RCA

Broadcast Equipment

BTF-20E1
FM Transmitter

ES-560602A

IB-8027531-2

Broadcast Equipment

Instructions

BTF-20E1

FM Transmitter

ES-560602A

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

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SAFETY PRECAUTIONS

The purpose of these instructions is to familiarize station and using personnel with the safety precautions in handling, unpacking, installing, operating and servicing RCA AM or FM Broadcast Transmitters.

Color coded safety warning labels are used throughout the equipment to alert station and using personnel:

1. Yellow *CAUTION* labels are used to warn against potential hazards or to caution against unsafe practice.

2. Orange *HAZARD* labels are used to designate dangerous areas of the equipment which may cut, shock, or otherwise injure using personnel whenever the cabinet doors are opened or removed.

HANDLING AND UNPACKING

General

Each AM or FM Transmitter consists of Master Items (MI's) which comprise the total Equipment Schedule (ES) for the transmitter. Thus, the method used to pack each MI is dependent on its size, weight, customer requirements, and transmitter site location.

The physical dimensions and weight information of the Major MI's is contained in the Technical Summary in the front of the Instruction Book provided with each transmitter.

The Packing methods used for the various MI's may vary from double wall cartons, and wood crates, to skid mounts with a plastic protective cover (van packed). This depends on customer requirements and transmitter site location (Domestic or Foreign). However, in each case, a forklift or any other safe method should be used to handle the various packed MI's.

Double Wall Cartons

To unpack the MI's and material placed in the double wall cartons, carefully cut and remove the strapping, remove the top protective cover of the carton, and remove the MI's and Installation Material as indicated on your order.

Van Packed Items

To unpack van packed items such as the cabinets and larger MI's, first place the unit close to its designated position, then carefully cut and remove the strapping, and finally, remove the wooden supports and protective plastic cover. The item should then be removed from the skid.

> NOTE: It is recommended that at least two people remove the cabinets and larger MI's from a skid using a forklift or any other safe method. Since the doors and heavy MI's are normally removed from the transmitter cabinet, extreme care should be used to avoid excess twisting of the cabinet frame.

Once the equipment is removed from the skid, position it in its designated place and follow the Installation and Assembly instructions.

Wood Crated Items

To unpack wood crated items, place the item close to its designated place; then carefully cut and remove the strapping; remove the wood crate and support material using appropriate tools; after the wood crate is removed, carefully remove any other strapping or material which is used to support the item.

The item should then be removed from the skid. Follow the recommended procedure under Van Packed Items. Once the item is removed from the skid, place it in its designated position and follow instructions provided in the Installation and Assembly sections.

INSTALLATION

After unpacking and checking the master items using the procedure recommended above, the transmitter should be assembled. Follow the procedures outlined in the Installation and Assembly sections of the Instruction Book for transmitter assembly. Be sure that the transmitter equipment is properly grounded and wired according to the wire charts provided.

SAFETY PRECAUTIONS (Continued)

OPERATION

Caution and Hazard labels are located in the major cabinets of the transmitter and on the rear enclosure panels to alert station personnel of the potential danger areas. Labels reading *CAUTION REPLACE COVER BEFORE OPERATING* or *CLOSE DOOR BEFORE OPERATING* are found in appropriate cabinets. Panels, doors or covers labeled in this manner have potentially hazardous voltages behind or on them, and must be closed before operating the transmitter. Areas within the transmitter that contain exposed hazardous voltages have *CAUTION HIGH VOLTAGE* labels.

During adjustment and tuning of the transmitter, it may be necessary to bypass an interlock. Extreme care should be observed whenever an interlock is bypassed. Observe all warnings and cautions to prevent possible injury or loss of life as indicated in the transmitter Instruction Book.

SERVICING

Any module or PWB on a module may have hazardous voltages exposed, so caution must be exercised.

When the transmitter is to be serviced or maintained according to the Maintenance Schedule, observe the Hazard label to *CONTACT ALL HIGH VOLTAGE POINTS WITH GROUNDING STICK BEFORE SERVICING* the transmitter.

Follow the recommended procedures provided in the Maintenance section of the Instruction Book for care and cleaning of the transmitter. Be sure that proper ventilation is provided whenever the recommended cleaning solvent is used to avoid direct inhalation.

Always replace the protective covers after servicing the transmitter or its associated parts.

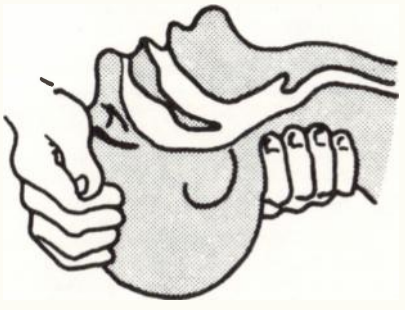
WARNING

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.

EMERGENCY
FIRST AID INSTRUCTIONS

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



1. Find out if the person is breathing.

   You must find out if the person has stopped breathing. If you think he is not breathing, place him flat on his back. Put your ear close to his mouth and look at his chest. If he is breathing, you can feel the air on your cheek. You can see his chest move up and down. If you do not feel the air or see the chest move, he is not breathing.

2. If he is not, open the airway by tilting his head backward.

   Lift up his neck with one hand and push down on his forehead with the other. This opens the airway. Sometimes doing this will let the person breathe again by himself. If it does not, begin rescue breathing.

3. If he is still not breathing, begin rescue breathing:

   Keep his head tilted backward.
   Pinch his nose shut.
   Put your mouth tightly over his mouth.
   Blow into his mouth once every five seconds.
   Do Not Stop Rescue Breathing Until Help Comes.

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.

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.

LIST OF REVISED, ADDED OR DELETED PAGES

The following is a list of the pages in this Instruction Book that have been Revised, Added, or Deleted with their effective date of change:

Title Page	Original
Safety Precaution Pages	Original
First Aid Page	Original
"A" Page	Original
Pages 1 thru 114	Original

WARRANTY ITEMS

Particular parts and/or equipment covered by warranty are specifically stated as such in the warranty or contract given to the customer at the time of sale. The warranty or contract also stipulates the conditions under which the warranty may be exercised.

To obtain a new replacement for such warranty items, contact your local RCA sales office and please supply Product Identification (including the Original Invoice Number, MI Number, Type Number, Model Number, and Serial Number) and Replacement Part Identification (including Stock Number and Description). Requests for warranty replacements may be unduly delayed if all this information is not supplied.

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, Communication 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.

TECH ALERT

Emergency 24 hour telephone consultation service for technical problems is available. Call TECH ALERT at 609-963-8000 extension PC3434. Telex messages will be forwarded to the addressee upon receipt. Western Union telex number is 83-4450.

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TECHNICAL SUMMARY

ELECTRICAL SPECIFICATIONS

Type of Emission	F3 and F9
Frequency Range	87.5 to 108 MHz
Power Output	7.5 to 20 kW[7]
Output Impedance (3-1/8 in. dia. EIA unflanged line)	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 (50-15,000 Hz)	±1 dB max.[3]
Pre-Emphasis Network Time Constant	75 or 50 usec, as desired
Harmonic Distortion (50-15,000 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 Audio Input Level (100% SCA modulation)	-15 to +10 dBm, adjustable
SCA Audio Input Impedance	600 ohms balanced
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, feet (meters)	Standard Blower	Optional Blower
60 Hz Line	7500 (2286)	11,000 (3353)
50 Hz Line	3000 (914)	6,500 (1981)

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

Dimensions and Weight:	Power Supply	Transmitter
Width, inches (cm)	32 (81.3)	48-1/4 (122.6)
Height, inches (cm)	49 (124)	77 (195.6)
Depth, inches (cm)	23 (58.4)	33-1/8 (84.1)
Weight (approx.) pounds (Kg)	676 (307)	1958 (888)

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

[2] Level measured at input jack J109 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 50 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 ±4.0 kHz by 30 to 5000 Hz tones main carrier modulated 30% by subcarrier, using a narrowband detector.

[7] The BTF-20E1 FM Transmitter has been type accepted for 21 kilowatts.

TECHNICAL SUMMARY (Continued)

Power Supply:	
Width, inches (cm)	32 (81.3)
Height, inches (cm)	49 (124.5)
Depth, inches (cm)	23 (58.4)
Weight:	
Transmitter (approx.), pounds (Kg)	1425 (646.4)
Power Supply (approx.), pounds (Kg)	1025 (464.9)

LIST OF EQUIPMENT

BTF-20E1 20kW FM TRANSMITTER
ES-560602A

Quantity	Description	Reference
1	Basic Transmitter	MI-560507A
1	Power Determining Kit	MI-560510A
1	Blower	
	0 - 7500 Ft., 60 Hz Line Frequency	MI-560347-A1
	0 - 3000 Ft., 50 Hz Line Frequency	MI-560347-A1
	*3000 - 6500 Ft., 50 Hz Line Frequency	MI-560347-3
	*7500 - 11,000 Ft., 60 Hz Line Frequency	MI-560347-3
1	Rectifier	MI-560340-4
1	Plate Transformer	MI-560341-7
1	Power Supply	MI-560342-6
2	Side Panel	MI-560755
1	Installation Material	MI-560515
1	Harmonic Filter, tuned to specified FM channel in the frequency range 87.5 to 108 MHz (not pressurized) or, alternatively,	MI-561509
	Harmonic Filter, selected as follows:	
	*87.5 to 108 MHz — Unpressurized	MI-561506
	*87.5 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	
	If MI-560347-A1 Blower is supplied	MI-560517
	*If MI-560347-3 Blower is supplied	MI-560705
*	Manometer Kit	
	If MI-560347-3 Blower is supplied	MI-560307-38
	If MI-560307-A1 Blower is supplied	MI-560307-36 or MI-560307-38
*	Elapsed Time Indicator (115V)	
	for 60 Hz Line Frequency	MI-561018-2
	for 50 Hz Line Frequency	MI-561018-4
1	Frequency Determining Parts, for assigned frequency as follows (for ES breakdown, see table 5):	
	ES NUMBER — **FREQUENCY**	
	ES-560272C-1 — 87.5 TO 89.9 MHz	
	ES-560272C-2 — 90.1 TO 91.9 MHz	
	ES-560272C-3 — 92.1 TO 93.9 MHz	
	ES-560272C-4 — 94.1 TO 95.9 MHz	
	ES-560272C-5 — 96.1 TO 97.9 MHz	
	ES-560272C-6 — 98.1 TO 99.9 MHz	
	ES-560272C-7 — 100.1 TO 101.9 MHz	
	ES-560272C-8 — 102.1 TO 103.9 MHz	
	ES-560272C-9 — 104.1 TO 105.9 MHz	
	ES-560272C-10 — 106.1 TO 107.9 MHz	
2	Instruction Book for BTF-20E1	IB-8027531-2
2	Instruction Book for BTE-15A FM Exciter	IB-8027524-2

*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 Module	MI-560718
Spare Crystal and Crystal Oven for BTE-15A Exciter *(specify carrier frequency)	MI-560717-*
Spare Crystal Oven only, for BTE-15A Exciter	MI-560717A
BTE-15A FM Exciter Module	MI-560712
BTS-1B Stereo Generator	MI-560713
BTX-1B Subcarrier Generator (Specify SCA Frequency)	MI-560714
5-kHz Filter (required when transmitting stereo and SCA; one filter normally supplied, installed, in each SCA generator	MI-560721
Type BW-75A FM Monitor	MI-560735
Type BW-85A FM Stereo Monitor	MI-560740
Type BW-95A SCA and	MI-560745
BW-100 RF Amplifier Modulation Monitor	MI-560738
AM Noise Reduction Kit (for low power operation)	MI-560307-31
Manometer Kit	MI-560307-36
Elapsed Time Indicator	
60 Hz Line Frequency	MI-561018-2
50 Hz Line Frequency	MI-561018-4
Adaptor Flange, adapts MI-27791K transmission line to MI-19089 transmission line	MI-27988-4C
Tower Lighting Monitoring and Control Unit (for remote control)	MI-27519
Tower Lighting Monitoring Unit	MI-27544
AC Voltage Pickup (for remote control)	MI-27516
Automatic Power Control	MI-561353

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-8027524-2 for the exciter semi-conductor complement.

INSTALLATION MATERIAL

MI-560515

Item	Qty	Description	Drawing No.
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	8812985-8
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 209A
Distortion and Noise Meter		Hewlett-Packard Model 331A/334A
Oscilloscope		Tektronix Model 422
Senior VoltOhmist VTVM	WV-98C	
Volt-Ohm-Milliammeter	WV-38A	
Grid-Dip Meter		Measurements Corp. Model 59
Step Attenuator, 1 dB and 10 dB steps		Hewlett-Packard Model 350D
Coaxial Components used for PA neutralizing		
One 6 foot length of RG-8/AU Cable with type N connectors Reducer Cone (3-1/8" dia. coaxial line to type N connector)		
RG-8/U Cable (specify length) (2) Type N connectors (1) Reducer Cone (3-1/8" dia. coaxial line to type N connector)	MI-74A Stock No. 236025 MI-27791K-5A	

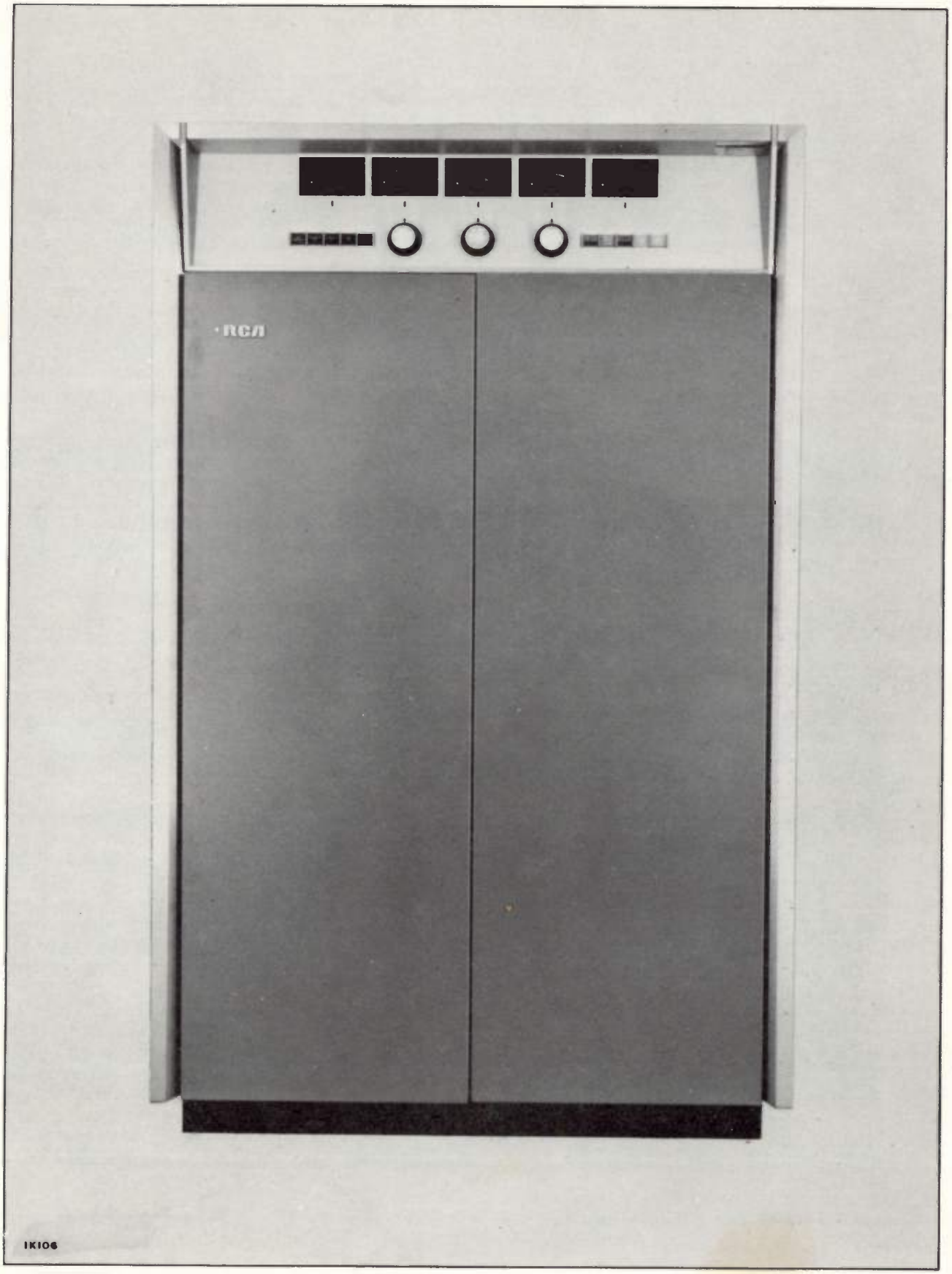


Figure 1. BTF-20E1 FM Transmitter

DESCRIPTION

GENERAL

The RCA Type BTF-20E1 20 KW FM Broadcast Transmitter is designed for high-power operation in the standard FM band, 87.5 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 manometer, which indicates air filter efficiency and warns of reduced cooling-air supply to the power tubes, is available as an optional item.

