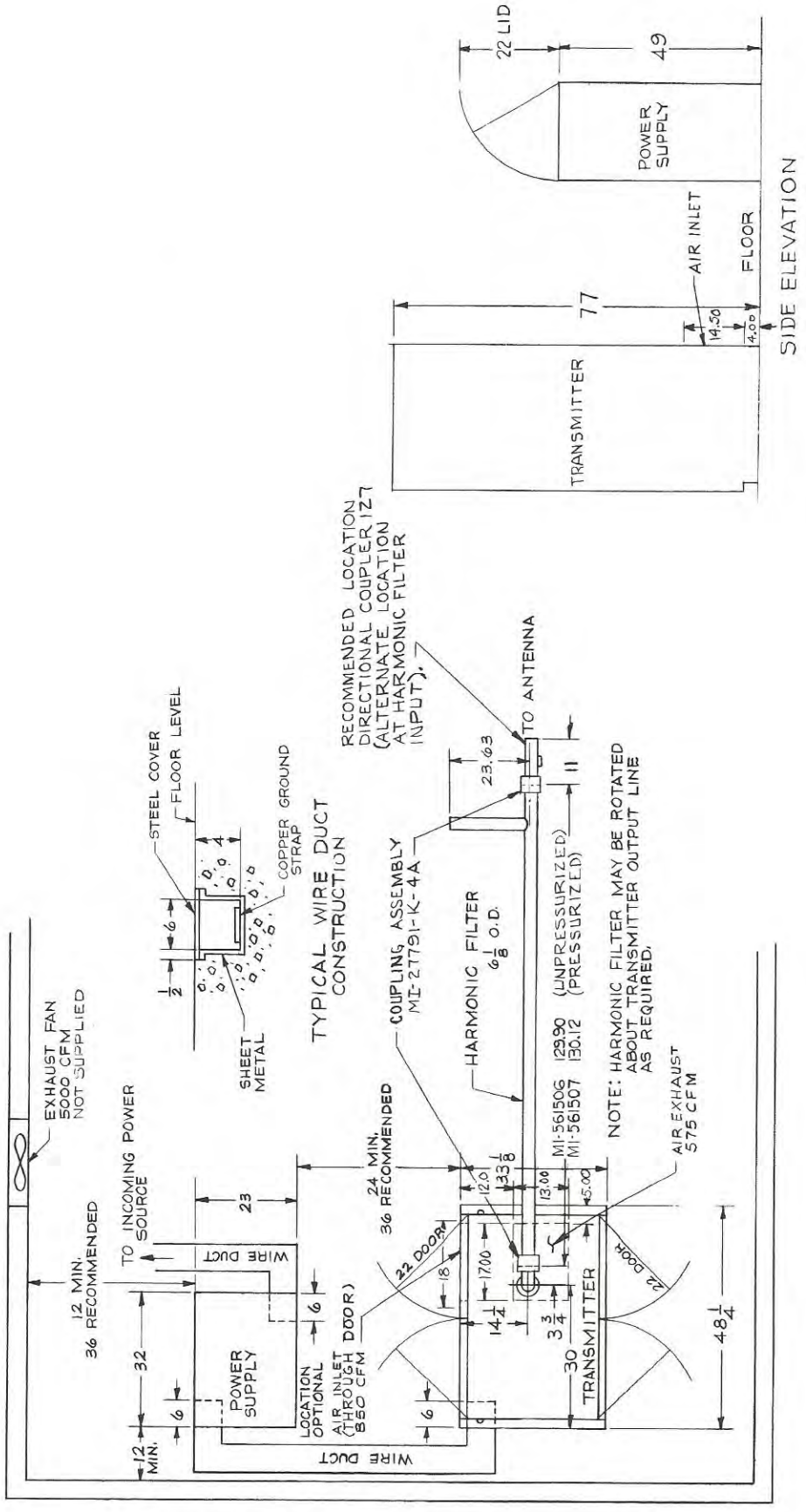


Figure 3. BTF-20E1 Typical Floor Plan

inches for the opening of doors is required at the front of the transmitter, and a similar space should be provided at the rear for access to transmitter components and circuits. Floor ducts can be installed for power wiring and remote control inter-connection (if desired), or conduit may be run overhead to the transmitter wire duct at the top of the cabinet. If wiring is to be placed in floor ducts, they should be laid out so that cables can leave the duct and enter notches provided in the side panels. Notches are provided at both the top and bottom of the side panels for flexibility.

UNPACKING

An understanding of the shipping system will be of assistance in unpacking the equipment and locating items. Each RCA equipment is accompanied by a shipping voucher which lists the complete contents of the shipment by "Equipment Schedule" or "ES" numbers and "Master Item" or "MI" numbers. This shipping voucher is usually packed in one of the smaller cardboard cartons, appropriately marked. Where there are two or more packages to a major item, the package containing the MI list is identified by stenciling.

The complete equipment for the BTF-20E1 FM Transmitter is listed on ES-560602 which references the major items of the shipment and their MI number.

The equipment should be carefully unpacked and inspected to make certain that no damage has been incurred during shipment. Any damage or shortages should be reported immediately to RCA and to the transportation company so that lost or damaged material can be recovered. Tubes should not be unpacked until all equipment is installed and all preliminary adjustments have been made.

ASSEMBLY

General

Reference should be made to the illustrations which will aid in the assembly of the transmitter and in the installation of the items removed for shipping: 1L3, high-voltage filter reactor; 1Z7, directional coupler for remote power monitoring; one coupling, MI-27791-K-4A (used to mount 1Z7 in output transmission line); one transmission line elbow with monitor assembly and two adjustable clamps attached; and a length of shielded jacketed wire, used to connect the dc output of 1Z7 to transmitter circuitry.

Note that directional coupler 1Z7 is not provided with pressurized fittings. If a pressurized harmonic filter is used, 1Z7 must be installed in the line between the transmitter and harmonic filter. During installation of 1Z7, it will be necessary to assemble the connector cap assembly (see figure 4) and install the dc output lead, supplied as part of Power Determining Components, MI-560510. The dc output lead is then connected at terminal 1TB1-11 (located at the top of the basic transmitter rack, MI-560507), with the braid grounded.

The high-voltage power supply can be located in any convenient place in the station, preferably reasonably close to the incoming power line. This will reduce the amount of high current wiring that will be needed. After a location for the power supply has been chosen, place the high-voltage plate transformer 3T1 in this position and fasten it to the floor. The power supply cabinet is then moved into position over the transformer. This is easily done by removing the lower rear and front sections of the cabinet and sliding it into place over the transformer. Ensure that the cabinet is centered over the transformer and then fasten the cabinet securely to the floor.

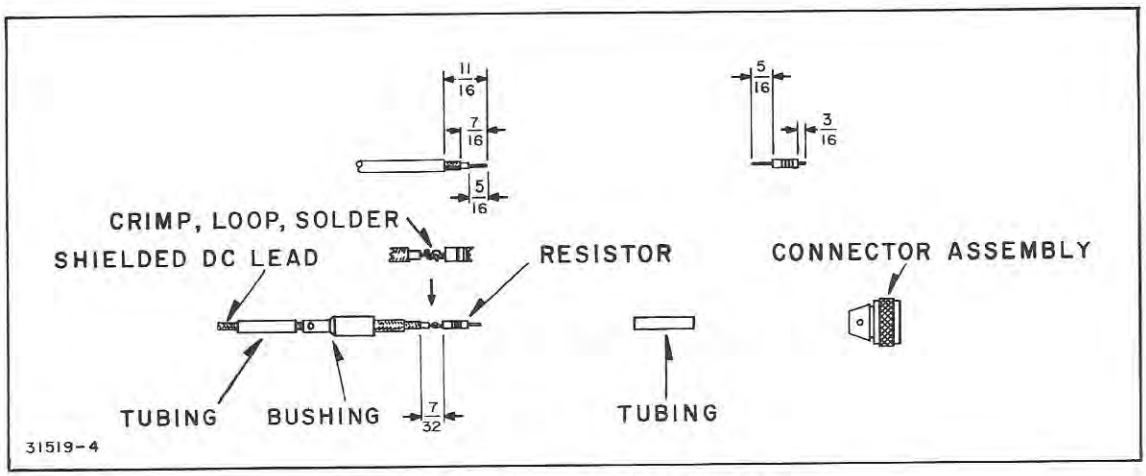


Figure 4. 1Z7 Connector Cap Assembly

Assembly of 1Z7 Connector Cap

The cap assembly supplied with the coupler consists of a connector, bushing, resistor and two lengths of tubing. These parts must be attached to the shielded dc indicator lead as illustrated in figure 4. The following procedure is recommended when assembling the connector cap.

1. Strip the shielded dc indicator lead as shown in figure 4.

2. Trim the resistor leads to the dimensions given.

3. Slide the longer section of tubing and bushing onto the shielded dc indicator lead.

4. Loop, crimp and solder the resistor to the center conductor of the shielded cable.

5. Position the shorter section of tubing over the resistor and solder the connection.

6. Solder the remaining resistor lead to the connector assembly terminal.

7. Seat the bushing in the connector body and tighten the set screw.

8. Solder the shielding (outer conductor) of the indicator lead to the bushing through the holes in the bushing.

9. Position the rubber tubing over the end of the bushing.

The silicon rectifier assembly (figure 35) should be removed from the power supply cabinet before the tuning procedure is begun. This can be done by disconnecting the rectifier negative lead at jack 2J1 and pulling up on each side of the rectifier assembly, which is mounted on five banana jacks. If, when replacing the rectifier assembly it seems to fit tight, reach under the cabinet shelf and, with an Allen type screwdriver, loosen the screws holding the insulators. Now push the assembly down onto the jacks, causing them to assume the proper positions, and retighten the screws.

HARMONIC FILTER INSTALLATION

Install the harmonic filter, as determined by the building layout (a horizontal mounting position is recommended). The filter should be located in a position which permits a reasonable amount of ventilation. Under no circumstances should the unpressurized (MI-561506) filter be located out of doors where "breathing" of the unit, due to temperature changes, may lead to condensation.

The pressurized version, MI-561507, makes possible mounting outdoors or indoors beyond the gas stop.

When installing the harmonic filter, keep in mind the clearances necessary for the various size transmission line inner and outer conductors. A clearance of 1/8 inch must be allowed for each joint in all outer conductors. Inner conductors of 3-1/8 inch lines require a clearance of 3/16 inch at each joint, while inner conductors of 1-5/8 inch lines require a clearance of 1/8 inch at each joint. Ascertain that the harmonic filter is adequately supported from the ceiling to avoid excessive strain on the output line.

Once installed, the harmonic filter is ready for operation since it requires no tuning or adjustment.

RF MONITOR ASSEMBLY

To install the RF Monitor Assembly position the rf pickup saddle assembly over the hole in the side of the elbow above the reflectometer so that the rf pickup coil enters the hole without touching the sides. Position and secure the saddle clamps around the elbow. The items involved are supplied as part of Power Determining Components, MI-560510.

> **NOTE:** The rf pickup coil may be positioned for best signal pickup by removing the four screws which hold the coaxial connector in place, then rotating it in either direction for maximum pickup (consistent with alignment of mounting holes). If necessary, the pickup coil may be altered by removing or adding turns to obtain the required signal.

Mount the elbow, with rf pickup monitor assembled, at the transmitter output, at the top of MI-560507.

EQUIPMENT WIRING

General

The equipment wiring consists of first providing an adequate ground system, then making the necessary transmitter cabinet and power supply cabinet connections, and finally, connections to any remote control equipment that may be used.

> **NOTE:** Prior to application of power, all connections should be checked for tightness. The high voltage and current present can damage transmitter components by arcing or heating at loose connections. A properly installed transmitter will be easier to set-up and maintain. The process of checking for tight connections provides the opportunity

to familiarize the operator with the transmitter and also to double-check that the transmitter is properly assembled and wired.

Equipment Grounding

Great care should be taken to provide an adequate ground system for the BTF-20E1. Before power is applied to the equipment the following ground connections must be completed.

Connect the power supply cabinet to the main transmitter cabinet using 1-1/2 inch wide copper strap (item 7 of Installation Material, MI-560515). This connection should be made from ground no. 2 in the power supply cabinet (a stud mounted on the side of the cabinet below the rectifier mounting shelf) to a hole in one of the copper-flashed side channels in the main transmitter rack.

Connect the main transmitter cabinet to the station ground using 1-1/2 inch wide copper strap (MI-560515 item 7). It is also advisable to connect the power supply cabinet to the station ground using 1-1/2 inch wide copper strap or equivalent.

After the above connections have been completed, check each ground connection for mechanical strength and continuity. If any soldered joints are involved, each should be tested for mechanical strength as well as continuity.

Equipment Connections

Make the necessary connections between the transmitter cabinet and the power supply cabinet, referring to figures 34, 36, 37, 41, 42 and to table 1. Use item 4 of Installation Material, MI-560515, for all connections.

Connect jack 2J2 in the power supply cabinet to 1TB1-101, the high-voltage terminal in the upper right hand corner of the transmitter cabinet (viewed from the rear), using high voltage wire, item 6 of MI-560515.

In the power supply cabinet connect contactor 2K1 to the primary of transformer 3T1 using high-current wire, item 5 of MI-560515.

Also in the power supply cabinet, connect the secondary of transformer 3T1 to silicon rectifier jacks 2J4, 2J5, and 2J6 using item 6 of MI-560515.

Connect 208/240 volt 3-phase input to terminals 1, 2, and 3 of circuit breaker 2S1 in the power supply cabinet and 117 volt single-phase BTE-15A ac power input to terminals 1TB1-13 and 1TB1-14 in the transmitter cabinet. The BTE-15A FM Exciter System may be connected for 117 volts, 208 volts, or 240 volts, single-phase, operation; however, the exciters are normally supplied connected for 117 volts. Refer to the exciter instruction book, IB-8027524, for detailed information on changing connections for various line voltages. Wire for these connections is not supplied. Check that all connections are mechanically tight. The protective safety shield, which normally prevents contact with the circuit breaker terminals, is removed during this step. The shield must be replaced after completion of this step.

TABLE 1. TRANSMITTER/POWER SUPPLY INTERCONNECTIONS

From Power Supply Terminal	To Transmitter Terminal
2TB1-1	1TB1-1
2TB1-2	1TB1-2
2TB1-3	1TB1-3
2TB1-4	1TB1-4
2TB1-5	1TB1-5
2TB1-6	1TB1-6
2TB1-7	1TB1-7
2TB1-8	1TB1-8
2TB1-9	1TB1-9

Remote Control Connections

The BTF-20E1 Transmitter may be remotely controlled by means of a BTR-11B or BTR-20D/20DT accessory Remote Control System. This system consists of an MI-27538-A Transmitter Control Unit and an MI-27537 Studio Control Unit for the BTR-11B System and the MI-27526B Transmitter Control Unit and the MI-27539-C Studio Control Unit for the BTR-20D/20DT system. The BTR-11B or the BTR-20D/20DT may be connected directly to terminals in the BTF-20E1 to provide the remote control and remote meter reading functions shown in table 2. Designated terminals will be found on the 1TB1 terminal board located at the top of the transmitter cabinet and on the 1TB2 terminal board located on the sidewall of the cabinet, and are indicated on the overall schematic diagram. All metering positions are designed to deliver approximately 1 volt into 5000 ohms.

NOTE: REFLECTOMETER switch 1S3 should be left in the NORMAL position when the transmitter is remotely controlled.

Remote control of tower lights can be accomplished by utilizing a Tower Lighting Unit (MI-27519). Remote reading of the frequency and modulation monitor is accomplished by placing the monitor in the studio, and feeding it an off-air signal through an antenna and rf preamplifier, which are also available as accessories.

TABLE 2. REMOTE CONTROL CONNECTIONS

Remote Control Function	Terminals
Transmitter ON	1TB2-22, 1TB2-23
Transmitter OFF	1TB2-21, 1TB2-23
Plate OFF	1TB2-24, 1TB2-25
Plate ON	1TB2-30, 1TB2-26
Overload Reset	1TB2-24, 1TB2-27
Power Output-Raise	1TB2-24, 1TB1-15
Power Output-Lower	1TB2-24, 1TB1-16
Modulation Mode	
Left Remote	1TB6-15
Right Remote	1TB6-16
Stereo Remote	1TB6-17
Ground; Common	1TB6-18
SCA Mute	
SCA Mute	1TB6-5
Muting Ground	1TB6-6
Remote Meter Reading Function	Terminals
PA Plate Voltage	1TB1-10 (+), 1TB1-6 (-)
PA Plate Current	1TB1-6 (+), 1TB1-9 (-)
Power Output	1TB1-12 (+), 1TB1-11 (-) (remove jumper)
Exciter Final Current	1TB6-3 (+), 1TB6-4 (-)

After completion of wiring, check all connections for accuracy, continuity and mechanical strength.

Transformer Primary Taps

The primaries of the filament and plate transformers are provided with taps which permit operation of the equipment over a wide range of ac line voltages (refer to table 3). Measure the source line voltage and, if necessary change the transformer primary connections to those designated for operation at the voltage closest to that measured. The primary taps are identified on the schematic diagram and figure 41.

WARNING

Before making power circuit connections, all switches and circuit breakers should be in the OFF position. Possible injury to personnel or equipment damage may result due to accidental application of power during installation.

TABLE 3. TRANSFORMER PRIMARY TAPS

Transformer Symbol	Range of Line Voltage					
	197 – 202.5	202.5 – 213.5	213.5 – 224	224 – 234.5	234.5 – 245.5	245.5 – 251
1T1	-11 and 208	0 and 208	+11 and 208	-11 and 240	0 and 240	+11 and 240
1T2	-11 and 208	0 and 208	+11 and 208	-11 and 240	0 and 240	+11 and 240
1T3	Factory Wired, No Tap Changes Required					
1T4	Factory Wired, No Tap Changes Required					
1T5	Factory Wired, No Tap Changes Required					
1T6*	-11 and 208	0 and 208	+11 and 208	-11 and 240	0 and 240	+11 and 240
1T7	-11 and 208	0 and 208	+11 and 208	-11 and 240	0 and 240	+11 and 240
1T8	H3 and H4	H2 and H4	H1 and H4	H3 and H5	H2 and H5	H1 and H5
	Make Secondary Connections for 1T8 to X1 and X3					
3T1*	-11 and 208	0 and 208	+11 and 208	-11 and 240	0 and 240	+11 and 240

* Leave primaries disconnected until initial steps of tuning procedure have been completed.

OVERLOAD RELAY ADJUSTMENT

Adjustment of trip setting of overload relays 1K1, 1K2 and 1K4, located on the control panel behind the left-hand door, is carried out at the factory. However, the following adjustment procedure is given for use in the event that it may be necessary to adjust the sensitivity of these relays, so that they will pull-in at the current specified for each relay as shown in table 4.

This can be accomplished by the use of an ammeter of the proper range and a dc supply which is adjustable from 0.5 to 1.5 volts and capable of delivering 6.0 amperes. An "A" battery, such as an RCA Type VS006C used with a series rheostat of between 5 and 10 ohms maximum resistance is a convenient supply for making this adjustment. When adjusting 1K2, change to a series rheostat of approximately 1 ohm, if available. Remove the relay covers and, with the rheostat set for maximum resistance, connect the supply across the coil of the relay to be adjusted, with the ammeter connected in series. Slowly decrease the resistance to obtain the current

reading given in table 4. Adjust the spring tension on the relay so that it just pulls in at the specified current. After adjustment, decrease and increase the current several times to check for proper operation. Replace the relay covers after adjustments have been completed.

TABLE 4. OVERLOAD RELAY SETTINGS

Relay	Circuit	Pull-In Current
1K1	L V Rectifier	1.5 amp.
1K2	PA Plate Current	5.0 amp.
1K4	Driver Cathode Current	0.6 amp.

BLOWER CONTACTOR 1K15 OVERLOAD RELAY ADJUSTMENT

The overload relay portion of 1K15 is normally tested and shipped set for manual reset operation only. This is done to avoid accidents which could possibly occur if the relay should operate (shutting down the transmitter), and then automatically recycle, energizing transmitter circuitry while operating personnel are investigating the cause of interruption.

However, the relay can be adjusted for automatic reset by tightening down the screw located next to the manual reset button. The automatic reset option will be found useful in remotely controlled stations.

If it should be necessary to change the trip setting of 1K15 the following procedure may be followed:

1. Remove the snap-on cover which covers the overload relay portion of the 1K15 assembly.

2. Adjust the variable trip setting dial to the desired value. A setting of 5.0 amperes is recommended in BTF-20E1 transmitters.

3. Replace the snap-on cover.

DRIVER AND PA TUBE INSTALLATION

Insert the 7203/4CX250B tubes and the PA tube in their respective sockets.

> **NOTE:** Care should be exercised to ensure that the PA tube and socket are properly aligned before tube insertion is carried out.

The fit of the PA tube in its socket is tight and special attention should be given to its installation to ascertain that it is properly seated. Proper seating can be determined by observation; the screen grid ring will be hidden by the screen collet when the tube is properly seated (refer to figures 17, 18 and 21).

After insertion of the driver tubes, the plate rings are slipped over the tubes and tightened with the screw provided (refer to figures 18 and 20).

CAUTION

> Do not operate the transmitter without tightening the plate rings. Failure to do so may cause the screen current to become excessive with possible damage to the driver tubes.

CONTROL CIRCUIT CHECK

WARNING

> All circuit breakers should be initially set to the OFF position.

To ensure that all connections have been made correctly the following control circuit checks should be made before applying plate and screen voltages to the transmitter. (See figures 5 and 11 which show the transmitter controls and indicators utilized in the following procedures).

1. Disconnect the high voltage rectifier negative lead at jack 2J1 and remove the rectifier assembly from the high voltage power supply cabinet.

2. Disconnect the primary connections to transformers 1T6 and 3T1 and tape wires to prevent short circuits. Disconnect the primary connections to transformers 1T1 and 1T2, taping leads as before.

CAUTION

> When disconnecting the primary leads to transformers 1T1 and 1T2, note that in cases where two leads are removed from a transformer terminal, the leads involved should be temporarily connected using a bolt, nut and lockwasher. In this way, "through" connections to other circuitry are preserved.

3. Operate the following circuit breakers (and switches) to the ON position: MAIN breaker 2S1 and LOW POWER breaker 2S2 on the power supply cabinet, and DISCONNECT switch 1S4, FILAMENT breaker 1S5, and CONTROL breaker 1S18 on the transmitter cabinet. (CONTROL breaker 1S18 is located behind the front panel directly above the FM exciter.)

4. Rotate AC VOLTAGE switch 1S1 to PHASE 1, PHASE 2 and PHASE 3 positions and read the voltages on AC VOLTAGE meter 1M1. The three indications should be well balanced.

5. Set the REFLECTOMETER switch 1S3 to the DISABLE position.

6. Depress TRANSMITTER ON pushbutton 1S7 and PLATE OFF pushbutton 1S10. Relays 1K16 (transmitter on-off), 1K15 (blower), and 1K12 (filament) should energize, blower 1B2 (and cooling fan 2B1) should operate, and TRANSMITTER ON indicators 1DS6 and 2DS2 should light. In addition, air interlock switch 1S21 should close. Check the direction of rotation of blower 1B2. If the direction of rotation is incorrect, and a three phase blower is supplied, depress TRANSMITTER OFF pushbutton 1S8 and operate DISCONNECT switch 1S4 to OFF. Reverse the direction of rotation of the blower by reversing the connections to terminals 1TB4-1 and 1TB4-2. Operate 1S4 to ON and depress 1S7. Blower 1B2 should now rotate in the proper direction, closing air interlock switch 1S21.

WARNING

With FILAMENT circuit breaker 1S5 closed and the TRANSMITTER ON pushbutton operated, power is applied to the PA bias supply. Since this supply is not interlocked, caution should be exercised when making adjustments in the area of the bias supply.

7. Relay 1K13 should start timing and after approximately 45 seconds its contacts should close.

8. Depress and hold POWER RAISE pushbutton 1S11 and note that variable transformer 1T5 rotates in the clockwise direction (looking down). Depress and hold POWER LOWER pushbutton 1S12 and note that transformer 1T5 rotates in the counterclockwise direction. Leave 1T5 in the extreme counterclockwise position.

9. Depress TRANSMITTER OFF pushbutton 1S8 and note that blower 1B2 continues to operate for approximately two minutes and then shuts off.

10. Depress TRANSMITTER ON pushbutton 1S7 and after a period of time check ELAPSED TIME meter 1M6 to make sure it is operating.

11. Close the rear doors, rf unit door, meter panel and power supply cover and note that DOOR INTERLOCKS indicator 1DS5 lights. Open the interlock switches one at a time and note that indicator 1DS5 goes out as each is opened.

12. Disable the FM exciter AFC function. Manually change exciter center frequency until the off-frequency relay operates. Note that 1DS5 goes out. Return exciter to normal operation. 1DS5 should light again.

13. Check the operation of grounding switches. 1S19, 1S20, 1S102 and 2S4. There should be no evidence of erratic operation.

14. Place TRIP switch 1S13 in the SINGLE position and depress PLATE ON Pushbutton 1S9. Plate On-Off relay 1K11 should operate to the ON position, energizing high voltage plate contactor 2K1 and low voltage contactor 1K9. PLATE ON indicators 2DS1 and 1DS4 should light.

15. Checkout of VSWR and Carrier-Off protection circuits is carried out after completion of transmitter tuning.

16. Remove the covers from overload relays 1K1, 1K2 and 1K4. Operate 1K1 manually by depressing the armature with an insulated rod and note that contactors 1K9 and 2K1 drop out and L.V. RECT. OVERLOAD indicator 1DS1 lights. Depress O.L. RESET pushbutton 1S17; indicator 1DS1 should go out and 1K9 and 2K1 should pull in again. Repeat this procedure by operating 1K2 and 1K4 and note that POWER AMP. OVERLOAD indicator 1DS2 and DRIVER OVERLOAD indicator 1DS3, respectively, should light.

17. Place TRIP switch 1S13 in the MULTIPLE position and again operate 1K1 manually. Contactors 1K9 and 2K1 should drop out and after approximately one-half second they should pull in again. L.V. RECT. OVERLOAD indicator 1DS1 should light and stay lighted. Operate 1K1 a second time. This time 1K9 and 2K1 should drop out and stay out and indicator 1DS1 should stay lighted. Depress PLATE ON pushbutton 1S9; 1K9 and 2K1 should pull in again and indicator 1DS1 should go out.

18. Depress PLATE OFF pushbutton 1S10 and TRANSMITTER OFF pushbutton 1S8. Operate DISCONNECT switch 1S4 to OFF.

19. Reconnect the primary connections to transformers 1T1 and 1T2. This restores filament power to the driver and PA when the transmitter is turned on.

20. Operate DISCONNECT switch 1S4 and FILAMENT circuit breaker 1S5 to ON, then depress TRANSMITTER ON pushbutton. Open the door of the rf unit and with an accurate ac voltmeter measure the filament voltage of the PA tube at its socket. If air interlock 1S21 operates (opens its contacts), temporarily connect a jumper across its contact terminals. Remove the jumper after completion of adjustment of driver stage filament voltage.

21. Rotate AC VOLTAGE switch 1S1 to the PA FIL. position, and adjust FILAMENT control 1T4 for a filament voltage of 6.3 volts. Note the reading of AC VOLTAGE meter 1M1. For optimum tube life the PA FILAMENT reading of meter 1M1 should be maintained at this value.

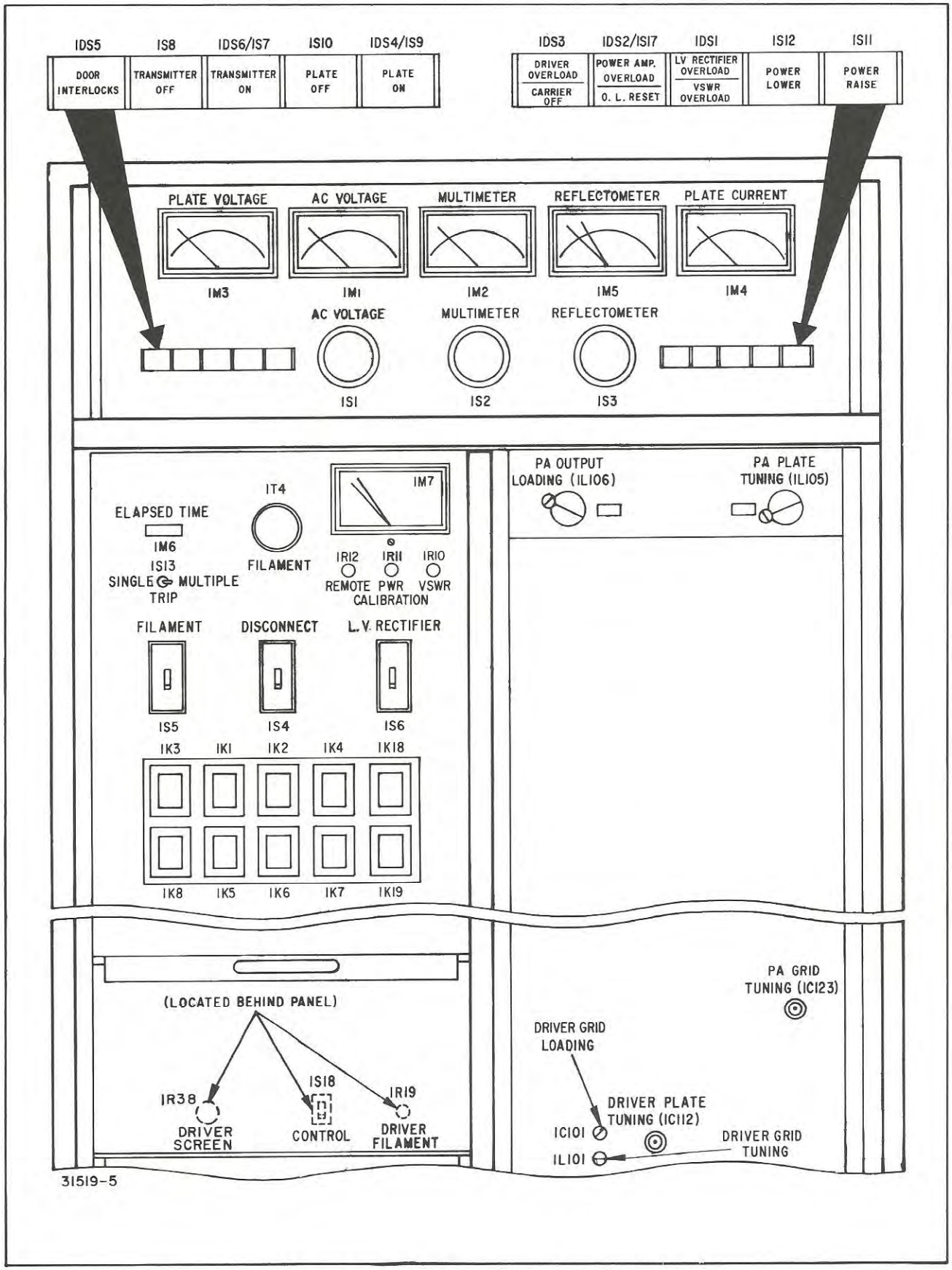


Figure 5. BTF-20E1 Controls and Indicators

22. In a similar manner, measure the filament voltage of each one of the 7203/4CX250B tubes at the socket. Rotate AC VOLTAGE switch 1S1 to the DRIVER FIL. position, and adjust DRIVER FILAMENT control 1R19 for a filament voltage of 6.0 volts on the external ac voltmeter. (The DRIVER FILAMENT control is located behind the front panel directly above the FM exciter.) Note the reading of AC VOLTAGE meter 1M1. For optimum tube life the DRIVER FILAMENT indication of meter 1M1 should be maintained at this value.

Measure PA grid bias at feed-thru capacitor 1C114 located at the rear of the rf unit. With fixed bias only (no grid current), the indication should be approximately 240 volts, with negative polarity.

23. Check driver grid bias at feed-thru capacitor 1C106 located at the side of the rf unit. This measurement should indicate a (fixed) bias of approximately -28 volts.

TUNING

GENERAL

The initial tuning procedure consists of checks to be made on the FM exciter and multiplex generator(s), adjustment of the driver stage, adjustment of the PA circuit and reflectometer calibration. The BTE-15A FM exciter, the BTS-1B stereo generator, and the BTX-1B SCA generator(s) are factory tuned and aligned. Instructions for tuning the exciter and multiplex units are contained in the instruction book supplied with these units, for use in those cases where readjustment should become necessary. For specific items of test equipment required for tuning, refer to the RECOMMENDED TEST EQUIPMENT list contained in the front of this book.

WARNING

Prior to performing the tuning procedures, ensure that the primary connections of transformers 1T6 and 3T1 are disconnected and that the high voltage rectifier is removed from the power supply cabinet.

EXCITER TUNING

1. Check that exciter power plug 1P11 is connected to the exciter ac input connector (twist-lock type). Connect exciter line power (normally 117 volts) to transmitter terminals 1TB1-13 and 1TB1-14.

2. Terminate the exciter with a small 50 ohm dummy load and wattmeter (see recommended test equipment list).

3. The BTE-15A includes an ac power line circuit breaker/switch. This circuit breaker is located near the top of the exciter, inside the exciter main frame. Open the exciter power supply access door and set the breaker/switch to the ON position.

4. Set the RF OUTPUT switch on the BTE-15A to the ON position. Depress TRANSMITTER ON pushbutton 1S7 and PLATE OFF pushbutton 1S10. Note that due to the use of exciter relay K101, there will be no exciter power output unless the TRANSMITTER ON pushbutton is depressed.

5. With the exciter RF POWER ADJUST control set fully clockwise, the exciter power output should be 15 watts or more. If exciter operation is not normal, retune or service the exciter in accordance with the FM exciter instruction book.

6. Remove exciter power temporarily and connect the exciter output cable to directional coupler 1Z8 (connector marked "load"). Connect 1Z8 (connector marked "transmitter") to driver input jack 1J101, using short jumper cable supplied.

DRIVER GRID TUNING

1. Check to ascertain that the driver input (grid) circuit components are the proper ones for operation of the driver stage as a straight-through amplifier. Inductor 1L101 should be a 5-1/4 turn coil on a slug tuned form, with taps. There should not be any fixed capacitance in parallel with 1C101. Before starting the subsequent tuning procedure, connect the straps to inductor 1L101 such that 4 turns are in use initially. If necessary, this adjustment may be changed during the tuning procedure.

2. Restore exciter power output. Rotate driver input loading capacitor 1C101 to its midposition. Adjust driver input tuning variable inductor 1L101 for a maximum reading on MULTIMETER 1M2 with MULTIMETER switch 1S2 in the DRIVER I_G position. If no indication of resonance is obtained, the position of the tap on 1L101 should be changed.