CONSTRUCTION

The BTF-20E1 transmitter is housed in a single, double-door cabinet, in a two-tone blue textured vinyl finish, set off with aluminum epoxy 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-8027524-2) is mounted on a single chassis and includes a modular stereo 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 module 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, OVER-LOAD RESET, and POWER RAISE/LOWER. A 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. 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 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 (available as an optional item) 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 if the AFC circuit should lose lock. In this event, DOOR INTER-LOCKS tally-light 1DS5 will also be extinguished.

Refer to BTE-15A FM Exciter Instruction Book, IB-8027524-2 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 parallel, 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 uses 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 (normally 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 operating 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.

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 percentage 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. 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.

Optical Meter-Relay Protection Circuits

The "carrier-off" and output transmission line VSWR protection circuitry utilizes two optical meter-

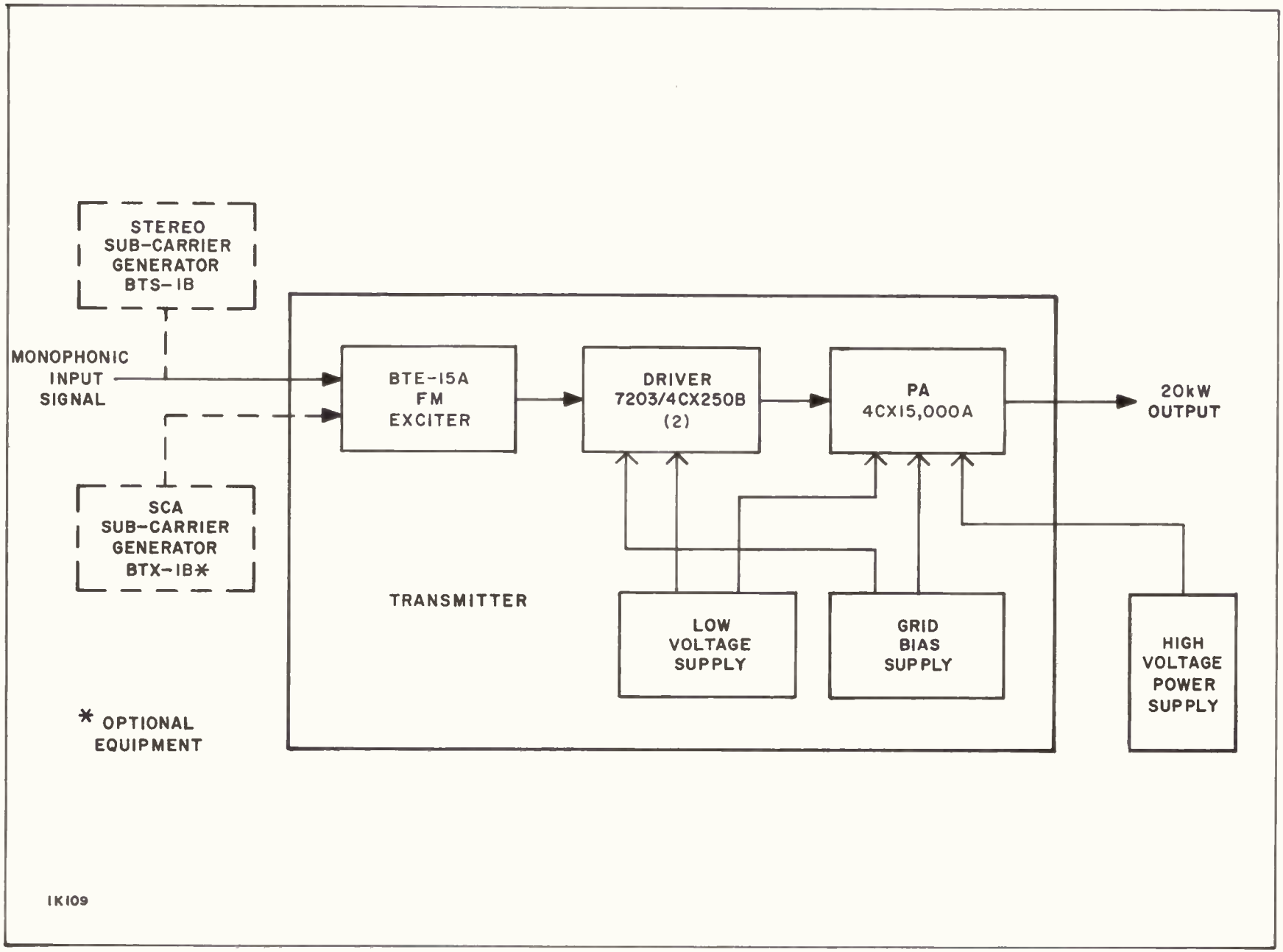


Figure 2. BTF-20E1 Simplified Block Diagram

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 38, BTF-20E1 Schematic Diagram and figure 30, 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 1S13 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 normally supplied with a "stub-type" harmonic filter, MI-561509. This filter consists of a section of 3-1/8 inch diameter coaxial transmission line with four coaxial transmission line stubs which act as tuned traps at harmonic frequencies. This filter is supplied as standard equipment to keep spurious emissions to a minimum. This unit is pre-tuned for operation at one specified carrier frequency.

Alternatively, the BTF-20E1 can be supplied with a 6-1/8 inch diameter harmonic filter. This 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 of the alternate filter 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. 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

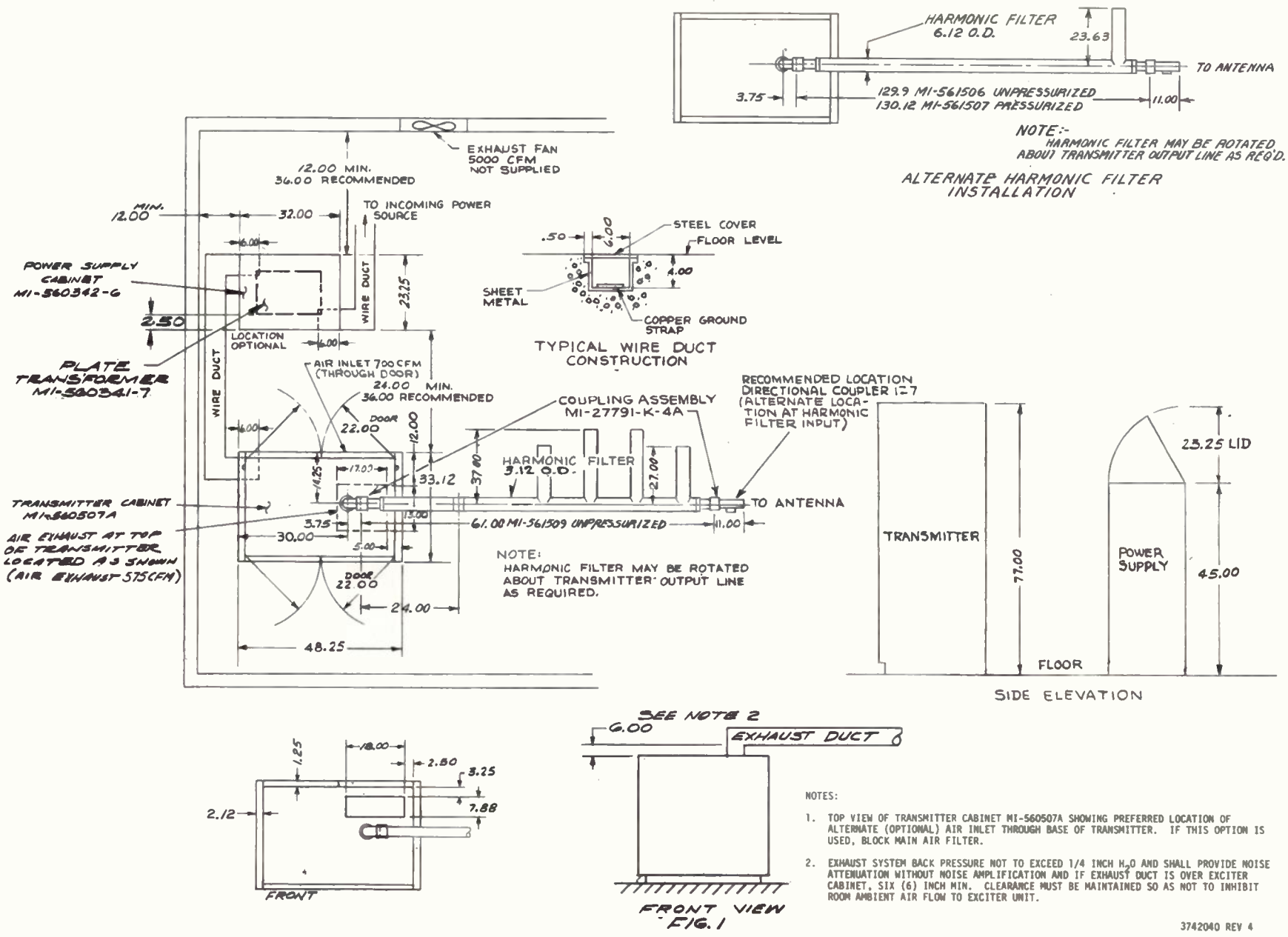
Basic steps in the installation of the BTF-20E1 transmitter consist of planning the equipment layout and making provisions for transmitter room power and light, transmission line runs and connections to the equipment. The units can then be unpacked, assembled and wired as specified in these instructions. 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 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. Space requirements for each type of harmonic filter are shown in figure 3, BTF-20E1 Typical Floor Plan.

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 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



NOTES:

1. TOP VIEW OF TRANSMITTER CABINET MI-560507A SHOWING PREFERRED LOCATION OF ALTERNATE (OPTIONAL) AIR INLET THROUGH BASE OF TRANSMITTER. IF THIS OPTION IS USED, BLOCK MAIN AIR FILTER.
2. EXHAUST SYSTEM BACK PRESSURE NOT TO EXCEED 1/4 INCH H_2O AND SHALL PROVIDE NOISE ATTENUATION WITHOUT NOISE AMPLIFICATION AND IF EXHAUST DUCT IS OVER EXCITER CABINET, SIX (6) INCH MIN. CLEARANCE MUST BE MAINTAINED SO AS NOT TO INHIBIT ROOM AMBIENT AIR FLOW TO EXCITER UNIT.

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Figure 3. BTF-20E1 Typical Floor Plan

transmitter components and circuits. Floor ducts can be installed for power wiring and remote control interconnection (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 shipment is accompanied by a shipping invoice which lists the complete contents of the shipment by "Master Item" or "MI" numbers. This shipping invoice is usually attached to one of the cartons, appropriately marked. Each master item (MI) containing two or more items normally contains a packing list (MI sheet).

The complete equipment for the BTF-20E1 FM Transmitter is listed on ES-560602A 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 required.

ASSEMBLY

General

The assembly procedure which follows is intended for use when the transmitter is assembled in the field. On transmitters which have been factory-tuned, some of the procedures described will have been previously carried out. In either case, it is recommended that the assembly procedure listed be followed, as it affords a convenient assembly check list.

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-560510A. The dc output lead is then connected at terminal 1TB1-11 (located at the top of the basic transmitter rack, MI-560507A), with the braid grounded.

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.

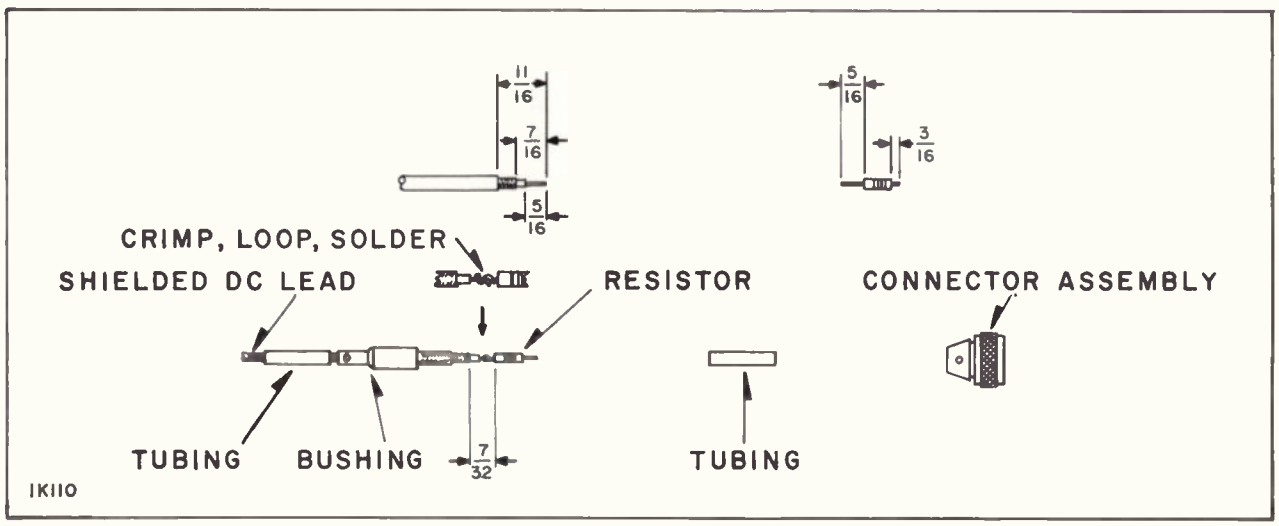


Figure 4. 1Z7 Connector Cap Assembly

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 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 front access panel and sliding the cabinet into place over the transformer. Ensure that the cabinet is centered over the transformer and then fasten the cabinet securely to the floor. *Adequate clearance must be provided between the plate transformer and power supply cabinet* (a safe distance is 2½ inches at the closest point).

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 an unpressurized filter be located out of doors where "breathing" of the unit, due to temperature changes, may lead to condensation.

The pressurized alternate harmonic filter, MI-561507, makes possible filter 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.

CAUTION

Use only 50 ohm components. If the use of 51.5 ohm components is unavoidable, use inner conductor adapter for 3-1/8 inch 50 ohm to 51.5 ohm as follows:

MI-27988-4A couples inner conductor of 50 ohm 3-1/8" MI-27791K to inner conductor of 51.5 ohm 3-1/8" MI-19113C steatite transmission line.

MI-27988-4B couples inner conductor of 50 ohm 3-1/8" MI-27791K to inner conductor of 51.5 ohm 3-1/8" MI-19313 teflon transmission line.

Inner Conductor	50 Ohm MI-27791K	51.5 Ohm MI-19113C Steatite	51.5 Ohm MI-19313 Teflon
OD	1.315"	1.200"	1.282"
ID	1.231"	1.136"	1.231"

POWER DETERMINING PARTS INSTALLATION

Power determining parts for the BTF-20E1 transmitter are supplied as MI-560510A. These items are normally installed during factory test procedures. The following items would then be packed separately for shipment:

MI-560510A Item	Quantity	Description
3	1	HV Reactor 1L3
17	1	Miter Elbow
18	2	Transmission Line Coupling
19	1	Monitor Assembly
20	2	Hose Clamps
22	1	Directional Coupler 1Z7

On factory-tested transmitters, the installation is therefore completed by re-installing the items listed, and installing the interconnecting cable (MI-560510A item 23) to directional coupler 1Z7 as previously described. Since MI-560510A items 17, 18, 19, 20, and 22 are normally shipped assembled together, the complete assembly is easily mounted to the transmitter output line, at the top of the transmitter rack.

On transmitters which are being installed in the field, the following installation procedure should be followed. For added information, refer to Power Determining Components Installation Drawing, figure 46, and the power determining parts packing list (supplied as part of MI-560510A). Unless noted otherwise, the item

numbers listed in the following power determining parts installation procedure refer to items listed on MI-560510A.

1. Install high-voltage filter capacitors 1C7 and 1C8 at location shown. These capacitors are supplied as item 1. Use .375-16 hardware supplied, part of item 16. Refer also to figure 15.