3. Set the EXCITER MULTIMETER switch to the EXTERNAL METERING position. With this setting, the indication on exciter meter M101 is a measure of

reflected energy in the coaxial line between exciter output and transmitter input jack 1J101. Note the reading on M101. The VSWR in this line should now be minimized by using the following procedure:

a. Make a small change in the setting of 1C101 in the direction of less capacitance. Reset 1L101 for maximum driver grid current. If the reflected energy indication is less than the initial value, and there is no significant change in grid current, this procedure should be repeated until the VSWR is optimized. If the reflected energy indication is higher than the initial value, adjust 1C101 in the direction of more capacitance and proceed as described above. If necessary, use a different number of turns on inductor 1L101. The driver grid current should be approximately 5 mA with the RF POWER ADJUST control fully clockwise. Depress the TRANSMITTER OFF pushbutton.

DRIVER TUNING

1. It is recommended that a grid dip meter be used for initial tune-up of all rf circuits in the transmitter. This assures that the circuits are reasonably close to proper adjustment before any power is applied, thus minimizing the chance of overloading of tubes or components.

2. With coil 1L109 disconnected, couple a grid dip meter to driver plate inductor 1L110. Adjust variable capacitor 1C112 for resonance at the assigned carrier frequency.

TABLE 5. BTF-20E1 FREQUENCY DETERMINING PARTS

Equipment Schedule No.	Frequency (MHz)	IC124 PA Loading	IC125 PA Loading	IC126 PA Loading	1L111 Front PA Grid Tuning	1L112 Rear PA Grid Tuning	1L111, 1L112 Shorting Blocks
ES-560272 -1	88.1-89.9	25pF 8521332-22 Stock #235990	25pF 8521332-22 Stock #235990	40pF 8521332-18 Stock #227938	3455135-1 Stock #243893	Not Used	3455763-1 Stock #243892
ES-560272 -2	90.1-91.9	25pF 8521332-22 Stock #235990	25pF 8521332-22 Stock #235990	40pF 8521332-18 Stock #227938	3455764-1 Stock #243894	3455764-2 Stock #243895	3455763-1 Stock #243892
ES-560272 -3	92.1-93.9	25pF 8521332-22 Stock #235990	25pF 8521332-22 Stock #235990	40pF 8521332-18 Stock #227938	3455764-1 Stock #243894	3455764-2 Stock #243895	3457763-1 Stock #243892
ES-560272 -4	94.1-95.9	40pF 8521332-18 Stock #227938	Not Used	40pF 8521332-18 Stock #227938	3455764-1 Stock #243894	3455764-2 Stock #243895	3455763-1 Stock #243892
ES-560272 -5	96.1-97.9	40pF 8521332-18 Stock #227938	Not Used	40pF 8521332-18 Stock #227938	3455764-1 Stock #243894	3455764-2 Stock #243895	3455763-1 Stock #243892
ES-560272 -6	98.1-99.9	40pF 8521332-18 Stock #227938	Not Used	40pF 8521332-18 Stock #227938	3455764-1 Stock #243894	3455764-2 Stock #243895	3455763-1 Stock #243892
ES-560272 -7	100.1-101.9	40pF 8521332-18 Stock #227938	Not Used	40pF 8521332-18 Stock #227938	3455764-1 Stock #243894	3455764-2 Stock #243895	3455763-1 Stock #243892
ES-560272 -8	102.1-103.9	40pF 8521332-18 Stock #227938	Not Used	40pF 8521332-18 Stock #227938	3455764-1 Stock #243894	3455764-2 Stock #243895	3455763-1 Stock #243892
ES-560272 -9	104.1-105.9	25pF 8521332-22 Stock #235990	Not Used	40pF 8521332-18 Stock #227938	3455764-1 Stock #243894	3455764-2 Stock #243895	3455763-1 Stock #243892
ES-560272 -10	106.1-107.9	25pF 8521332-22 Stock #235990	Not Used	40pF 8521332-18 Stock #227938	3462864-1 Stock #243896	3462864-1 Stock #243896	3455763-2 Stock #243891

3. With coil 1L109 disconnected, set 1L111 and 1L112 adjustments (metal blocks mounted between chassis and metal plates connected to blocking capacitors 1C140 through 1C143) to equal distances from the respective grid terminals of PA tube socket 1XV102. As an initial adjustment, move the sliding blocks along their "guide" slots until they touch the PA tube socket mounting plate, and then move each away from the PA socket about 1/2 inch. Tighten all hardware securely. Parts which vary with frequency are tabulated in table 5.

NOTE: In some transmitters, one of the variable inductors (1L111 or 1L112) will not be in use. In such cases, one of the variable inductors has been removed during factory tuning procedures. This situation is normal and represents optimum tuning conditions for a given transmitter and frequency.

Adjust PA GRID TUNING capacitor 1C123 so that its setting is approximately 3 turns from the fully meshed position. Couple a grid-dip meter to the PA grid circuit.

NOTE: Care should be taken to avoid coupling to the driver plate tank circuit. For this reason, it is advisable to remove the driver tubes until this step is completed.

Reset 1L111 and 1L112 as required, so that the PA grid circuit resonates at approximately the assigned carrier frequency.

4. Replace the driver tubes in their sockets. Reconnect the driver plate rings securely. Reconnect 1L109. Readjust DRIVER PLATE TUNING control 1C112 for resonance, using a grid dip meter, leaving the initial setting of 1C123 unchanged.

5. Set the PA PLATE TUNING and PA PLATE LOADING controls to the approximate positions shown in figure 6. The figures given are the distance from the shorting bars (1L105 or 1L106) to the plastic mounting shelf. If desired, these settings may be checked, using a grid dip meter.

6. Reconnect the primary terminals of low-voltage rectifier 1T6. DO NOT reconnect the primary terminals of high-voltage transformer 3T1; this prevents application of PA plate voltage. Set DRIVER SCREEN control 1R38 to the center of its range.

7. Remove resistor 1R9 from its clips and temporarily ground the upper clip (grid end). Remove resistors 1R15 and 1R16 to prevent application of PA screen voltage.

NOTE: During the following tuning procedure, it is advisable to remove power after each step by depressing the PLATE OFF pushbutton, and then (if desired) the TRANSMITTER OFF pushbutton. Latching relays (1K11 and 1K16) are used in the BTF-20E1 control circuit. If the PLATE OFF pushbutton is not operated each time high voltage will automatically be applied approximately 45 seconds after the TRANSMITTER ON pushbutton is depressed. This is not desirable, in general, during tune-up.

8. Close LV RECTIFIER circuit breaker 1S6, depress the TRANSMITTER ON pushbutton and then depress and hold POWER LOWER pushbutton 1S12 until variable transformer 1T5 is in its extreme counterclockwise position. REFLECTOMETER switch 1S3 should be set to the DISABLE position.

9. Rotate MULTIMETER switch 1S2 to the DRIVER Eg2 position. Depress the PLATE ON pushbutton. The indication on MULTIMETER 1M2 should be zero. Rotate MULTIMETER switch 1S2 to the DRIVER I_k position. Depress and hold the POWER RAISE pushbutton until MULTIMETER 1M2 reads approximately 100 milliamperes.

10. Using the tuning arm assembly provided (MI-560515, item 1), adjust DRIVER PLATE TUNING capacitor 1C112 for a dip in driver cathode current on MULTIMETER 1M2.

11. Rotate MULTIMETER switch 1S2 to the PA Ig position. Adjust PA GRID TUNING control 1C123 for maximum PA grid current. Set PA grid current to approximately 300 milliamperes, using either the POWER LOWER or POWER RAISE pushbutton.

12. The preceding procedure has established that the driver stage grid and plate tuned circuits are resonated at carrier frequency and that the driver stage is operative.

13. The driver cathode current should not be allowed to exceed 500 mA, as indicated on MULTIMETER 1M2 with 1S2 set to the DRIVER I_k position. DRIVER Ig2 should not exceed 30 mA. Depress the PLATE OFF and TRANSMITTER OFF pushbuttons.

14. Connect a dummy load and wattmeter (0 to 15 watt, 50 ohm) to the PA output line, using a 3-1/8" reducer cone (MI-19113-C58) and a short length (6 feet) of RG-8U cable.

PA NEUTRALIZATION

1. Remove and lay aside screen circuit voltage divider resistors 1R13 and 1R14 so that the PA screen dc circuit to ground is broken. For best results, the

MULTIMETER switch 1S2 must not be set to the PA Eg2 position during the PA neutralization procedure.

2. Remove the ground connection from the upper mounting clip of resistor 1R9. Complete the PA grid circuit by replacing (temporarily) 1R9 with a 6300 ohm 200 watt resistor. 1R13 or 1R14, previously removed, will serve the purpose. DRIVER SCREEN control 1R38 should be set to the center of its range.

3. Depress the TRANSMITTER ON and PLATE ON pushbuttons. After the plate time delay relay cycles, applying plate voltage, readjust DRIVER PLATE TUNING control 1C112 for minimum driver cathode current.

Set MULTIMETER switch 1S2 to the PA Ig position. If a grid current indication is noted, adjust both 1C112 and 1C123 for maximum indication. (If no grid current is apparent initially, operate the POWER RAISE pushbutton as required to initiate grid current). Using the POWER RAISE/POWER LOWER pushbuttons, establish a reference value of PA grid current. A reading of 75 milliamperes is a convenient value. This reference value should be held constant during the neutralizing procedure.

4. The small wattmeter connected at the PA output now indicates feed-through power (power coupled from PA grid circuit to PA output circuit through the "feed-through" capacitance of the PA tube).

5. Adjust PA PLATE TUNING control 1L105 and PA OUTPUT LOADING control 1L106 for a peak in the wattmeter indication.

6. Remove power from the transmitter. Adjust the front neutralizing slide (part of PA tube socket assembly) 3/8 inch to the right. Reapply power, adjust 1L105 and 1L106, and note the change in the wattmeter reading. If the meter reading has decreased, repeat this procedure until a minimum wattmeter reading is obtained. If the meter reading increased, move the neutralizing slide to the left and repeat. If an appreciable movement is required at the front neutralizing slide, all four slides should be adjusted so that they are approximately balanced. If necessary, one of the semi-fixed slides may be removed.

Normally, with 75 milliamperes of PA grid current (to establish a reference driving voltage) it should be possible to obtain a feed-through power indication of less than one watt. However, the important consideration in neutralization is to secure a minimum feed-through indication.

7. Depress and hold the POWER LOWER pushbutton until the DRIVER E_G2 indication is zero, then remove all power.

8. After completion of neutralization of the PA stage, replace resistors 1R9, 1R15, 1R16, 1R13 and 1R14 in their normal mounting positions.

9. Plug high voltage rectifier (MI-560340) into place in the high-voltage power supply (MI-560342). Connect the rectifier negative lead by plugging it into jack 2J1. Reconnect the primary leads of high-voltage plate transformer 3T1 (refer to table 3).

10. Disconnect the small dummy load and wattmeter from the output line of the PA and connect in its place a suitable dummy load and wattmeter.

11. The transmitter should be unmodulated during the following procedure for determination of operating power.

12. Check to confirm that REFLECTOMETER switch 1S3 is set to the DISABLE position.

PA TUNING - DIRECT METHOD OF POWER MEASUREMENT

1. Depress TRANSMITTER ON pushbutton. Set DRIVER SCREEN control 1R38 completely counterclockwise (for minimum rf drive to PA). Apply plate voltage. Note that PLATE VOLTAGE meter 1M3 indicates somewhat higher than the nominal value. Rotate MULTIMETER switch 1S2 to the PA E_G2 position and then depress and hold the POWER RAISE pushbutton until MULTIMETER 1M2 indicates 600 volts. Adjust DRIVER SCREEN control 1R38 for an indication of one-half ampere on PLATE CURRENT meter 1M4.

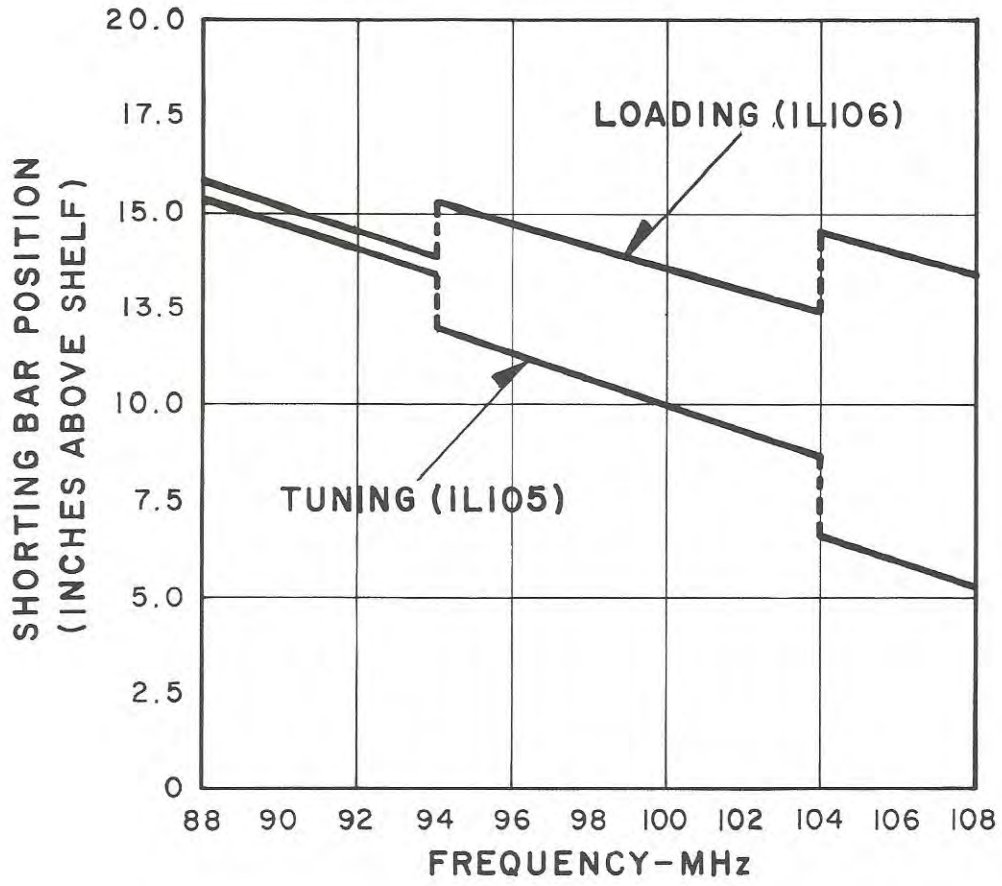
2. Using tuning arm assembly, readjust 1C123 until the PLATE CURRENT indication is maximum. DO NOT PERMIT THE PA PLATE CURRENT TO EXCEED 0.75 AMPERES AT THIS TIME.

3. With REFLECTOMETER switch 1S3 set to the DISABLE position, rotate POWER CALIBRATE control 1R11 to its maximum clockwise position. As transmitter power is increased during tuning procedures, the setting of 1R11 must be adjusted as required.

4. Note the reading on REFLECTOMETER meter 1M5 and adjust PA PLATE TUNING control 1L105 for a maximum reading.

5. Adjust the DRIVER SCREEN control 1R38 clockwise (increasing PA grid drive) until the required power output is reached as determined by feed-through wattmeter or calibrated dummy load, if available. If necessary, operate the POWER RAISE/POWER LOWER pushbuttons as required to set the power output.

Check all meters for acceptable readings. Typical



PLOT BASED ON LOADING CAPACITOR VALUES AS FOLLOWS:

FREQUENCY (MHz)	88-94	94-104	104-108
IC124	25pF	40pF	25pF
IC125	25pF	NOT USED	NOT USED
IC126	40pF	40pF	40pF

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Figure 6. Typical Settings, PA Tuning Controls

meter readings for a power output of 20 kilowatts are given in table 6.

In the case of transmitters which have been factory tuned at the required output power, no further PA tuning adjustments should be required – provided that the load in use at the transmitter output presents a 50 ohm resistive impedance to the transmitter.

In the event the transmitter has not been factory tuned at the required power output or if the efficiency or load impedance is not as desired, it will be necessary to retune the PA output circuit. PA loading is determined by the value of capacitance across the PA output line (vacuum capacitors 1C124, 1C125, 1C126) and the setting of PA OUTPUT LOADING control 1L106.

In tuning the PA (or other tetrodes) it should be noted that the screen current is a sensitive loading indicator. In general, the screen current will rise as the loading is decreased (higher load impedance) and drop as the loading is increased.

To increase loading, reset 1L106 to a position nearer the PA tube mounting shelf. Conversely, to reduce loading, reset 1L106 to a higher position (further from the PA tube mounting shelf).

In order to obtain best efficiency it is important that the PA stage be operated with its output tank circuit adjusted for optimum loading. The following procedure is recommended to attain this condition.

a. With power OFF, set 1L105 and 1L106 to the positions shown in figure 6, for the assigned frequency. The positions plotted are in inches above the PA tube plastic mounting shelf. This setting will establish a preliminary loading condition which should serve as a good starting point.

b. Depress the TRANSMITTER ON and PLATE OFF pushbuttons. Depress and hold the POWER LOWER pushbutton until variable transformer 1T5 rotates to the minimum (extreme clockwise) position. Set driver screen control 1R38 to the extreme counterclockwise (minimum PA drive) position.

c. Depress the PLATE ON pushbutton. Rotate MULTIMETER switch 1S2 to the PA E_G2 position and then depress and hold the POWER RAISE pushbutton until MULTIMETER 1M2 indicates 600 volts. Adjust driver screen control 1R38 for an indication of one-half ampere on PLATE CURRENT meter 1M4.

d. Note the reading on REFLECTOMETER 1M5 and adjust PA PLATE TUNING control 1L105 for a maximum indication.

e. Adjust the driver screen control 1R38 clockwise (increasing PA grid drive) until the desired power output is obtained or the PA plate current reaches 4.0 amperes. If necessary, operate the POWER RAISE/ POWER LOWER pushbuttons as required to set power output.

The PA efficiency should now be calculated from the following formula (refer to figure 7).

$$\text{Efficiency Factor} = \frac{\text{Power Output (watts)}}{\text{Plate Volts x Plate Current (amperes)}}$$

The "Plate Volts" in this formula refers to the meter voltage as read from voltmeter 1M3 (this value differs slightly from actual PA plate-to-cathode voltage).

6. If PA efficiency is low and screen current comparatively low, the loading is too heavy and the load impedance must be increased as previously described. Reset 1L106 first, then 1L105. If PA efficiency is low and screen current comparatively high, the loading is too light and must be increased as previously described. Reset 1L106 first, then 1L105. In either case, after each loading adjustment, readjust PA PLATE TUNING control 1L105 for maximum power output (refer to figure 9).

Once the PA tank load impedance is determined, the recommended procedure is to adjust the PA grid drive (using driver screen control 1R38) to obtain the required PA plate current at the specified grid bias, plate voltage, and, as nearly as possible, the screen voltage specified. It may be necessary to increase PA screen voltage, however, in order to obtain rated power output.

If this procedure is followed, there will be little variation in output power when tubes are changed, even though there may be some variations in grid and screen currents. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variation in current. No maximum tube ratings should be exceeded.

NOTE: Power output of the transmitter is proportional to the screen voltage, but at a certain point the output will not increase further in spite of a further increase in screen voltage. Care should be taken not to operate beyond this point since PA efficiency will decrease rapidly if screen voltage is raised further. With sufficient drive, the tapering-off should occur at a power output in excess of 20 kilowatts at a screen voltage of about 800 volts. However, insufficient drive may cause this point to shift to

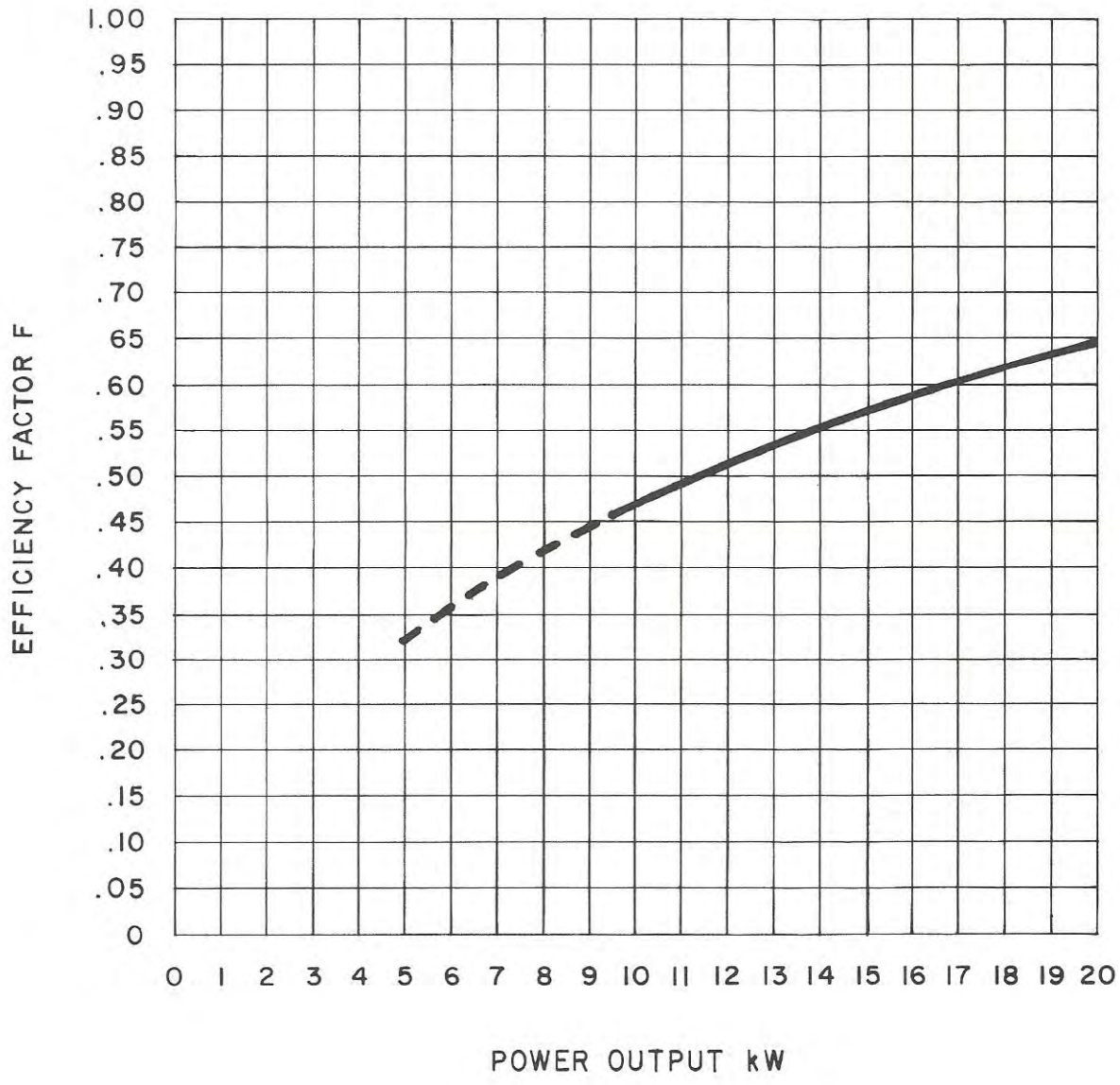

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Figure 7. Efficiency Curve

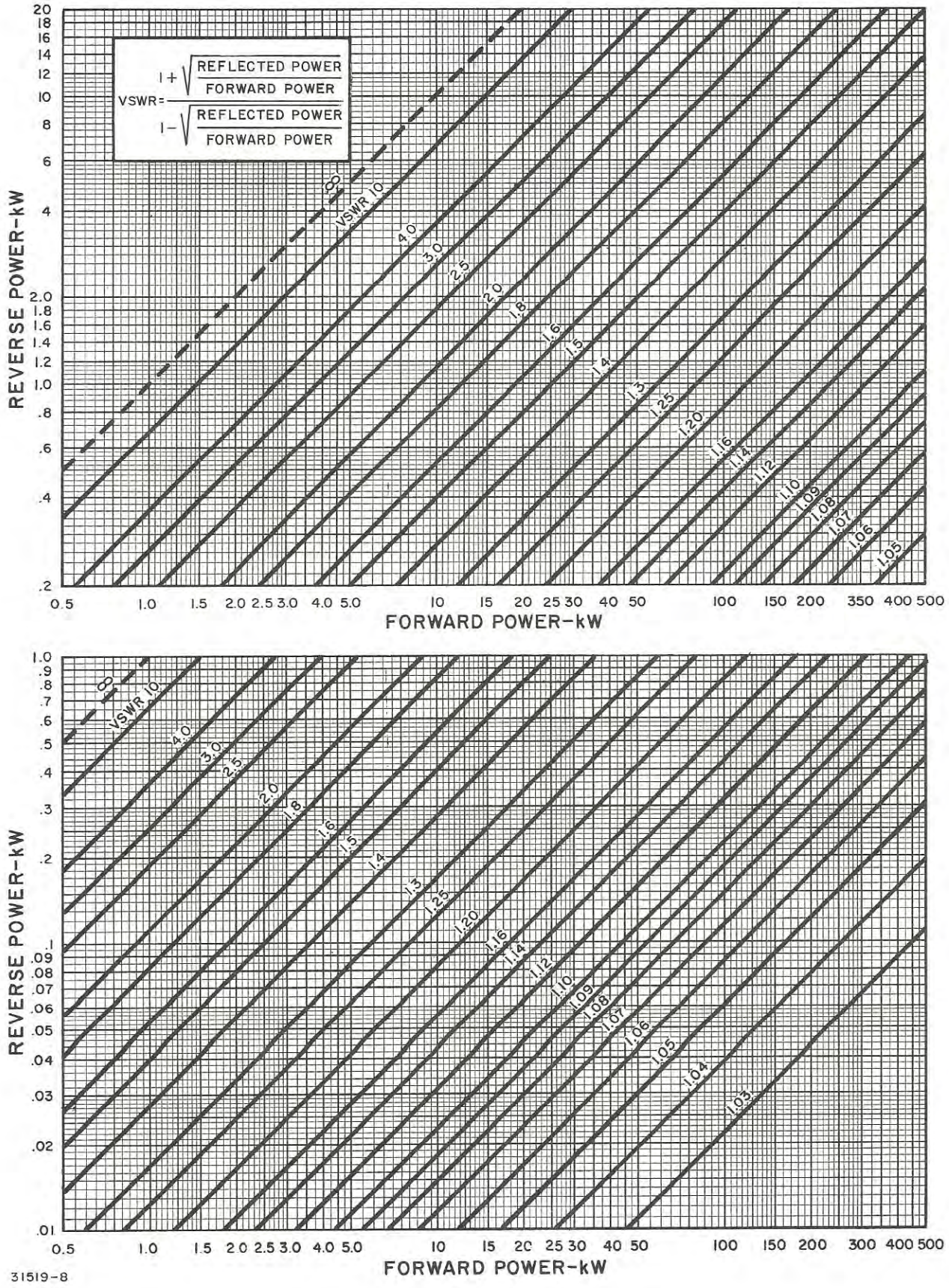


Figure 8. VSWR Nomograph

power levels less than rated power output. See figure 9.

It should be noted that operation of POWER RAISE pushbutton 1S11 and POWER LOWER pushbutton 1S12 will vary PA screen voltage as well as driver plate and screen voltages, while control 1R38 varies only driver screen voltage and therefore acts as a PA excitation control.

7. Set MULTIMETER switch 1S2 to the DRIVER E_G2 position. The indication should be 300 volts or less. If this reading is high, adjust driver screen control 1R38 as required. If necessary, readjust screen (slider type) resistor 1R18. Set MULTIMETER switch 1S2 to the DRIVER I_G2 position. The indication should be between 5 and 25 mA. If screen current is high, indicating a high driver plate load impedance, remove power and move the sliding blocks, which are part of 1L111 and 1L112, closer to tube socket 1XV102. This should result in a lower value of screen current when the power is restored and tuning adjustments repeaked. Conversely, to increase screen current, the blocks would be moved away from the tube socket. Adjustments should be in small increments of about 1/4 inch.

After driver screen voltage and screen current are adjusted as described, repeak the PA PLATE TUNING control and check power output. If necessary, set power output for the desired value, using the POWER RAISE/ POWER LOWER pushbuttons.

8. Repeat step 7 if necessary.

PA TUNING - INDIRECT METHOD OF POWER MEASUREMENT

1. Perform steps 1 through 4 of the procedure described above.

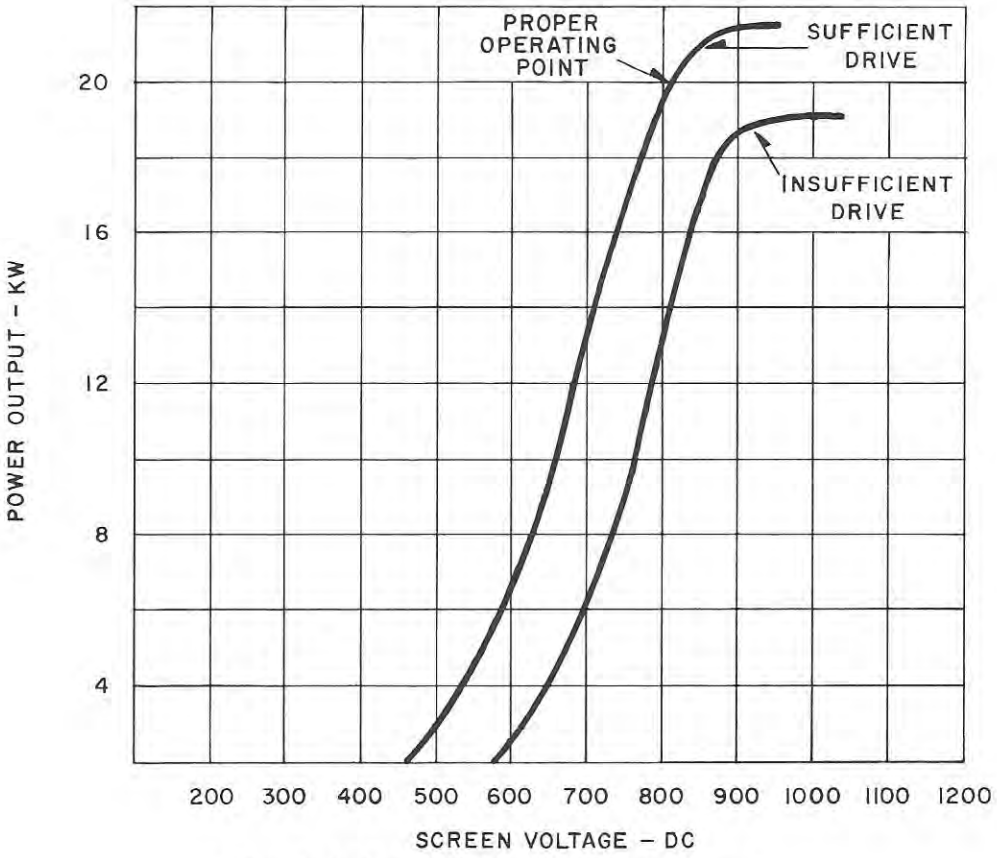


Figure 9. PA Screen Voltage/Power Output Curve

2. Adjust the DRIVER SCREEN control 1R38 clockwise (increasing PA grid drive) until the PA PLATE CURRENT indication rises to 3.5 amperes. Using power calibration control 1R11, set the reading on REFLECTOMETER 1M5 to an easily read value. 80% is a suitable value.

3. Using the REFLECTOMETER 1M5 as a power output indicator, vary PA output circuit tuning controls 1L105 and 1L106 for maximum output indication on 1M5, for a given value of PA plate current. After each tuning adjustment, readjust PA plate current to the reference value (using the POWER RAISE and POWER LOWER pushbuttons) so that the relative efficiency may be evaluated. As previously described, the PA screen

current may be used, within limits, as a PA tank circuit loading indicator.

4. Repeat step 3 at higher values of plate current until the value of plate current corresponding to 20 kW power output is reached. See figure 7.

5. Using the indirect method of power determination, the operating power is the product of the plate voltage and the plate current of the final stage and the efficiency factor, F. The efficiency factor is plotted as a function of power output in figure 7.

6. To set operating power, refer to figure 7 and determine efficiency factor F for the licensed operating power. The operating plate current is

$$\text{Plate Current} = \frac{\text{Licensed Power Output}}{\text{Plate Voltage x F}}$$

The plate voltage in this formula refers to the reading of PLATE VOLTAGE meter 1M3 (this value differs slightly from actual PA plate-to-cathode voltage).

Without making tuning adjustments, operate the POWER LOWER/POWER RAISE pushbuttons for the calculated value of operating plate current.

REFLECTOMETER CALIBRATION

Tune and adjust the transmitter for the required power output and then perform the following calibration procedures.

1. Power Indication – With the transmitter adjusted for the required output, and REFLECTOMETER switch 1S3 set to the DISABLE position, adjust POWER CALIBRATION control 1R11 so that REFLECTOMETER meter 1M5 reads 100%.

CAUTION

Do not adjust the POWER CALIBRATION control except when calibrating the REFLECTOMETER.

2. Initial setting of "carrier-off" protection feature – With REFLECTOMETER switch 1S3 set to the DISABLE position, the adjustment of the "set-point" or tripping point of REFLECTOMETER meter-relay 1M5 is made by varying the position of the red "set-point" needle as desired. The adjusting screw which varies the position of the "set-point" is normally located at the rear of 1M5. The transmitter high voltage must therefore be removed in order to adjust the 1M5 set-point.

The set-point used should be between 50 and 70% of the nominal transmitter power output. 60% is recommended. High set-point values make the transmitter subject to spurious tripping which might be caused by power line transients, while low set-point values do not afford adequate protection.

3. Calibration of Reflected power meter 1M7 – Set 1S3 to the VSWR CAL position. With the transmitter operating at nominal power output, adjust VSWR CALIBRATION control 1R10 for an indication of 100% on reflected power meter 1M7. 1M7 will now indicate output transmission line VSWR on its VSWR scale, and reflected power in the output transmission line (in percent of incident power) on its percent power scale, when 1S3 is set to the NORMAL position or the DISABLE position.

4. Initial setting of VSWR protection feature – The adjusting screw which varies the position of the "set-point" on reflected power meter 1M7 is located at the front of 1M7 immediately above the zero-set adjustment. The recommended setting is for a VSWR of 1.5:1.

5. Calibration of Remote Power Indication – Adjust transmitter for licensed power output. With a 5000 ohm remote power metering circuit connected between terminals 1TB1-11 and 1TB1-12, adjust REMOTE CALIBRATION control 1R12 for an indication of 100% (or other desired logging indication) on the remote power meter.

PROTECTION CIRCUITRY CHECKOUT

One section of REFLECTOMETER switch 1S3 is connected in series with the operating coil of time delay relay 1K20. The following description is for checks made with 1S3 set to the NORMAL position, allowing 1K20 to be energized.

Approximately 7 seconds after application of power to the operating coil of low voltage contactor 1K9, relay 1K20 should close its contact, energizing auxiliary relay 1K21. Relay 1K21 then closes two normally open contacts. One contact (3-5) makes the "carrier-off"/VSWR protection circuit operative. The other (6-7) makes the "carrier-off" and VSWR overload indicator lights operative. There will be an audible click when 1K20 and 1K21 operate. However, operation of 1K20 (and 1K21) will not (of itself) initiate a control circuit overload sequence.

If a more positive check is desired, connect an ac voltmeter (0 to 150 volt or higher) between module terminal 1Z6-16 and ground (1TB2-20). 117 volts will appear between these terminals when 1K20 and 1K21 are energized. If the delay between application of power to low voltage contactor 1K9 (by depressing the PLATE

ON pushbutton) and the operation of time delay relay 1K20 (and auxiliary relay 1K21) is not approximately 7 seconds, the timing adjustment on relay 1K20 should be set as required. To set 1K20, loosen the screw which secures the actuating arms to the rotating shaft, move the actuating arm which establishes the time delay (as required), and retighten the screw.

The following procedure will provide a positive check for proper operation of the "carrier-off/VSWR" circuitry.

1. "Carrier-off" Circuitry

With transmitter operating normally, at licensed power output, set REFLECTOMETER switch 1S3 to the NORMAL position. The transmitter power output should now be lowered slowly. When the power output indication on meter 1M5 drops to the set-point value (red needle value), the normal transmitter overload sequence should be initiated (see the subsequent paragraph "OVERLOAD RESETTING"). Power may be restored by depressing the O.L. RESET pushbutton. However, tripping will reoccur after each reset operation until the power output is readjusted to a value higher than the "set-point" indicated on meter-relay 1M5.

2. VSWR Protection Circuitry

With the transmitter operating normally, at licensed power output, set REFLECTOMETER switch 1S3 to the NORMAL position. If the indication on reflected power meter 1M7 is appreciable (VSWR indication of 1.3 or higher), the circuitry may be checked by simply moving the set-point to progressively lower scale positions. When the set-point pointer reaches the same position as the VSWR pointer, the normal transmitter overload sequence should be initiated. Again, tripping will reoccur after each (manual) resetting, until the set-point is readjusted to a value higher than the VSWR indication.

If the normal VSWR indication is less than 1.3, the procedure described may still be used by varying the zero set adjustment on 1M7 for a higher reading. After completion of the test, 1M7 should be re-zeroed (with transmitter power OFF), and the set-point pointer reset to the desired value.

CAUTION

It is recommended that the protection circuitry (optical meter-relays) be checked periodically (weekly) to be certain the protection is operative. Vary the set point adjustment on each optical meter-relay to induce an overload; then reset to normal setting.

OVERLOAD RESETTING

When TRIP switch 1S13 is in the SINGLE position, an overload will cause the plate power to be removed instantly. After the cause of the overload has been corrected, depress O.L. RESET pushbutton 1S17 on the front panel to place the transmitter back on the air, and extinguish the overload tally light involved.

When TRIP switch 1S13 is in the MULTIPLE position, an overload will remove the plate power momentarily. After a short time delay (determined by time-delay 1K17) the plate power will be reapplied. If the cause of the overload has been corrected the power will remain on and the appropriate overload indicator will light and stay lighted until reset manually by depressing the O.L. RESET pushbutton. If the overload persists, the plate power will be removed again and will remain off until reset manually be means of the PLATE ON pushbutton or remotely by shorting terminals 1TB2-26 and 1TB2-30. When the circuit is reset remotely, the overload indicator will remain lighted until reset manually.

OPERATION

STARTING AND STOPPING THE TRANSMITTER

In normal transmitter operation all circuit breakers should be left in the ON position and the crystal heaters left running continuously, unless the transmitter is to be shut down for an extended period of time. This way it is possible to start and stop the transmitter by operating only the TRANSMITTER ON (1S7) and TRANSMITTER OFF (1S8) pushbuttons and the PLATE ON (1S9) and PLATE OFF (1S10) pushbuttons.

To interrupt transmission for a short interval the PLATE OFF pushbutton should be depressed. This will remove plate voltage from the transmitter circuits but the filament power will remain on the tubes. The transmitter can then be returned to immediate operation when the PLATE ON pushbutton is depressed.

NOTE: Two pushbutton control of the transmitter may be achieved by not operating the PLATE OFF/PLATE ON push-

button, and operating the TRANSMITTER ON/TRANSMITTER OFF pushbuttons. Operated in this manner the transmitter will automatically go through the necessary starting steps including time delay relay operation.

Normally the time delay relay provides sufficient warm-up time (approximately 45 seconds) after which plate voltage can be applied. The crystal heater unit (in the exciter), from a cold start, requires several minutes of warm-up time before complete stability of the carrier frequency is attained.

PANEL METER READINGS

The typical meter readings shown were recorded during transmitter factory tests, with a power output of 20 kilowatts. With regard to PA meter readings, it is assumed that the PA rf grid drive is adjusted to obtain the required PA plate current at the specified grid bias, plate voltate, and, as nearly as possible, the screen voltage shown. If this procedure is followed, there will be little variation in output power when tubes are changed, even though there may be some variations in grid and screen currents. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variation in current.

At start-up, and at regular intervals during operation, note and record the panel meter readings in a suitable log. This will aid in maintaining the proper values of voltage and current and will disclose gradual changes in transmitter operation.

TABLE 6. TYPICAL METER READINGS FOR POWER OUTPUT – 20 kW

Position of Multimeter Switch	Meter Range	Reading
DRIVER I_G	0–30 mA	5 mA
DRIVER I_K	0–600 mA	300 mA
DRIVER I_{G2}	0–30 mA	15 mA
DRIVER E_{G2}	0–600 V	250 V
PA I_G	0–600 mA	85 mA
PA I_{G2}	0–600 mA	300 mA
PA E_{G2}	0-1200 V	800 V
PA PLATE VOLTAGE	0–10000 V	7500 V
PA PLATE CURRENT	0–5A	4.1 A

EMERGENCY OPERATION - AFC FAILURE

In the event of an AFC failure in the FM exciter, the output carrier frequency can be controlled manually (if the master oscillator is functioning) until such time as repairs can be made. To control the carrier frequency manually, operate AFC switch S1 to the OFF position and adjust AFC ADJUST control of the master oscillator for correct center frequency reading on the frequency monitor. The stability of the master oscillator is such that center frequency can be maintained within FCC limits for extended periods of time without AFC provided that changes in ambient temperature or line voltage is not excessive.

MAINTENANCE

GENERAL

With ordinary care a minimum of service will be required to keep the BTF-20E1 in operation. However, a regular schedule of inspection and service as outlined in the Recommended Maintenance Schedule, table 7, will help to avoid interruptions to broadcasts, greatly extend the life of components, and contribute in large measure to overall peak efficiency in operation.

WARNING

Always open the line circuit breaker, and discharge circuits with a grounding stick before touching any component inside the transmitter.

CLEANING

Ceramic insulators and bushings should be kept clean at all times. Insulators subject to stress in high-voltage dc fields may rupture if sufficient dust accumulates to cause a corona discharge. Clean insulators with a soft cloth and Clorothene.

NOTE: Because of the toxic effects of carbon tetrachloride, the use of Chlorothene is recommended. Chlorothene is a Dow Chemical Co. product and is available through that company's outlets.

CIRCUIT BREAKERS AND RELAYS

Circuit breakers and relays should be inspected periodically, and at such time contacts should be cleaned and adjusted if necessary. Relay contacts should be cleaned with Chlorothene applied with a soft brush,

after which they should be burnished with a tool, such as the RCA Stock No. 22963 Contact Cleaning Tool. Finally, contacts should be wiped with a clean piece of bond paper.

TUBES

Large tube failure can be anticipated by keeping a log of tube life, and replacing tubes as indicated by the log or when reduced output is apparent.

TABLE 7. RECOMMENDED MAINTENANCE SCHEDULE

DAILY
– Check and compare all meter readings at start-up. Correct any conditions revealed by abnormal readings.
– If overloads have occurred, examine components involved at shut-down. Repair or replace any components as necessary.
WEEKLY
– Operate optical-meter relay protection circuits to make certain they are operative.
– Make a general visual inspection and clean internal parts of transmitter. Use a clean, soft cloth on the insulators. Use a vacuum cleaner or hand blower for removing dust or dirt.
– Test all door interlocks and grounding switches.
– Check PA and output rf circuits for evidence of heating at connector or junction points. In particular, examine finger contact assemblies which are part of variable inductances 1L105 and 1L106.
– Check manometer reading. When manometer reading indicates filter clogging, clean or replace the filters as necessary.
– Make an overall check of distortion and noise level.
MONTHLY
– Check spare crystal in operating socket.
– Check voltages in exciter. Compare with previous readings.
– Inspect electrodes of spark gap 1E1 for pitting. Replace if necessary.
QUARTERLY
– Tighten all connections in the transmitter.
SEMI-ANNUALLY
– Lubricate moving bearing surfaces, with the exception of plastic lead screws, on tuning drive mechanisms. Use molybdenum disulphide powder, Molykote Type Z, or equivalent.
– Inspect relay contacts and replace where required.
– Test spare tubes.

AIR FILTERS

During normal operation, with clean air filters, the manometer reading should be approximately 0.1 inch (at sea level). As the filters become clogged over a period of time, the manometer reading will change (reading will increase). When the manometer reading exceeds 0.5 inch the filters must be cleaned or replaced.

SILICON RECTIFIER TESTING

A short-circuited silicon rectifier cell may be detected by simple resistance checks using a voltohmmeter such as a Simpson Model 260. With the diode removed from the circuit (if the diode is part of a series "stack" of diodes, the connections to the "stacks" should be removed), measure the diode resistance. Reverse the ohmmeter leads and measure the diode resistance. If both readings are low, the diode is short circuited.

The condition of individual cells in an RCA CR232 or CR233 series stack may be checked by applying an external voltage to the individual cells and measuring the resultant current flow through the cell. A simple test circuit as shown in figure 10 can be used to perform the individual cell checks. It should be noted that some other value of voltage can be used in the test circuit; however, 50 volts was selected because it is low enough to be safe for testing, but is also sufficient to present a good indication of cell degradation. A lower voltage, such as that available in a vacuum-tube voltmeter, will not isolate defective cells unless they are almost complete shorts. Also note that the 100 kilohm resistor and

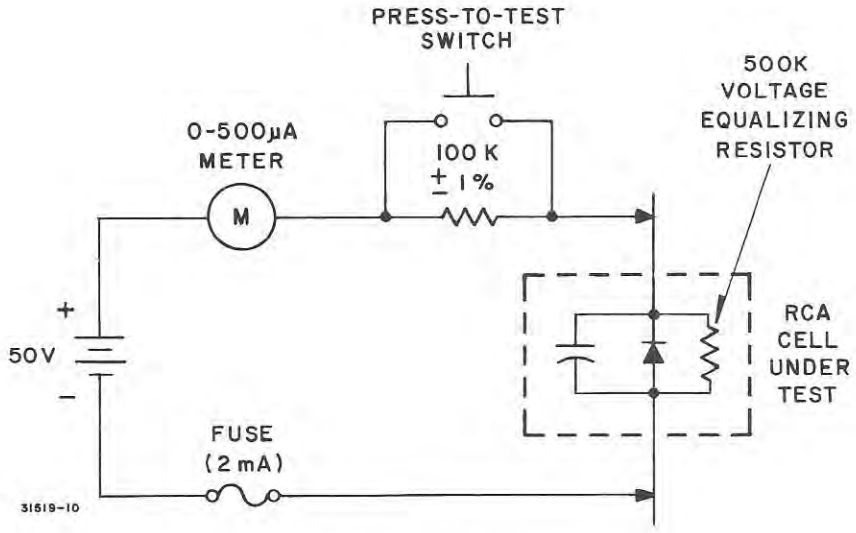


Figure 10. Rectifier Test Circuit

the "press-to-test" switch have been included in the test circuit to protect the meter from shorted and incorrectly connected (reversed) diodes. This test is based on the use of 500 K equalizing resistors across individual cells. Connect the test circuit across the cell to be tested, observing the polarity as shown in the diagram. It should be noted that an area on each of the fins of a CR200 series stack has been left unpainted to facilitate this connection.

If the cell under test is shorted (or connected with reversed polarity) the meter will indicate approximately 500 uA. If this indication is observed, do not depress the "press-to-test" switch.

When the "press-to-test" switch is operated, a good cell will provide an indication of approximately 100 microamperes, while a cell that has degraded will indicate several hundred microamperes.

Reverse the connections to the cell. A good cell should indicate approximately 500 microamperes. A low reading indicates poor forward conduction, or an open cell.

This circuit is not satisfactory for checking diodes using a voltage equalizing resistor below 500 K. In such cases, the equalizing resistor must be disconnected during tests.

The test circuit described may also be used to test other silicon rectifiers if the different values of voltage equalizing resistors are accounted for.

The RCA Type CR104 silicon rectifiers used in the low voltage supply consist of seven series connected diodes encapsulated to make up one rectifier module (Type CR104, or RCA stock no. 230913). Each of the seven series diodes is shunted by a 2.2 megohm voltage equalizing resistor. This gives a resistance of about 15 megohms across the CR104 module if all diodes are good.

To test CR104 rectifiers using the test circuit described, proceed as follows.

Connect the test circuit across the CR104 unit to be tested, observing the polarity shown in the diagram.

If the CR104 rectifier is shorted (or connected with reversed polarity) the meter will indicate approximately 500 microamperes. If this indication is observed, do not depress the "press-to-test" switch.

When the "press-to-test" switch is operated, a good rectifier will provide an indication of about 4 microamperes. Higher readings indicate degradation of one or more individual diodes.

Reverse the connections to the diode. A good unit should indicate approximately 500 microamperes. A low reading indicates poor forward conduction, or an open diode.

CONTROL MODULE

The control module works in conjunction with 1M5 and 1M7 to remove the transmitter plate power when the transmitter power output indication drops below the

set point value on 1M5 or the VSWR indication exceeds the set point value on 1M7. Normal position of these relays is as follows:

1. The control relay in the Power Trip (carrier-off) circuit is de-energized as long as the indication of 1M5 is above the set point.

2. The control relay in the VSWR Trip circuit is de-energized as long as the indication of 1M7 is below the set point.

3. Set TABLE 8 for a summary of relay contact status vs various circuit conditions.

Some helpful voltage readings are as follows:

	Normal	Tripped
Q1 (or Q2) collector	+2.6	-3.4
Q1 (or Q2) emitter	-0.2	+0.1
SCR1 (or SCR2) anode	-0.2	-10.5

AC voltages from T1 are shown on figure 28.

DC voltages, measured with respect to red (center tap) or wht/grn transformer lead, using RCA WV-98A Voltohmyst VTVM.

The waveforms shown in figure 29 show the reversal of phase which occurs in the base circuit of buffer transistor Q1 (or Q2) when a transition is made from above set-point to below set-point (REFLECTOMETER meter-relay 1M5: Power Trip) or vice-versa (REFLECTED POWER meter-relay 1M7).

TABLE 8. CONTROL MODULE 1Z6 SERVICING CHART

Condition	High Set Point (VSWR) N. O. Relay Contacts 16-17 19-20	High Set Point (VSWR) N. C. Relay Contacts 15-16 18-19	Low Set Point (Power) N. O. Relay Contacts 6-7 9-10	Low Set Point (Power) N. C. Relay Contacts 5-6 8-9
AC Power OFF	Open	Closed	Open	Closed
AC Power ON, Indication Below Set Point	Open	Closed	Closed	Open
AC Power ON, Indication Above Set Point	Closed	Open	Open	Closed
AC Power ON, Meter Lamp Failure	Closed	Open	Closed	Open

Notes: 1. Contact status (closed or open) versus circuit condition.
2. See figure 28 for Control Module schematic diagram and terminal identification.

BLOWER LUBRICATION

MI-560347 Blower motors are lubricated with a special moisture resistant grease by the motor manufacturer. The motor bearings should be relubricated at least every two years with an equivalent type ball bearing grease. High grade, neutral, ball bearing grease such as Keystone No. 44, Lubriko M-21 or Alemite No. 38 should be suitable. The blower must be removed from the cabinet and the motor disassembled to properly lubricate the bearings.

The blower motor manufacturer (General Electric Co.) maintains Service Centers in most major cities. If desired, the motor lubrication may be made at a Service Center.

Further motor maintenance information will be found in General Electric Co. publication GEI-56110.

MUFFIN FAN LUBRICATION

The muffin fan used to ventilate the high-voltage power supply cabinet will provide reliable performance from 2 to 5 years under favorable conditions of temperature and vibration without the necessity of oiling.

If the cabinet should be installed in areas of great heat or severe vibration, its life may be extended by periodic oilings (a small amount once per year) which is absorbed by the bearing. For this oiling procedure, an Oil Injector is required, which may be ordered from Rotron Manufacturing Co., Inc., Hasbrouck Lane, Woodstock, New York, at a modest price. To lubricate the fan proceed as follows:

1. Remove cap from end of Oil Injector.

2. Place needle at the center of circle marked on the Gold label.

3. Position the needle at an angle of approximately 45° to the surface of the label and tangent to the perimeter of the circle.

4. Pierce the label and the concealed self-sealing rubber cap located under the label.

5. Insert the needle approximately 1/4 inch.

6. Depress the plunger of the Oil Injector slowly to the next calibration mark which will allow 1/16-inch of oil to escape.

NOTE: It is better to give a little more oil than not enough, however, do not overflow the well. If the ambient temperatures are extremely high, it may be advisable to oil more frequently to insure the optimum performance characteristics of the fan.

Muffin fans manufactured by Pamoter, Inc. incorporate sealed bearings which do not require added lubrication.