2. Install meter bypass capacitor 1C10 (item 2) at the terminals of plate ammeter 1M4 (item 4). Mount 1M4 in meter bezel (item 21) and install this assembly in the meter panel, near top of transmitter rack. Connect meter wiring at rear of 1M4. Refer to figure 39 for wiring information.

3. Install high voltage reactor 1L3 (item 3) at location shown in figure 46. Position as shown in figure 15. Connect high voltage leads to 1L3, following wiring diagram, figure 39. Do not interchange high voltage wires 233 and 234. Gap setting should be .25 inches (6.35 mm).

4. Install relay shunt resistor 1R24 (item 5) on transmitter side panel as shown in figure 15 and figure 46. Use hardware provided (items 28G, 28H, 28I, 28J). Solder leads to 1R24, referring to figure 39 for 1R24 connection information.

5. Mount PA filament transformer 1T2, using hardware supplied (items 28B, 28C, 28K), at the location designated. See figure 14. Make connections from the secondary of 1T2 to feed-through capacitors 1C115 and 1C116, using filament connector cables provided (items 9 and 10). Make primary connections to 1T2, utilizing wires from existing transmitter wire harness. Refer to figure 39 for 1T2 connection information.

6. Mount PA plate blocking capacitor 1C113 (item 7) at the location designated. See figure 18. Use 10-32 x .25 inch long brass screws supplied (item 28L) and 10-32 lockwashers (item 28I). Orient 1C113 as required to connect to rf choke 1L107. Use the .25 inch long brass screws to secure 1C113 to the plastic mounting ring below it. Do not use metal screws to mount the plastic ring to the plastic mounting shelf. Refer to figure 19. Before tightening any of the 1C113 mounting hardware, install the 4CX15000A PA tube, seating securely (see page 23). Tighten all 1C113 mounting hardware. Remove PA tube.

7. Install the reflectometer (directional coupler) 1Z5 (item 8) in the output transmission line above the transmitter rf unit. Use transmission line coupling supplied with the transmitter rack. Each transmission line coupling consists of:

1 outer sleeve
1 inner conductor connector
2 hose clamps

Install the two dc output connectors (1Z5-P1 and 1Z5-P2) at the mating jacks on 1Z5. These connectors are connected to wires 241 and 245 (see figure 39). Check that a diode is present in each jack on 1Z5.

Secure 1Z5 in place, using a hose clamp (item 20) at the top of 1Z5.

8. Install plate contactor 2K1 (item 26) on contactor mounting plate provided in power supply, MI-560342-6. This mounting plate is situated behind the power supply front panel and has mounting holes for either an Allen-Bradley or Westinghouse contactor. Use mounting hardware supplied (items 28G, 28H, 28I, 28J). Mounting holes for the Allen-Bradley contactor are identified by the stencilled letters A-B on the contactor mounting plate while mounting holes for the Westinghouse contactor are keyed by the letter W.

9. Install circuit breaker 2S1 (item 27) adjacent to 2K1 in the power supply, MI-560342-6. Use two .250 (1/4)-20 x 5.0 inch long screws (items 28A), two flat washers (item 28B), two lock washers (item 28C), and two hex nuts (item 28D) at the lower two 2S1 mounting holes. At the upper two mounting holes for 2S1, install spacer plate (item 29) between 2S1 and the power supply cabinet. Use two .250 (1/4)-20 x 4.0 inch long screws (items 28E) and special nuts (item 28F) at the upper two 2S1 mounting holes. Avoid over-tightening 2S1 mounting hardware to prevent damage to the plastic breaker housing. Install pressure type terminals supplied (item 30) at the three top terminals of 2S1. These are used to connect to the three-phase power source.

10. Using the large power cable provided (size 2/0 black; item 11), install jumper wires from the bottom terminals of 2S1 to the top terminals of 2K1. Refer to the Power Supply Wiring Diagram, figure 40 for wiring destinations. Strip the insulation from each end of the three jumpers, to fit the pressure type connectors on 2S1 and 2K1.

11. Install grounds at high voltage filter capacitor terminals 1C7-2 and 1C8-1, using 0.128 diameter bare (tinned) copper wire (item 12) and terminals (items 13 and 14) as required. Also, connect a jumper between 1C7-1 and 1C8-2, using wire (item 12) and terminals (item 13) required. Refer to figure 39.

12. Remove the filler plate supplied mounted to the driver shelf immediately below driver socket 1XV101. Retain plate mounting hardware. Install the 1XV103 socket assembly (item 15), situated as shown in figure 21 and figure 42. Use the 4-40 x .38 long screws and 4-40 lockwashers formerly used to secure the filler plate in place. Install suppressor network 1Z102 (item 24) between the center terminals (the control grid) of 1XV103 and the bottom terminal (insulator side) of capacitor 1C102.

Connections between 1XV101 and 1XV103 are made by means of three jumper wires which are supplied connected to the 1XV103 socket assembly. Connect

these three wires (wires no. 57, 58, and 59) at socket 1XV101, referring to wiring diagram figure 42.

Note that the socket assembly (item 15) includes a clamp assembly used for connection to the anode of driver tube 1V103. Refer to figure 22. Mount 1V103 in socket 1XV103 and mount the clamp assembly loosely on the anode of 1V103. Now install plate strap (item 25) from the clamp assembly to the junction between 1C111 and 1L103.

13. The special miter elbow (item 17) has a hole, provided for use with monitor assembly (item 19). Position the monitor assembly over the hole in the side of the elbow so that the rf pickup coil enters the hole without touching the sides. Secure in place, using two hose clamps (item 20).

> 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 the rf monitor assembly attached, at the transmitter output, using a transmission line coupling (item 18). The elbow is normally mounted with the long leg vertical.

If remote operation is to be used, install directional coupler 1Z7 (item 22) in accordance with figure 3, using a transmission line coupling (item 18) at each end of 1Z7. One transmission line coupling is used for connection to the harmonic filter.

If remote control is not planned, directional coupler 1Z7 may be omitted.

14. Using the shielded wire provided (item 23), install the dc output lead from 1Z7 to 1TB1-11, as previously described.

BLOWER INSTALLATION

The main blower, MI-560347-A1, includes an adjustable vane as shown in figure 48. The blower vane setting should be checked, and adjusted if necessary. The vane setting should be as shown in figure 48. After making this adjustment, lock the vane control in place with the Allen locking screw, using 1/8 inch hex wrench.

Install the main blower, using the following procedure. Use components supplied as Blower Mounting Kit MI-560517 to install the blower. Item numbers given in this installation procedure are item numbers of MI-560517. Refer to figure 5 for clarification.

1. Install the four blower shock-mounts (items 5 and 6), using 16 .138 (6)-32 x .38 long screws (item 8C) and lockwashers (item 8G), on the top of blower mounting bracket (item 4). Assemble the two (2) 20 pound shockmounts (item 6) to the mounting holes in the bracket that are on 4-7/8 inch mounting centers and 1-3/4 inches from the right angle bend in the bracket. After assembly, these shockmounts should be at the side of the mounting bracket nearest the front of the transmitter cabinet.

2. Temporarily remove air filters and front access panel to gain access to the blower enclosure.

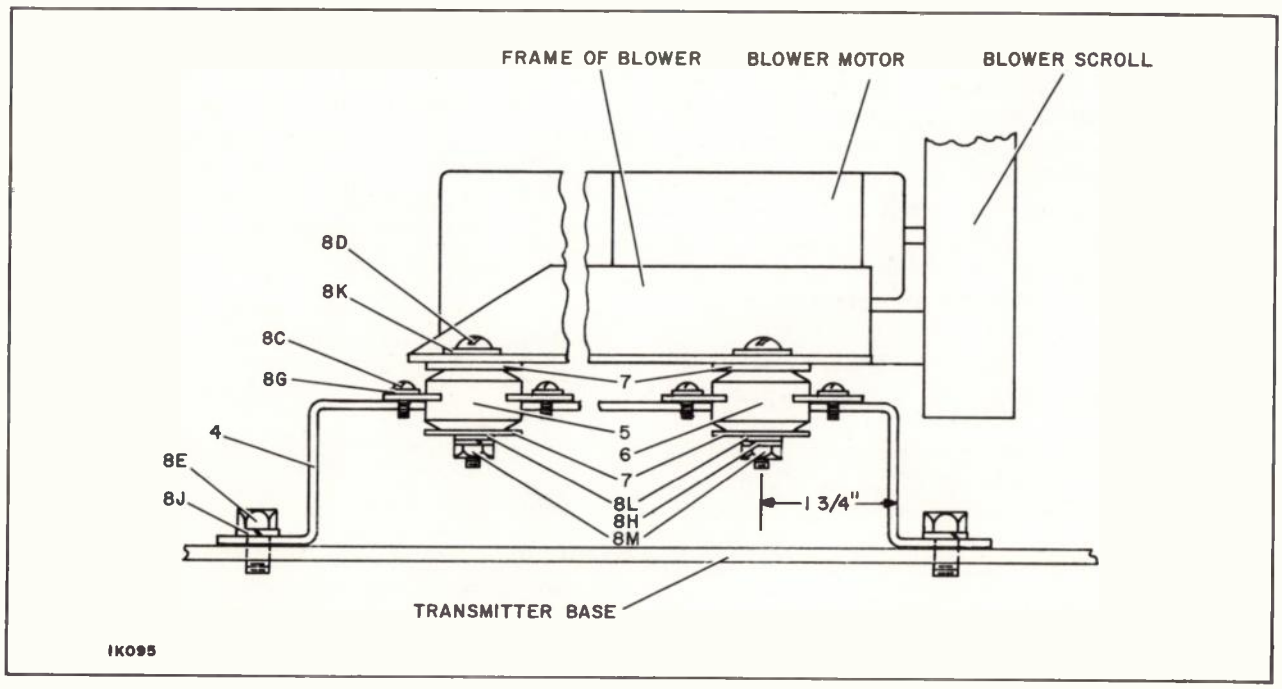


Figure 5. Blower Motor Installation

3. Install blower air exhaust cover assembly (item 1), to the underside of blower enclosure top cover, using the 10 .164 (8)-32 tapped holes provided in the top cover. Use 10 .164 (8)-32 screws (item 8A) and 10 lockwashers (item 8F) to secure the cover assembly in place.

4. Mount blower air boot (item 2) on air exhaust cover assembly (item 1), using two clamps (items 3) and 2 .164 (8)-32 x .50 inch long screws (item 8B), 2 #8 lockwashers (item 8F), and 2 #8 nuts (item 8N).

5. Mount the blower to the shock-mounts, using .250 (1/4)-20 hardware as shown in figure 5. Orient blower so that the outlet scroll will be adjacent to the two (2) 20 pound shock mounts (item 6) assembled in step 1 above.

6. Move the assembled blower and mounting bracket into position in the blower enclosure, positioning the blower outlet inside the air boot. Secure the blower mounting bracket to the transmitter base, using 4 .312 (5/16)-18 x .63 long bolts (item 8E) and 4 .312 (5/16) lockwashers (item 8J).

7. Secure air boot to blower outlet using remaining clamps (item 3) and #8 hardware (items 8B 8F, and 8N).

8. Replace front blower access panel and air filters.

HIGH ALTITUDE BLOWER INSTALLATION

If a BTF-20E1 transmitter is to be operated at altitudes above 7500 feet (with 60 Hz power line), a larger blower (MI-560347-3) is required. With 50 Hz power lines the larger blower is required above 3000 feet. Blower mounting components for such high altitude installations are supplied as MI-560705. Installation instructions for this option are included in MI-560705.

HIGH VOLTAGE RECTIFIER INSTALLATION

Mount the high voltage rectifier assembly, MI-560340-4, in the power supply cabinet, MI-560342-6. Place in position on the ceramic insulators supplied as part of the power supply. If necessary, move two of the insulators to the position identified by the marking "MI-560340-4" on the power supply chassis. Secure the rectifier assembly in place, using the .190 (10)-32 hardware supplied in place at the tops of the insulators.

Check high-voltage grounding switch 2S4 for free operation. With power supply cover raised, use an ohmmeter to assure that 2S4 grounds the high voltage positive terminal.

ELAPSED TIME INDICATOR (Optional) INSTALLATION

To install the elapsed time indicator, 1M6, perform the following steps:

1. Remove and discard the cover plate (see figure 12).

2. Install 1M6, using the cover plate mounting hardware.

3. Connect the two leads from 1M6 to the two terminals on terminal board 1TB3, mounted directly above 1M6. Refer to figure 41. This completes installation of the optional elapsed time indicator 1M6.

MANOMETER (Optional) INSTALLATION

If blower MI-560347-A1 is installed, either manometer MI-560307-36 or MI-560307-38 may be mounted on the panel below the rf unit. If high altitude blower MI-560347-3 is used, mount manometer MI-560307-38 on the blank panel at the bottom of the control cabinet (see figure 13). To install the optional manometer, proceed as follows:

MI-560307-36

1, Remove the blower access panel below the transmitter rf unit (see figure 13).

2. Remove the plug button supplied and install the manometer in place on the panel, using existing hardware.

3. Install one of the connector fittings provided with the manometer, in the mounting hole provided in the panel. Slit the double column flexible plastic tubing, supplied with the manometer, to make a single hose. Cut to required length. Interconnect the manometer and panel mounted connector fitting, using the cut length of hose.

4. Install the gauge oil (supplied with the manometer) and zero set the manometer, using zero set screw at the bottom of the manometer.

5. Remount panel below the rf unit.

MI-560307-38 and Blower MI-560347-A1

1. Remove the blower access panel below the transmitter rf unit and discard plug and 2 screws on 6-7/16 centers.

2. Cut holes as specified on Panel Assembly print 8765737. (Note: holes may exist in later units.)

3. Install manometer, item 1, and male fitting, item 2, on front panel.

4. Install 1/4" tubing from right hand fitting on manometer to male elbow installed in step 3.

5. Add gauge oil provided to manometer.

6. Remount panel below rf unit.

7. Zero set manometer and tighten locking screw.

MI-560307-38 and High Altitude Blower MI-560347-3

1. Remove the blank panel at the bottom of the control unit (see figure 13).

2. Add holes as specified on Panel print 8491390. (Note: holes may exist on later units.)

3. Add a 1/8-27 tap to filter panel channel as specified on Panel, Filter Channel print 3742028. (Note: hole may exist on later units). Install male elbow, item 2, in hole.

4. Install manometer, item 1, on front panel.

5. Add gauge oil to manometer.

6. Remount panel at bottom of control unit.

7. Install 1/4" tubing supplied from the right hand manometer fitting through the 7/16" hole in the panel to the male elbow on the filter channel panel.

8. Zero set manometer and tighten locking screw.

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 and installation and connection of accessory equipment.

CAUTION

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 a cabinet ground in the power supply cabinet (copper-flashed angle brackets are welded to both sides of the power supply cabinet, with clearance holes for ground connections), 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 36, 38, 39, 40, 44, 45 and table 1. Use item 4 of Installation Material, MI-560515, for all connections.

Connect the power supply high voltage dc output (at high voltage rectifier assembly connector designated HV+) 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. See figures 38 and 40.

Also in the power supply cabinet, connect the secondary of transformer 3T1 to the high voltage rectifier assembly at the AC1, AC2, and AC3 terminals, using high voltage wire supplied, item 6 of MI-560515.

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

Connect 208/240 volt 3-phase input to terminals 1, 2, and 3 of circuit breaker 2S1 in the power supply cabinet. 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.

Connect 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-8027524-2, for detailed information on changing connections for various line voltages. Wire for these connections is not supplied.

Remote Control Connections

The BTF-20E1 Transmitter may be remotely controlled by means of a remote control system. This remote control 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.

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

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 (-)

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 45.

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.

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 normally 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 procedure is required when the transmitter is not factory tested.

This can be accomplished by the use of an ammeter of the proper range and a dc supply which is

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.

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 turning the small screw, located next to the manual reset button, to the extreme clockwise position. The automatic reset option may be desired 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 6.5 amperes is recommended in BTF-20E1 transmitters using the MI-560347-A1 blower. When the high-altitude blower, MI-560347-3, is used, a different overload relay is used. This overload relay, part of MI-560705, should be set to 8.5 amperes.

3. Replace the snap-on cover.

LOW VOLTAGE CIRCUIT BREAKER 1S6 ADJUSTMENT

Circuit breaker 1S6 gives fast acting protection against short circuit conditions in low voltage power supply circuitry. 1S6 is normally factory set at its highest trip setting, however, if spurious tripping of 1S6 is encountered, it will be necessary to dismount the unit and adjust the trip setting on each pole to its highest setting. Remount breaker.

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 18, 20 and 23).

After insertion of the driver tubes, the plate rings are slipped over the tubes and tightened with the screw provided (refer to figures 20 and 22).

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 6 and 12 which show the transmitter controls and indicators utilized in the following procedures).

1. Disconnect the primary connections to transformers 3T1 (the high voltage plate transformer) and 1T6 (the low voltage rectifier transformer). Tape the exposed connectors at the ends of the disconnected wires to prevent short circuits.

2. 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 to the ON position: MAIN breaker 2S1 and LOW POWER breaker 2S2 on the power supply cabinet, and LV RECTIFIER switch 1S6, FILAMENT breaker 1S5, and CONTROL breaker 1S18 on the transmitter cabinet.

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, depress TRANSMITTER OFF pushbutton 1S8. Reverse the direction of rotation of the blower by reversing the connections to terminals 1TB4-1 and 1TB4-2. Depress TRANSMITTER ON pushbutton 1S7. Blower 1B2 should now rotate in the proper direction, closing air interlock 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 3 minutes 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 the ELAPSED TIME meter 1M6 (an optional item) for normal operation.

11. With control circuit terminals 1TB2-11 and 1TB2-12 temporarily jumpered (remove power while installing jumper), close the transmitter 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. Remove the temporary jumper. If the exciter AFC circuit is locked, the 1DS5 indicator should stay lighted.

12. Set the exciter AFC switch S1 to the OPERATE position. Vary the AFC ADJUST control C14 either clockwise or counterclockwise until exciter AFC UNLOCK relay K102 operates. Note that DOOR INTERLOCKS indicator 1DS5 goes out. Reset C14 to approximately its initial position. 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 2DS4 should light.

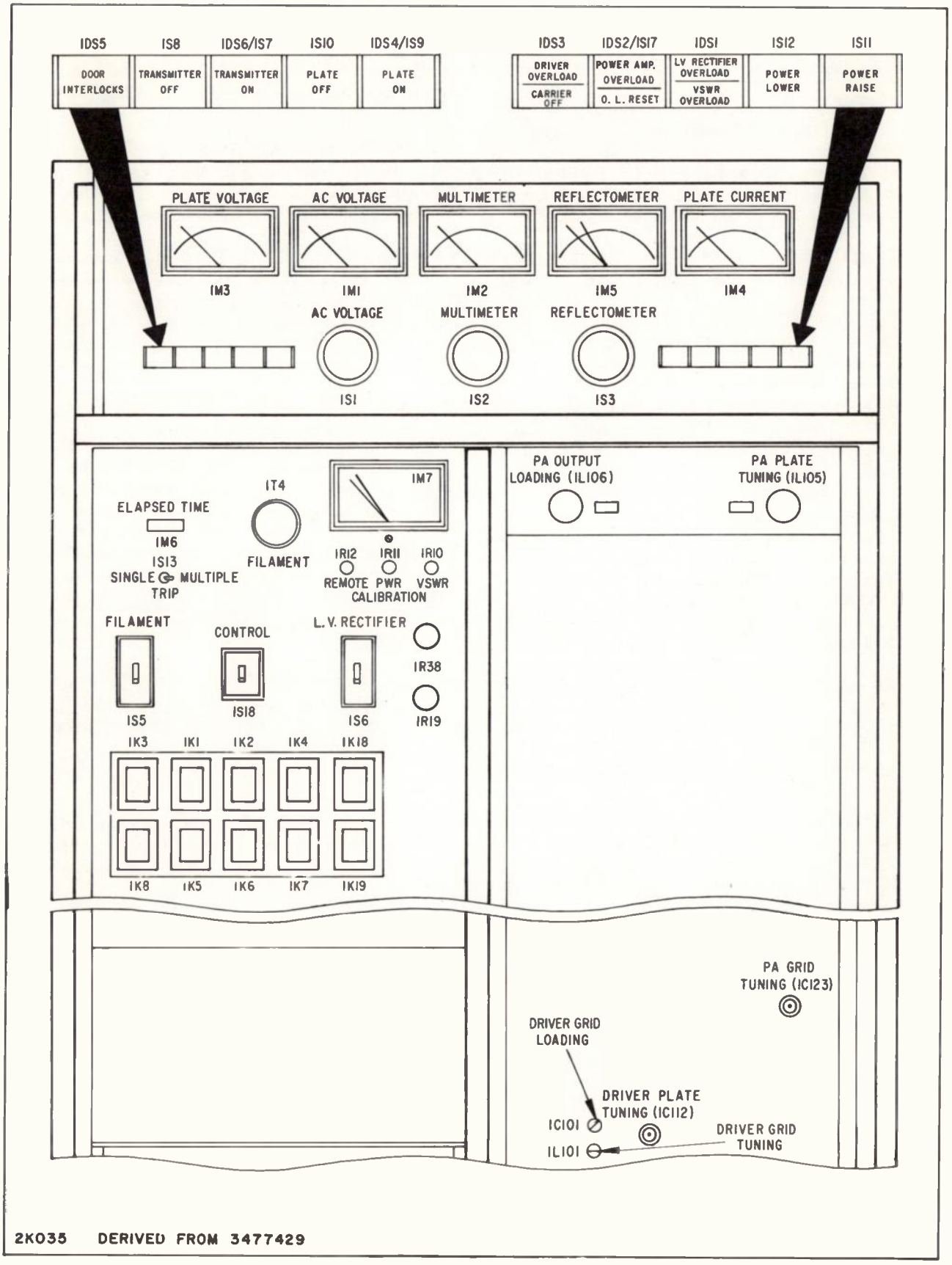


Figure 6. BTF-20E1 Controls and Indicators

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.

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. Set the exciter RF OUTPUT switch to the off position while setting (and measuring) amplifier filament voltages in the steps which follow. This prevents rf energy from the exciter unit from affecting the ac voltmeter indication.

20. Operate 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 for the 4CX15000A. Note, however, that for extended tube life, the filament voltage should be adjusted to the *lowest value* that does not limit the power output and should be carefully maintained at that point. For further information see Technical Bulletin TB-334-3 on page 101. After establishing the optimum filament voltage, note the reading of AC VOLTAGE meter 1M1. For optimum tube life the PA FILAMENT reading of meter 1M1 should be maintained at this point.

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 for the 7203/4CX250B tetrode, on the external ac voltmeter. Note the reading of AC VOLTAGE meter 1M1. The DRIVER FILAMENT indication of meter 1M1 should be maintained at this value.

23. 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.

24. 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 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.

NOTE: The BTF-20E1 transmitter is normally tuned at the factory before shipment. The following is included for information only, or use when the transmitter is tuned in the field.

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.

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 taped.

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 3 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.

b. 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.

c. 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.

d. 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)	1C124 PA Loading	1C125 PA Loading	1C126 PA Loading	1L111 Front PA Grid Tuning	1L112 Rear PA Grid Tuning	1L111, 1L112 Shorting Blocks
ES-560272C -1	87.5-89.9	25pF MI-560355-1 Stock #235990	25pF MI-560355-1 Stock #235990	40pF MI-560355-2 Stock #227938	MI-560356-5 Stock #243893	MI-560356-6 Stock #423694	3455763-1 Stock #243892
ES-560272C -2	90.1-91.9	25pF MI-560355-1 Stock #235990	25pF MI-560355-1 Stock #235990	40pF MI-560355-2 Stock #227938	MI-560356-1 Stock #243894	MI-560356-2 Stock #243895	3455763-1 Stock #243892
ES-560272C -3	92.1-93.9	25pF MI-560355-1 Stock #235990	25pF MI-560355-1 Stock #235990	40pF MI-560355-2 Stock #227938	MI-560356-1 Stock #243894	MI-560356-2 Stock #243895	3457763-1 Stock #243892
ES-560272C -4	94.1-95.9	40pF MI-560355-2 Stock #227938	Not Used	40pF MI-560355-2 Stock #227938	MI-560356-1 Stock #243894	MI-560356-2 Stock #243895	3455763-1 Stock #243892
ES-560272C -5	96.1-97.9	40pF MI-560355-2 Stock #227938	Not Used	40pF MI-560355-2 Stock #227938	MI-560356-1 Stock #243894	MI-560356-2 Stock #243895	3455763-1 Stock #243892
ES-560272C -6	98.1-99.9	40pF MI-560355-2 Stock #227938	Not Used	40pF MI-560355-2 Stock #227938	MI-560356-3 Stock #243896	MI-560356-3 Stock #243896	3455763-1, & -2 Stock #243892 Stock #243891
ES-560272C -7	100.1-101.9	40pF MI-560355-2 Stock #227938	Not Used	40pF MI-560355-2 Stock #227938	MI-560356-3 Stock #243896	MI-560356-3 Stock #243896	3455763-1, & -2 Stock #243892 Stock #243891
ES-560272C -8	102.1-103.9	25pF MI-560355-1 Stock #235990	Not Used	40pF MI-560355-2 Stock #227938	MI-560356-3 Stock #243896	MI-560356-3 Stock #243896	3455763-2 Stock #243891
ES-560272C -9	104.1-105.9	25pF MI-560355-1 Stock #235990	Not Used	40pF MI-560355-2 Stock #227938	MI-560356-3 Stock #243896	MI-560356-3 Stock #243896	3455763-2 Stock #243891
ES-560272C -10	106.1-107.9	25pF MI-560355-1 Stock #235990	Not Used	40pF MI-560355-2 Stock #227938	MI-560356-3 Stock #243896	MI-560356-3 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) may 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 7. 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 3 minutes 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-27791K-5A) and a short length (6 feet) of RG-8/U cable.

PA NEUTRALIZATION

NOTE: If neutralizing the PA stage (with driver previously tuned and adjusted), the neutralizing procedure should start with DRIVER TUNING step 6. PA plate and screen voltages must be removed during 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. 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.

*Requires the use of a calibrated rf wattmeter and dummy load.

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 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.

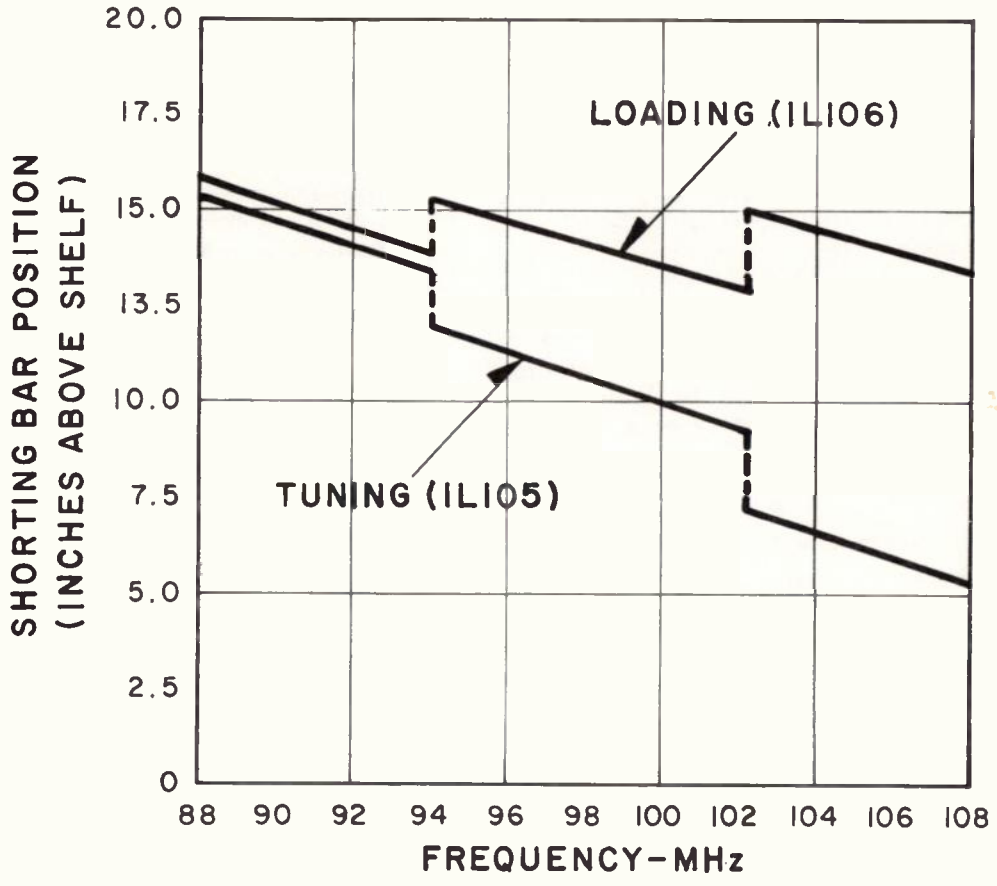
In tuning the PA (or other tetrodes) it should be noted that the screen current is a sensitive loading indicator. In general, the screen current will rise as the loading is decreased (higher load impedance) and drop as the loading is increased.

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 7, 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



PLOT BASED ON LOADING CAPACITOR VALUES AS FOLLOWS:

FREQUENCY (MHz)	87.5-94	94-102	102-108
IC124	25pF	40pF	25pF
IC125	25pF	NOT USED	NOT USED
IC126	40pF	40pF	40pF

IK081

Figure 7. Typical Settings, PA Tuning Controls

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 8).

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

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 10).

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 power levels less than rated power output. See figure 10.

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.

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 otuput 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 value of plate current until the value of plate current corresponding to 20 kW power output is reached. See figure 8.

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 8.

6. To set operating power, refer to figure 8 and determine efficiency factor F for the licensed operating power. The operating plate current is