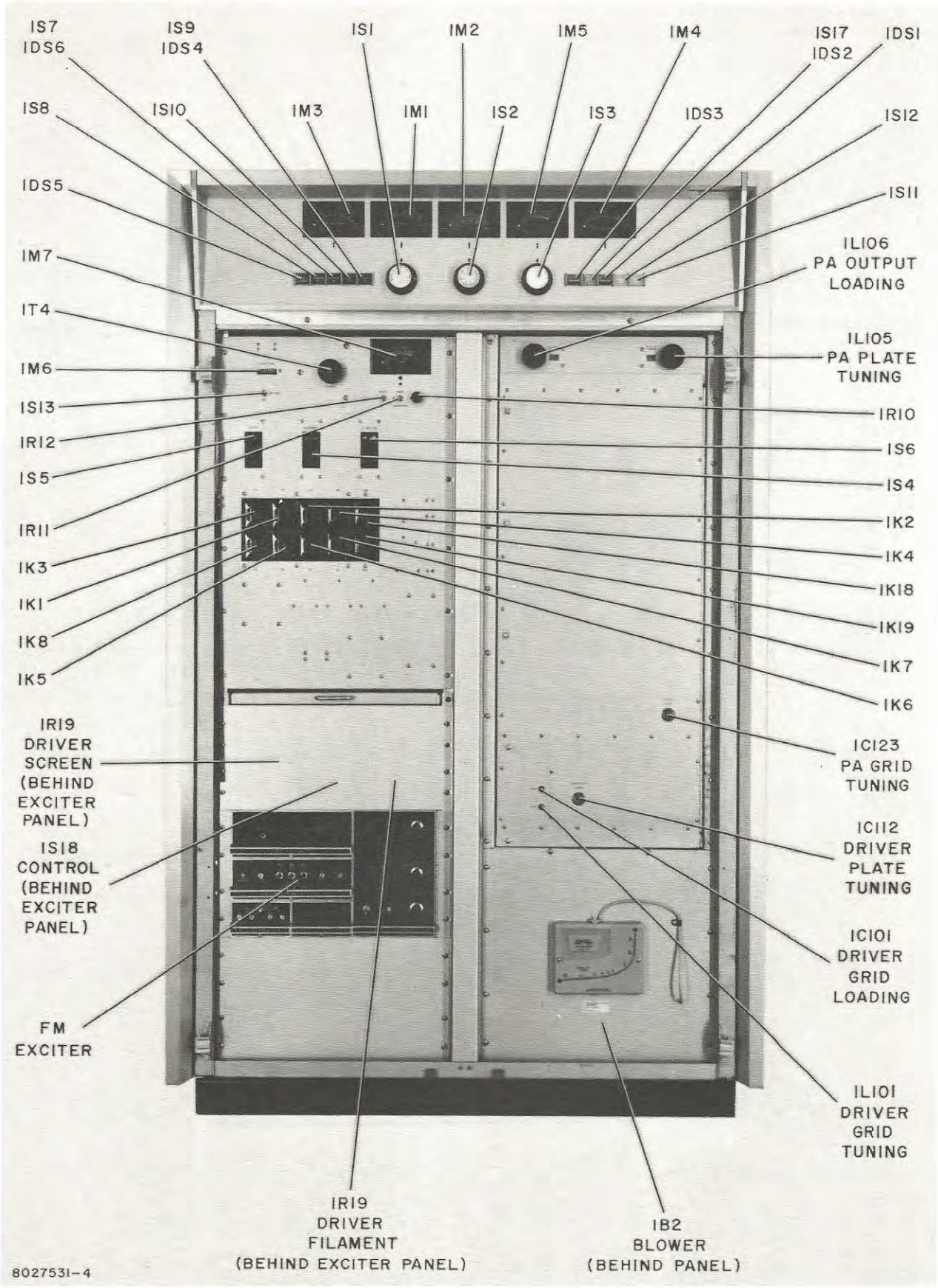


Figure 11. Transmitter, Electrical Parts, Front View

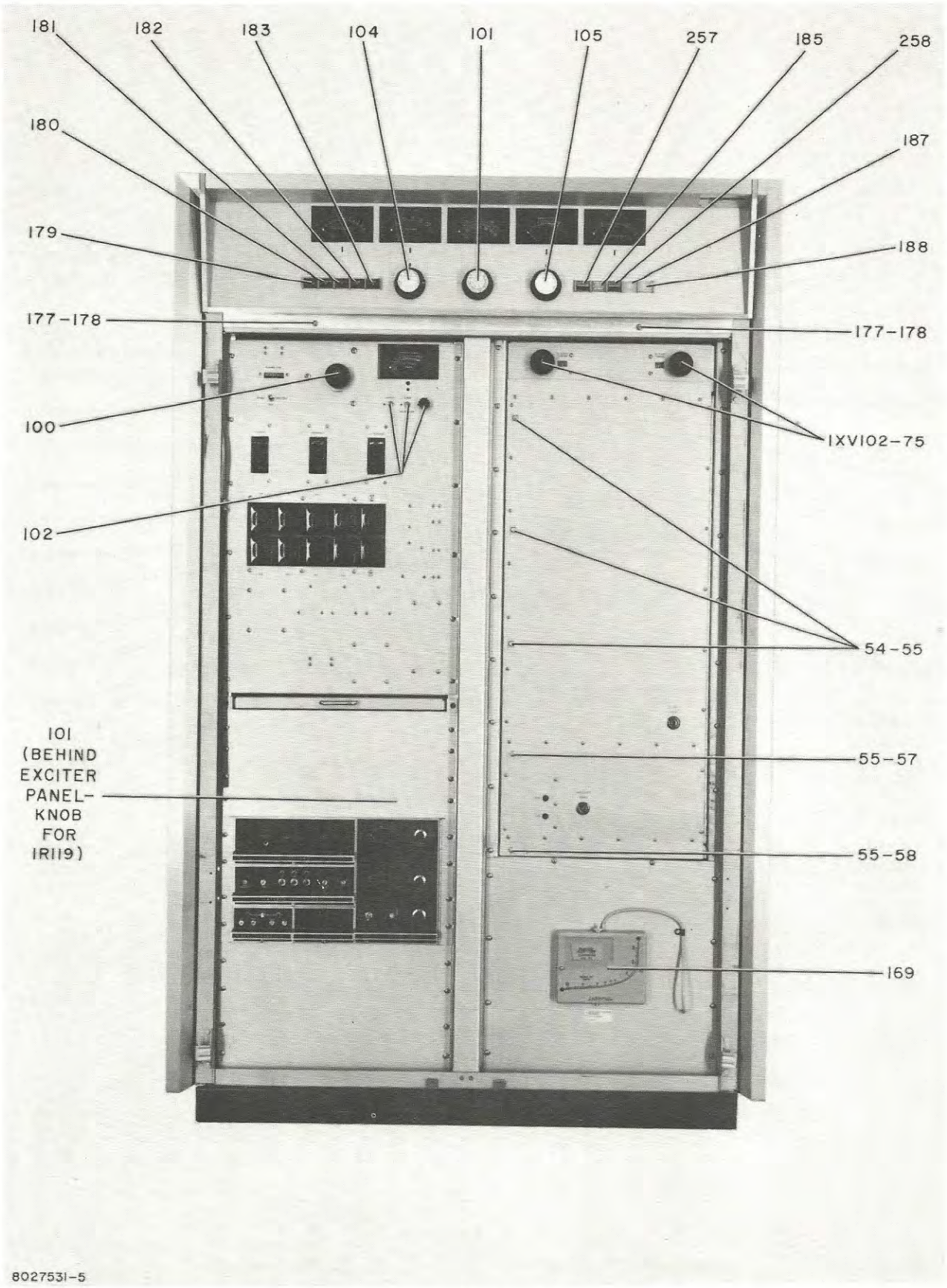


Figure 12. Transmitter, Mechanical Parts, Front View

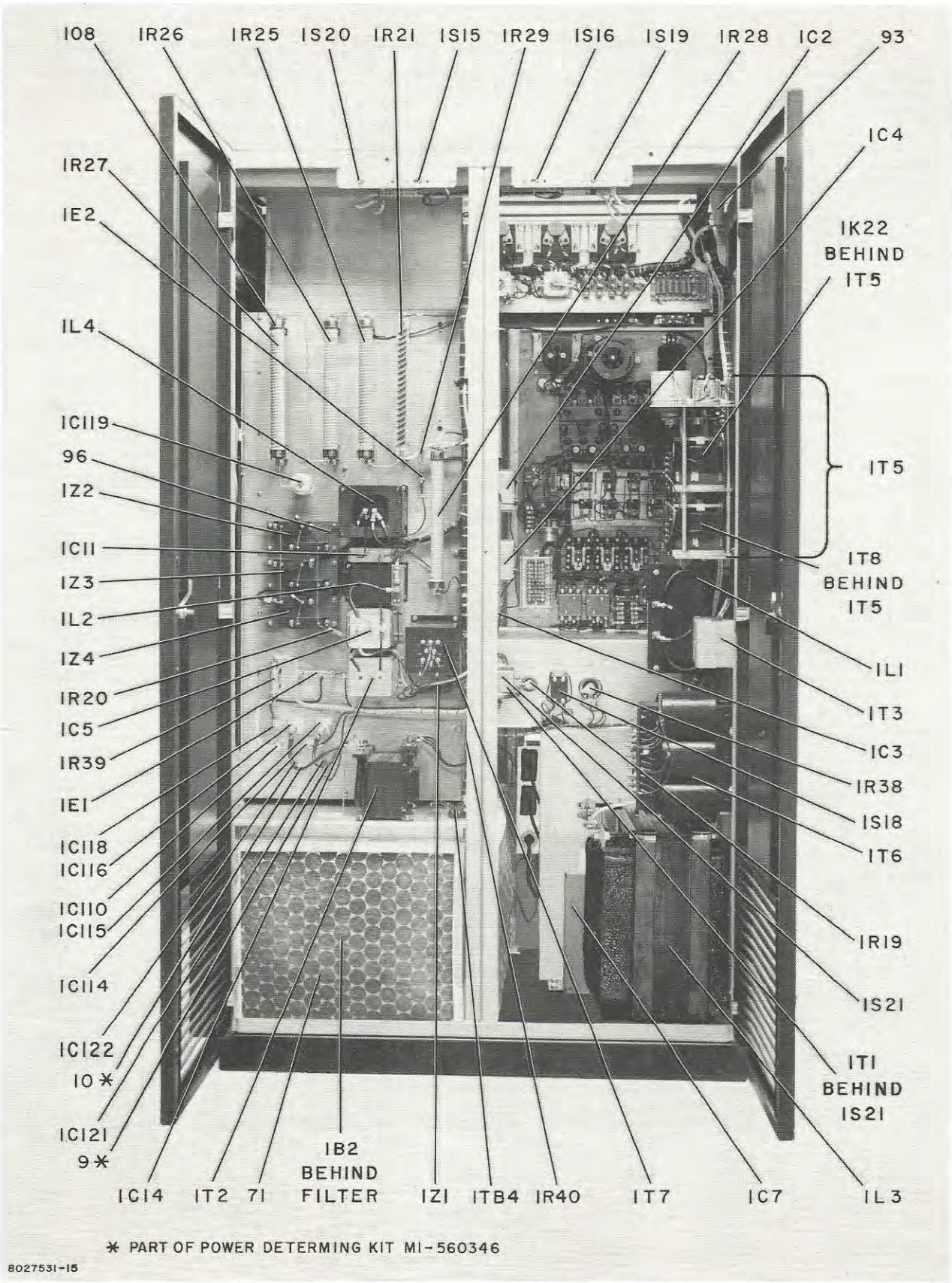


Figure 13. Transmitter, Rear View

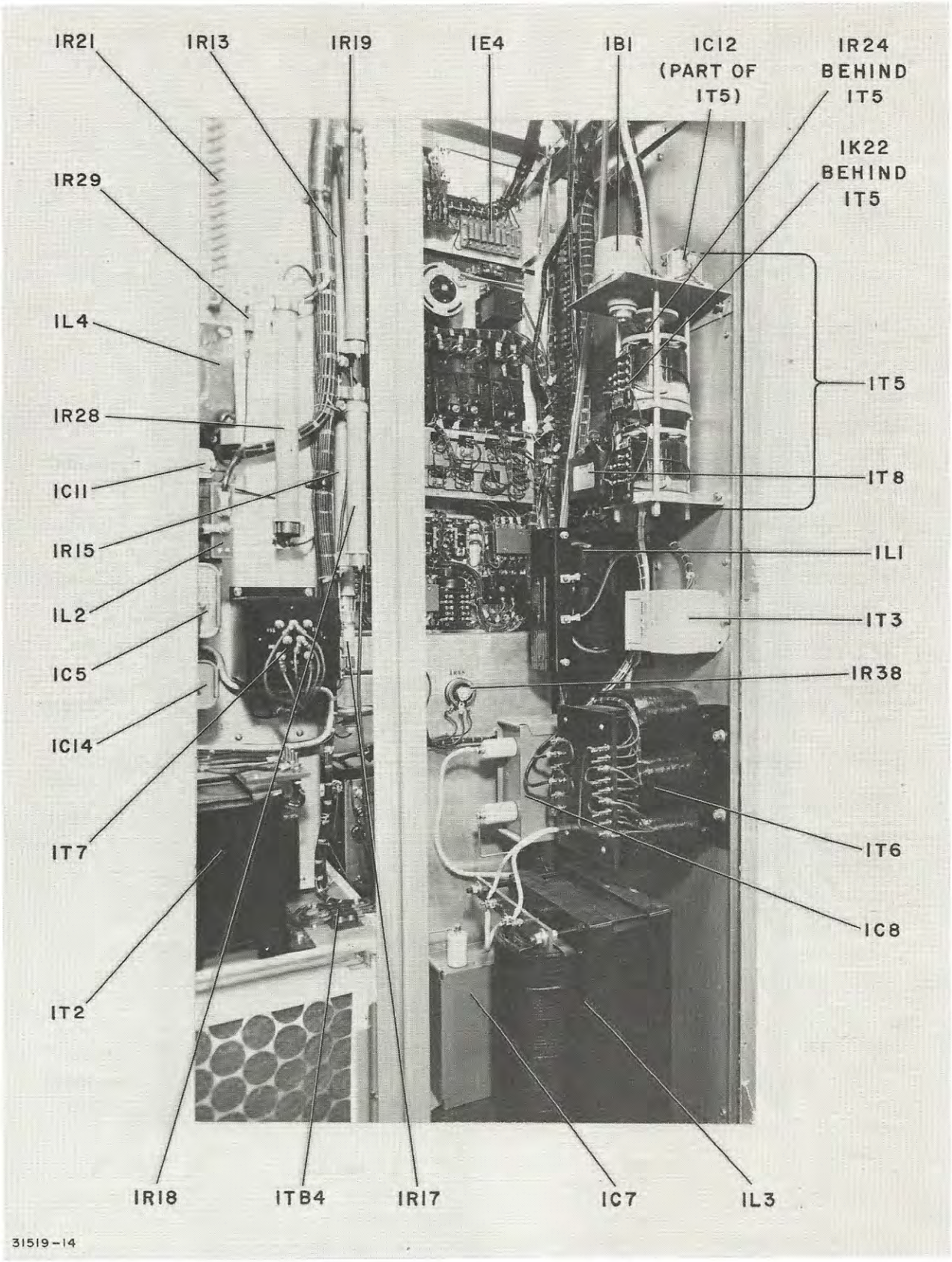


Figure 14. Transmitter, Left Rear Oblique View

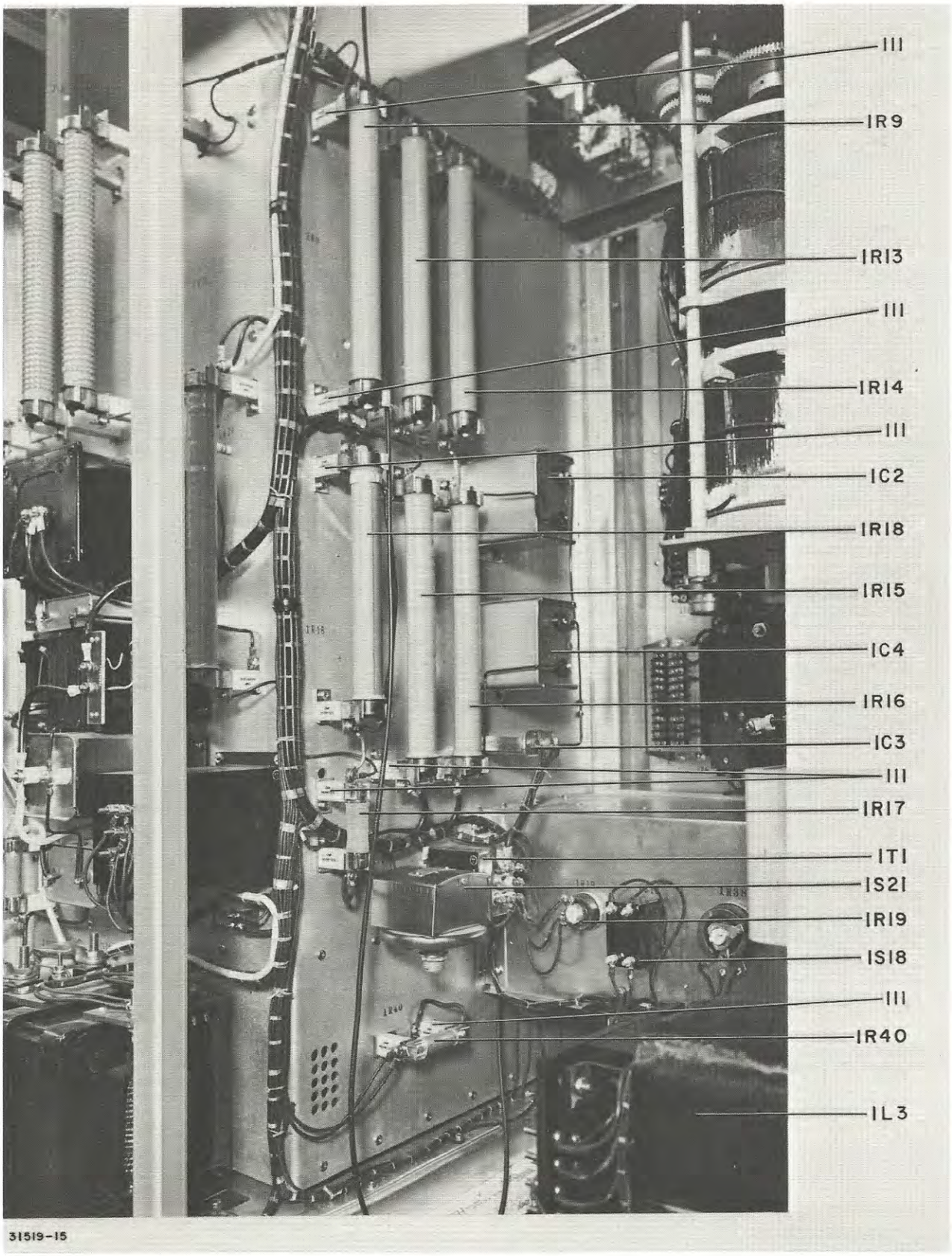


Figure 15. Transmitter, Right Rear Oblique View

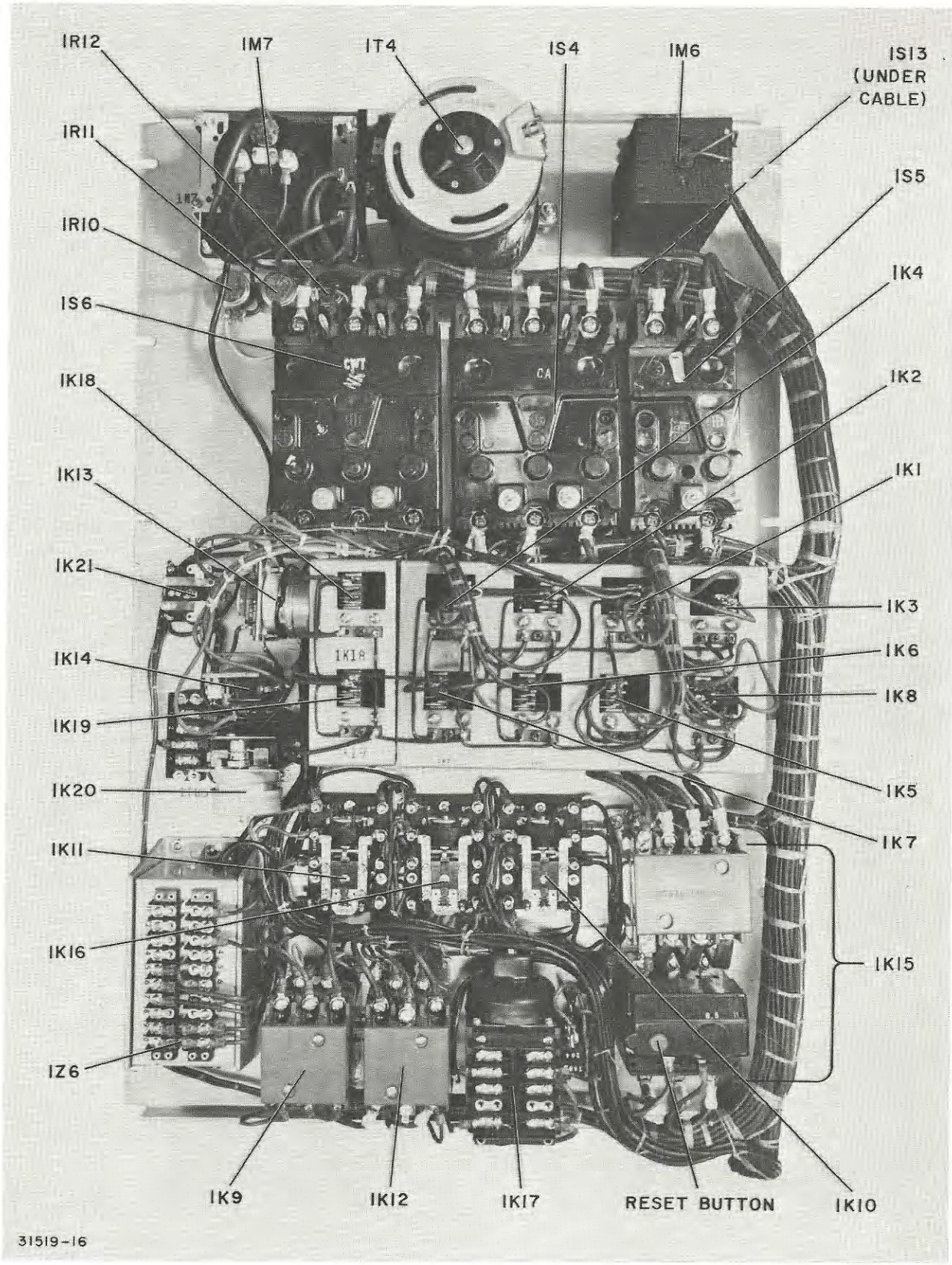


Figure 16. Control Panel, Rear View

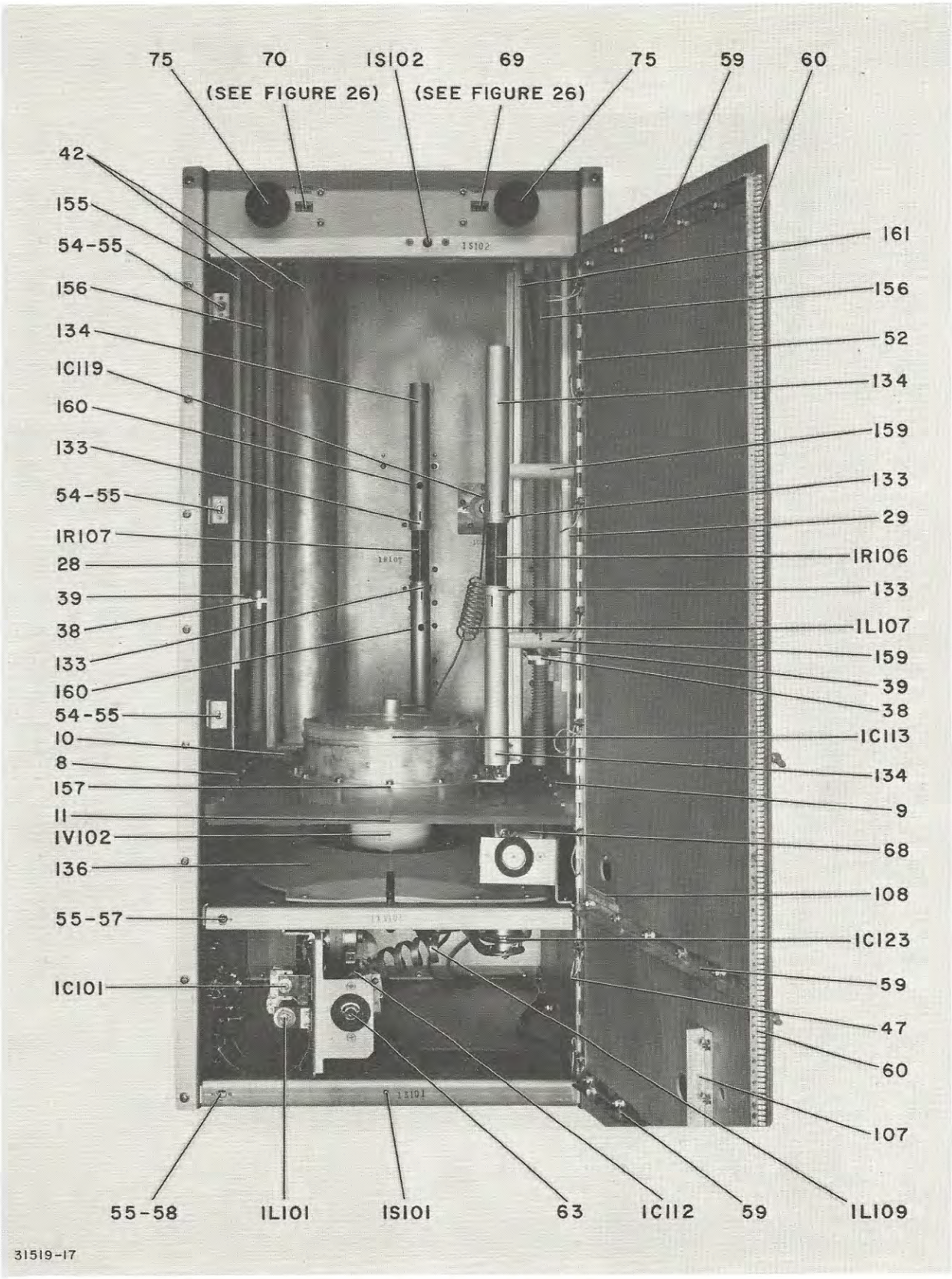


Figure 17. RF Unit, Front View

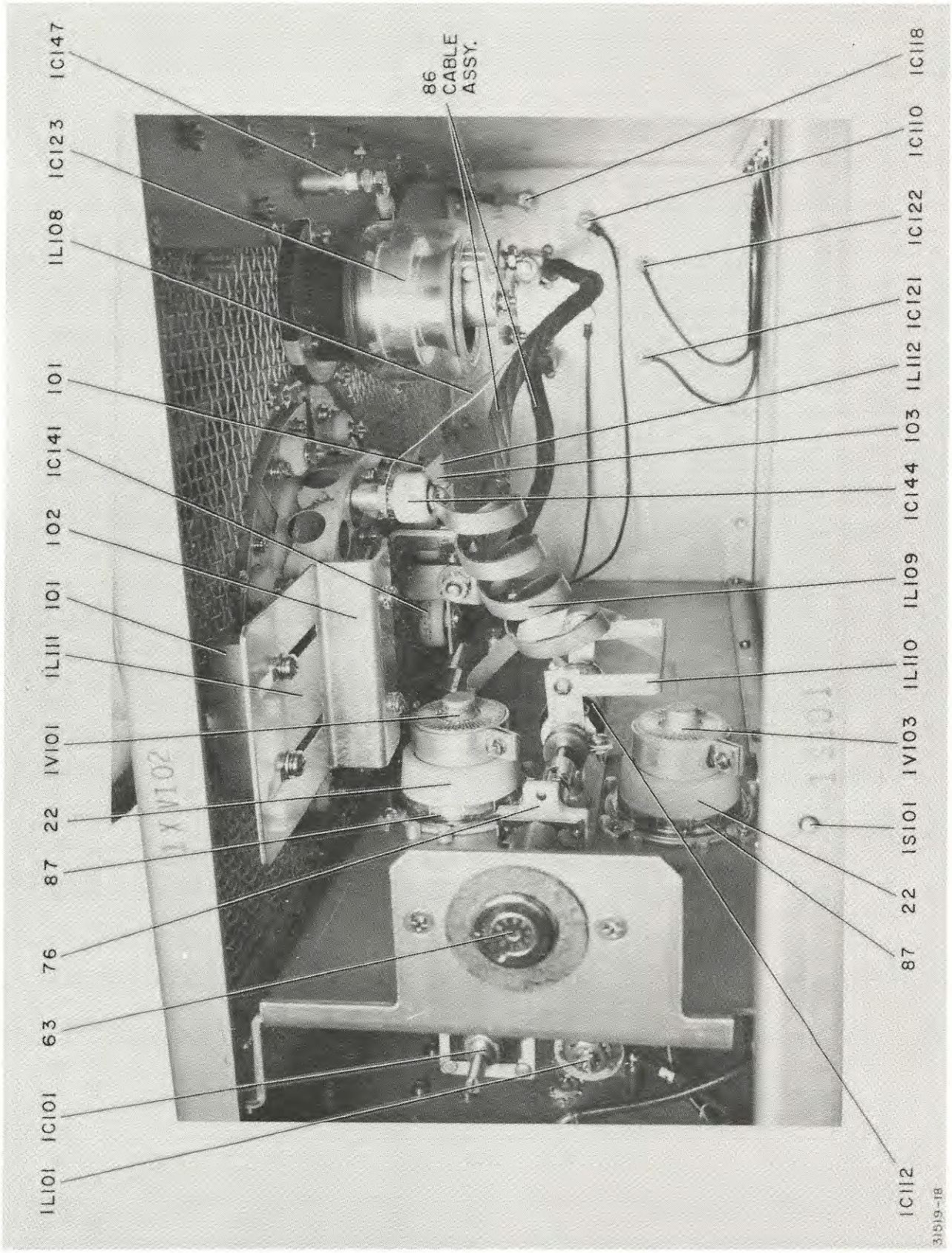


Figure 18. Driver Shelf and 1XV102 Shelf, Front View

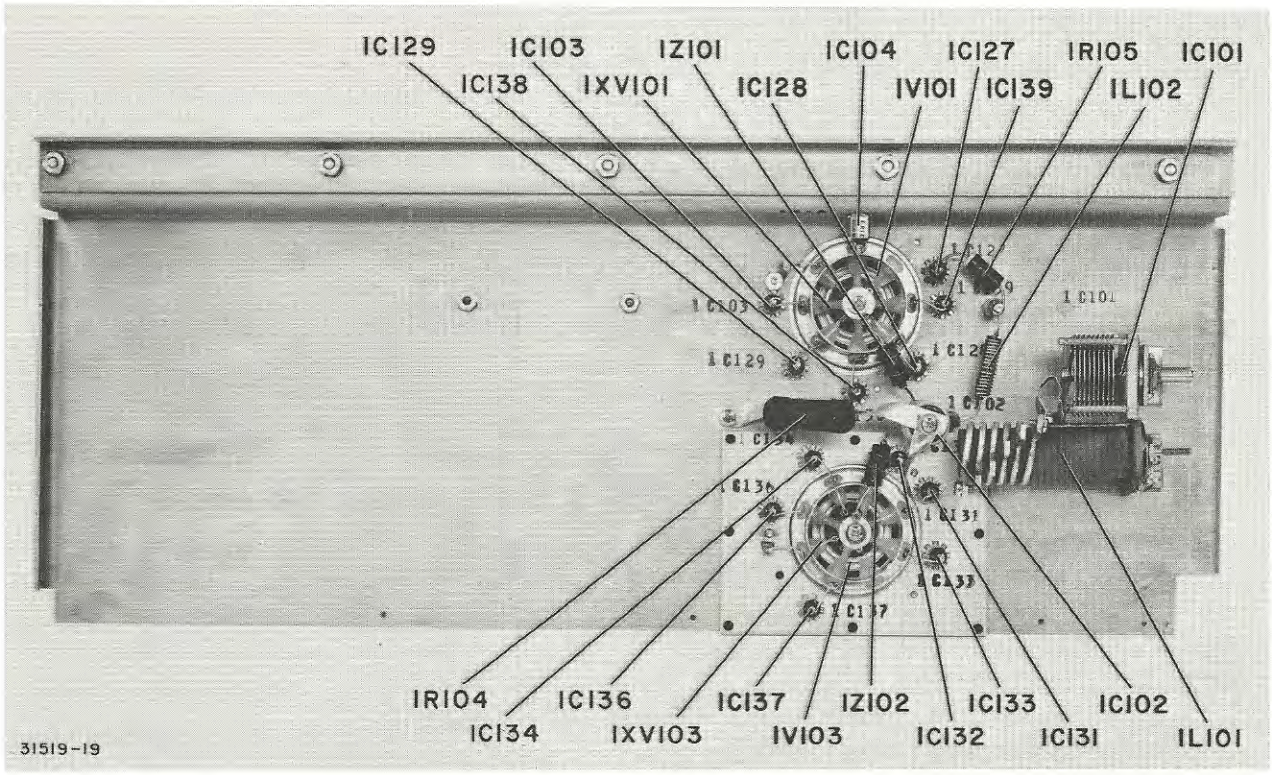


Figure 19. Driver Shelf, Left Side

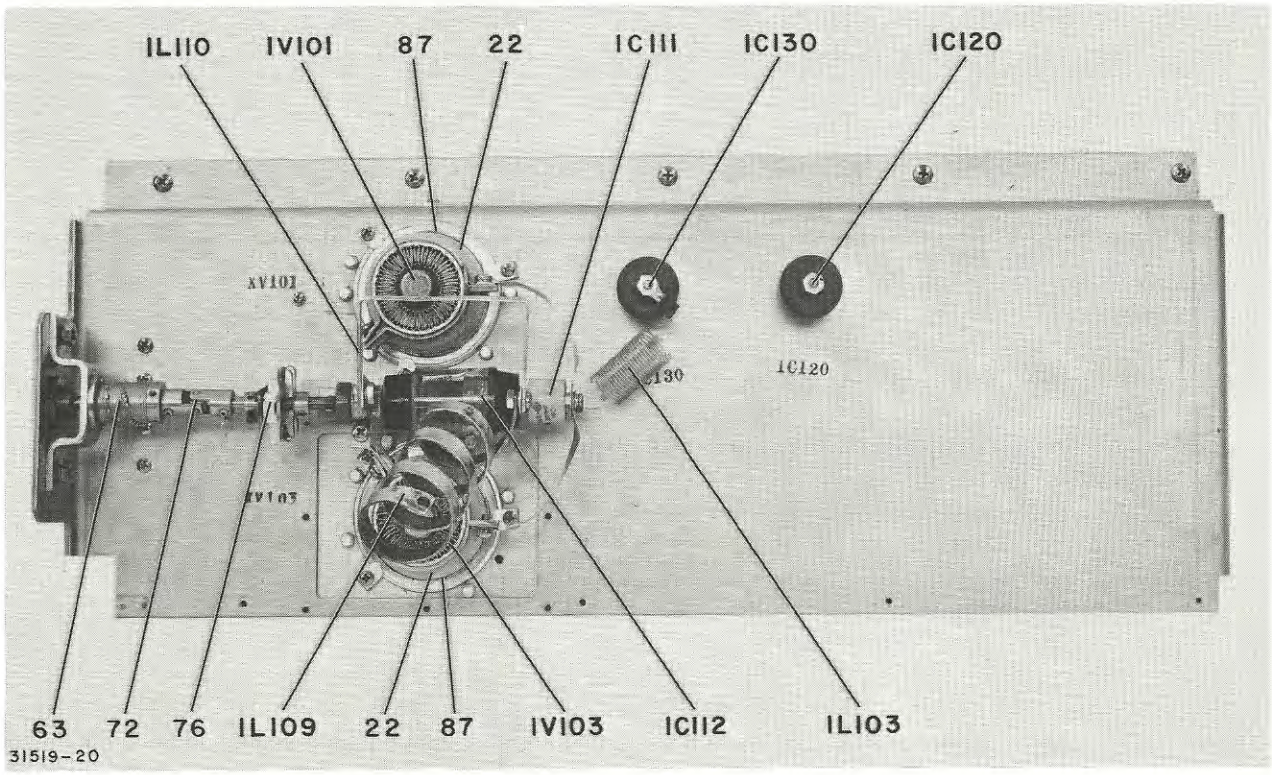


Figure 20. Driver Shelf, Right Side

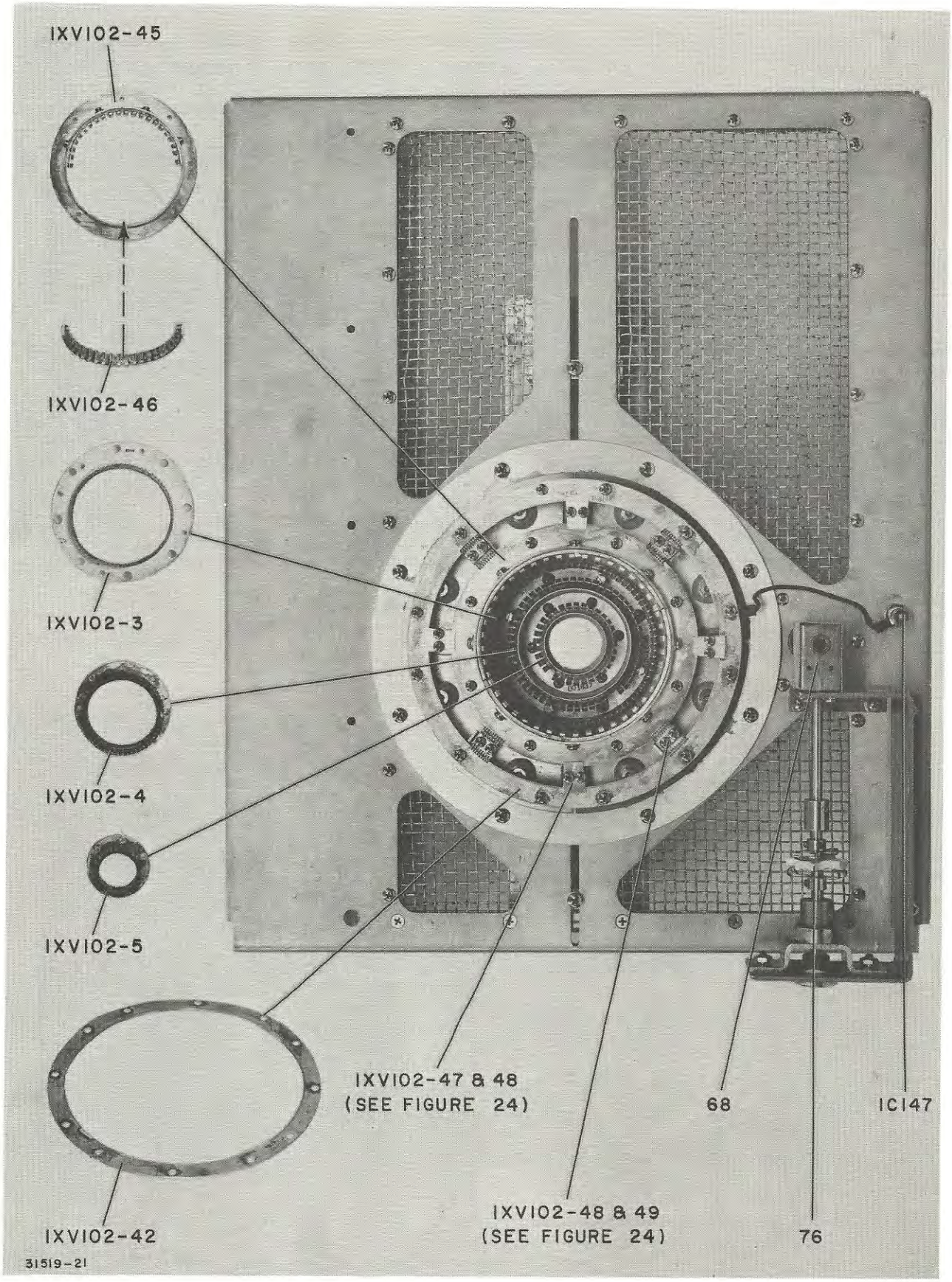


Figure 21. 1XV102 Socket Assembly, Top View

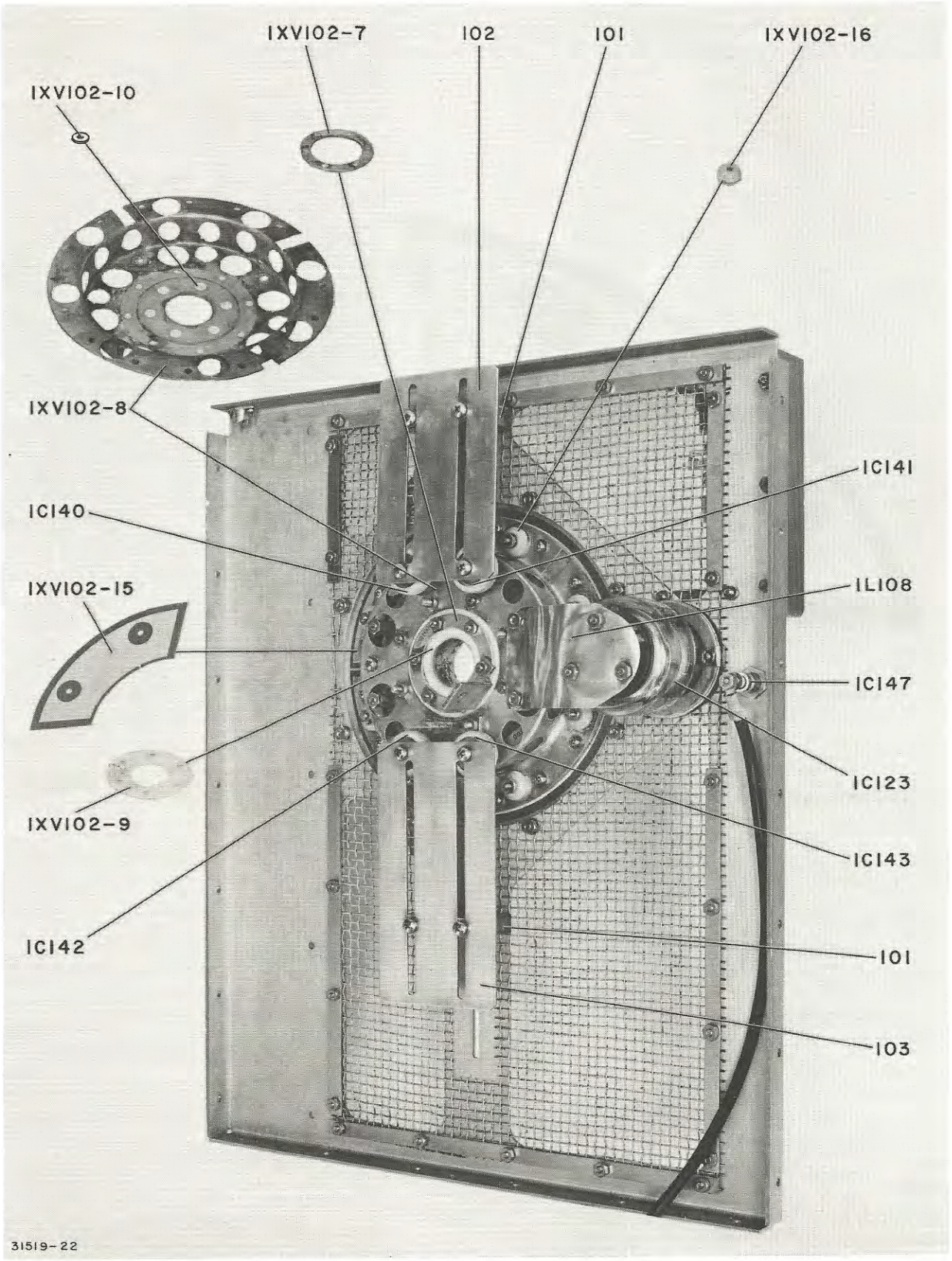


Figure 22. 1XV102 Socket Assembly, Bottom View

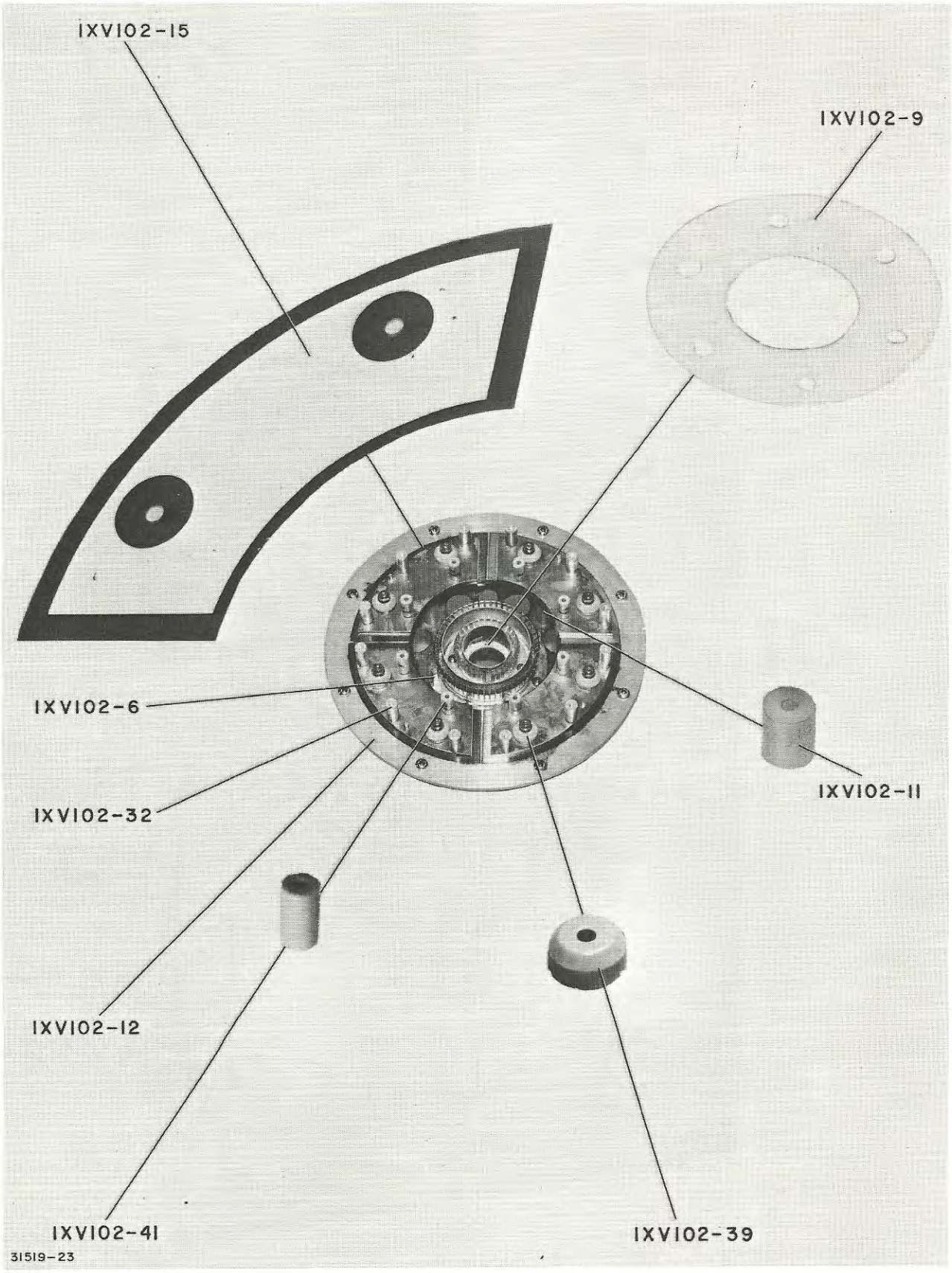


Figure 23. 1XV102 Insulators and Capacitors

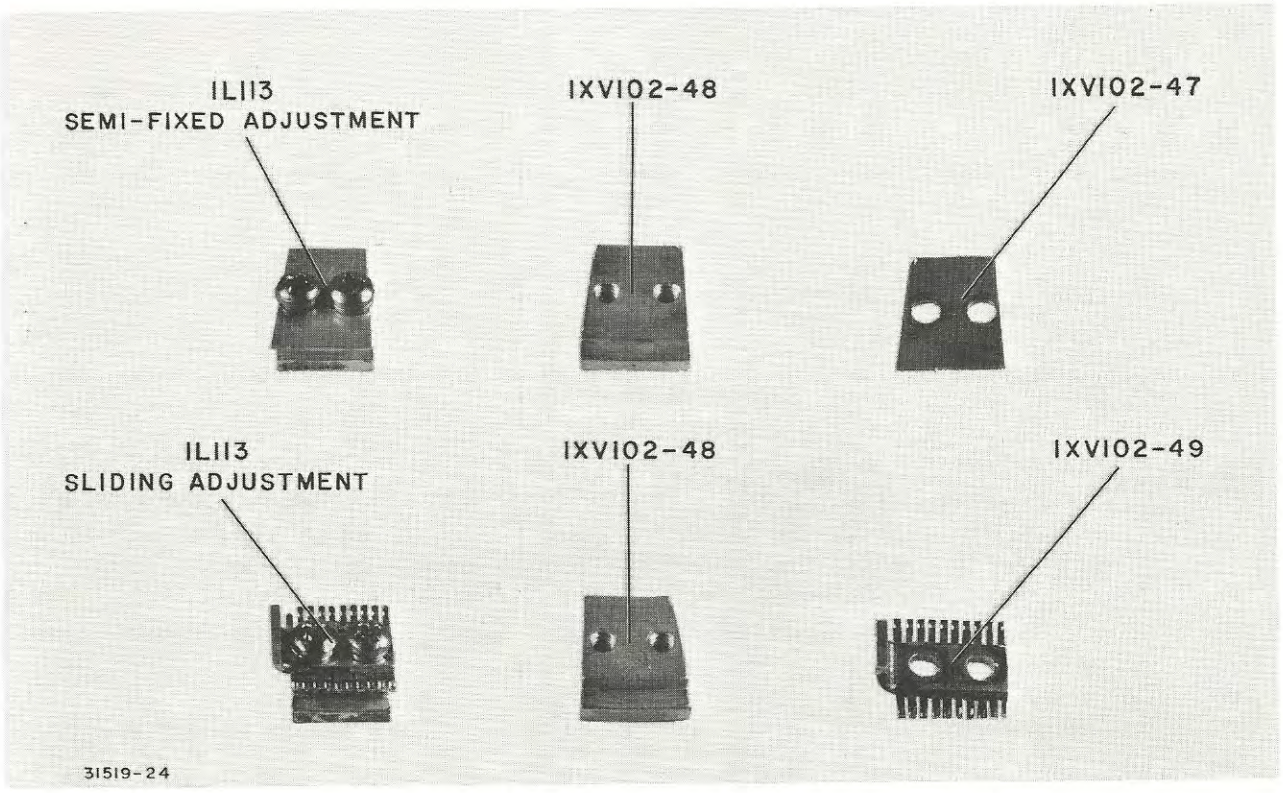


Figure 24. 1L113 Semi-Fixed and Sliding Contacts

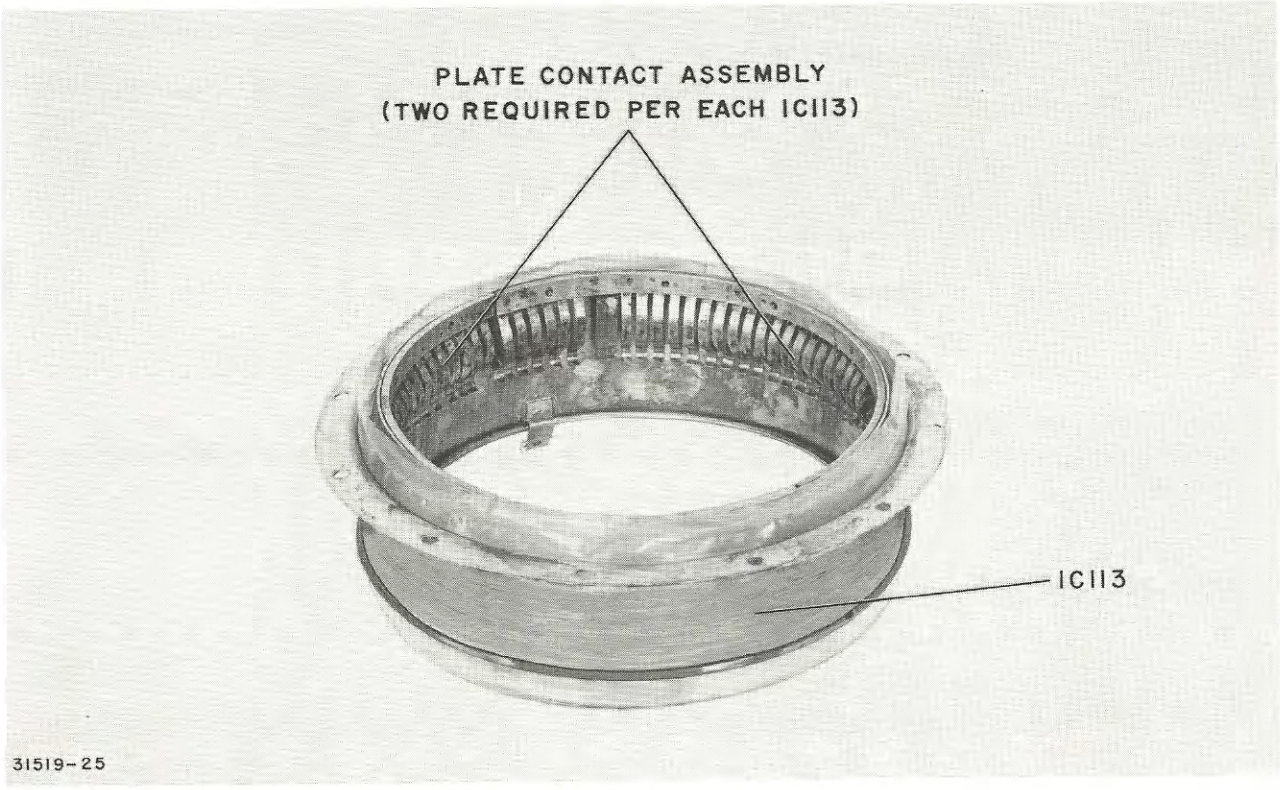


Figure 25. 1V102 Plate Contacts and Plate Blocking Capacitors

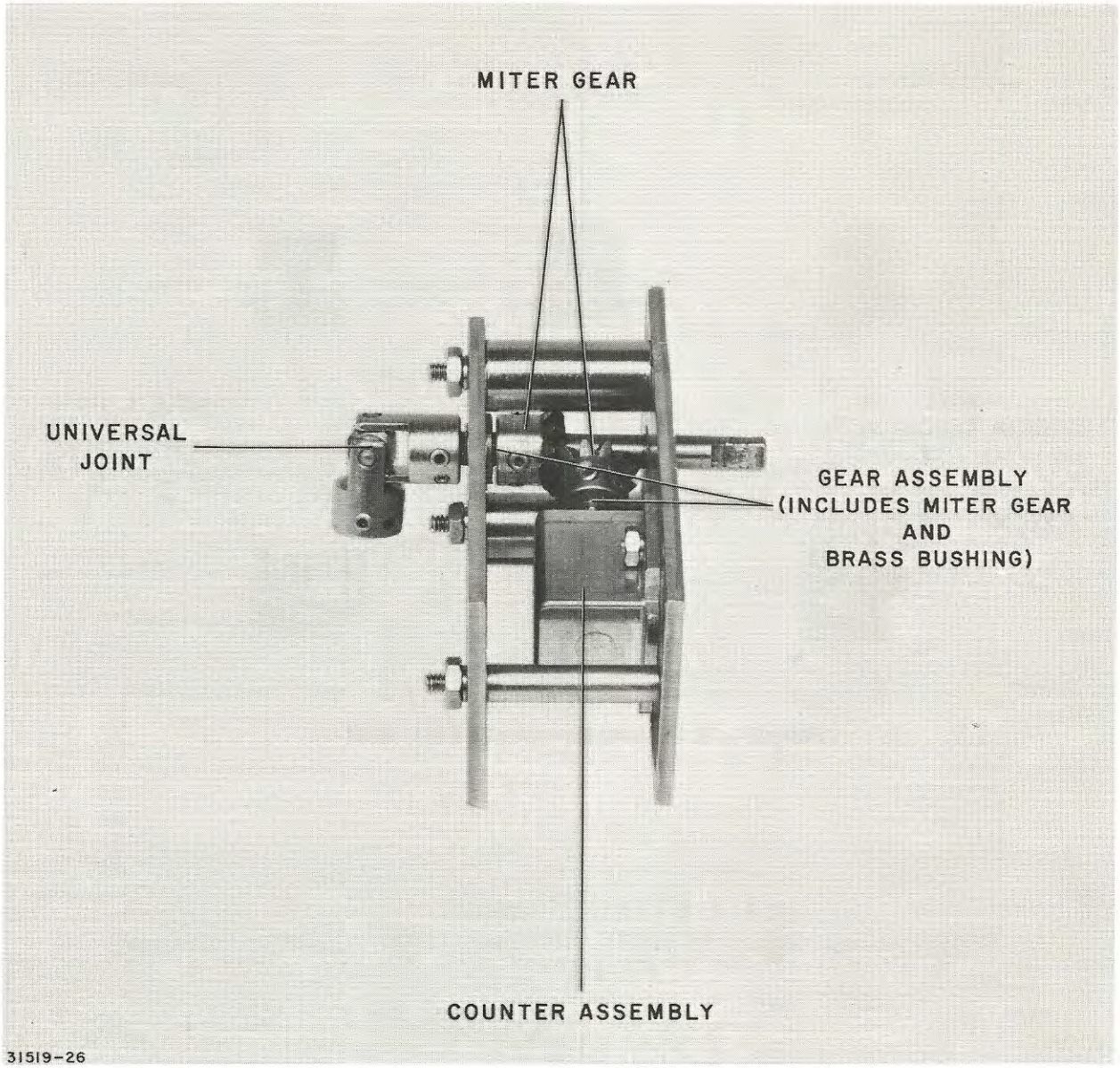


Figure 26. 1L105 and 1L106 Counter Assemblies

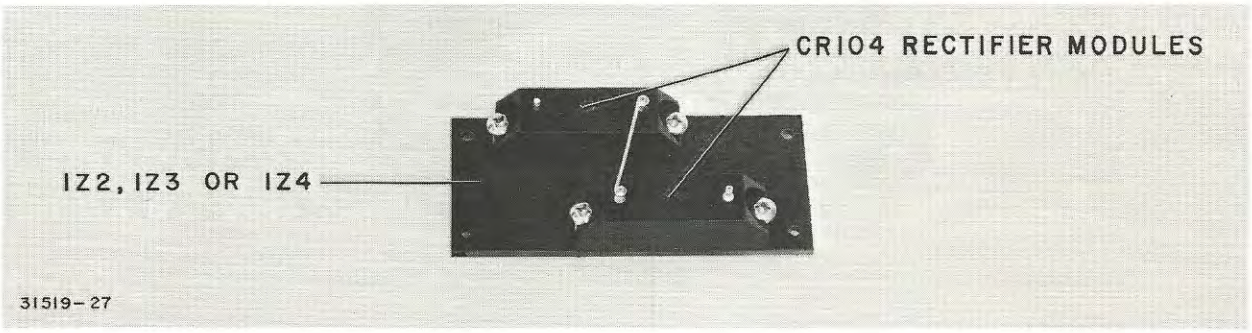
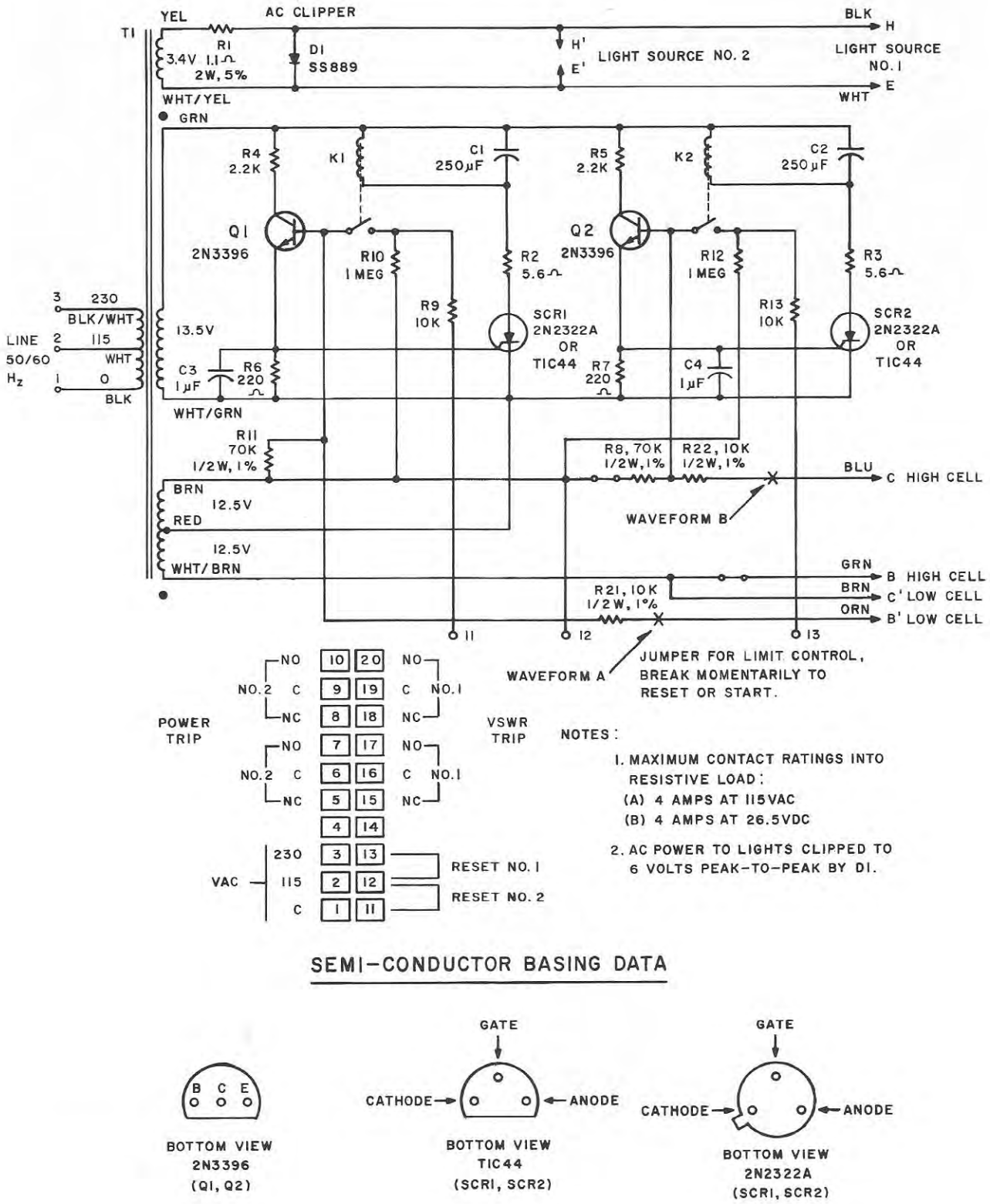


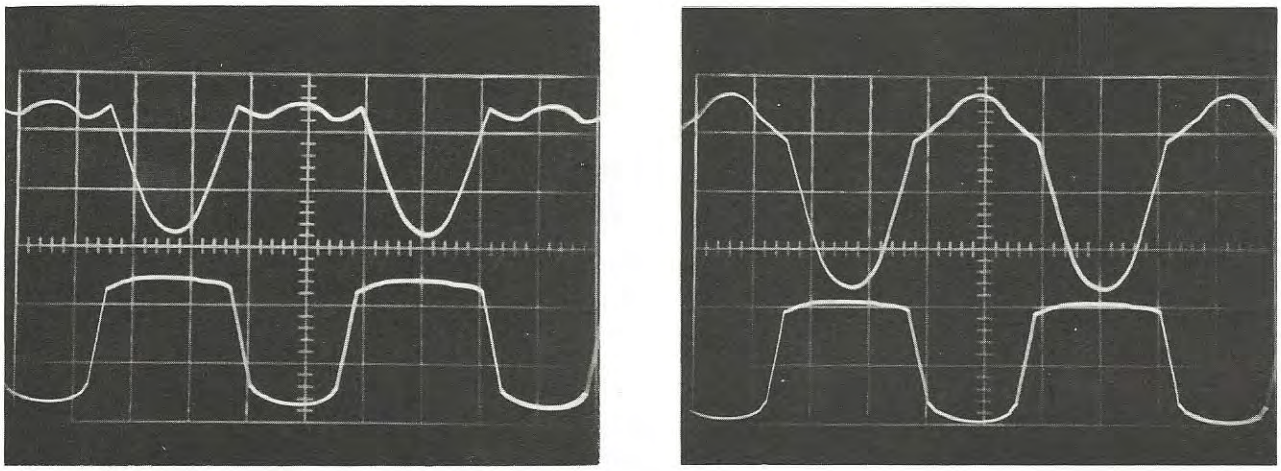