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

The plate voltage in this formula refers to the

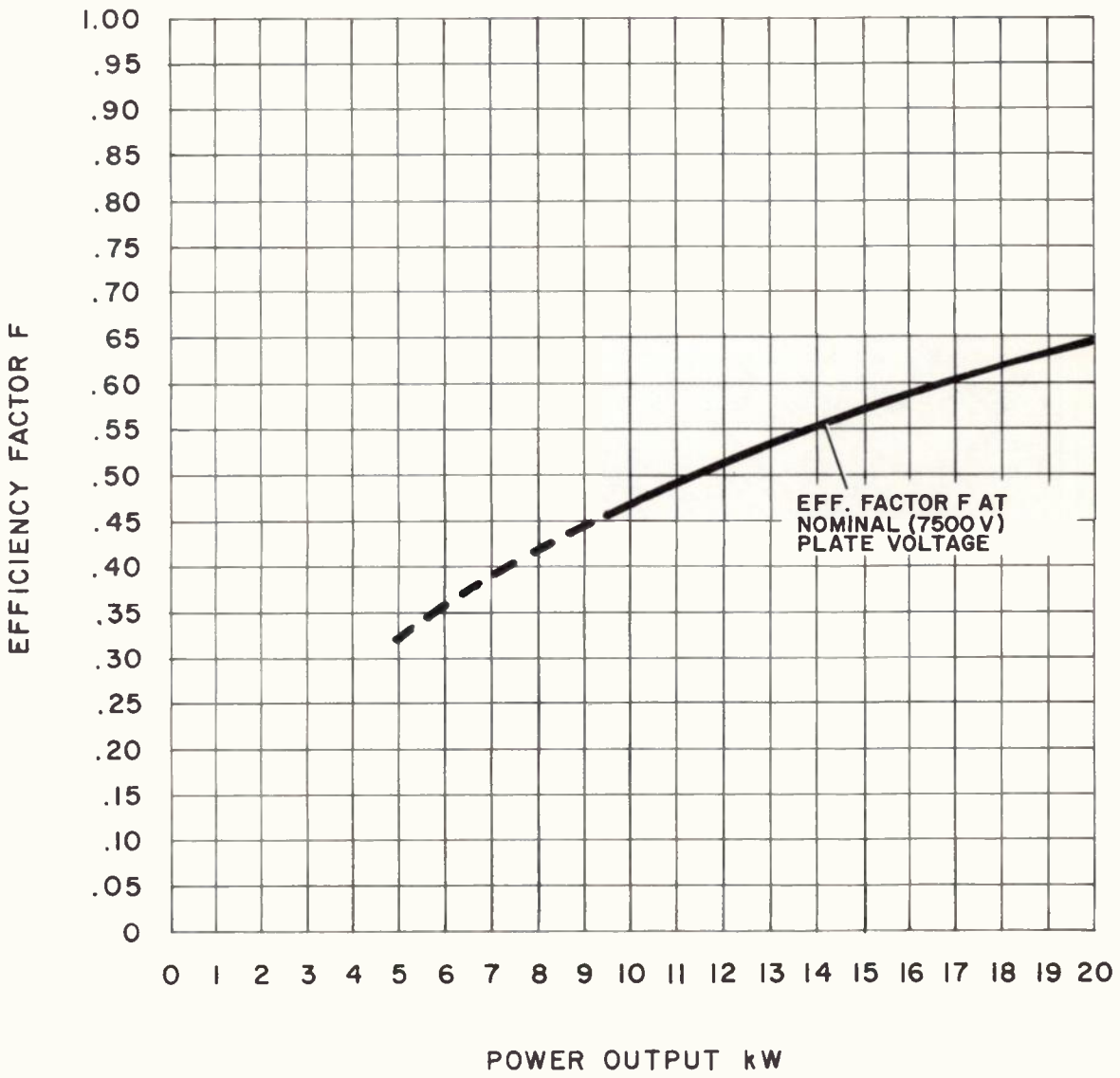


Figure 8. Efficiency Curve

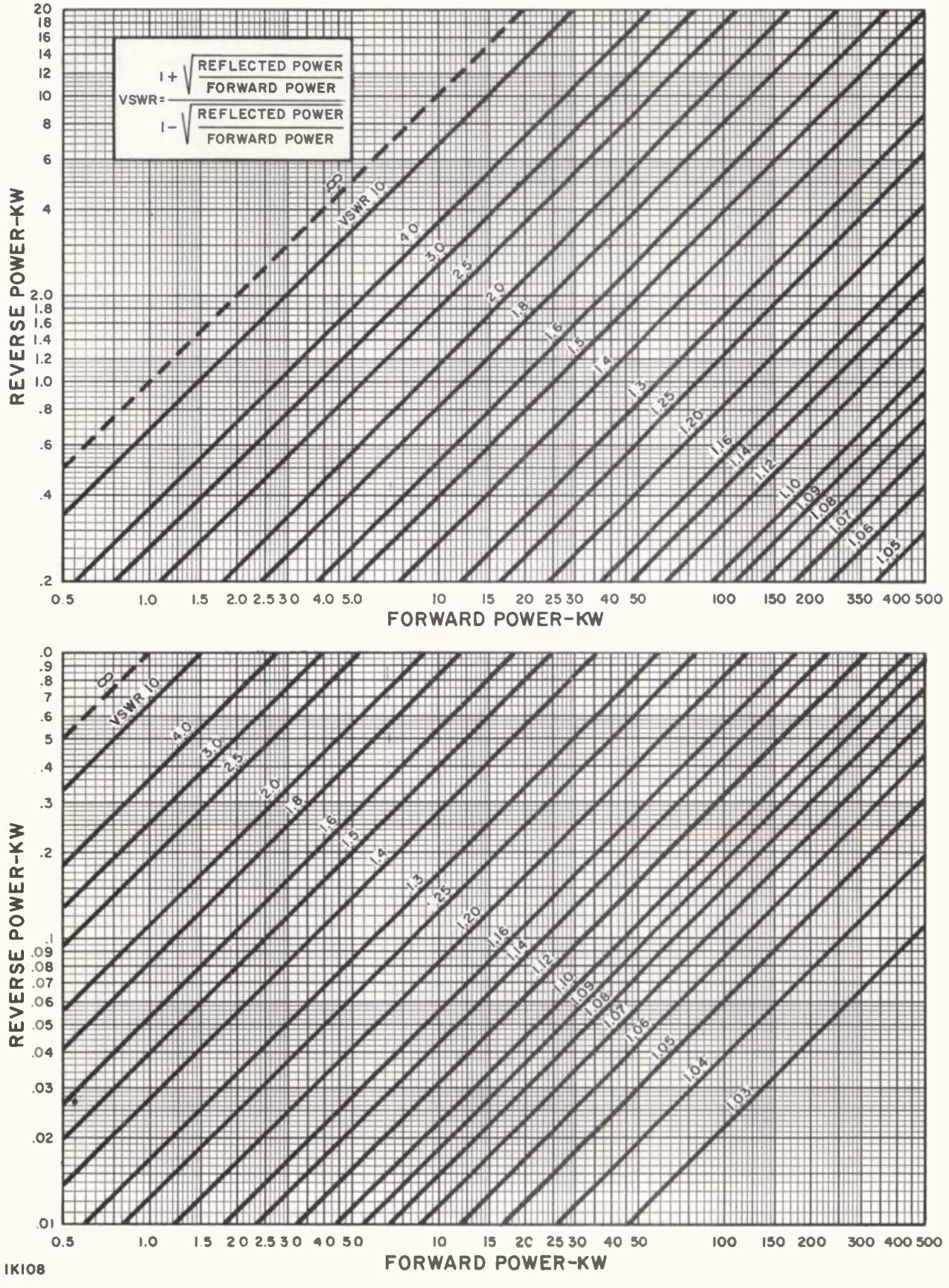


Figure 9. VSWR Nomograph

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.

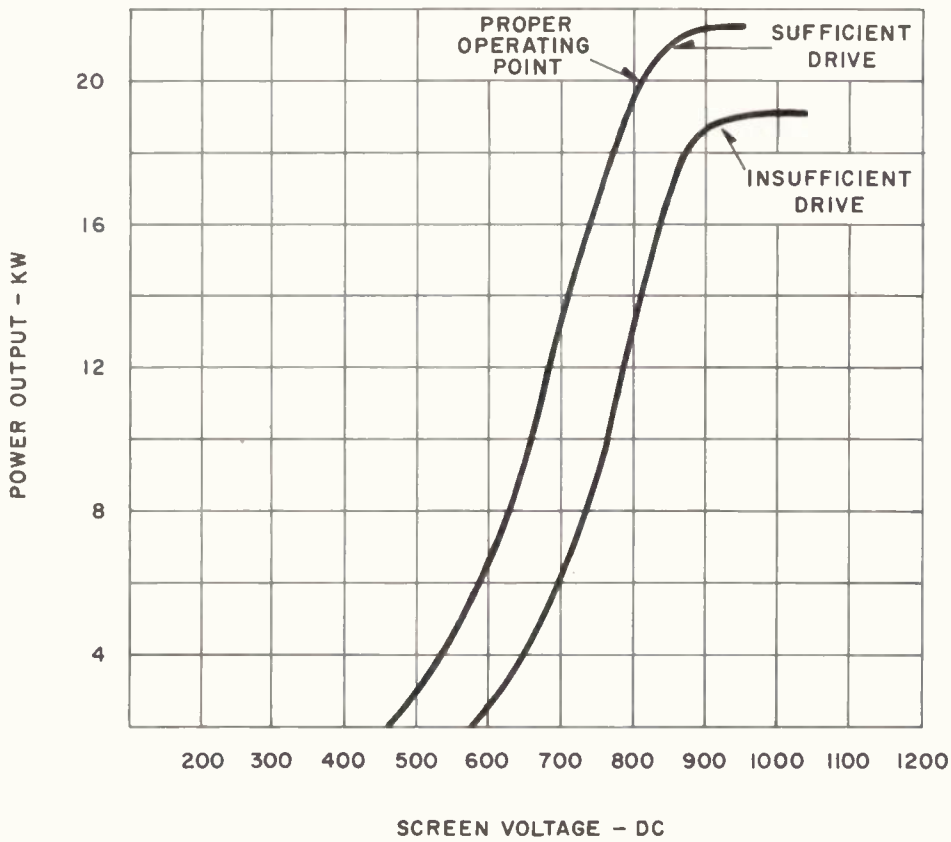


Figure 10. PA Screen Voltage/Power Output Curve

The set-point used should be between 50 and 70% of the licensed 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 licensed 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 by 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 pushbutton, 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 3 minutes) 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

Panel meter readings are provided for guidance, and must *not* be interpreted as specification values which must be duplicated. PA plate current and plate voltage, for example, vary with power output. PA plate current is also a function of PA plate efficiency (see PA tuning procedure). Therefore, even at the 20 kW power output level for which typical meter readings are supplied, some deviation from listed values is to be expected and should not cause concern. In addition, the driver cathode and screen currents, driver screen voltage, and PA grid and screen currents and screen voltage will be lower at reduced power output levels.

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 voltage, 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	200 V
PA I_G	0–600 mA	85 mA
PA I_{G2}	0–600 mA	400 mA
PA E_{G2}	0–1200 V	700 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 close 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

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 on tuning drive mechanisms, using molybdenum disulphide powder, Molykote Type Z, or equivalent. Do not lubricate plastic lead screws.
– 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. (The manometer is an optional item).

SILICON RECTIFIER TESTING

A short-circuited silicon rectifier cell may be detected by simple resistance checks using a voltohmmeter such as a RCA Model WV-38A. 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 CR307 rectifier stack, RCA stock No. 426162, 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 11 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 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 CR307 series stack has been left unpainted to facilitate this connection.

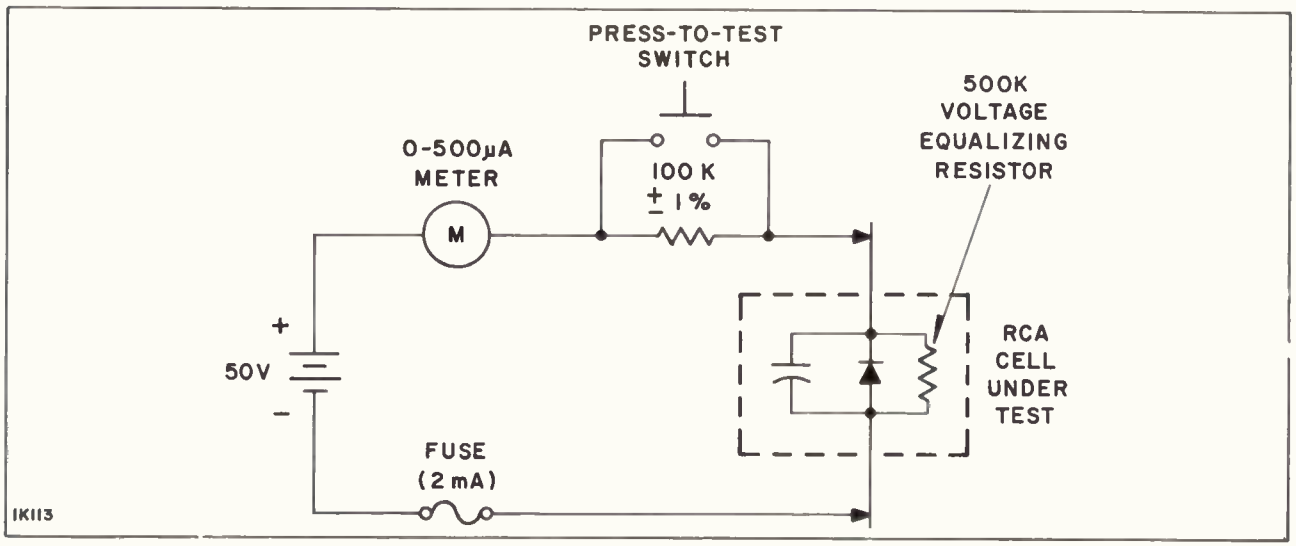


Figure 11. Rectifier Test Circuit

If the cell under test is shorted (or connected with reversed polarity) the meter will indicate approximately 500 μA. 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. See 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 30.

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

The waveforms shown in figure 31 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. O. 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 30 for Control Module schematic diagram and terminal identification.

BLOWER LUBRICATION

MI-560347-A1 Blower motors are lubricated with a special moisture resistant grease by the motor manufacturer. The motor bearings should be lubricated at least every two years with an equivalent type ball bearing grease. Use only a high grade ball bearing grease that is clean, and do not use "silicone" grease without special instructions. Avoid greases with solid additives such as graphite, talc, etc. High grade, neutral ball bearing grease such as Lubriko M21 or Alemite No. 38 or Keystone No. 44 are suitable. Lubriko M21 is available in one (1) and five (5) pound cans from local ball bearing distributors.

The blower without pressure type fittings must be removed from the cabinet and the motor disassembled to properly lubricate the bearings. Carefully clean bearings and housing before adding grease. Do not fill housing more than half full.

Motors with pressure type fittings may be lubricated in place. Remove the bottom plug before adding lubricant and remove any hardened grease that may have accumulated. Add grease to flush out old grease. Run motor a few minutes to permit excess grease to drain out the bottom hole, then replace bottom plug.

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, and uses a Rotron muffin fan, the fan's 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 RCA Parts and Accessories, stock No. 227686. 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.

Fans manufactured by Pamotor, Inc., incorporate sealed bearings which do not require added lubrication.