Figure 27. Low Voltage Rectifier Assembly



SEMI-CONDUCTOR BASING DATA

8027531-11

Figure 28. 1Z6 Control Module, Schematic Diagram



8027531-12

A B

Figure 29. Control Module Waveforms

NOTES:

1. WAVEFORM A IN BASE CIRCUIT OF Q1 (POWER TRIP) AT "WAVEFORM A" POINT ON FIGURE 28.
2. WAVEFORM B IN BASE CIRCUIT OF Q2 (VSWR TRIP) AT "WAVEFORM B" POINT ON FIGURE 28.
3. SCOPE NEGATIVE (GROUND) LEAD CONNECTED TO RED (CENTER-TAP) LEAD OF T1.
4. SCOPE VERTICAL SENSITIVITY 5V/CM.
5. SCOPE SWEEP RATE 5 MILLISEC/CM.

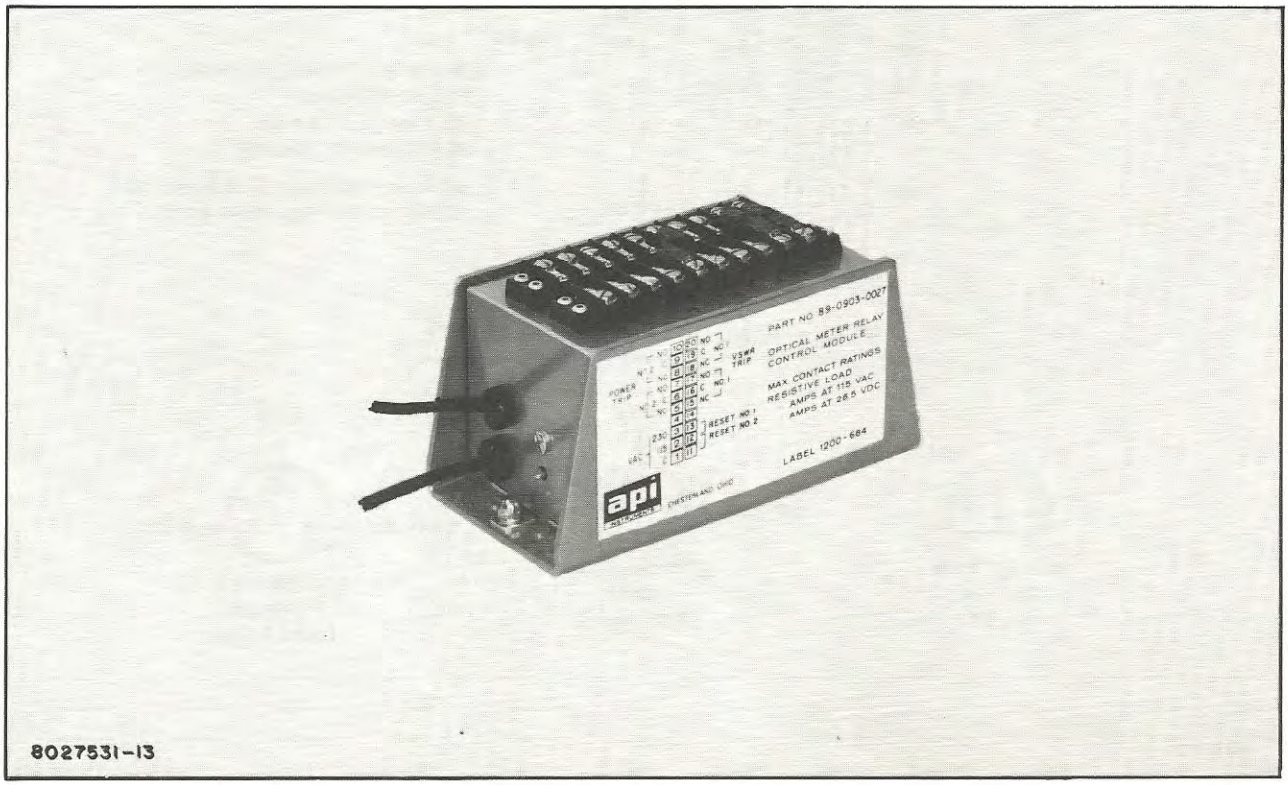


Figure 30. Control Module

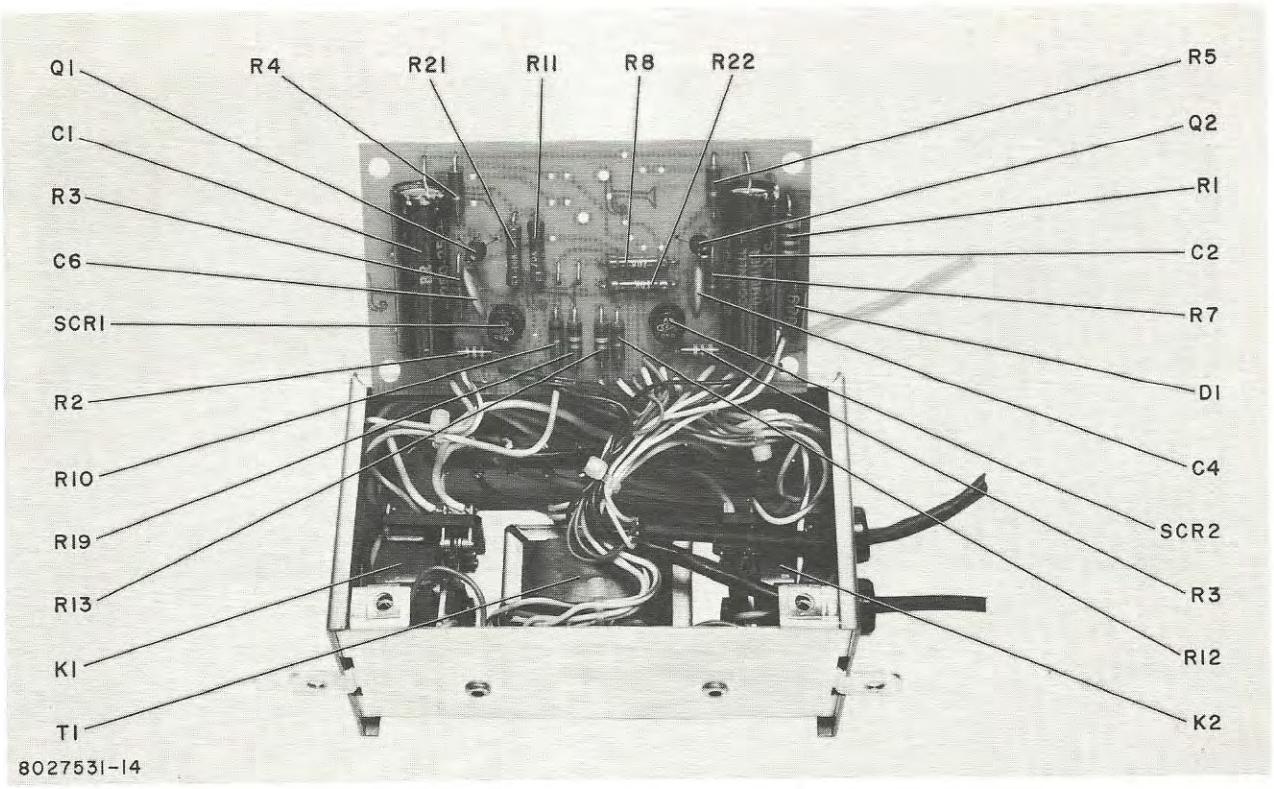


Figure 31. Control Module, Electrical Parts

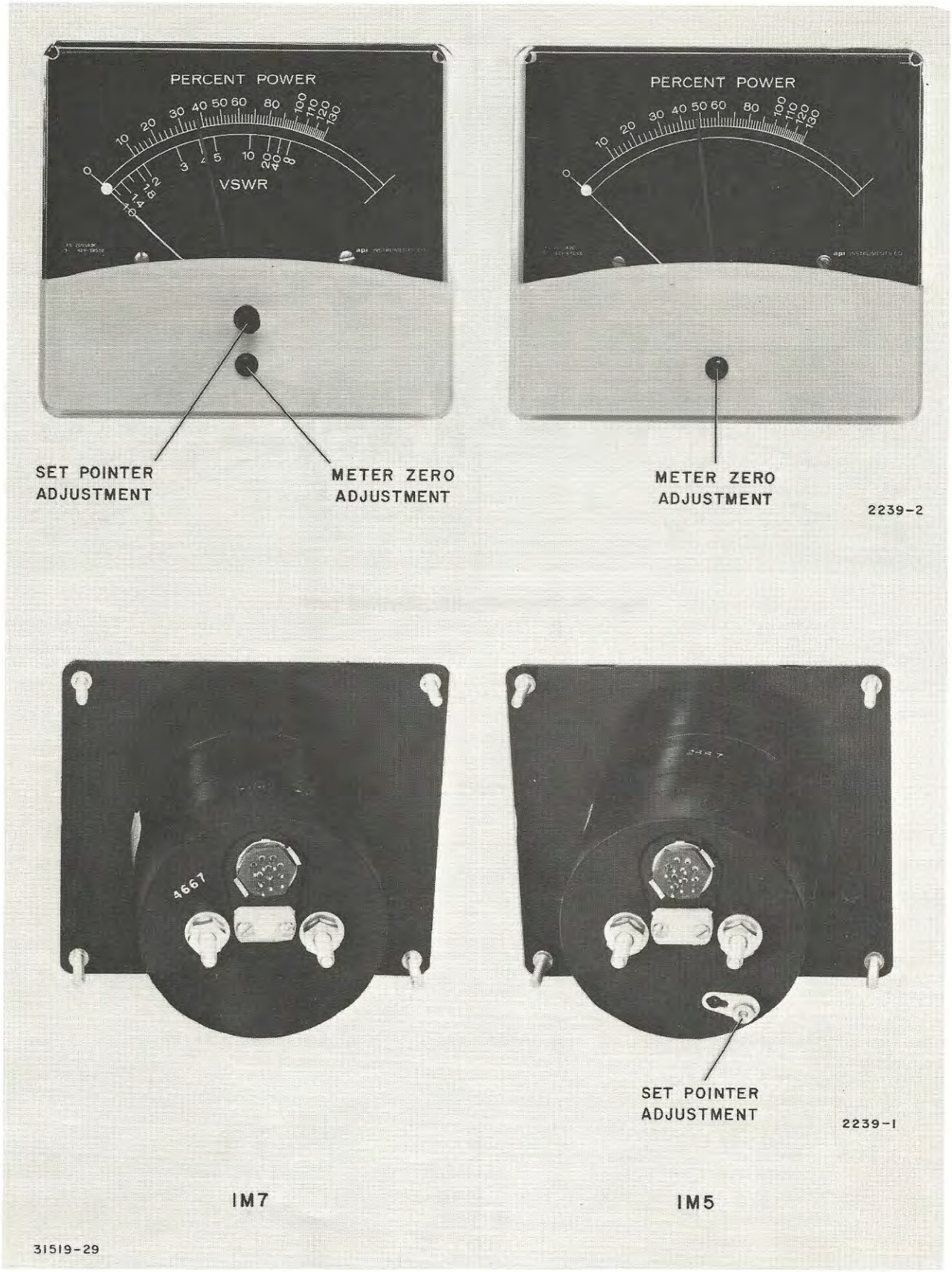


Figure 32. 1M5 and 1M7 Panel Meters

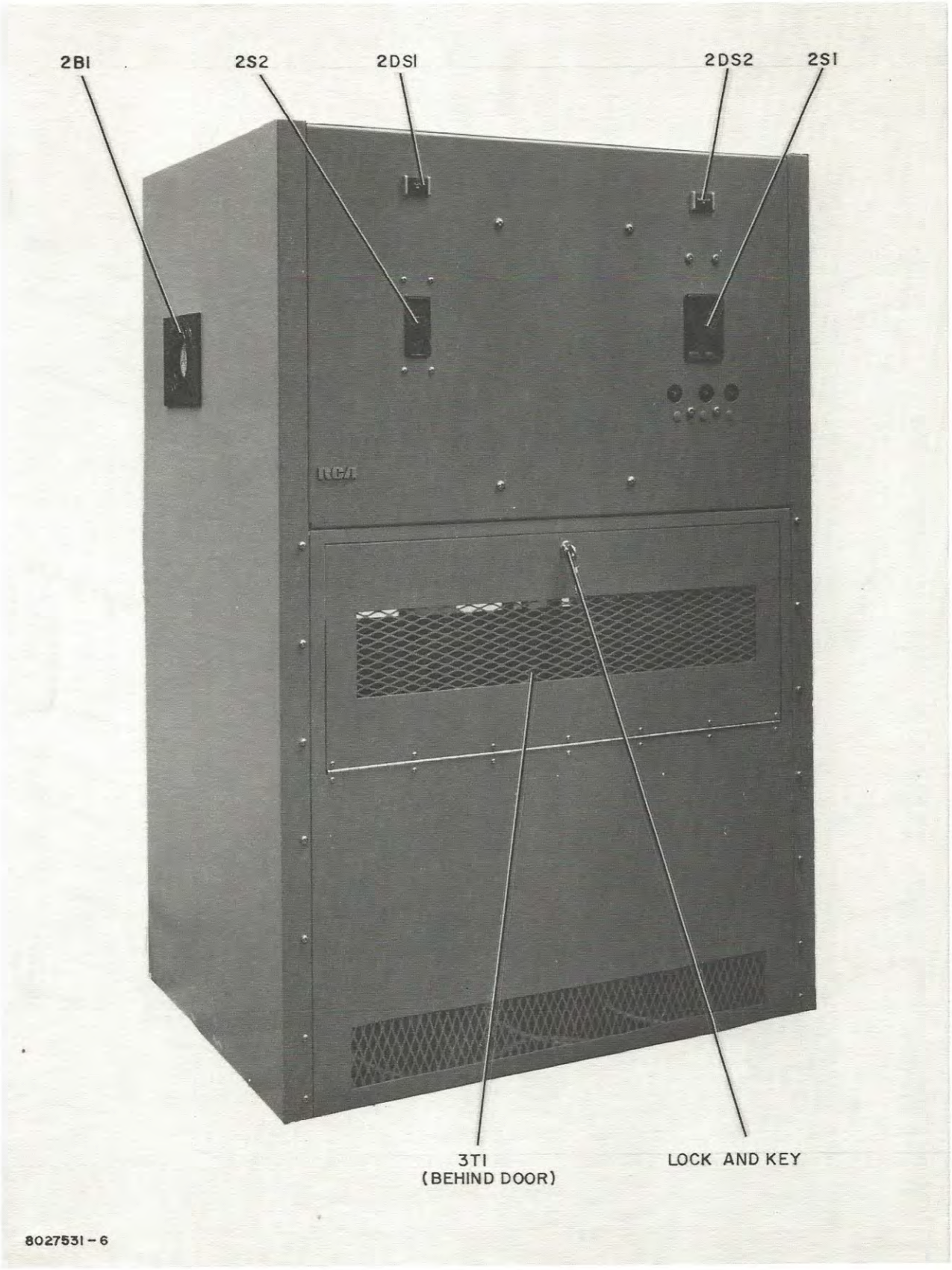


Figure 33. High Voltage Power Supply, Front View

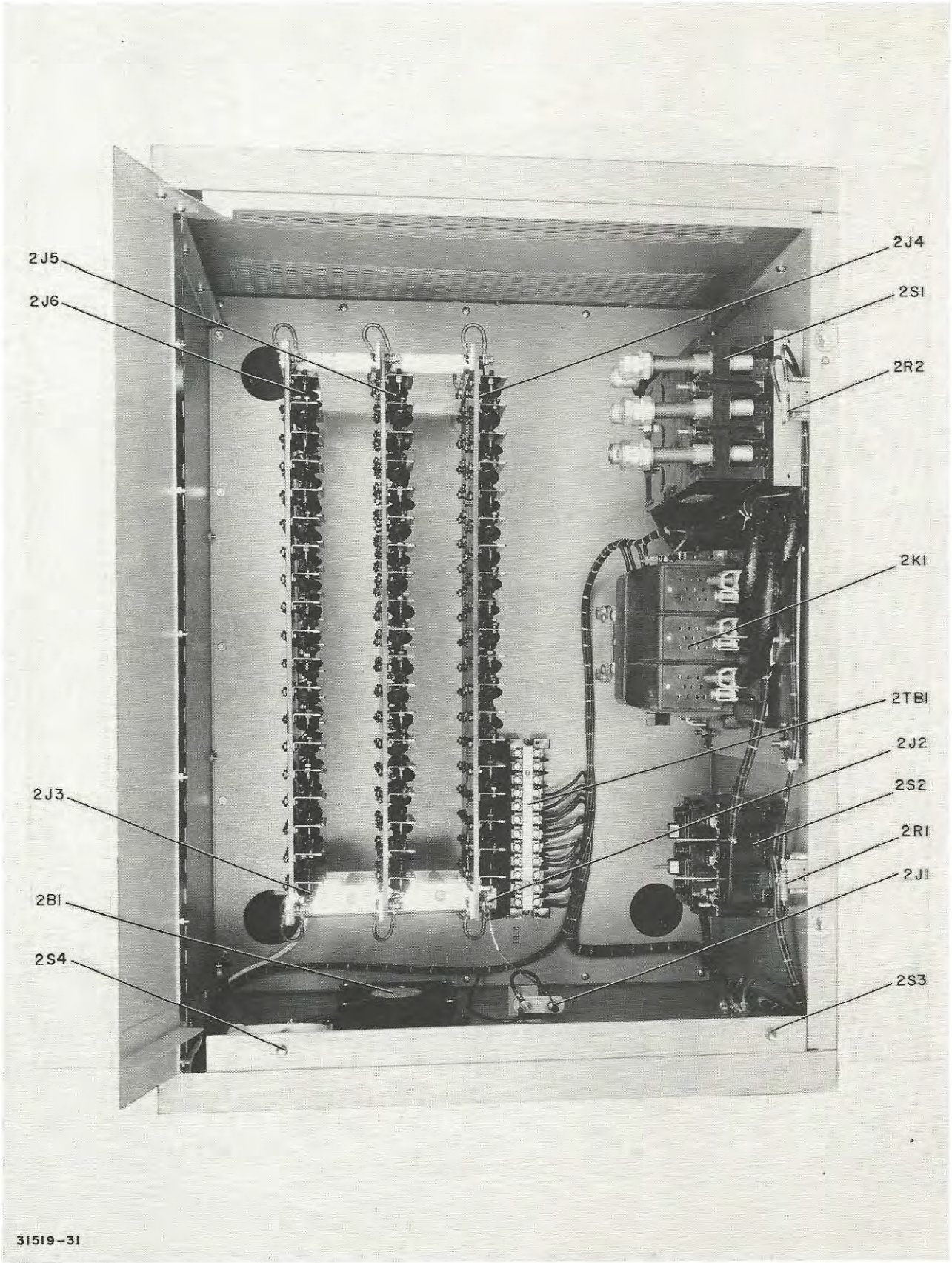


Figure 34. High Voltage Power Supply, Top View

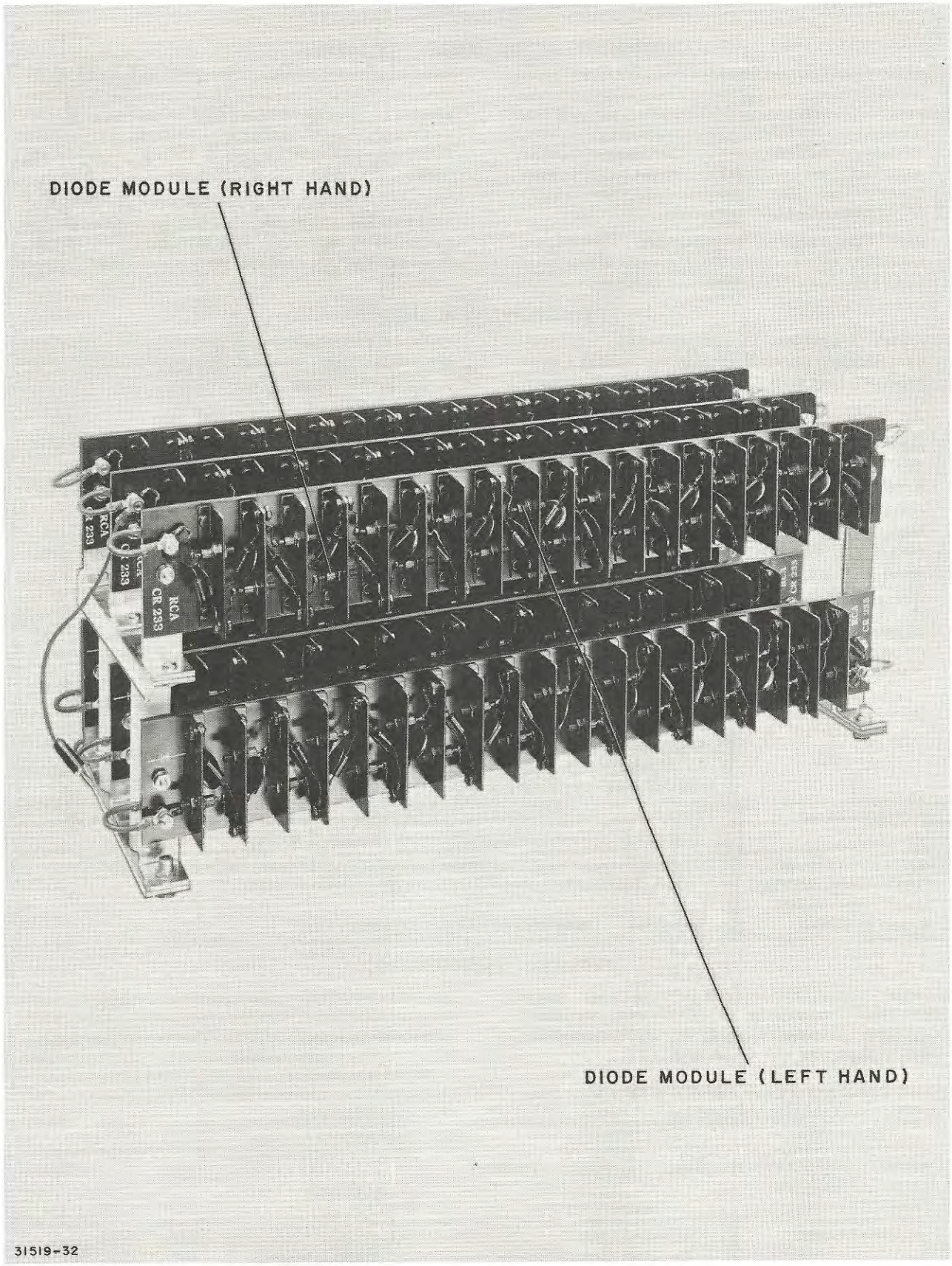


Figure 35. High Voltage Power Supply, Rectifier Stack

PARTS ORDERING INFORMATION

EQUIPMENT LOST OR DAMAGED IN TRANSIT

When delivering the equipment to you, the truck driver or carrier's agent will present a receipt for your signature. Do not sign it until you have (a) inspected the containers for visible signs of damage and (b) counted the containers and compared with the amount shown on the shipping papers. If a shortage or if evidence of damage is noted, insist that notation to that effect be made on the shipping papers before you sign them.