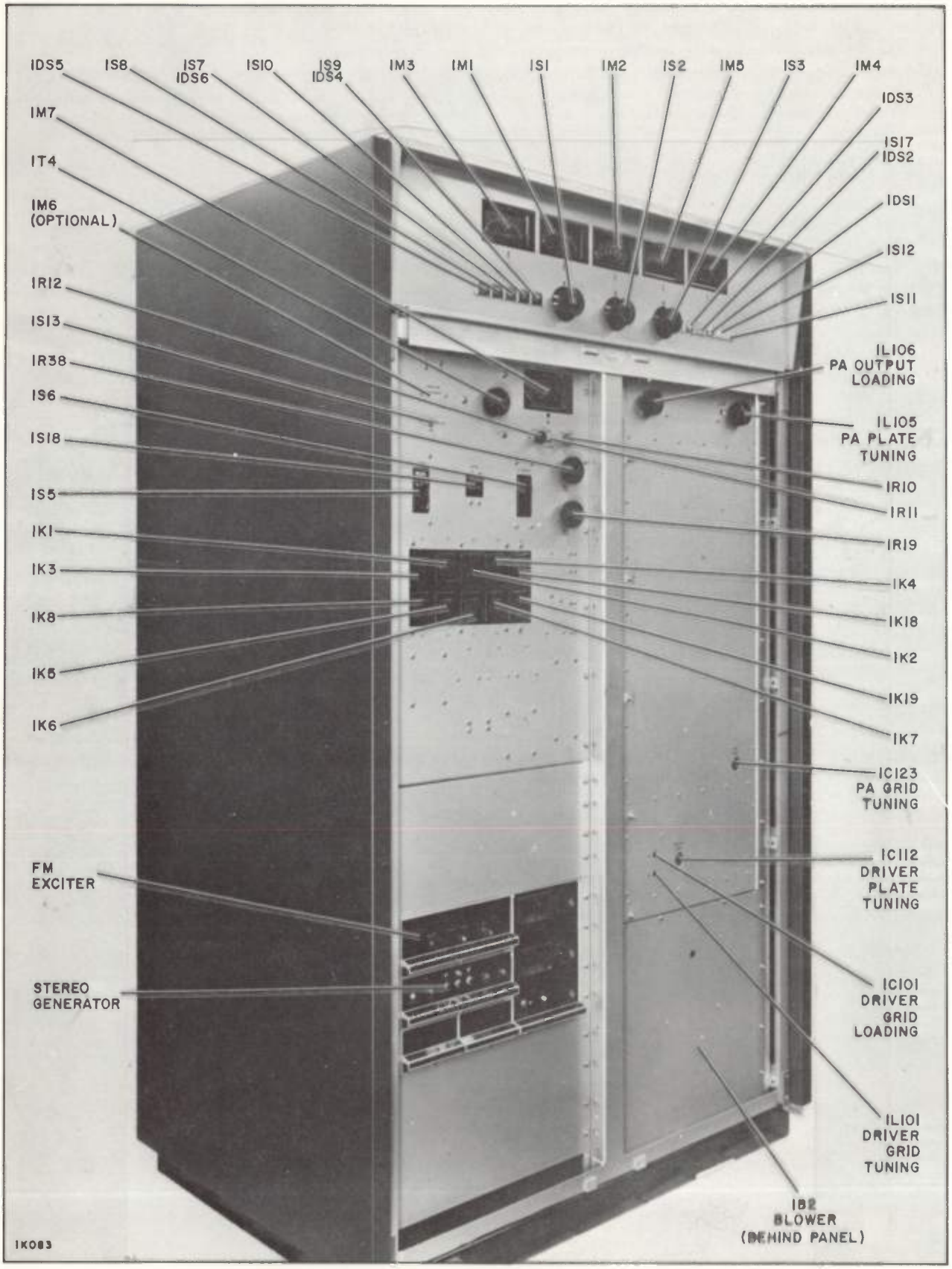


Figure 12. Transmitter, Electrical Parts, Front View

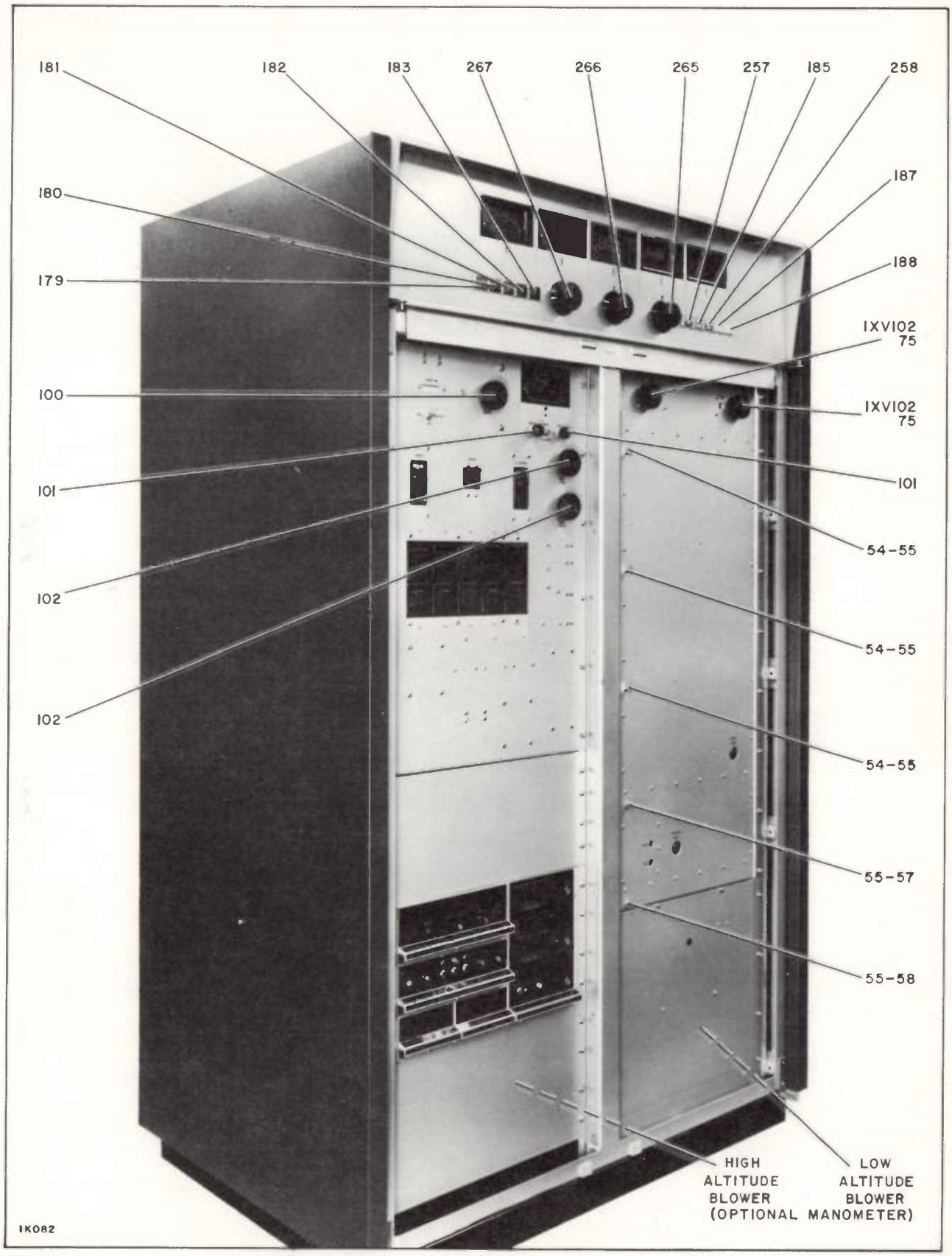


Figure 13. Transmitter, Mechanical Parts, Front View

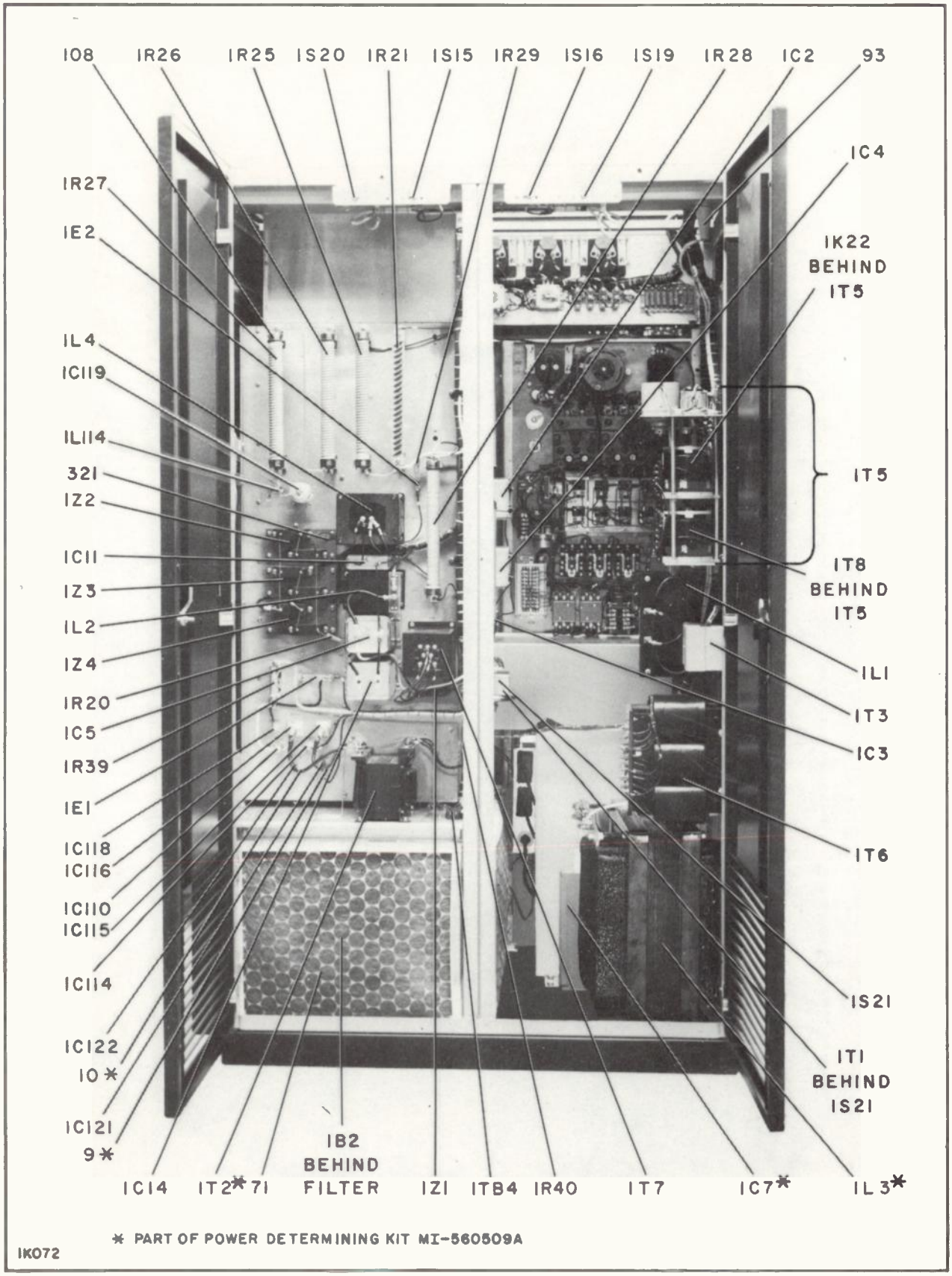


Figure 14. Transmitter, Rear View

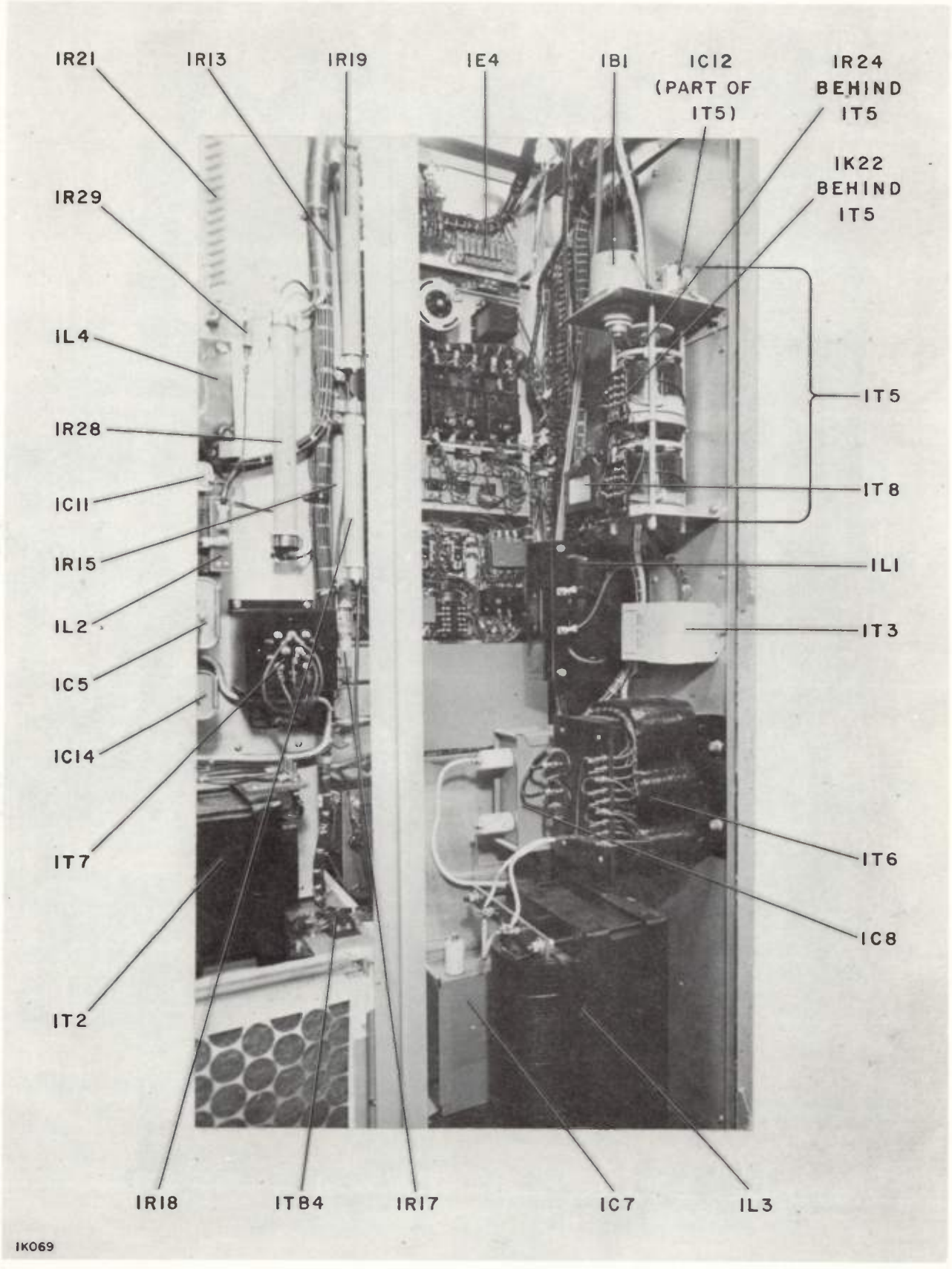


Figure 15. Transmitter, Left Rear Oblique View

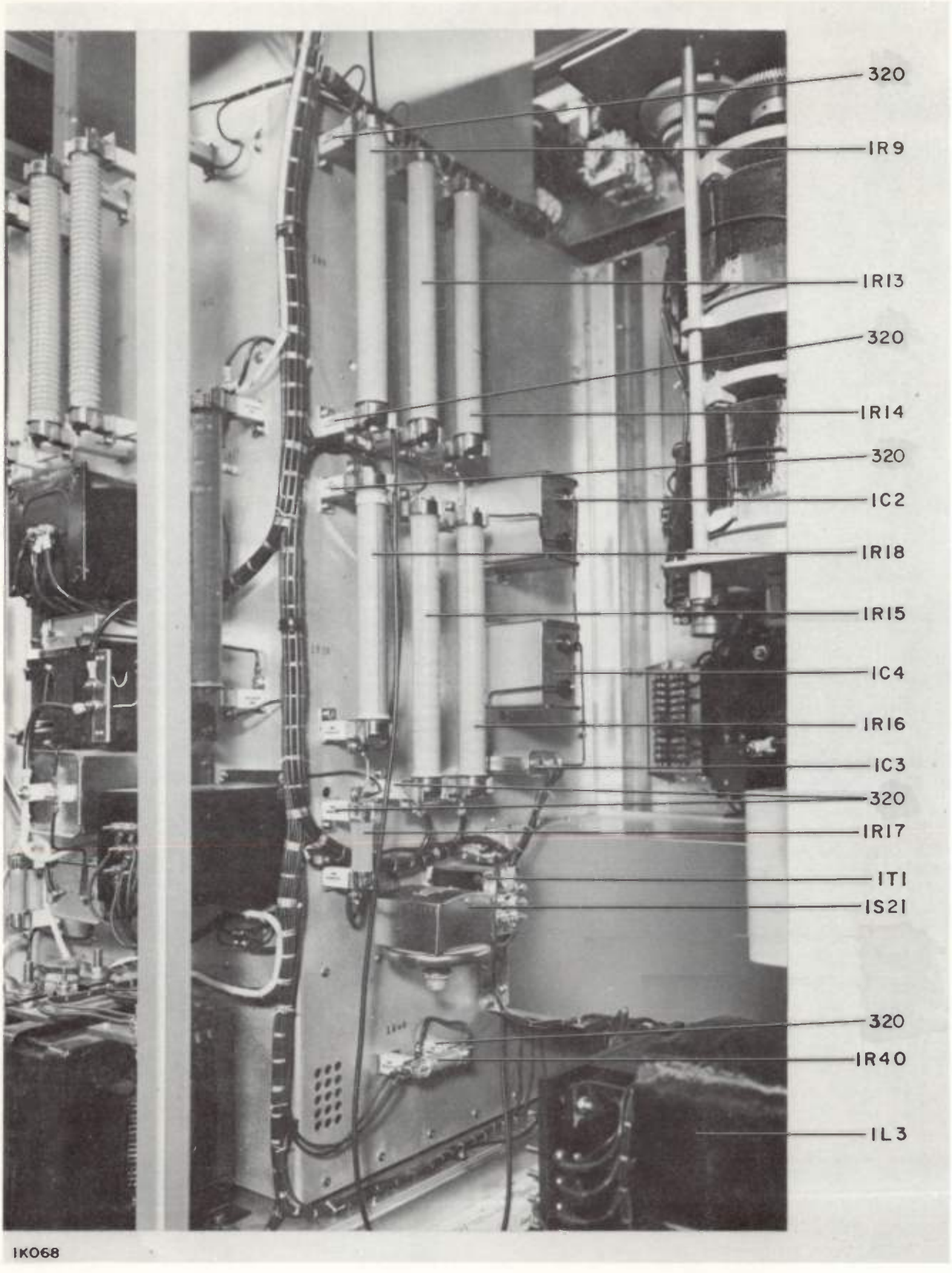