Further, after receiving the equipment, unpack it and inspect thoroughly for concealed damage. If concealed damage is discovered, immediately notify the carrier, confirming the notification in writing, and secure an inspection report. This item should be unpacked and inspected for damage WITHIN 15 DAYS after receipt. Report all shortages and damages to RCA, Commercial Electronics Systems Division - Camden, New Jersey 08102.

RCA will file all claims for loss and damage on this equipment so long as the inspection report is obtained. Disposition of the damaged item will be furnished by RCA.

FIELD ENGINEERING SERVICE

RCA Field Engineering Service is available at current rates. Requests for field engineering service may be addressed to your RCA Broadcast Field Representative or the RCA Service Company, Incorporated - Broadcast Service Division - Camden, New Jersey 08102. Telephone 609-963-8000.

REPLACEMENT PARTS

When ordering replacement parts, please give Stock or Master Item (MI) Number, Description, and Symbol of each item ordered.

The part which will be supplied against an order for a replacement item may not be an exact duplicate of the original part. However, it will be a satisfactory replacement differing only in minor mechanical or electrical characteristics. Such differences will in no way impair the operation of the equipment.

Emergency Service

For emergency service after working hours, contact RCA Parts and Accessories, Telephone 609-963-8000.

LOCATION	ORDERING INSTRUCTIONS
Continental United States, including Alaska and Hawaii	Replacement Parts bearing a STOCK NUMBER should be ordered from RCA Parts and Accessories - 2000 Clements Bridge Road - Deptford, New Jersey 08096. Replacement Parts bearing a MASTER ITEM (MI) NUMBER should be ordered from RCA, Commercial Electronic Systems Division - Attention Commercial Service - Camden, New Jersey 08102 or your nearest RCA Regional Office. Replacement Parts with NO STOCK or MASTER ITEM (MI) NUMBER are standard components. They are not stocked by RCA and should be obtained from your local electronics distributor.
Dominion of Canada	Order from your local RCA Sales Representative or his office or from: RCA Victor Company Limited, 1001 Lenoir Street, Montreal, Quebec.
Outside of Continental United States, Alaska Hawaii, and the Dominion of Canada	Order from your local RCA Sales Representative or from: RCA International Division, Clark, New Jersey - U.S.A. - Wire: RADIOINTER **Emergency:** Cable RADIOPARTS, DEPTFORD, N.J.

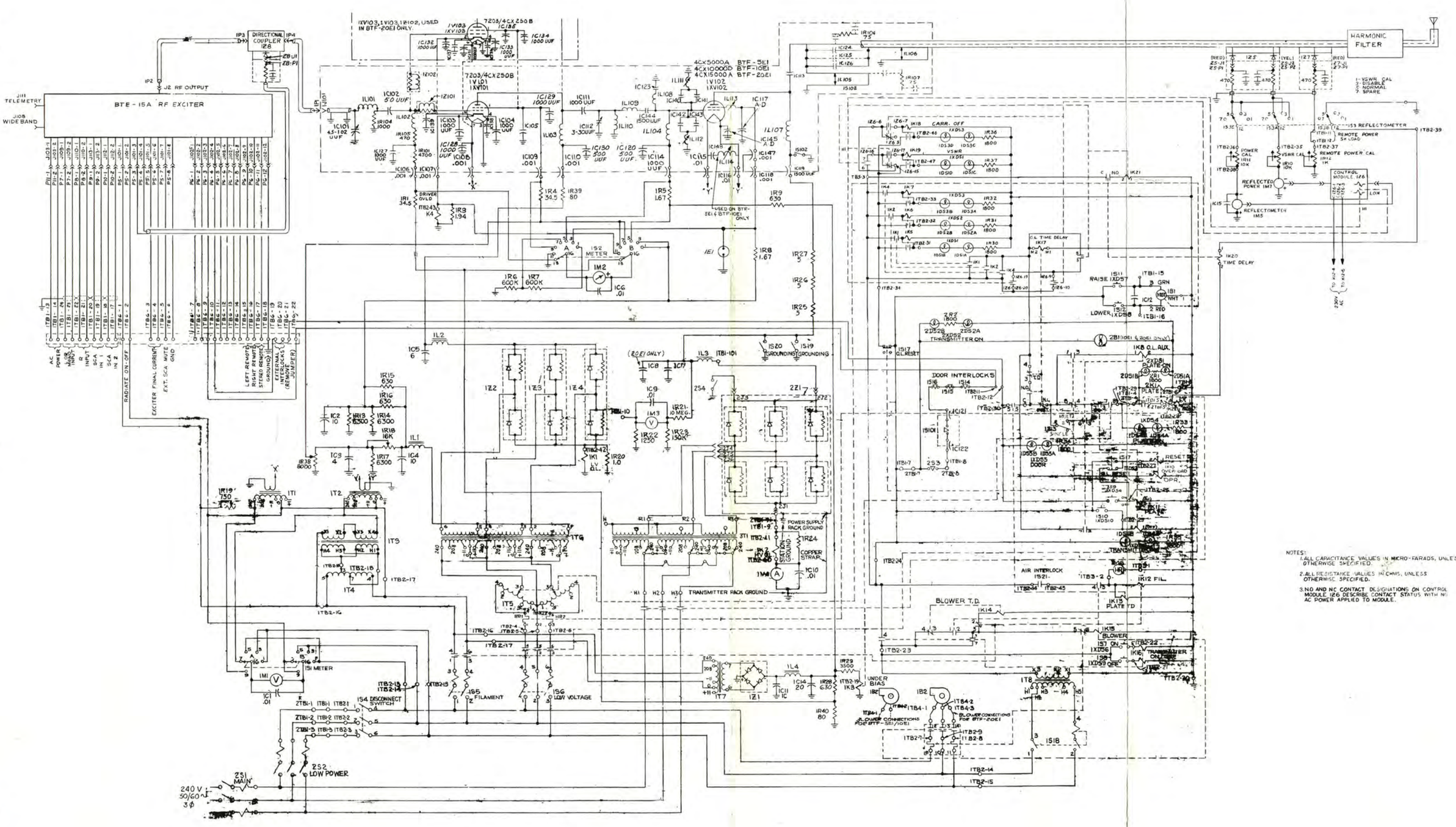
RETURN OF ELECTRON TUBES

If for any reason, it is desired to return tubes, please return them through your local RCA tube distributor, RCA Victor Company Limited, or RCA International Division, depending on your location.

Please do not return tubes directly to RCA without authorization and shipping instructions.

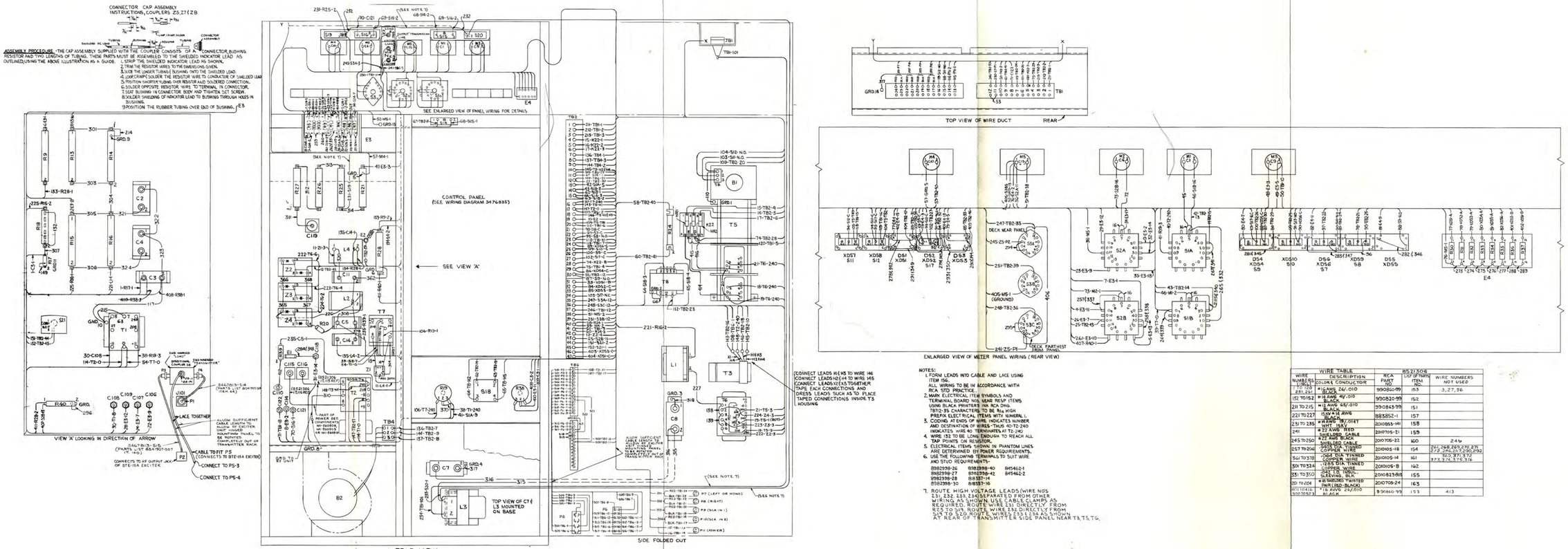
It is important that complete information regarding each tube (including type, serial number, hours of service and reason for its return) be given. When tubes are returned, they should be shipped to the address specified on the Return Authorization form. A copy of the Return Authorization and also a Service Report for each tube should be packed with the tubes.

LOCATION	ORDERING INSTRUCTIONS
Continental United States, including Alaska and Hawaii	Local RCA Tube Distributor.
Dominion of Canada	Order from your local RCA Sales Representative or his office or from: RCA Victor Company Limited, 1001 Lenoir Street, Montreal, Quebec
Outside of Continental United States, Alaska Hawaii, and the Dominion of Canada	Local RCA Tube Distributor or from: RCA International Division, Clark, New Jersey, U.S.A., Wire: RADIOINTER **Emergency:** Cable RADIOPARTS, DEPTFORD, N.J.



NOTES:
1. ALL CAPACITANCE VALUES IN MICRO-FARADS, UNLESS OTHERWISE SPECIFIED.
2. ALL RESISTANCE VALUES IN OHMS, UNLESS OTHERWISE SPECIFIED.
3. NO AND NC CONTACT DESIGNATIONS ON CONTROL MODULE IZ6 DESCRIBE CONTACT STATUS WITH NO AC POWER APPLIED TO MODULE.

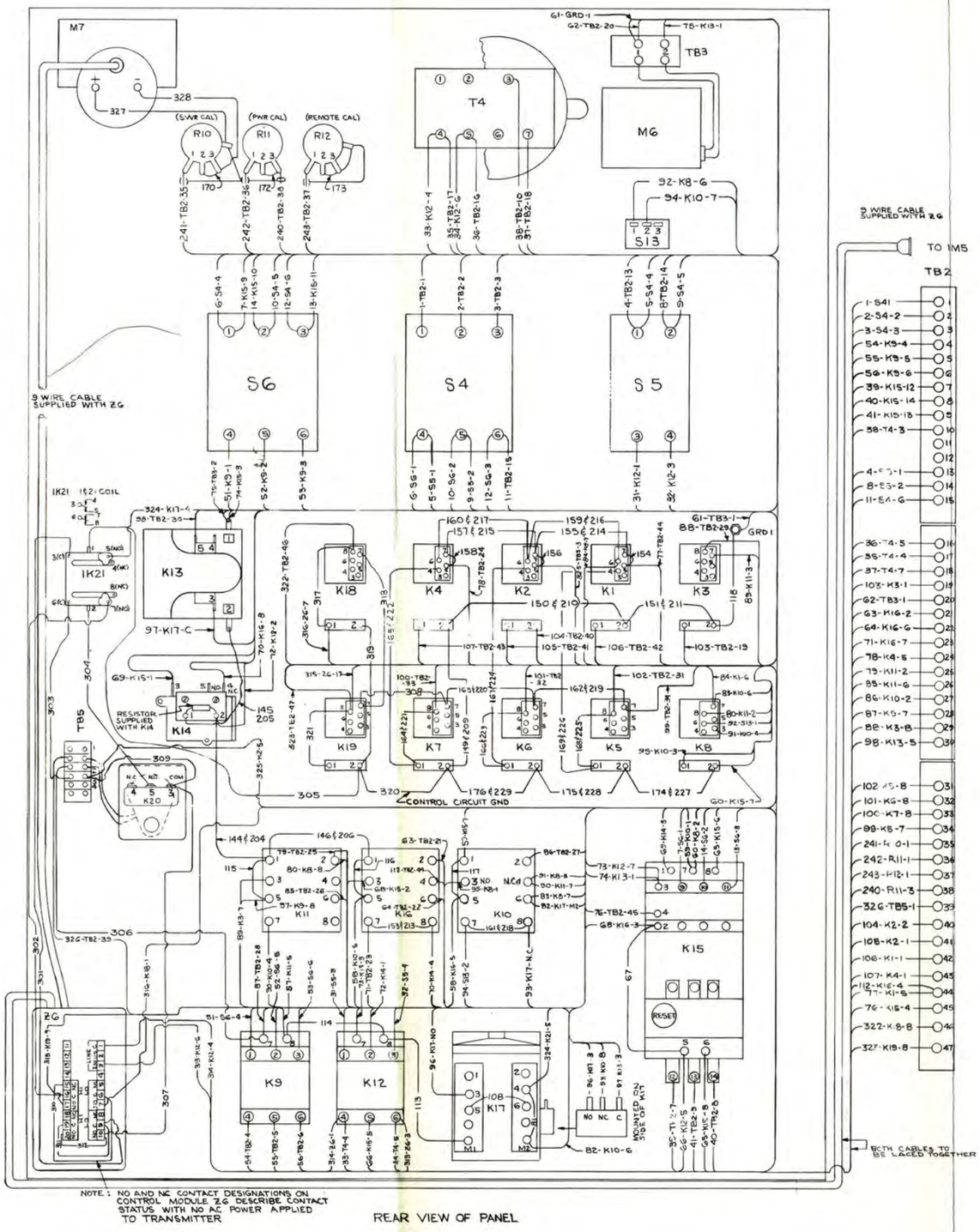
Figure 36. BTF-20E1, Schematic Diagram



NOTES:
1. FORM LEADS INTO CABLE AND LACE USING ITEM 156.
ALL WIRING TO BE IN ACCORDANCE WITH RCA STD PRACTICE.
2. MARK ELECTRICAL ITEM SYMBOLS AND TERMINAL BOARD NOS. NEAR RESP ITEMS USING BLACK PRINTERS INK RCA DWG. 78712-35 CHARACTERS TO BE 3/16 HIGH PREFIX ELECTRICAL ITEMS WITH NUMERAL 1.
3. CODING AT ENDS OF WIRE INDICATES NUMBER AND DESTINATION OF WIRES - THUS 40-T2-240 INDICATES WIRE 40 TERMINATES AT T2-240
4. WIRE 132 TO BE LONG ENOUGH TO REACH ALL TAP POINTS ON RESISTOR.
5. ELECTRICAL ITEMS SHOWN IN PHANTOM LINES ARE DETERMINED BY POWER REQUIREMENTS.
6. USE THE FOLLOWING TERMINALS TO SUIT WIRE AND STUD REQUIREMENTS:
8382930-26 8382930-60 845462-1
8382930-27 8382930-62 845462-2
8382930-28 8383317-14
8383930-30 8383317-16
7. ROUTE HIGH VOLTAGE LEADS (WIRE NOS. 231, 232, 233, 234) SEPARATED FROM OTHER WIRING AS SHOWN. USE CABLE CLAMPS AS REQUIRED. ROUTE WIRE 231 DIRECTLY FROM R25 TO S19. ROUTE WIRE 232 DIRECTLY FROM S19 TO L2. ROUTE WIRES 233 & 234 AS SHOWN AT REAR OF TRANSMITTER SIDE PANEL NEAR T8, T5, T6.

WIRE NUMBERS (SEE NOTE 5)	WIRE TABLE DESCRIPTION COLOR & CONDUCTOR	RCA PART NO.	LOT OF TWIN ITEM NO.	WIRE NUMBERS NOT USED
1 TO 231, 233, 234	#16 AWG 26/.010 BLACK	990860-09	153	3,27,56
152 TO 152	#14 AWG 41/.010 BLACK	990820-99	152	
211 TO 215	#12 AWG 65/.010 BLACK	990863-99	151	
221 TO 227	#10 AWG 104/.010 BLACK	885852-1	157	
231 TO 235	#14 AWG 19/.0147 WHT. MAY	2010853-141	158	
241	#22 AWG RED	2010705-21	159	
245 TO 250	SHIELDED CABLE 2 CONDUCTOR TWISTED COPPER WIRE	2010705-22	160	24w
257 TO 296	ONE DIA TINNED COPPER WIRE	2010105-18	154	261-268, 285, 286, 291, 292, 295, 297, 298, 299, 300, 302
541 TO 578	ONE DIA TINNED COPPER WIRE	2010105-14	161	573, 574, 575, 576
50 TO 524	.1265 DIA TINNED COPPER WIRE	2010105-13	162	
251 TO 350	#18 SHIELDED SCREENED WIRE	2010823-806	155	
201 TO 204	#18 SHIELDED TWISTED PAIR (RED-BLACK)	2010705-24	163	
401 TO 416 500 TO 537	#16 AWG 26/.010 BLACK	990860-99	153	413

Figure 37. BTF-20E1, Wiring Diagram



NOTE: NO AND NC CONTACT DESIGNATIONS ON CONTROL MODULE ZG DESCRIBE CONTACT STATUS WITH NO AC POWER APPLIED TO TRANSMITTER

WIRE TABLE		8521306		
WIRE NOS. (INCL)	DESCRIPTION	RCA PART NUMBERS	LIST OF PARTS ITEM NO.	WIRE NOS NOT USED
	COLOR & CONDUCTOR			
1 TO 14	BLACK # 12 AWG 65/.010 600V	990863-99	151	
31 TO 41	BLACK # 14 AWG 41/.010 600V	990820-99	152	
51 TO 118	BLACK # 16 AWG 26/.010 300V	990860-99	153	109 TO 111 81
141 TO 176	.0403 DIA. TINNED COPPER	2010105-18	154	141 TO 143 147,148,152
201 TO 229	INSULATING TUBING .323 I.D. BLACK	2010823-803	155	201 TO 203 207,208,212
240 TO 243	WHITE #20 AWG SHIELDED WIRE	8845679-1	246	
301 TO 307, 309, 313 314, 315, 316, 322, 324, 325, 326, 327, 328	BLACK # 16 AWG	990860-99	153	
308, 310, 311, 312, 321 317, 318, 319, 320	.0403 DIA. TINNED COPPER	2010105-18	154	

1— FORM LEADS INTO CABLE AND LACE USING ITEM 156 AS REQUIRED. ALL WIRING TO BE IN ACCORDANCE WITH RCA STANDARD PRACTICE.

2— CODING AT ENDS OF WIRES INDICATES NUMBER AND DESTINATION OF WIRES— THUS 1-S4-1 INDICATES WIRE 1 TERMINATES AT S4-1

3— MARK ELECTRICAL ITEM SYMBOLS AND TERMINAL BOARD NUMBERS NEAR RESPECTIVE PARTS USING BLACK STAMPING INK RCA DWG 78712-35 CHARACTERS TO BE STANDARD 3/16 HIGH. PREFIX ELECTRICAL ITEMS WITH NUMERAL 1.

4— USE THE FOLLOWING TERMINALS TO SUIT REQUIREMENTS

8982998-26	8982998-40
8982998-27	8982998-42
8982998-28	818337-14
8982998-30	818337-16

Figure 38. Control Panel, Wiring Diagram

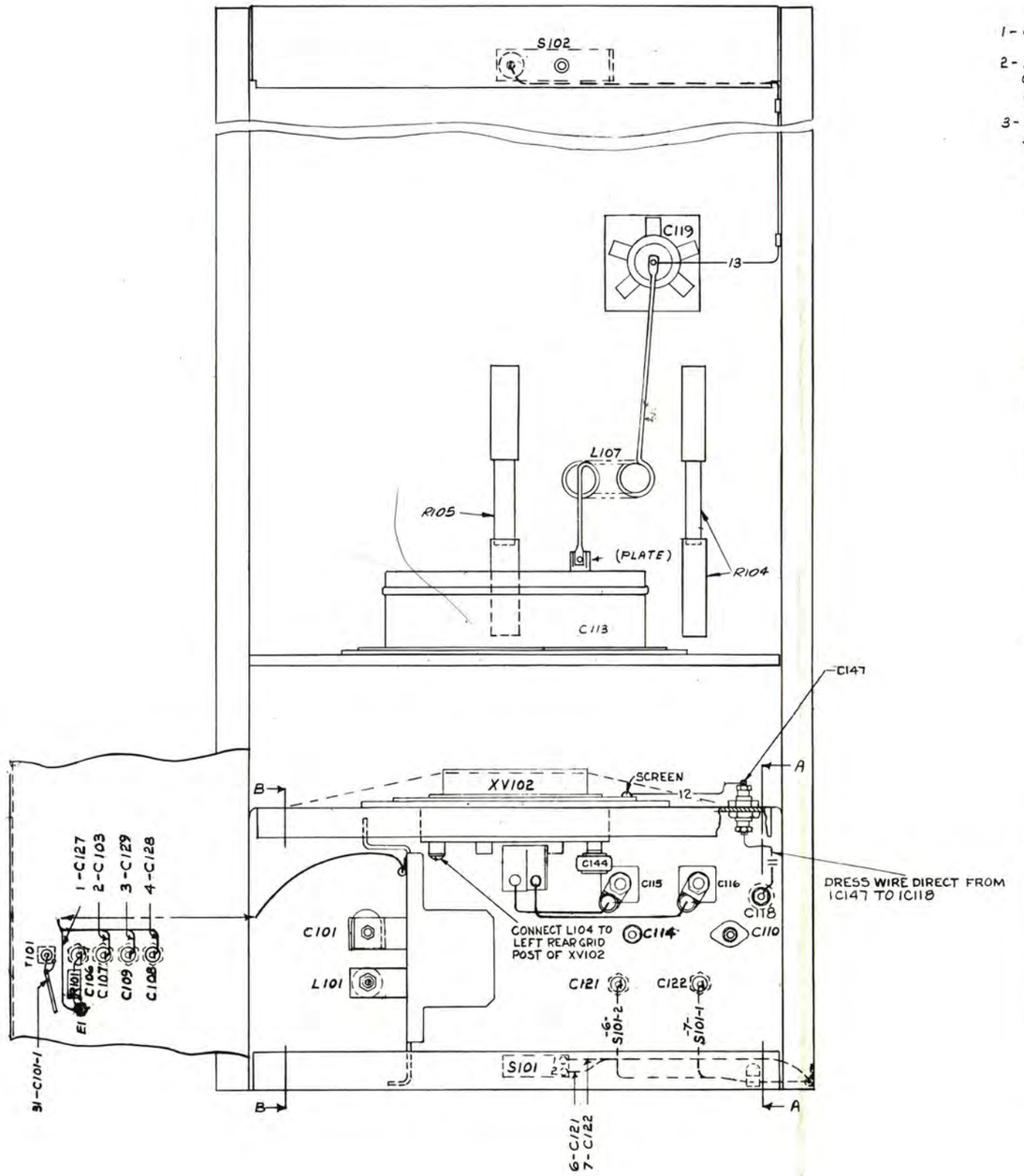
1- CABLE WIRES AS SHOWN AND LACE USING ITEM-121.

2- MARK ELECTRICAL SYMBOLS 3/16 HIGH, STANDARD CHARACTERS USING BLACK PRINTERS. PREFIX SYMBOLS WITH NUMERAL 1.

3- USE FOLLOWING TERMINALS TO SUIT WIRE AND STUD REQUIREMENTS.
8982998-15 (SOLDERLESS) 818337-27 (.128 BUS)
818337-6 (.064 BUS) 818337-23 (30 KV WIRE)
818337-1 (WHT. H.V WIRE NO.13).

3474003-1

WIRE TABLE			B541907	
WIRE NOS INCL	DESCRIPTION	RCA PART NO.	LIST OF PARTS ITEM NO.	WIRE NOS NOT USED
1 TO 7	BLACK #18 AWG 16/0.10 600V	2010592-25	125	5
11 & 12	BLACK #14 AWG 19/0.147 30KV DC	2010706-35	126	
21 TO 26 51 TO 60	TINNED COPPER WIRE .040 DIA.	2010105-18	127	
32,33	TINNED COPPER WIRE .064 DIA.	2010105-14	128	
41,42,43	SLEEVING, INSULATING, BLACK .076 NOM. I.D	2010823-806	130	
13	WHITE #10AWG. 19/0.234 15KVDC	2010853-145	131	
31	COAXIAL CABLE RG-58/U	2010745-458		



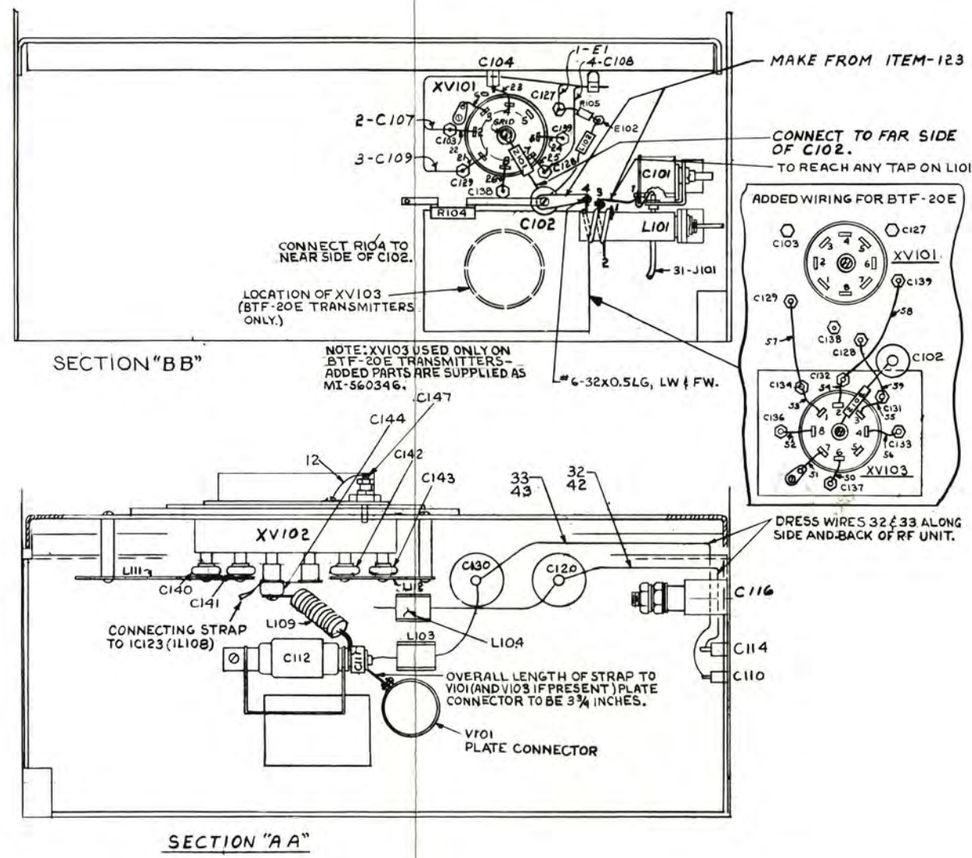
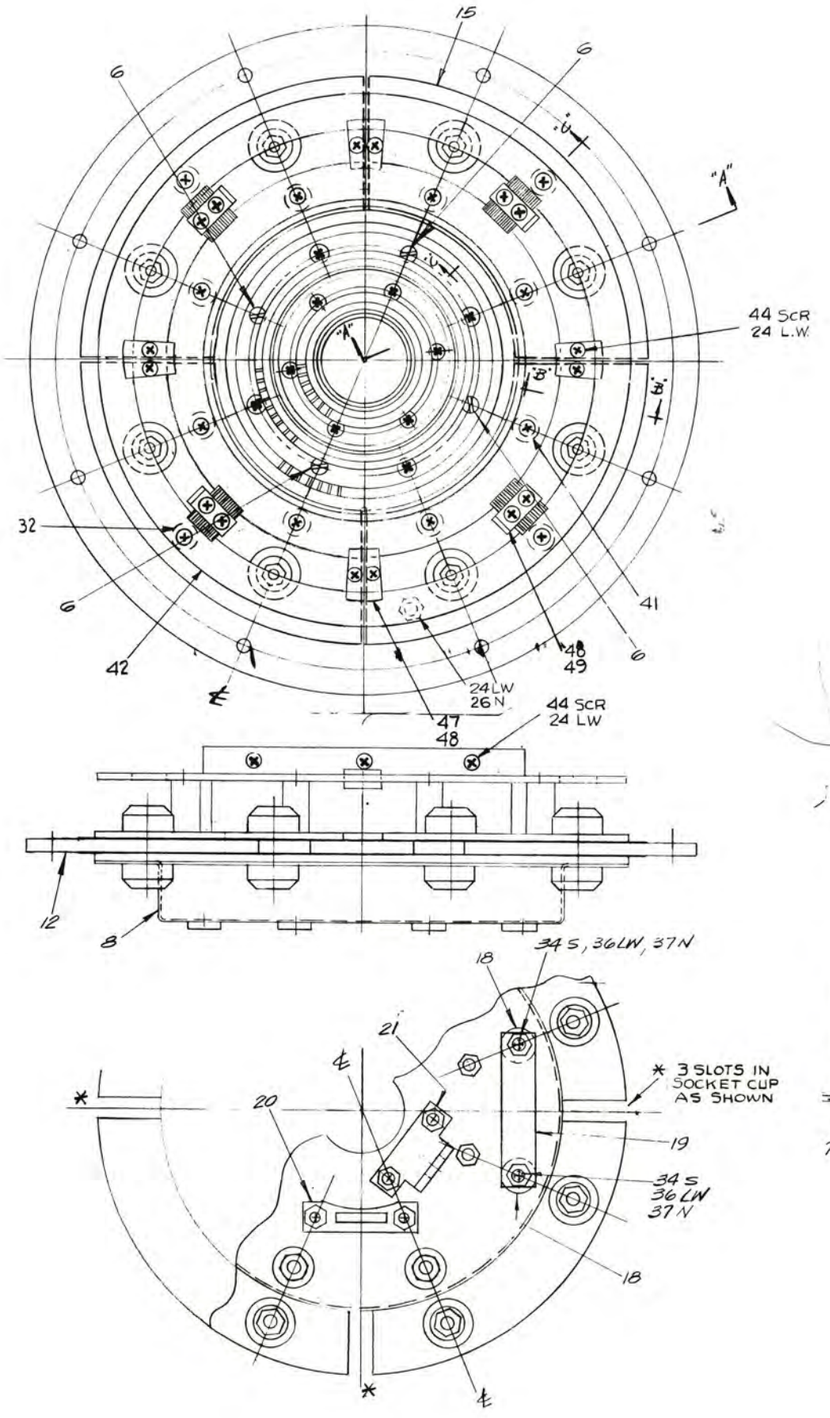
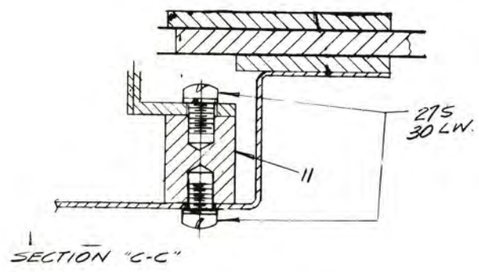
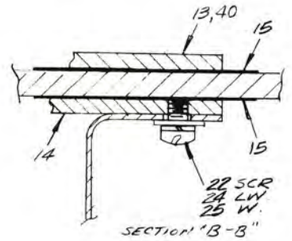


Figure 39. RF Box, Wiring Diagram

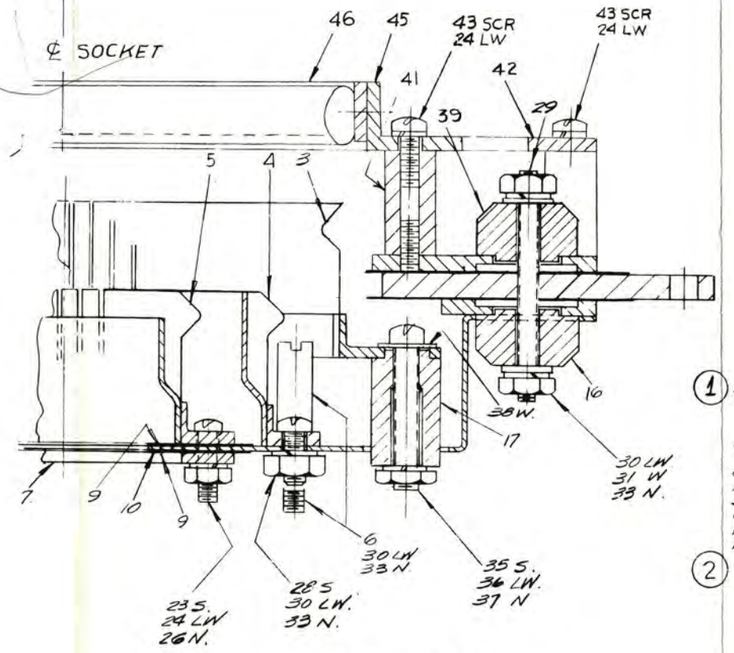




SECTION "C-C"



SECTION "B-B"



SECTION "A-A"

GROUP NO. 504	503	502	501	QUANTITY				ITEM OR SYMBOL	REFERENCE DRAWING OR SPECIFICATION	REFERENCE PART GROUP	DESCRIPTION
					X			1			ASSEMBLY.
				X				2			ASSEMBLY
				1	1			3	644382	4	COLLET, CONTROL GRID.
				1	1			4	644382	5	COLLET, OUTER FIL.
				1	1			5	644382	6	COLLET, INNER FIL.
				4	4			6	644382	7	POST, STOP
				1	1			7	644382	13	RING, INNER FIL. BUSS.
				1	1			8	3467706	1	CUP, SOCKET
				2	2			9	8519978	1	RING, INSULATOR
				6	6			10	886304A	7	BUSHING.
				4	4			11	8519977	4	POST, INSULATOR
				1	1			12	8741459	1	PLATE
				–	4			13	8449769	6	PLATE
				4	4			14	8449769	5	PLATE
				8	8			15	8446964	2	CAPACITOR, SILVERED MICA
				8	16			16	426763	3	INSULATOR, NS5W4001
				8	8			17	3455760	2	STANDOFF
				2	2			18	3455762	1	WASHER
				1	1			19	3455155	1	STRAP
				1	1			20	8543184	501	BRACKET ASSEMBLY
				1	1			21	8543185	1	BRACKET
				16	16			22	990106	153	SCR, PAN HD .138(6)-32 X .19LG.
				6	6			23	990106	163	SCR, PAN HD .138(6)-32 X .50LG.
				68	22			24	93620	157	LOCKWASHER #6.
				16	6			25	82278	154	WASHER (PLAIN) #6
				7	6			26	57435	154	NUT, HEX. #6
				8	8			27	990108	157	SCR, PAN HD. .164(#8)-32 X .31 LG.
				4	4			28	990108	159	SCR, PAN HD. .164(#8)-32 X .38 LG.
				8	8			29	69271	172	STUD .164(#8)-32 x 1.69 LG.
				32	24			30	93620	159	LOCKWASHER #8
				16	8			31	82278	155	WASHER (PLAIN) #8
				12		32			3453185	3	SPACER
				24	16			33	57435	155	NUT, HEX. #8-32
				2	2			34	990140	179	SCR, PAN HD .190(#10)-32 X 1.75LG.
				6	6			35	990140	175	SCR, PAN HD .190(#10)-32 X 1.18 LG.
				8	8			36	93620	162	LOCKWASHER #10
				8	8			37	57435	156	NUT, HEX. #10-32
				8				38	82278	171	WASHER (PLAIN) #10 (LARGE PART)
				8				39	426763	9	INSULATOR NS5W4003
				4				40	3462630	502	PLATE ASSEMBLY
				8				41	426765	9	INSULATOR NS5W0106
				1				42	3462629	2	RING
				20				43	990106	159	SCR. PAN. HD. .138(6)-32x.38 LG.
				24				44	990106	155	SCR. PAN. HD. .138(6)-32x.25LG.
				1				45	3467564	501	BASE ASSY, SCREEN GRID COLLET
				2				46	8465194	501	CONTACT ASSY SCREEN GRID COLLET
				4				47	3462634	2	SPACER
				8				48	3462634	1	SPACER
				4				49	3462635	501	CONTACT ASSEMBLY
								50			

(1) PTS. 3, 4, & 5 TO BE ALIGNED WITH A 4CX800A DUMMY TUBE OR GAUGE TO NOMINAL DIMENSIONS.

TEST SPECIFICATION.
CAPACITY OF (4) SEGMENTS (PT. 13) TO CENTER PLATE TO BE 6500 UUF MIN. TOTAL.
CAPACITY OF PT. 14 TO CENTER PLATE TO BE 2,750 UUF MIN. TOTAL. A TEST VOLTAGE OF 5000 VOLTS DC MUST BE APPLIED BETWEEN THE (4) SEGMENTS (PT. 13) AND THE CENTER PLATE, ALSO BETWEEN PT. 14 AND THE CENTER PLATE. EACH SIDE TO BE TESTED FOR 1 MINUTE WITHOUT ARCING.

(2) ASSEMBLY GR502 SAME AS PART 1 EXCEPT AS SHOWN

Figure 40. 1XV102 Assembly Diagram

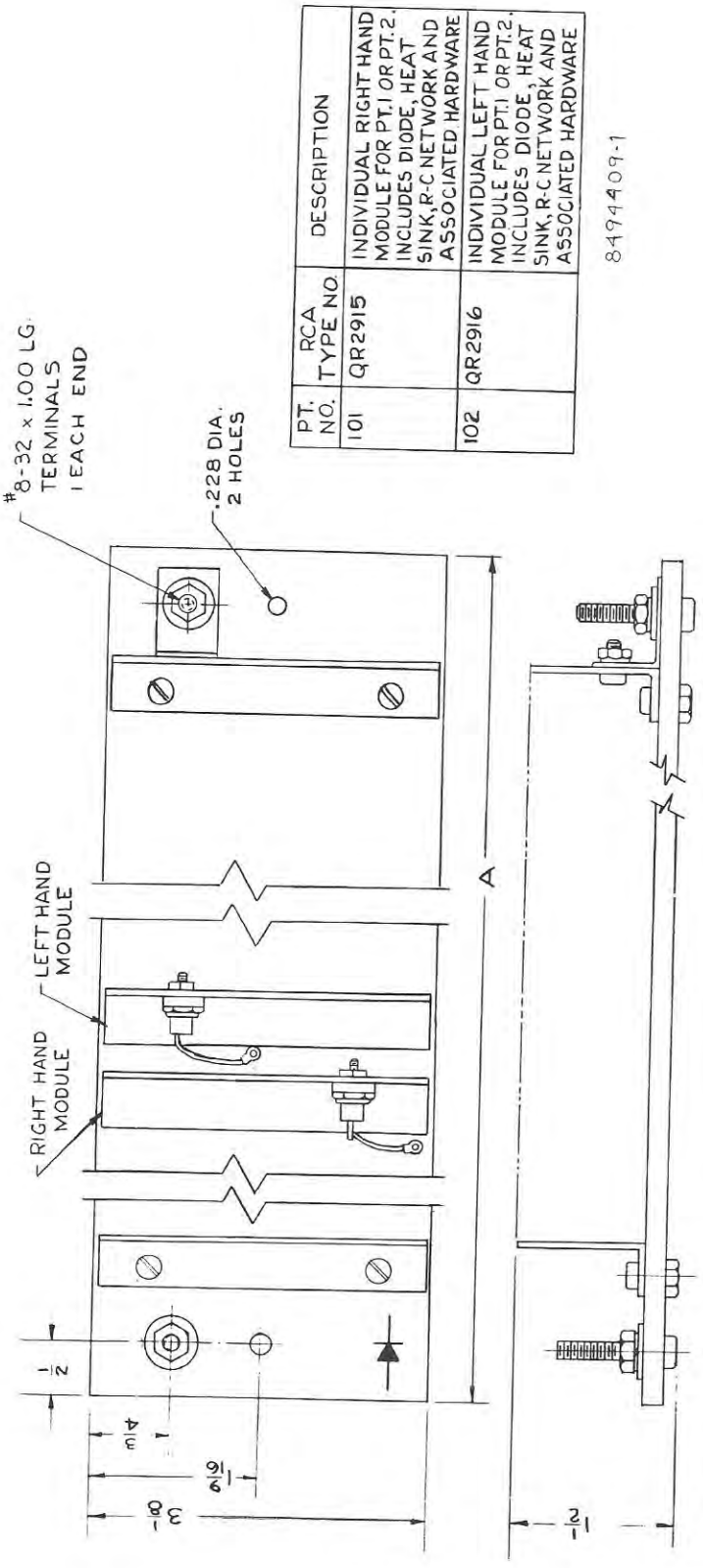
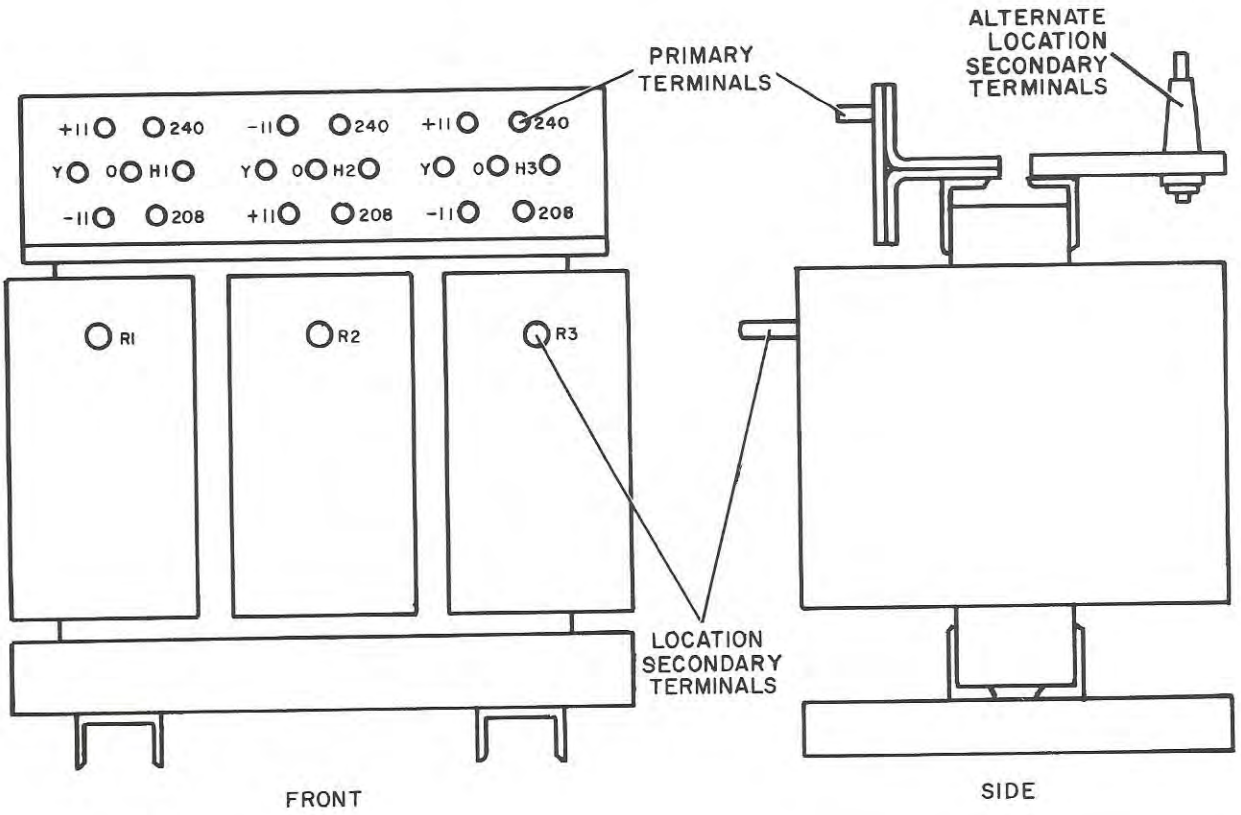
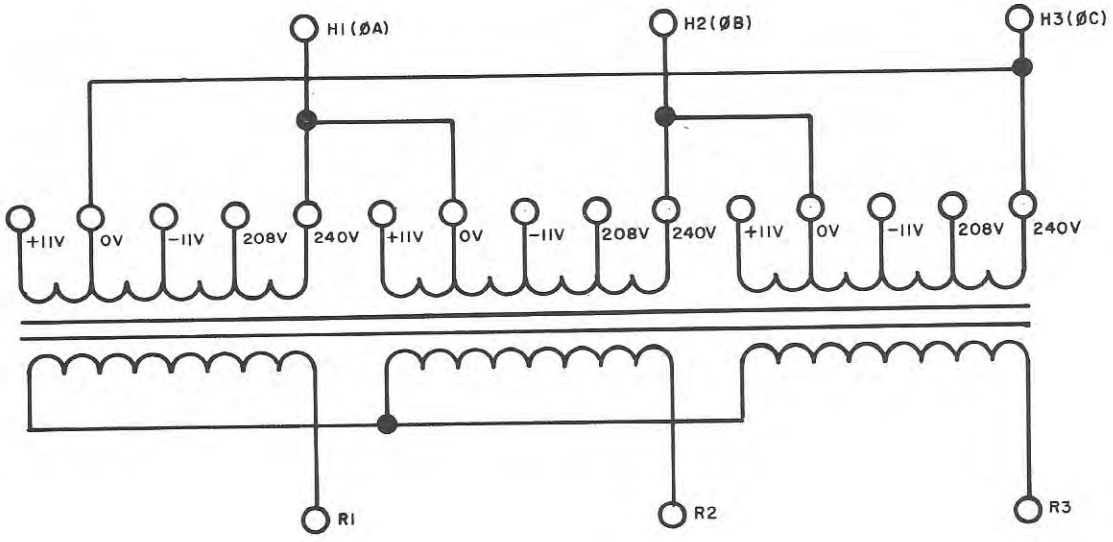


Figure 41. High Voltage Rectifier Assembly





31519-39

Figure 42. High Voltage Plate Transformer Terminals

MOUNTING SLOT DIMENSIONS			
SHORT BARRIER TYPE SLOT WIDTH .875 ±.010		LONG BARRIER TYPE SLOT WIDTH 1.115 ±.010	
NO. UNITS	SLOT LENGTH TOL. ±.010	NO. UNITS	SLOT LENGTH TOL. ±.010
1	1.431	1	1.191
2	2.693	2	2.213
3	3.957	3	3.237
4	5.221	4	4.261
5	6.485	5	5.285
6	7.749	6	6.309
7	9.013	7	7.333
8	10.277	8	8.357
9	11.541	9	9.381
10	12.805	10	10.405
11	14.069	11	11.429
12	15.333	12	12.453

NOTE -
1. FOR LAMP SEE 8890654.
FOR COLOR FILTER SEE 8543360.
FOR LAMP TOOL SEE 8545851

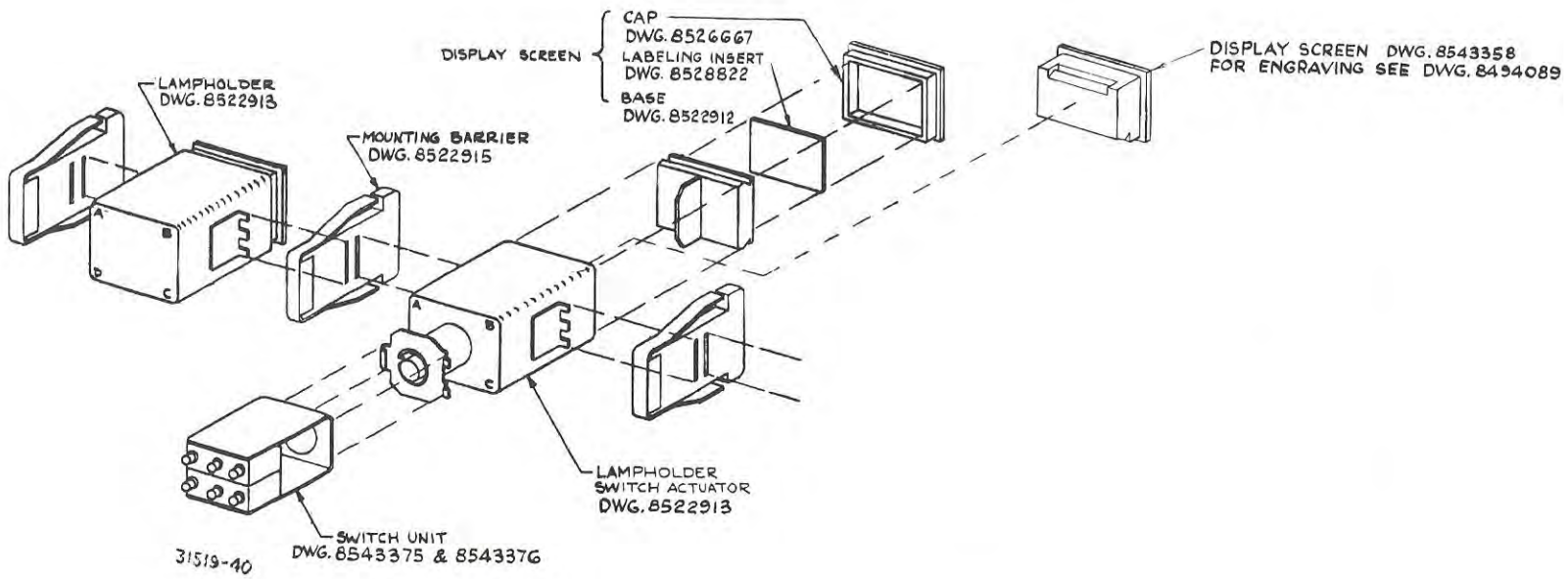
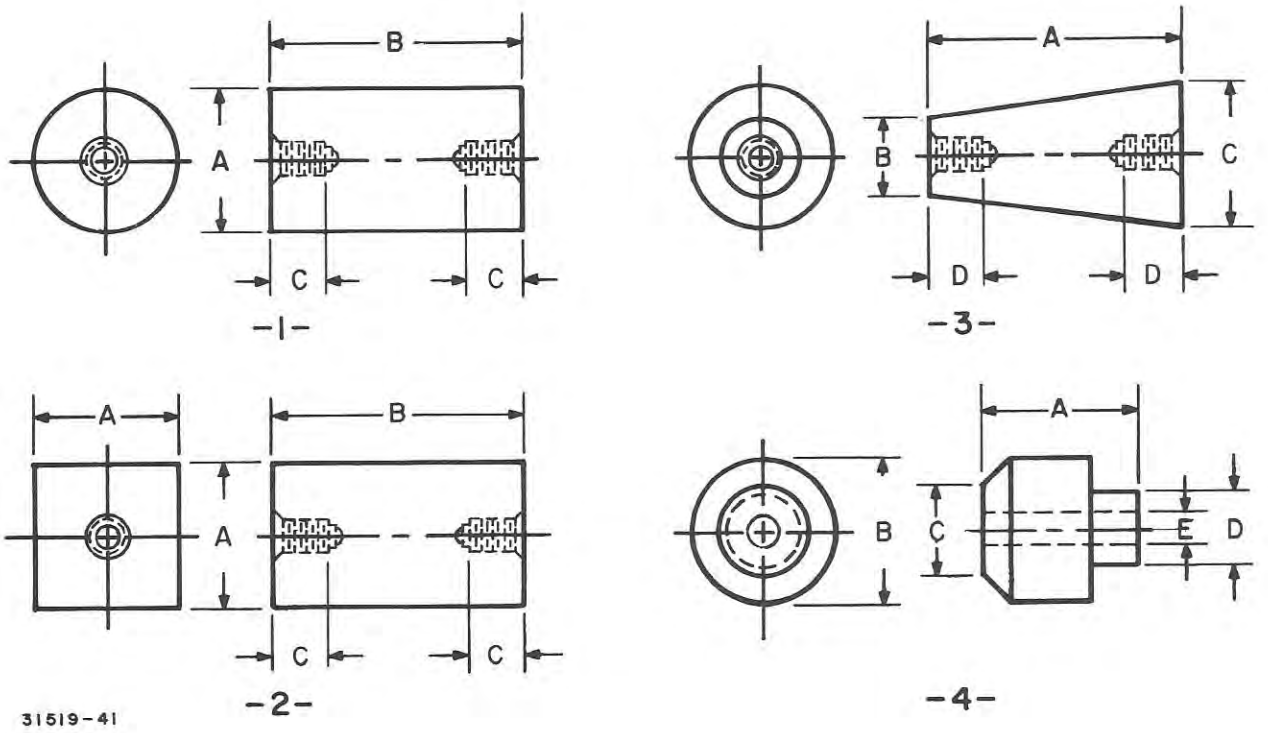


Figure 43. Pushbutton Switch Assembly



Drawing No.	Stock No.	Style	Dimensions In Inches A	B	C	D	E	Tap Size
426762-12	55081	3	3.0	3/4	1-1/2	3/8	–	10-32
426763-3	97459	4	0.425	3/4	1/2	15/32	–	–
426765-3	211423	1	3/8	1/2	0.16	–	0.173	6-32
426765-9	208115	1	3/8	3/4	1/4	–	–	6-32
426766-6	211371	1	1/2	3/4	1/4	–	–	8-32
426767-3	97457	1	3/4	1.0	3/8	–	–	10-32
426767-12	209091	1	3/4	2.0	3/8	–	–	10-32
426767-18	211081	1	3/4	3.0	3/8	–	–	10-32
426768-21	209928	1	1.0	5.0	5/8	–	–	1/4-20
426771-12	217658	2	3/8	1/0	3/8	–	–	6-32
426772-3	211370	2	1/2	3/4	1/4	–	–	8-32
426773-6	209664	2	3/4	1-1/4	3/8	–	–	10-32
426773-15	213360	2	3/4	2-1/2	3/8	–	–	10-32
8519977-4	233495	1	1/2	0.656	0.22	–	–	8-32
426767-15	231640	1	3/4	2-1/2	3/8	–	–	10-32

Figure 44. Insulator Data

This bulletin also applies to RCA-7204/4CX250F which is identical with RCA-7203/4CX250B except for its heater rating of 26.5 ± 10% volts, 0.58 ampere. The 7204 is unilaterally interchangeable with the 4X250F and bilaterally interchangeable with the 4CX250F.

7204/4CX250F

7203/4CX250B

BEAM POWER TUBE

Ceramic-Metal Seals
Coaxial-Electrode Structure
Compact Design

For Use at Frequencies up to 500 Mc
Forced-Air Cooled
400 Watts CW Output to 175 Mc
250 Watts CW Output at 500 Mc

2.464" Max. Length
1.640" Max. Diameter
Integral Radiator

RCA-7203/4CX250B is a very small and compact forced-air-cooled beam power tube constructed with ceramic-metal seals throughout and having a maximum plate dissipation of 250 watts. It is intended for service as an af power amplifier and modulator, a wide-band amplifier in video applications, a linear rf power amplifier in single-sideband suppressed-carrier equipment, and a class C amplifier and oscillator. The 7203 can be used with full ratings at frequencies up to 500 megacycles per second.

The ceramic-metal-seal construction employed in the 7203 permits operation at higher temperatures than a glass-seal construction and thus provides improved reliability. The specially designed, high-efficiency radiator which is brazed directly to the plate for better heat transfer, makes possible the maximum plate-dissipation rating of 250 watts with no sacrifice in tube reliability.

The terminal arrangement of the 7203 facilitates use of the tube with tank circuits of the coaxial type. Effective isolation of the output circuit from the input circuit is provided at the higher frequencies by the ring terminal for grid No.2. A base-pin termination for grid No.2 is also available for operation of the 7203 at the lower frequencies.

The 7203 is unilaterally interchangeable with the 4X250B and bilaterally interchangeable with the 4CX250B.

GENERAL DATA

Electrical:

Heater, for Unipotential Cathode:		
Voltage (AC or DC)§	6.0 ± 10%	volts
Current at 6.0 volts	2.6	amp
Minimum heating time	30	seconds
Mu-Factor, Grid No.2 to Grid No.1, for grid-No.2 volts = 300 and grid-No.2 ma. = 50	5.0	
Direct Interelectrode Capacitances (Approx.):□		
Grid No.1 to plate	0.03	μμf
Grid No.1 to cathode, grid No.2, and heater	16	μμf
Plate to cathode, grid No.2, and heater	4.4	μμf

Mechanical:

Operating Position	Any
Maximum Overall Length	2.464"
Maximum Seated Length	1.910"
Maximum Diameter	1.640"
Base	Special 8-Pin
Socket	Air-System Socket, such as SK-600■ and SK-606 Air Chimney■; or 124-110-1▬ (Supplied with Air Chimney)
Radiator	Integral part of tube

Air Flow:

Through Indicated Air-System Socket--This fitting directs the air over the base seals; past the grid-No.2 seal, envelope, and plate seal; and through the radiator to provide effective cooling with minimum air flow. When the tube is operated at maximum plate dissipation for each class of service, a minimum air flow of 3.8 cfm through the system is required. The corresponding pressure drop is approximately 0.3 inch of water. These requirements are for operation at sea level and at an ambient temperature of 200 C. At higher altitudes and ambient temperatures, the air flow must be increased to maintain the respective seal temperatures and the plate temperature within maximum ratings.

Without Air-System Socket--If an air-system socket is not used, it is essential that adequate cooling air be directed over the base seals, past the envelope, and through the radiator. Under these conditions and with the tube operating at maximum plate dissipation for each class of service, a minimum air flow of 3.6 cfm must pass through the radiator. The corresponding pressure drop is approximately 0.1 inch of water. These requirements are for operation at sea level and at an ambient temperature of 200 C. At higher altitudes and ambient temperatures, the air flow must be increased to maintain the respective seal temperatures and the plate temperature within maximum ratings.

Plate Temperature (Measured on base end of plate surface at junction with fins)	250 max.	°C
Temperature of Plate Seal, Grid-No.2 Seal, and Base Seals	250 max.	°C
Weight (Approx.)	4	ounces

■ Available from Eitel-McCullough, Inc., San Bruno, Calif.
▬ Available from E. F. Johnson Co., Waseca, Minn.

ELECTRON TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

7203/4CX250B 2-61
Printed in U.S.A.

AF POWER AMPLIFIER & MODULATOR—Class AB$_1$♦

Maximum CCS● Ratings, *Absolute-Maximum Values:*#

DC PLATE VOLTAGE	2000 max.	volts
DC GRID-No.2 VOLTAGE	400 max.	volts
MAX.-SIGNAL DC PLATE CURRENT*	250 max.	ma
PLATE DISSIPATION*	250 max.	watts
GRID-No.2 DISSIPATION*	12 max.	watts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	150 max.	volts
Heater positive with respect to cathode	150 max.	volts

Typical CCS Operation:

Values are for 2 tubes

DC Plate Voltage	1000	1500	2000	volts
DC Grid-No.2 Voltage	350	350	350	volts
DC Grid-No.1 Voltage	-55	-55	-55	volts
Peak AF Grid-No.1-to-Grid-No.1 Voltage	94	94	94	volts
Zero-Signal DC Plate Current	166	166	166	ma
Max.-Signal DC Plate Current	500	500	500	ma
Zero-Signal DC Grid-No.2 Current	0	0	0	ma
Max.-Signal DC Grid-No.2 Current (Approx.)	10	8	8	ma
Effective Load Resistance (Plate to plate)	3300	6000	8700	ohms
Max.-Signal Driving Power (Approx.)	0	0	0	watts
Max.-Signal Power Output (Approx.)	220	400	590	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance (Per tube). 0.1 max. megohm

RF POWER AMPLIFIER—Class B Television Service

Synchronizing-level conditions per tube unless otherwise specified

Maximum CCS● Ratings, *Absolute-Maximum Values:*#

	54 to 216 Mc	
DC PLATE VOLTAGE	2000 max.	volts
DC GRID-No.2 VOLTAGE	400 max.	volts
DC GRID-No.1 VOLTAGE	-250 max.	volts
DC PLATE CURRENT (Average)⊕	250 max.	ma
PLATE DISSIPATION	250 max.	watts
GRID-No.2 DISSIPATION	12 max.	watts
GRID-No.1 DISSIPATION	2 max.	watts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	150 max.	volts
Heater positive with respect to cathode	150 max.	volts

Typical CCS Operation with Bandwidth of 5 Mc:

DC Plate Voltage	1000	1500	2000	volts
DC Grid-No.2 Voltage	350	350	350	volts
DC Grid-No.1 Voltage	-60	-65	-70	volts
Peak RF Grid-No.1 Voltage:				
Synchronizing level	65	71	76	volts
Pedestal level	52	57	62	volts
DC Plate Current:				
Synchronizing level	355	360	360	ma
Pedestal level	250	250	250	ma
DC Grid-No.2 Current:				
Synchronizing level	27	29	29	ma
Pedestal level	4	0	0	ma
DC Grid-No.1 Current:				
Synchronizing level	2	5	5	ma
Pedestal level	0	0	0	ma
Driving Power (Approx.):♦				
Synchronizing level	0.4	1.2	1.2	watts
Pedestal level	0	0	0	watts
Power Output (Approx.):				
Synchronizing level	160	300	440	watts
Pedestal level	90	170	250	watts

LINEAR RF POWER AMPLIFIER
Single-Sideband Suppressed-Carrier Service

Maximum CCS● Ratings, *Absolute-Maximum Values:*#

	Up to 500 Mc	
DC PLATE VOLTAGE	2000 max.	volts
DC GRID-No.2 VOLTAGE	400 max.	volts
MAX.-SIGNAL DC PLATE CURRENT	250 max.	ma
PLATE DISSIPATION	250 max.	watts
GRID-No.2 DISSIPATION	12 max.	watts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	150 max.	volts
Heater positive with respect to cathode	150 max.	volts

Typical CCS Class AB$_1$♦ "Single-Tone" Operation up to 175 Mc:◆◆

DC Plate Voltage	1000	1500	2000	volts
DC Grid-No.2 Voltage‡	350	350	350	volts
DC Grid-No.1 Voltage	-55	-55	-55	volts
Zero-Signal DC Plate Current	83	83	83	ma
Zero-Signal DC Grid-No.2 Current	0	0	0	ma
Effective RF Load Resistance	1650	3000	4350	ohms
Max.-Signal DC Plate Current	250	250	250	ma
Max.-Signal DC Grid-No.2 Current	5	4	4	ma
Max.-Signal Peak RF Grid-No.1 Voltage	47	47	47	volts
Max.-Signal Driving Power (Approx.)	0	0	0	watts
Max.-Signal Power Output (Approx.)	110	200	295	watts

Typical CCS Operation with "Two-Tone Modulation" at 30 Mc:□□

DC Plate Voltage	1000	1500	2000	volts
DC Grid-No.2 Voltage‡	350	350	350	volts
DC Grid-No.1 Voltage**	-55	-55	-55	volts
Zero-Signal DC Plate Current	83	83	83	ma
Effective RF Load Resistance	1650	3000	4350	ohms
DC Plate Current at Peak of Envelope	250	250	250	ma
Average DC Plate Current	175	175	175	ma
DC Grid-No.2 Current at Peak of Envelope	30	30	30	ma
Average DC Grid-No.2 Current	6	9.5	15	ma
Average DC Grid-No.1 Current	0	0	0	ma
Peak-Envelope Driver Power (Approx.)	1	1	1	watt
Output-Circuit Efficiency (Approx.)	95	95	95	%
Distortion Products Level:⊕				
Third Order	29	29	30	db
Fifth Order	40	38	35	db
Useful Power Output (Approx.):♠				
Average	55	100	147.5	watts
Peak Envelope	110	200	295	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance Under Any Condition:
With fixed bias. . . . . 25000 max. ohms
With cathode bias. . . . . .Not recommended

PLATE-MODULATED RF POWER AMP.—Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

Maximum CCS● Ratings, *Absolute-Maximum Values:*#

	Up to 500 Mc	
DC PLATE VOLTAGE	1500 max.	volts
DC GRID-No.2 VOLTAGE	300 max.	volts
DC GRID-No.1 VOLTAGE	-250 max.	volts
DC PLATE CURRENT	200 max.	ma

PLATE DISSIPATION.		165 max.		watts
GRID-No.2 DISSIPATION.		8 max.		watts
GRID-No.1 DISSIPATION.		2 max.		watts
PEAK HEATER-CATHODE VOLTAGE:				
Heater negative with respect to cathode		150 max.		volts
Heater positive with respect to cathode		150 max.		volts

Typical CCS Operation at Frequencies up to 175 Mc:

DC Plate Voltage	500	1000	1500	volts
DC Grid-No.2 Voltage (Modulated approx. 55%)▲	250	250	250	volts
DC Grid-No.1 Voltage★.	-100	-100	-100	volts
Peak RF Grid-No.1 Voltage. . . .	113	113	113	volts
DC Plate Current	200	200	200	ma
DC Grid-No.2 Current	32	31	31	ma
DC Grid-No.1 Current (Approx.) .	6	6	6	ma
Driving Power (Approx.)●	0.7	0.7	0.7	watt
Power Output (Approx.)	50	140	235	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance Under Any Condition.	25000 max.		ohms

RF POWER AMPLIFIER & OSC.—Class C Telegraphy† and RF POWER AMPLIFIER—Class C FM Telephony

Maximum CCS● Ratings, *Absolute-Maximum Values:*#

	Up to 500 Mc	
DC PLATE VOLTAGE	2000 max.	volts
DC GRID-No.2 VOLTAGE	300 max.	volts
DC GRID-No.1 VOLTAGE	-250 max.	volts
DC PLATE CURRENT	250 max.	ma
PLATE DISSIPATION.	250 max.	watts
GRID-No.2 DISSIPATION.	12 max.	watts
GRID-No.1 DISSIPATION.	2 max.	watts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	150 max.	volts
Heater positive with respect to cathode	150 max.	volts

Typical CCS Operation at Frequencies up to 175 Mc:

DC Plate Voltage	500	1000	1500	2000	volts
DC Grid-No.2 Voltage . . .	250	250	250	250	volts
DC Grid-No.1 Voltage . . .	-90	-90	-90	-90	volts
Peak RF Grid-No.1 Voltage.	109	109	109	109	volts
DC Plate Current	250	250	250	250	ma
DC Grid-No.2 Current . . .	48	45	36	30	ma
DC Grid-No.1 Current (Approx.).	12	12	11	11	ma
Driving Power (Approx.). .	1	1	1	1	watt
Power Output (Approx.) . .	65	180	290	400	watts

Typical CCS Operation at Frequency of 500 Mc with Coaxial Cavity:

DC Plate Voltage.	2000	volts
DC Grid-No.2 Voltage.	300	volts
DC Grid-No.1 Voltage.	-90	volts
DC Plate Current.	250	ma
DC Grid-No.2 Current.	10	ma
DC Grid-No.1 Current (Approx.).	25	ma
Driver Power Output (Approx.)●	18	watts
Useful Power Output (Approx.)	250	watts

Maximum Circuit Values:

Grid-No.1-Circuit Resistance Under Any Condition	25000 max.		ohms

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Note	*Min.*	*Max.*	
Heater Current:				
Type 7203.	1	2.3	2.9	amp
Type 7204.	2	0.50	0.62	amp
Direct Interelectrode Capacitances (Types 7203 & 7204):□				
Grid No.1 to plate	-	-	0.06	μμf
Grid No.1 to cathode, grid No.2, and heater. .	-	14.2	17.2	μμf
Plate to cathode, grid No.2, and heater. .	-	4.0	4.8	μμf
Grid-No.1 Voltage:				
Type 7203.	1,3,7,8			
Type 7204.	2,3,7,8	-32	-46	volts
Grid-No.2 Current:				
Type 7203.	1,3,7,8			
Type 7204.	2,3,7,8	-7	+3	ma
Useful Power Output:				
Type 7203.	5,7,8			
Type 7204.	6,7,8	225	-	watts

Note 1: With 6.0 volts on heater.

Note 2: With 26.5 volts on heater.

Note 3: With dc plate voltage of 1000 volts, dc grid-No.2 voltage of 300 volts, and grid-No.1 voltage adjusted to give plate current of 150 ma.

Note 4: With plate floating, dc grid-No.2 voltage of 300 volts, and grid-No.1 voltage adjusted to give grid-No.2 current of 50 ma.