Figure 16. Transmitter, Right Rear Oblique View

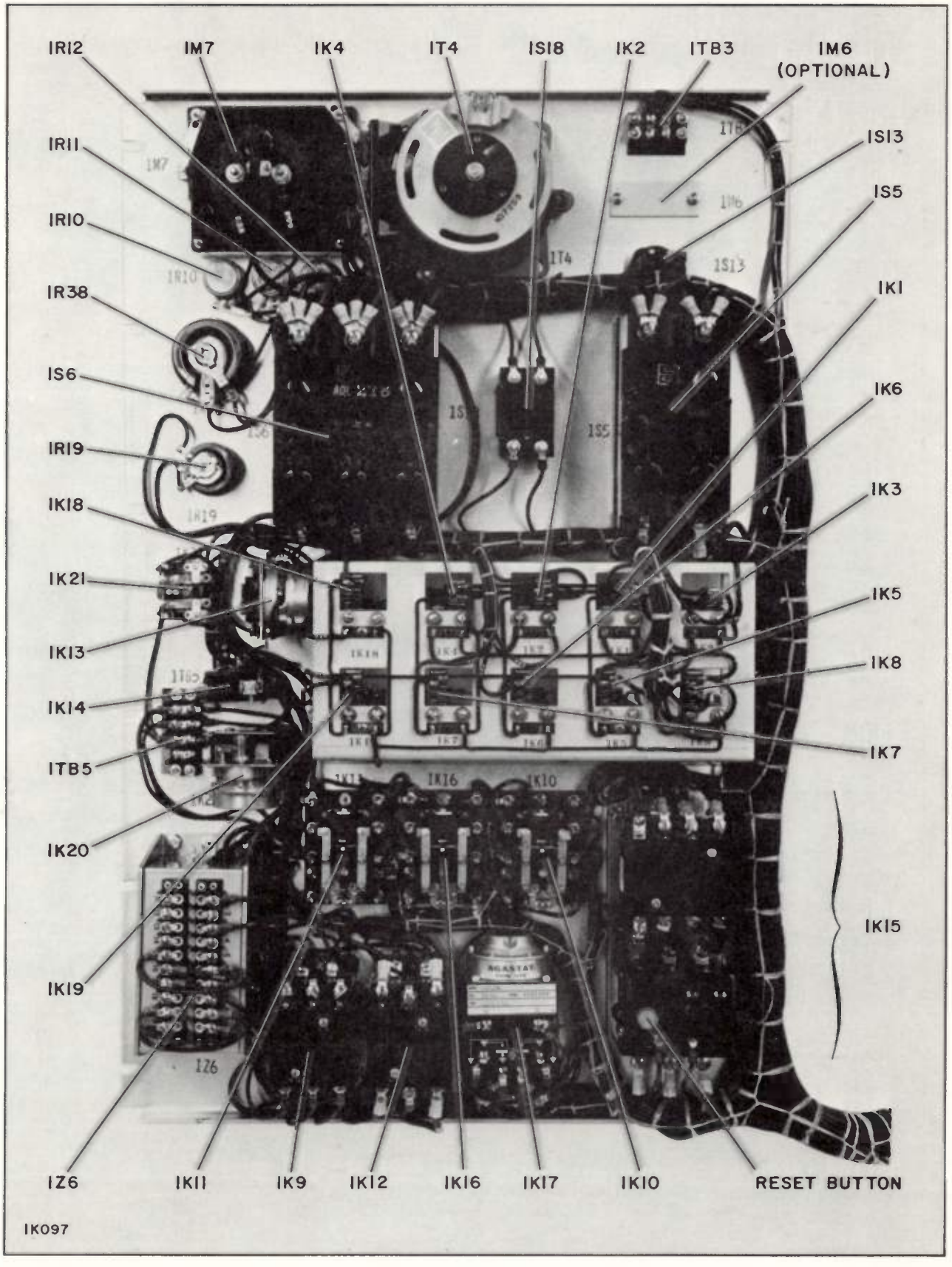


Figure 17. Control Panel, Rear View

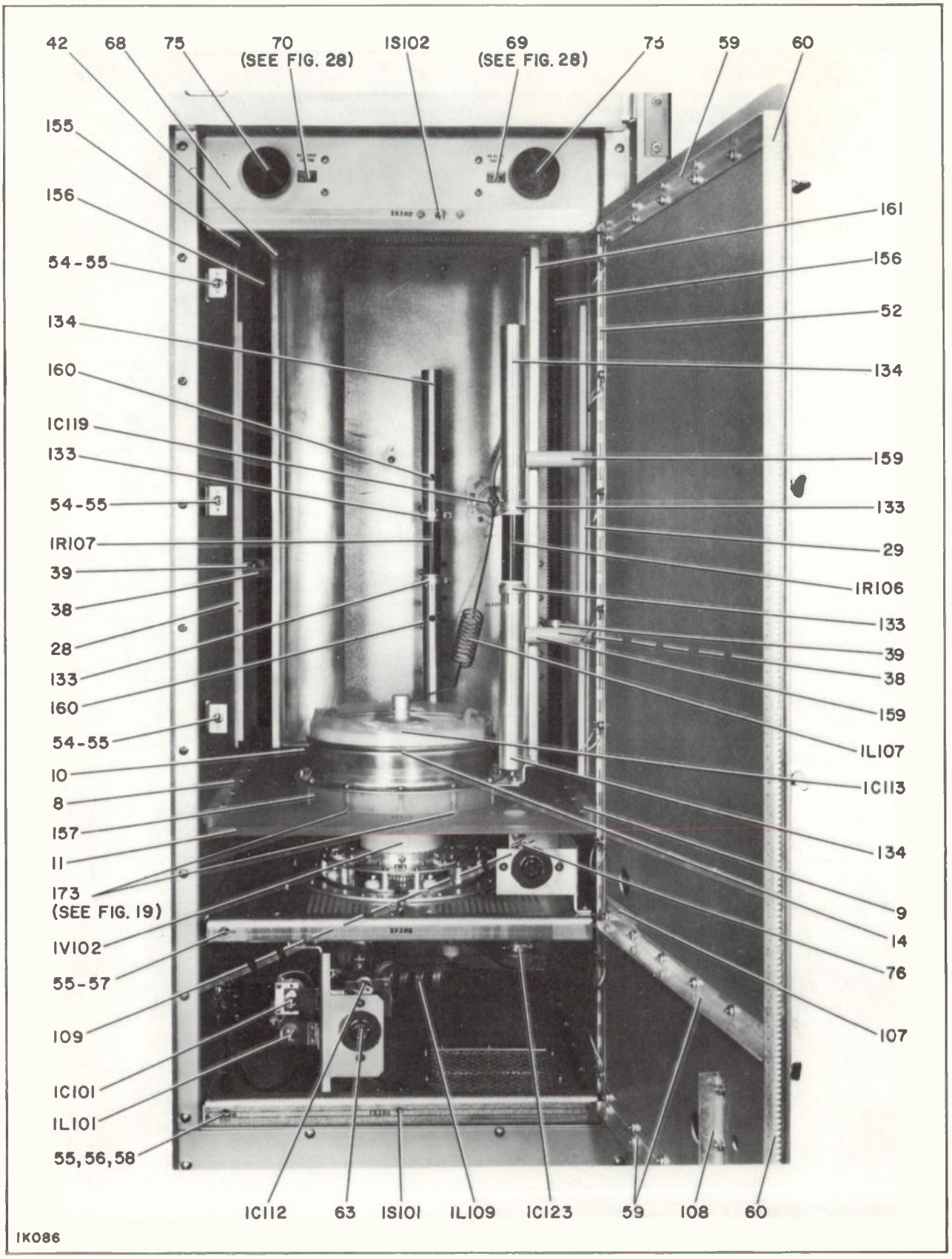


Figure 18. RF Shelf, Front View

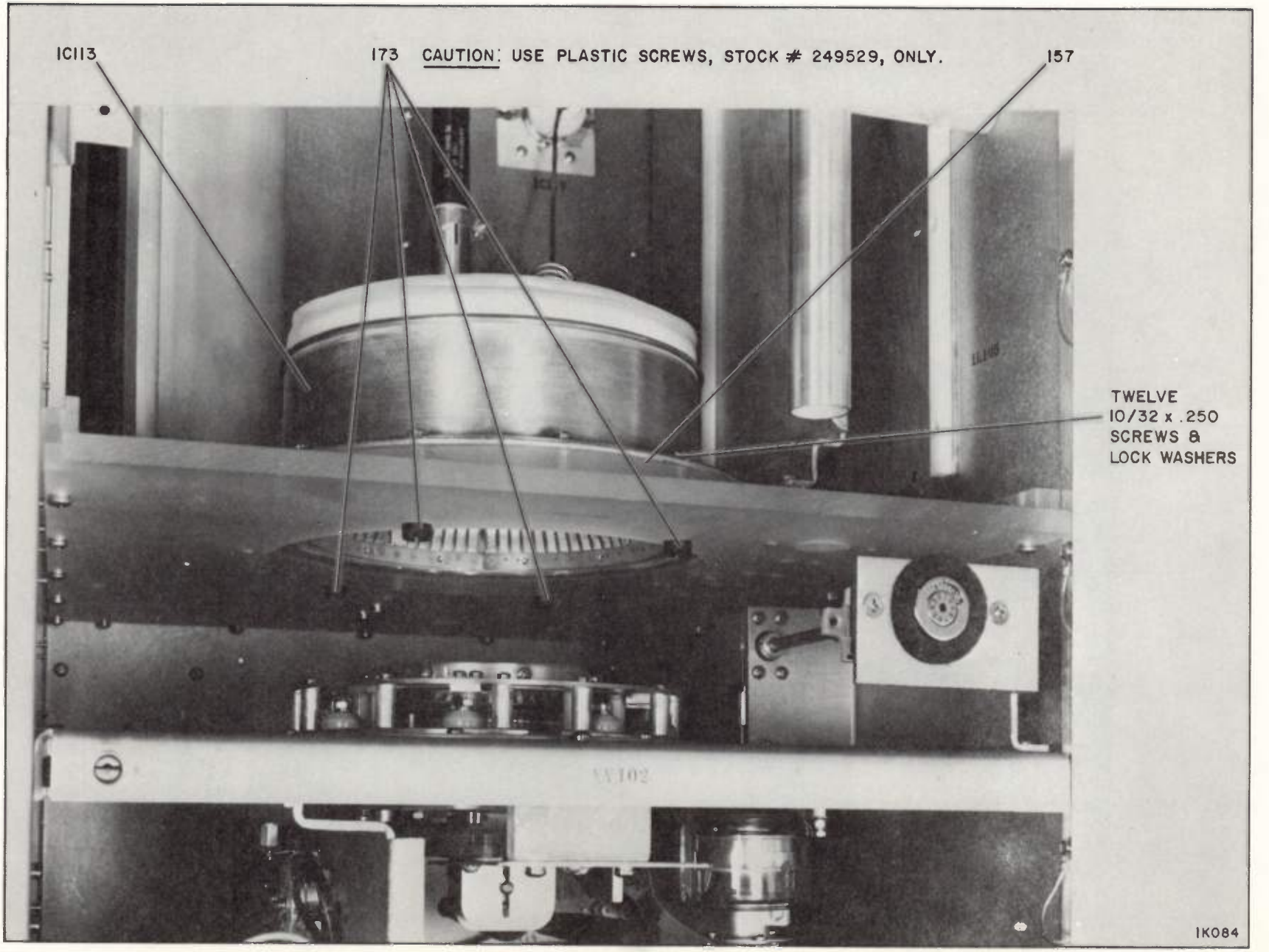


Figure 19. RF Box Showing 1C113 Mounting Assembly

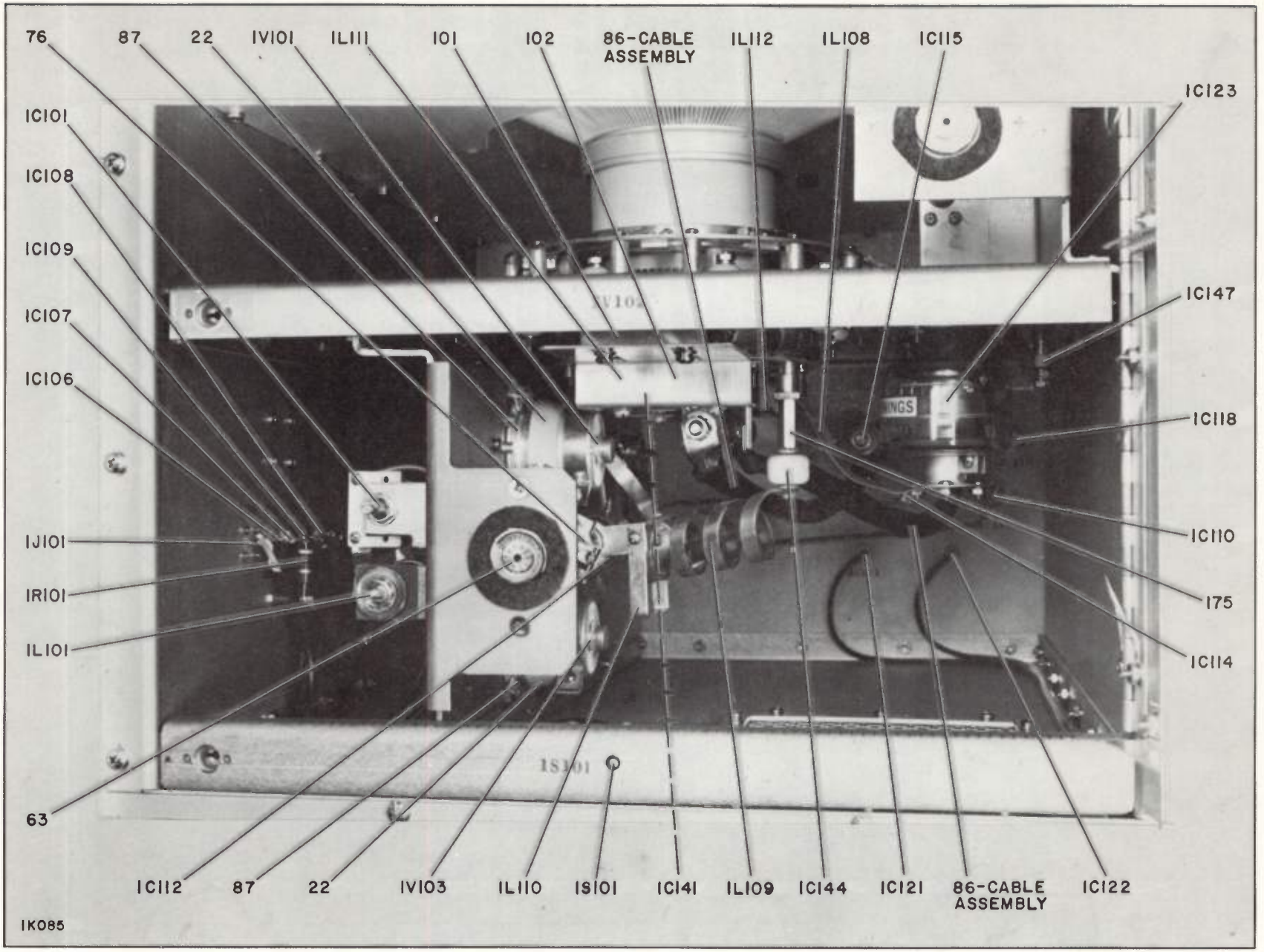


Figure 20. Driver Shelf and 1XV102 Shelf, Front View