Note 5: With heater voltage of 5.5 volts, dc plate voltage of 2000 volts, dc grid-No.2 voltage of 300 volts, dc grid-No.1 bias of -90 volts, dc grid-No.1 current of 25 ma maximum, grid-No.1 signal voltage adjusted to produce dc plate current of 250 ma, and coaxial-cavity amplifier circuit operating at a frequency of 475 Mc.

Note 6: Same as Note 5 except heater voltage is 24.3 volts.

Note 7: With Forced-Air Cooling as specified under GENERAL DATA—*Air-System Socket*.

Note 8: Heater voltage must be applied for at least 30 seconds before application of other voltages.

SPECIAL PERFORMANCE DATA

Interelectrode Leakage:

This test is destructive and is performed on a sample lot of tubes from each production run under the following conditions: ac heater volts = 6.6 for type 7203 or 29.1 for type 7204, no voltage on other elements, and specified forced-air cooling for *Air-System Socket*. At the end of 500 hours, with tube at 25° C, and with no voltage applied to heater, the minimum resistance between indicated electrodes as measured with a 500-volt Megger-type ohmmeter having an internal impedance of 2.5 megohms, will be:

Grid No.1 and Grid No.2.	10 min.	megohms
Grid No.1 and Cathode.	10 min.	megohms
Grid No.2 and Cathode.	10 min.	megohms

§ Because the cathode is subjected to considerable back bombardment as the frequency is increased with resultant increase in temperature, the heater voltage should be reduced depending on operating conditions and frequency to prevent overheating the cathode and resultant short life.

□ With cylindrical shield JEDEC No.320 surrounding radiator; and with a cylindrical shield JEDEC No.321 surrounding the grid-No.2 ring terminal. Both shields are connected to ground.

The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no Absolute-Maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

♦ Subscript 1 indicates that grid-No.1 current does not flow during any part of the input cycle.

● Continuous Commercial Service.

* Averaged over any audio-frequency cycle of sine-wave form.

⊕ Averaged over any frame.

♣ The driver stage is required to supply tube losses and rf circuit losses. The driver stage should be designed to provide an excess of power above the indicated values to take care of variations in line voltage, in components, in initial tube characteristics, and in tube characteristics during life.

♣♣ "Single-Tone" operation refers to that class of amplifier service in which the grid-No.1 input consists of a monofrequency rf signal having constant amplitude. This signal is produced in a single-sideband suppressed-carrier system when a single audio frequency of constant amplitude is applied to the input of the system.

‡ Preferably obtained from a fixed supply.

□□ "Two-Tone Modulation" operation refers to that class of amplifier service in which the input consists of two equal monofrequency rf signals having constant amplitude. These signals are produced in a single-sideband suppressed-carrier system when two equal-and-constant-amplitude audio frequencies are applied to the input of the system.

** Obtained from a fixed supply.

⊕ Without the use of feedback to enhance linearity.

♠ Measured at load of output circuit having indicated efficiency.

▲ The dc grid-No.2 voltage must be modulated approximately 55% in phase with the plate modulation in order to obtain 100% modulation of the 7203. The use of a series grid-No.2 resistor or reactor may not give satisfactory performance and is therefore not recommended.

★ Obtained from grid-No.1 resistor or from a combination of grid-No.1 resistor with either fixed supply or cathode resistor.

† Key-down conditions per tube without amplitude modulation. Amplitude modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

OPERATING CONSIDERATIONS

The *maximum temperatures* in the tabulated data for the base seals, grid-No.2 seal, plate seal, and plate are tube ratings and are to be observed in the same manner as other tube ratings. The temperature of the respective seals and of the plate may conveniently be measured with temperature-sensitive paint, such as Tempilaq. The latter is made by the Tempil Corporation, 132 W. 22nd Street, New York 11, N.Y. in the form of liquid and stick.

The *socket* for the 7203 should be of a type (such as is indicated in the tabulated data) which permits adequate air-cooling of the tube. Although the base will fit a conventional lock-in socket, the latter does not permit adequate cooling and its use is therefore not recommended.

The *plate connection* is made by means of a metal band or spring contacts to the cylindrical surface of the radiator. It is essential that the contact areas be kept clean to minimize rf losses especially at the higher frequencies.

The rated plate and grid-No.2 voltages of this tube are extremely dangerous to the user. Great care should be taken during the adjustment of circuits. The tube and its associated apparatus, especially all parts which may be at high potential above ground, should be housed in a protective enclosure. The protective housing should be designed with interlocks so that personnel can not possibly come in contact with any high-potential point in the electrical system. The interlock devices should function to break the primary circuit of the high-voltage supplies when any gate or door on the protective housing is opened, and should prevent the closing of this primary circuit until the door is again locked.

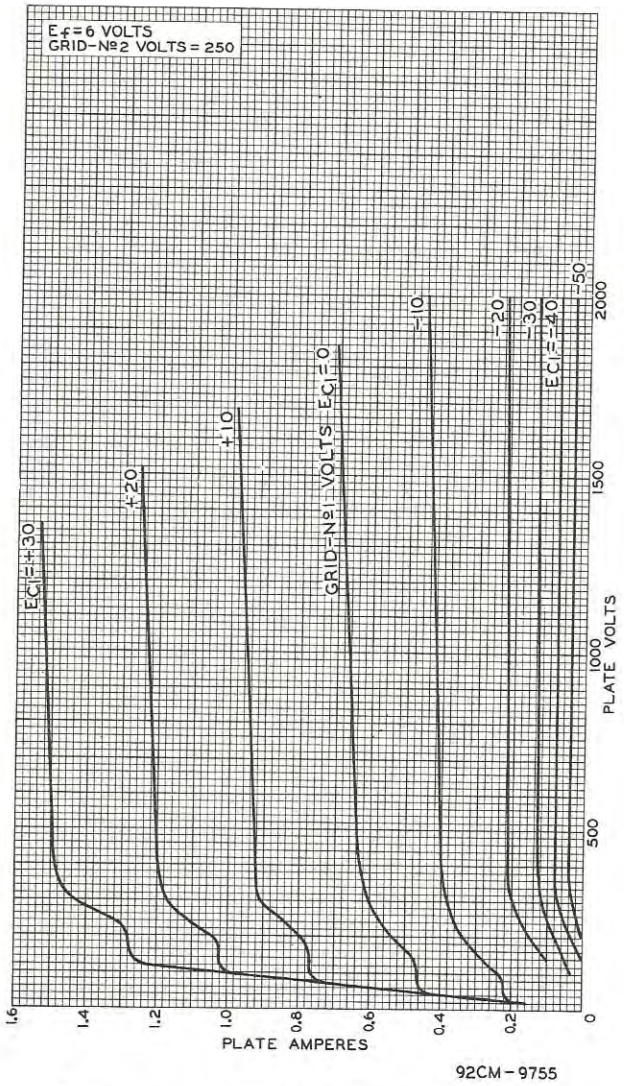


Fig. 1 - Typical Plate Characteristics of Type 7203.

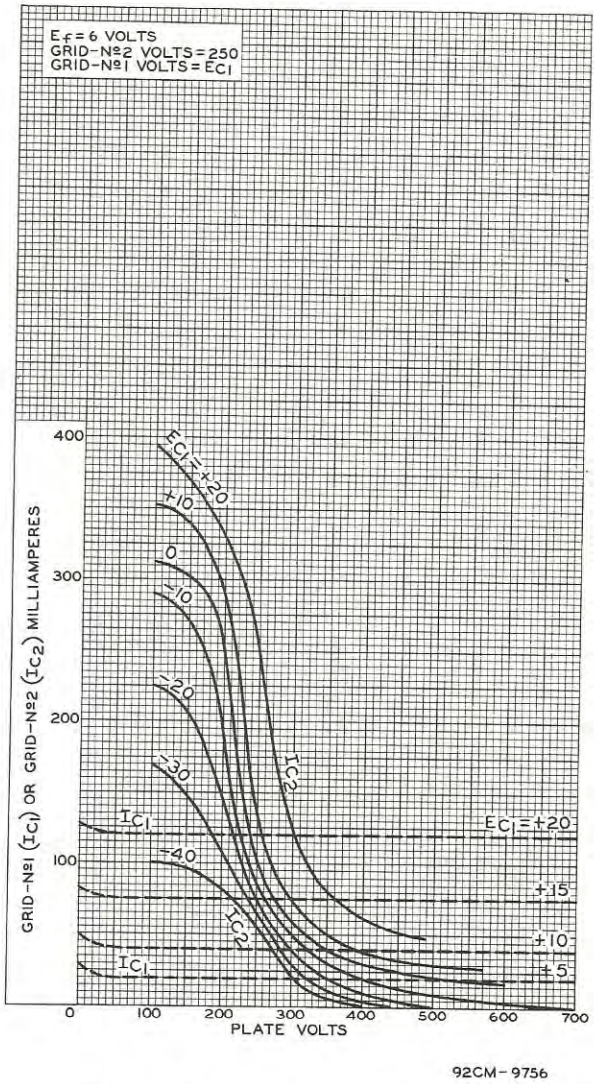


Fig. 2 - Typical Characteristics of Type 7203.

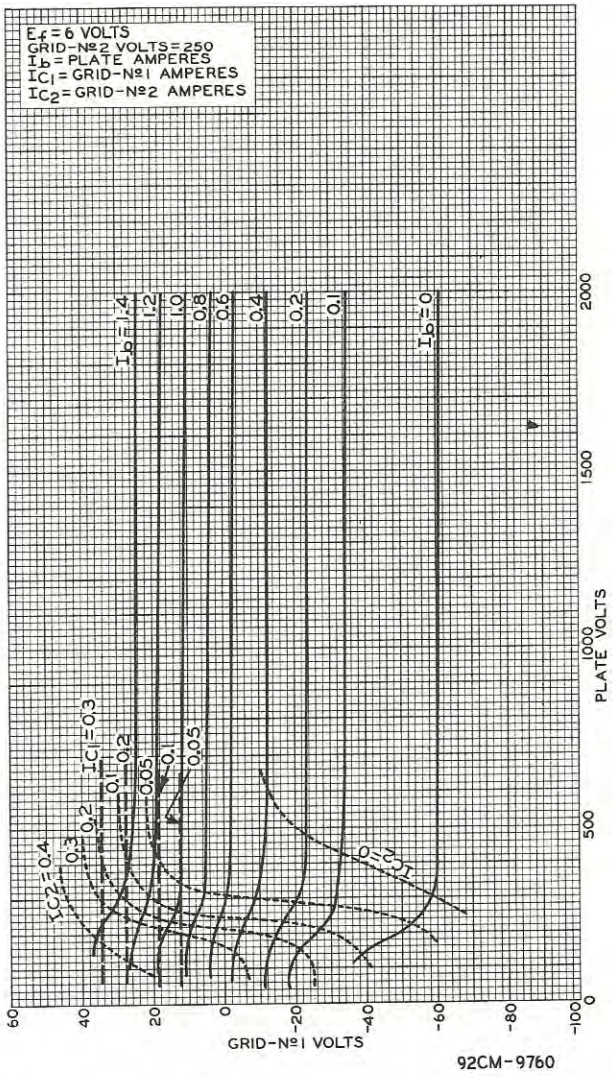


Fig. 3 – Typical Constant-Current Characteristics of Type 7203.

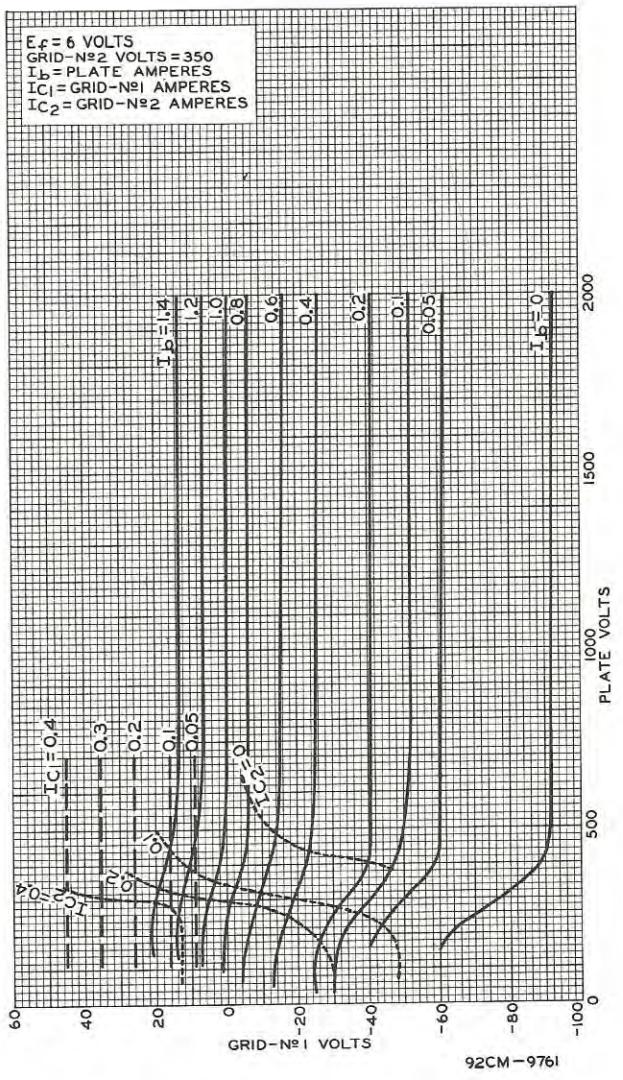
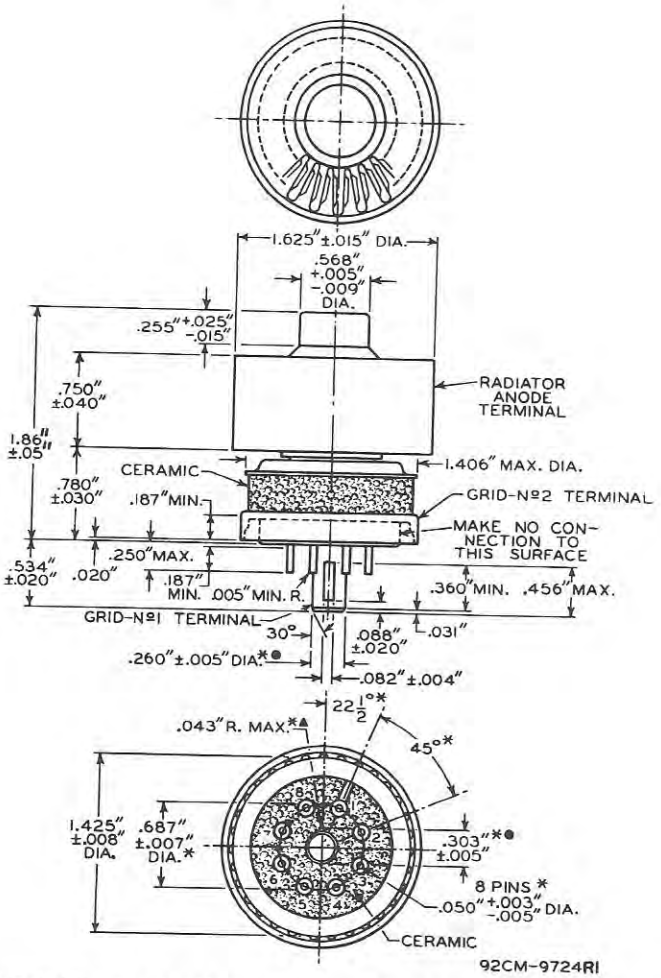


Fig. 4 – Typical Constant-Current Characteristics of Type 7203.

DIMENSIONAL OUTLINE



92CM-9724RI

GRID-No.1 PLUG DIMENSIONS ARE MEASURED BY THE USE OF THE SERIES OF GAUGES SHOWN IN SKETCHES G_1 AND G_2. IN THE FOLLOWING INSTRUCTIONS FOR THE USE OF THESE GAUGES, "GO" INDICATES THAT THE ENTIRE GRID-No.1 PLUG KEY WILL ENTER THE GAUGE; AND "NO-GO" INDICATES THAT THE GRID-No.1 PLUG KEY WILL NOT ENTER THE GAUGE MORE THAN 1/16". INSTRUCTIONS FOR THE USE OF THE GAUGES FOLLOW:

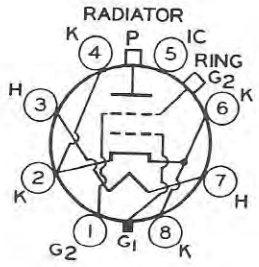
▲ GAUGES G_1-1, G_1-2, G_1-3, AND G_1-4:
USING ONLY SLOT C, TRY THESE GAUGES IN NUMERICAL ORDER UNTIL ONE IS FOUND THAT WILL ACCEPT THE ENTIRE GRID-No.1 PLUG. USING THE FIRST GAUGE THUS FOUND, IT WILL NOT BE POSSIBLE TO INSERT THE GRID-No.1 PLUG IN SLOT B.

● GAUGES G_2-1, G_2-2, AND G_2-3:
THE GRID-No.1 PLUG WILL BE REJECTED BY GAUGES G_2-1 AND G_2-2, BUT WILL BE ACCEPTED BY GAUGE G_2-3.

* BASE-PIN POSITIONS ARE HELD TO TOLERANCES SUCH THAT THE ENTIRE LENGTH OF THE PINS WILL, WITHOUT UNDUE FORCE, PASS INTO AND DISENGAGE FROM THE FLAT-PLATE GAUGE SHOWN IN SKETCH G_3.

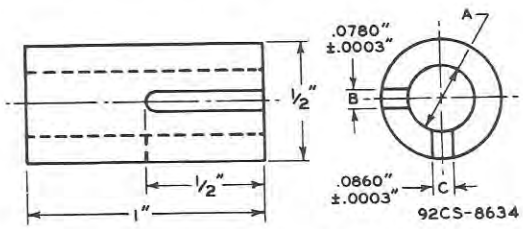
BASING DIAGRAM

Bottom View



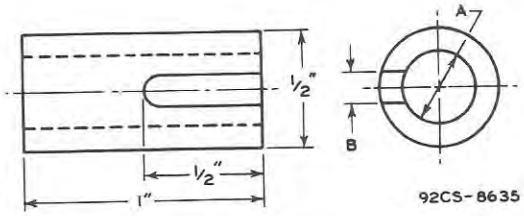
PIN 1: GRID No.2 (For use at the lower frequencies)
PIN 2: CATHODE
PIN 3: HEATER
PIN 4: CATHODE
PIN 5: INTERNAL CONNECTION--DO NOT USE
PIN 6: CATHODE
PIN 7: HEATER
PIN 8: CATHODE
BASE INDEX PLUG: GRID No.1
RADIATOR: PLATE
RING TERMINAL: GRID No.2 (For use at the higher frequencies)

Gauge Sketch G_1



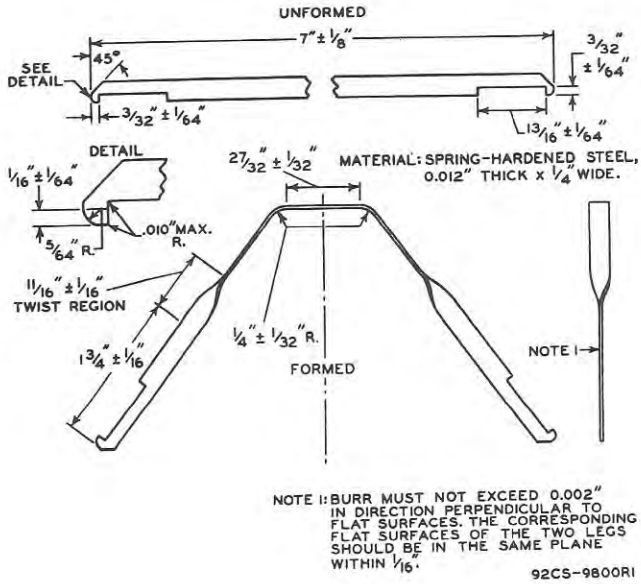
Gauge	Dimension A
G_1-1	.2575" + .0000" − .0005"
G_1-2	.2600" + .0000" − .0005"
G_1-3	.2625" + .0000" − .0005"
G_1-4	.2650" + .0000" − .0005"

Gauge Sketch G_2

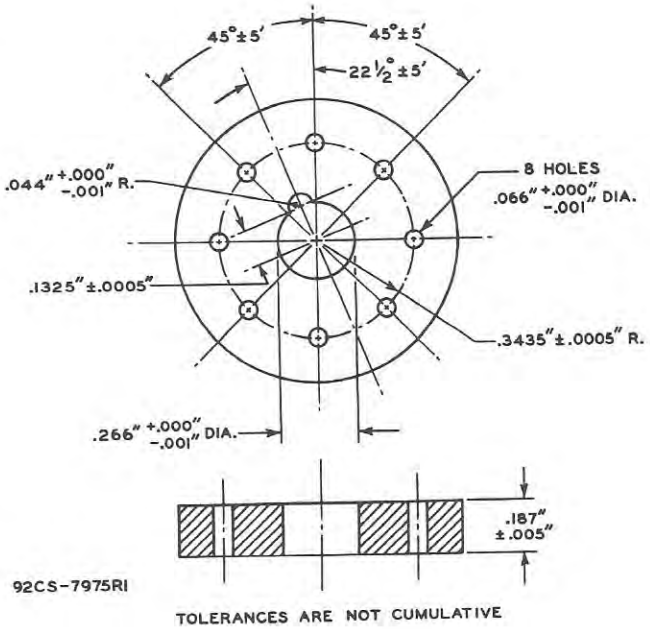


Gauge	Dimension	
	A	B
G_2-1	.2550" + .0000" − .0005"	.125"
G_2-2	.2980" + .0000" − .0005"	none
G_2-3	.3080" + .0000" − .0005"	none

Suggested Design for Extractor to Remove Tube from Cavity



Gauge Sketch G_3



Eimac®

EIMAC
Division of Varian
SAN CARLOS
CALIFORNIA

8281
4CX15,000A

RADIAL-BEAM POWER TETRODE

The EIMAC 8281/4CX15,000A is a ceramic-metal power tetrode intended for use as a Class-C amplifier in radio-frequency applications. It features a new type of internal mechanical structure which results in higher rf operating efficiency. Low rf losses in this mechanical structure permit operation of the 8281/4CX15,000A at full ratings up to 110 megahertz.

The 8281/4CX15,000A is also recommended for Class-AB audio-frequency and radio-frequency linear power amplifier service.

GENERAL CHARACTERISTICS

	Min.	*Nom.*	*Max.*	
Filament: Thoriated Tungsten				
Voltage		6.3		volts
Current	152		168	amps
Amplification Factor (Grid-Screen) (average)	4.5			
Direct Interelectrode Capacitances, Grounded Cathode:				
Input	148.5		161.5	μμf
Output	22.0		27.0	μμf
Feedback			2.0	μμf
Direct Interelectrode Capacitances, Grounded Grid and Screen:				
Input	60.0		70.0	μμf
Output	23.0		28.0	μμf
Feedback			0.3	μμf
Base		Special, concentric		
Maximum Seal Temperature				250°C
Maximum Anode Core Temperature				250°C
Recommended Socket				EIMAC SK-300A
Recommended Air Chimney				EIMAC SK-316
Operating Position	Axis vertical, base up or down			
Maximum Dimensions:				
Height				9.44 inches
Diameter				7.58 inches
Cooling				Forced air
Net Weight				12.8 pounds
Shipping Weight (Approximate)				24 pounds

Printed in U.S.A.

Eimac 4CX15,000A

RADIO-FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class-C Telegraphy or FM Telephony (Key-down conditions)

MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000 VOLTS
DC SCREEN VOLTAGE	2,000 VOLTS
DC PLATE CURRENT	5.0 AMPS
PLATE DISSIPATION*	15,000 WATTS
SCREEN DISSIPATION	450 WATTS
GRID DISSIPATION	200 WATTS

TYPICAL OPERATION

DC Plate Voltage	7,500	10,000 volts
DC Screen Voltage	750	750 volts
DC Grid Voltage	—510	—550 volts
DC Plate Current	4.65	4.55 amps
DC Screen Current	.595	.545 amp
DC Grid Current	.300	.275 amp
Peak RF Grid Voltage	730	790 volts
Driving Power	220	220 watts
Plate Dissipation	8,100	9,000 watts
Plate Output Power	26,700	36,500 watts

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER

Class-C Telephony (Carrier Conditions unless noted)

MAXIMUM RATINGS

DC PLATE VOLTAGE	8,000 VOLTS
DC SCREEN VOLTAGE	1,500 VOLTS
DC PLATE CURRENT	4.0 AMPS
PLATE DISSIPATION	10,000 WATTS
SCREEN DISSIPATION	450 WATTS
GRID DISSIPATION	200 WATTS

*Corresponds to 15,000 watts at 100% sinewave modulation.

TYPICAL OPERATION

DC Plate Voltage	6,000	8,000 volts
DC Screen Voltage	750	750 volts
Peak AF Screen Voltage (For 100% modulation)	740	710 volts
DC Grid Voltage	—600	—640 volts
DC Plate Current	3.75	3.65 amps
DC Screen Current	.450	.430 amp
DC Grid Current	.185	.180 amp
Peak RF Grid Voltage	800	840 volts
Grid Driving Power	150	150 watts
Plate Dissipation	5,100	5,800 watts
Plate Output Power	17,400	23,500 watts

AUDIO-FREQUENCY AMPLIFIER OR MODULATOR

Class-AB_1

MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	10,000 VOLTS
DC SCREEN VOLTAGF	2,000 VOLTS
DC PLATE CURRENT	6.0 AMPS
PLATE DISSIPATION	15,000 WATTS
SCREEN DISSIPATION	450 WATTS
GRID DISSIPATION	200 WATTS

*Per Tube
**Approximate Values

TYPICAL OPERATION (Two Tubes)

DC Plate Voltage	7,500	10,000 volts
DC Screen Voltage	1,500	1,500 volts
DC Grid Voltage	—350	—370 volts
Max-Signal Plate Current	8.8	8.5 amps
Zero-Signal Plate Current*	1.0	1.0 amp
Max-Signal Screen Current**	.340	.300 amp
Zero-Signal Screen Current	0	0 amps
Peak AF Driving Voltage*	330	340 volts
Driving Power	0	0 watts
Load Resistance, Plate-to-Plate	1,730	2,520 ohms
Max-Signal Plate Dissipation*	12,200	14,000 watts
Max-Signal Plate Output Power	41,600	57,000 watts

RADIO-FREQUENCY LINEAR AMPLIFIER

Class-AB_1

MAXIMUM RATINGS

DC PLATE VOLTAGE	10,000 VOLTS
DC SCREEN VOLTAGE	2,000 VOLTS
DC PLATE CURRENT	6.0 AMPS
PLATE DISSIPATION	15,000 WATTS
SCREEN DISSIPATION	450 WATTS
GRID DISSIPATION	200 WATTS

*Approximate Values

TYPICAL OPERATION, Peak-Envelope or Modulation-Crest Conditions

DC Plate Voltage	7,500	10,000 volts
DC Screen Voltage	1,500	1,500 volts
DC Grid Voltage	—350	—370 volts
Max-Signal Plate Current	4.4	4.25 amps
Zero-Signal Plate Current	1.0	1.0 amp
Max-Signal Screen Current*	.170	.150 amp
Peak RF Grid Voltage*	330	340 volts
Driving Power	0	0 watts
Plate Dissipation	12,200	14,000 watts
Plate Output Power	20,800	28,500 watts
Resonant Load Impedence	865	1,260 ohms

NOTE: "TYPICAL OPERATION" data are obtainable by calculation from published characteristic curves and confirmed by direct tests. Adjustment of the rf grid drive to obtain the specified plate current at the specified grid bias, screen voltage, and plate voltage is assumed. If this procedure is followed, there will be little variation in output power when tubes are changed, even though there may be some variations in grid and screen currents. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variation in current. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf driving voltage is applied.

APPLICATION

MECHANICAL

Mounting—The 4CX15,000A must be operated with its axis vertical. The base of the tube may be down or up at the convenience of the circuit designer.

Socket — A new, more efficient EIMAC Air-System Socket Type SK-300A has been designed especially for the concentric base terminals of the 4CX15,000A. The use of recommended air-flow rates through this socket provides effective forced-air cooling of the tube. Air forced into the bottom of the socket passes over the tube terminals and through an Air Chimney, the SK-316, into the anode cooling fins.

Cooling — The maximum temperature rating for the external surfaces of the 4CX15,000A is 250°C. Sufficient forced-air circulation must be provided to keep the temperature of the anode at the base of the cooling fins and the temperature of the ceramic-metal seals below 250°C. Air-flow requirements to maintain seal temperatures at 225°C in 50°C ambient air are tabulated below (for operation below 30 megacycles).

Plate Dissipation* (Watts)	SEA LEVEL		10,000 FEET	
	Air Flow (CFM)	Pressure Drop (Inches of Water)	Air Flow (CFM)	Pressure Drop (Inches of Water)
7,500	179	0.8	283	1.27
12,000	358	2.4	566	3.8
15,000	513	4.2	812	6.64

*Since the power dissipated by the filament represents about 1000 watts and since grid-plus-screen dissipation can, under some conditions, represent another 600 watts, allowance has been made in preparing this tabulation for an additional 1600 watts dissipation.

The blower selected in a given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop encountered in ducts and filters.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases, using rated maximum temperatures as the criteria for satisfactory cooling.

ELECTRICAL

Filament Operation — The rated filament voltage for the 4CX15,000A is 6.3 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate by more than plus or minus five percent from the rated value.

Electrode Dissipation Ratings — The maximum dissipation ratings for the 4CX15,000A must be respected to avoid damage to the tube. An exception is the plate dissipation which may be permitted to rise above the rated maximum during brief periods, such as may occur during tuning.

Control-Grid Operation — The 4CX15,000A control grid has a maximum dissipation rating of 200 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible. The maximum grid circuit resistance should not exceed 100,000 ohms per tube.

Screen-Grid Operation—The power dissipated by the screen of the 4CX15,000A must not exceed 450 watts.

Screen dissipation, in cases where there is no AC applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage, or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit the screen dissipation to 450 watts in the event of circuit failure.

Plate Dissipation — The plate-dissipation rating for the 4CX15,000A is 15,000 watts.

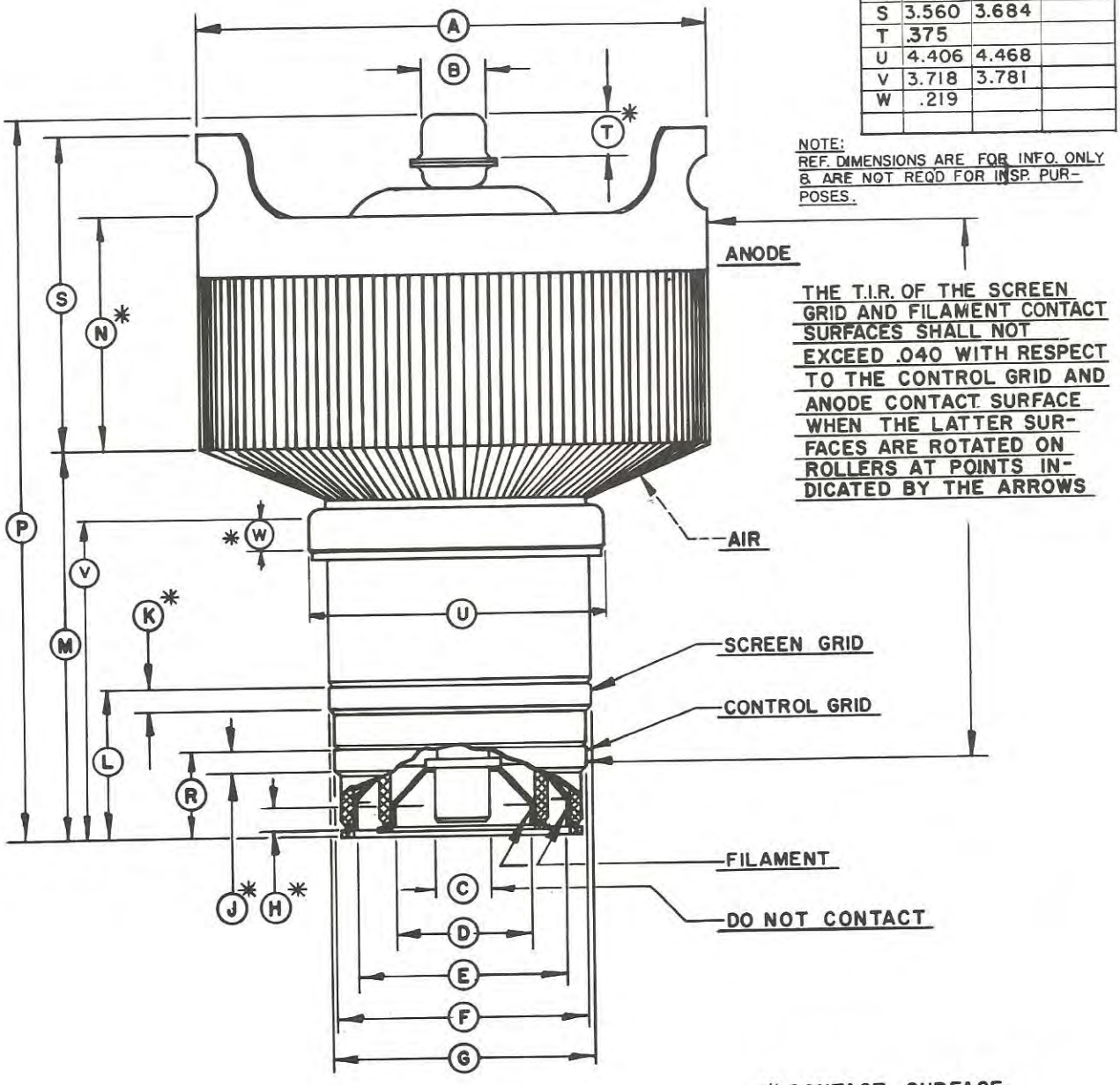
When the 4CX15,000A is operated as a plate-modulated r-f power amplifier, the input power is limited by conditions not connected with the plate efficiency, which is quite high. Therefore, except during tuning there is little possibility that the 10,000 watt maximum plate dissipation rating will be exceeded.

Special Applications — If it is desired to operate this tube under conditions widely different from those given here, write to the Power Grid Division, EIMAC, Division of Varian, 301 Industrial Way, San Carlos, California, for information and recommendations.

DIMENSIONS IN INCHES

DIMENSIONAL DATA			
DIM.	MIN.	MAX.	REF.
A	7.460	7.580	
B	.855	.895	
C	.720	.760	
D	1.896	1.936	
E	3.133	3.173	
F	3.792	3.832	
G	3.980	4.020	
H	.188		
J	.188		
K	.188		
L	1.764	1.826	
M	4.659	4.783	
N	2.412	2.788	
P	9.000	9.375	
R	.986	1.050	
S	3.560	3.684	
T	.375		
U	4.406	4.468	
V	3.718	3.781	
W	.219		

NOTE:
REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQD FOR INSP. PURPOSES.



* CONTACT SURFACE

4CX 15,000 A