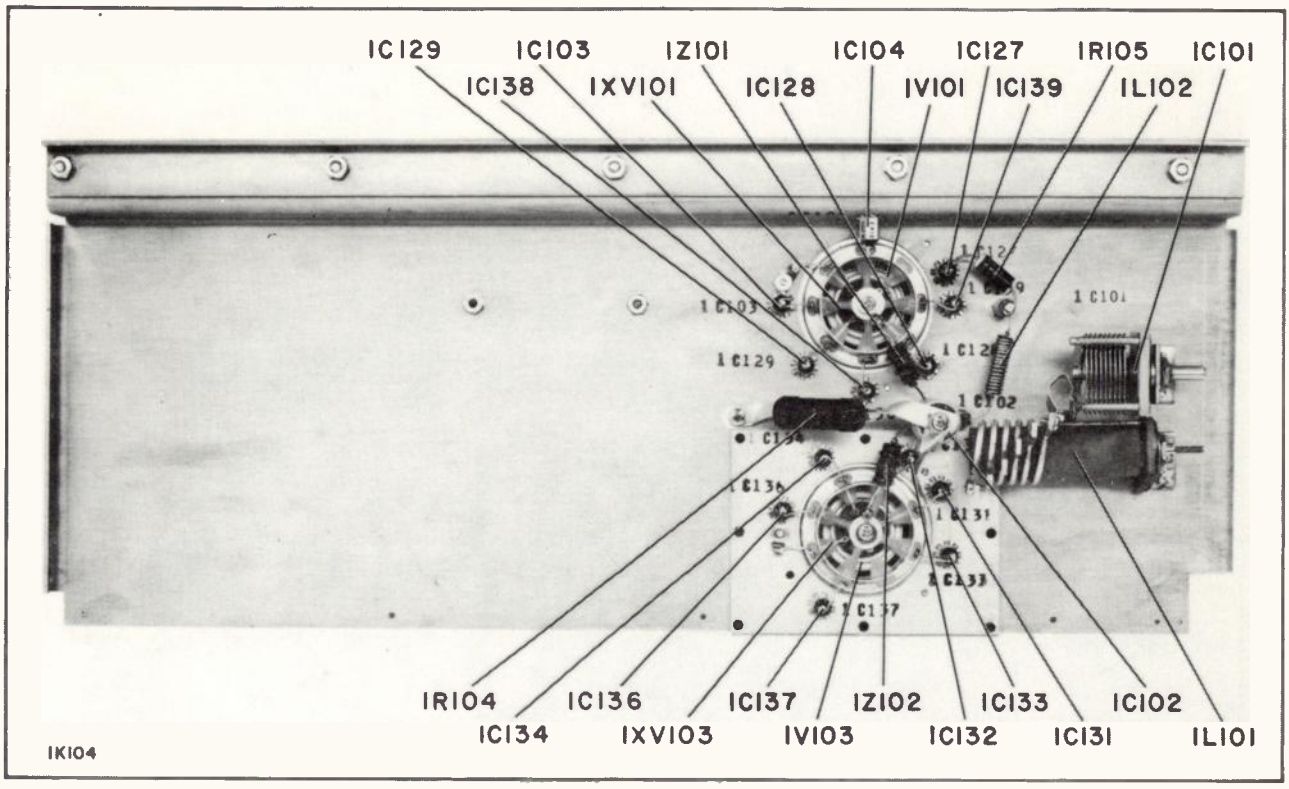


Figure 21. Driver Shelf, Left Side

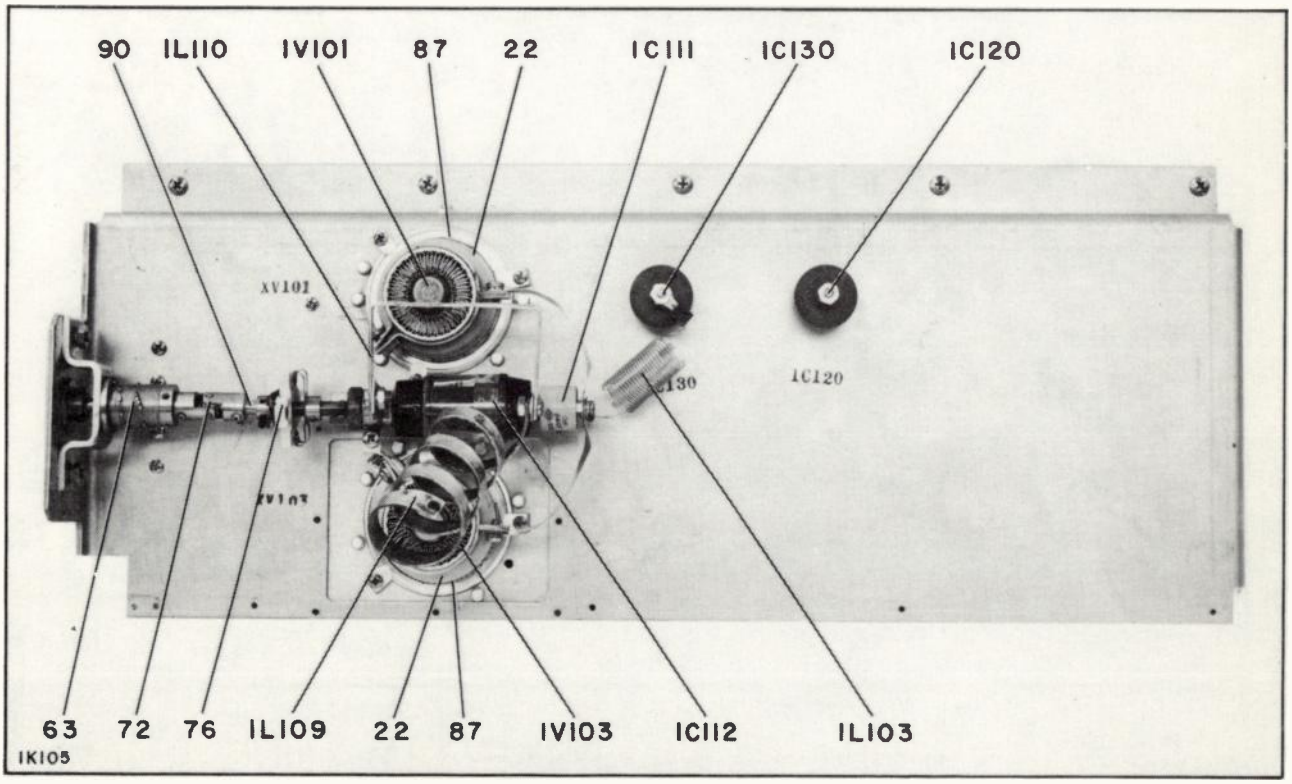


Figure 22. Driver Shelf, Right Side

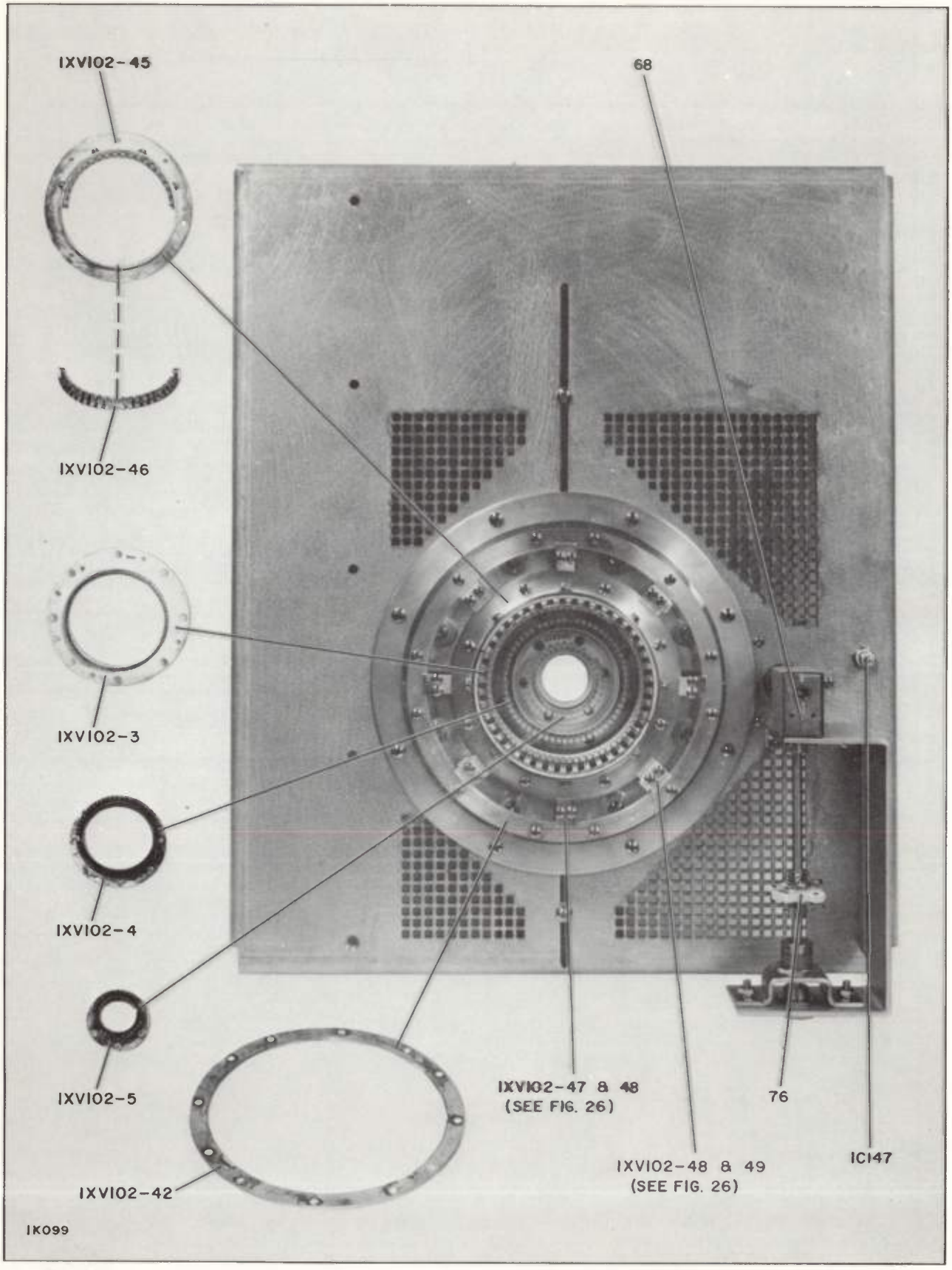


Figure 23. 1XV102 Socket Assembly, Top View

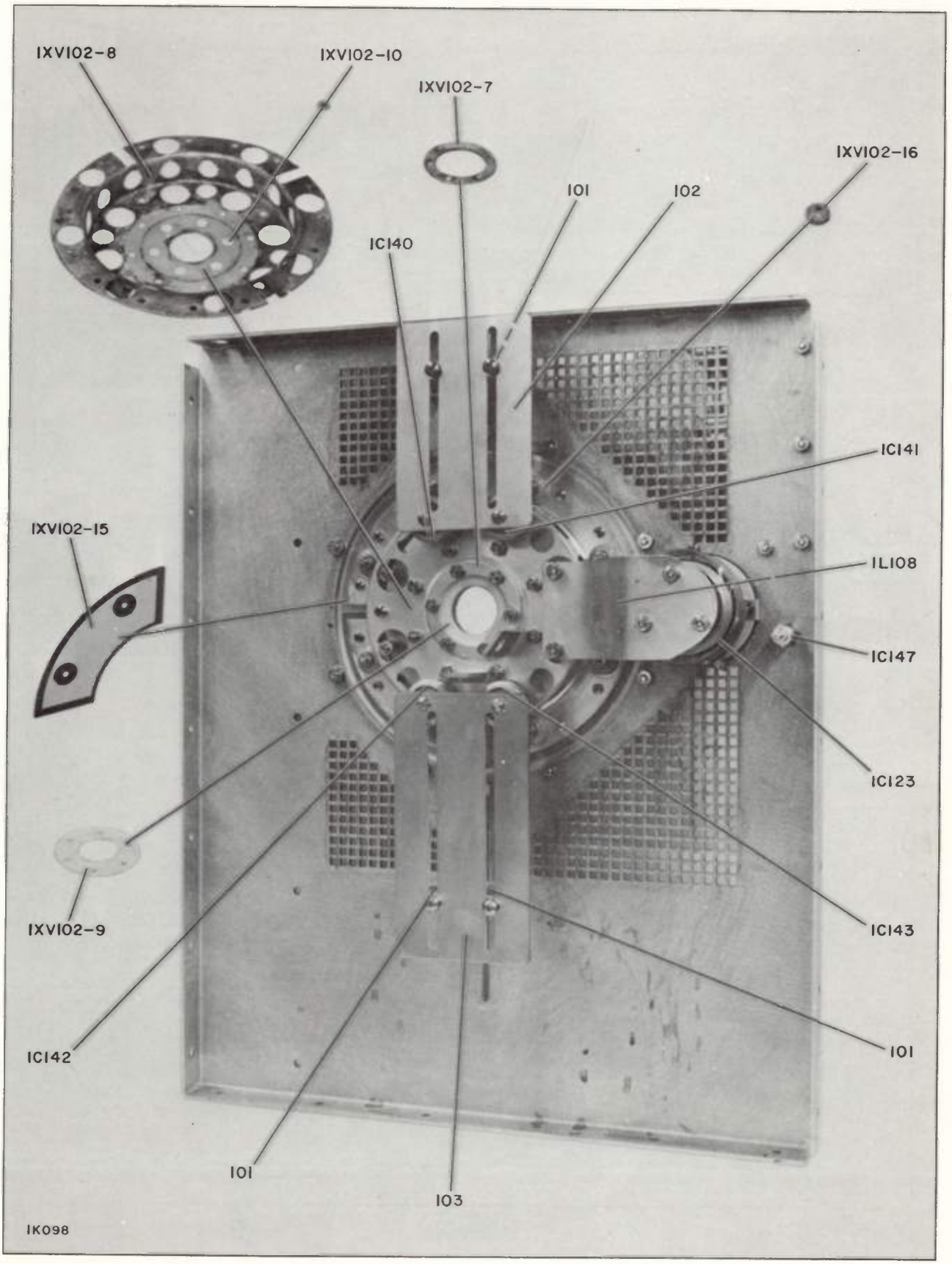


Figure 24. 1XV102 Socket Assembly, Bottom View

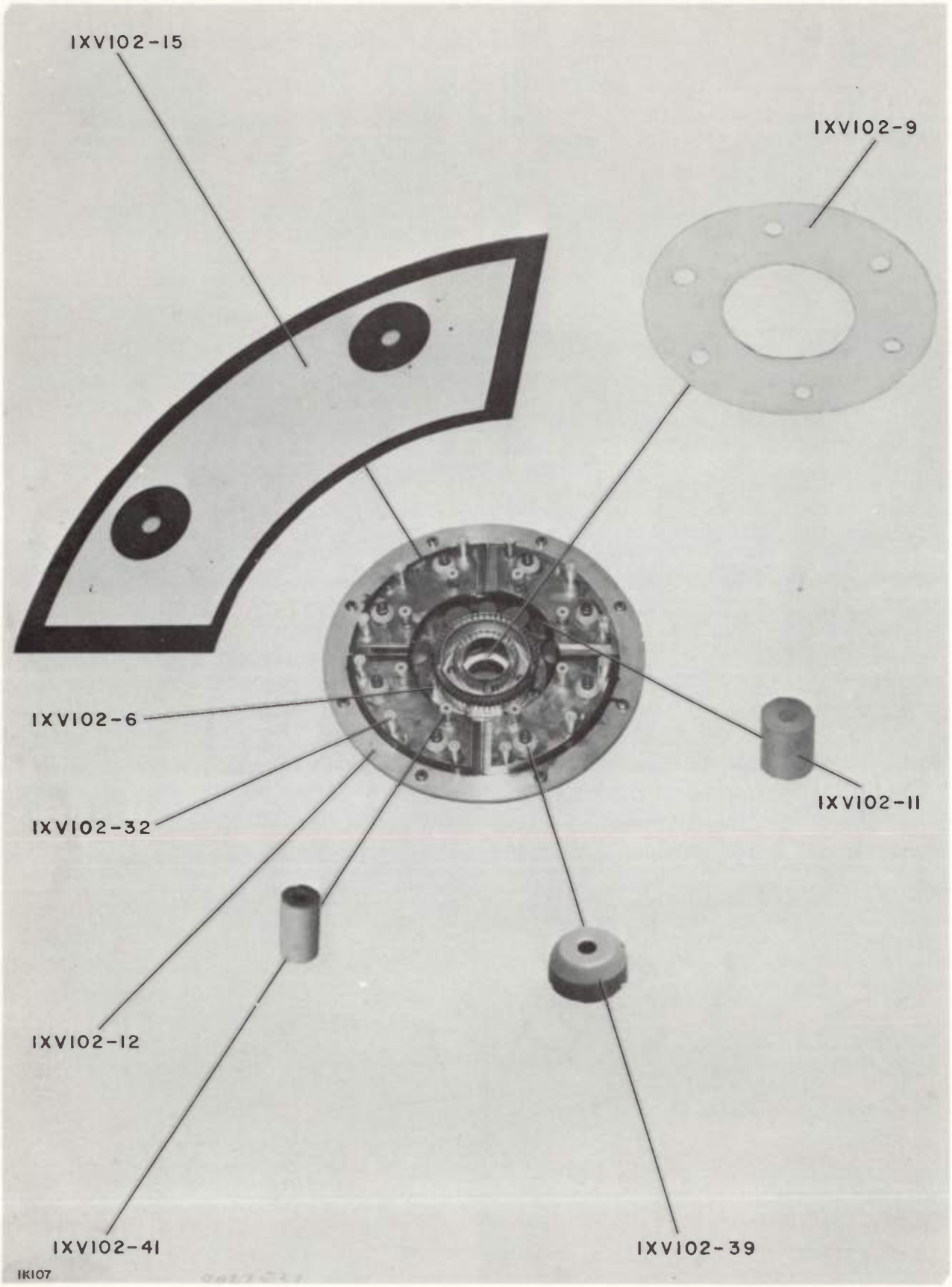


Figure 25. 1XV102 Insulators and Capacitors

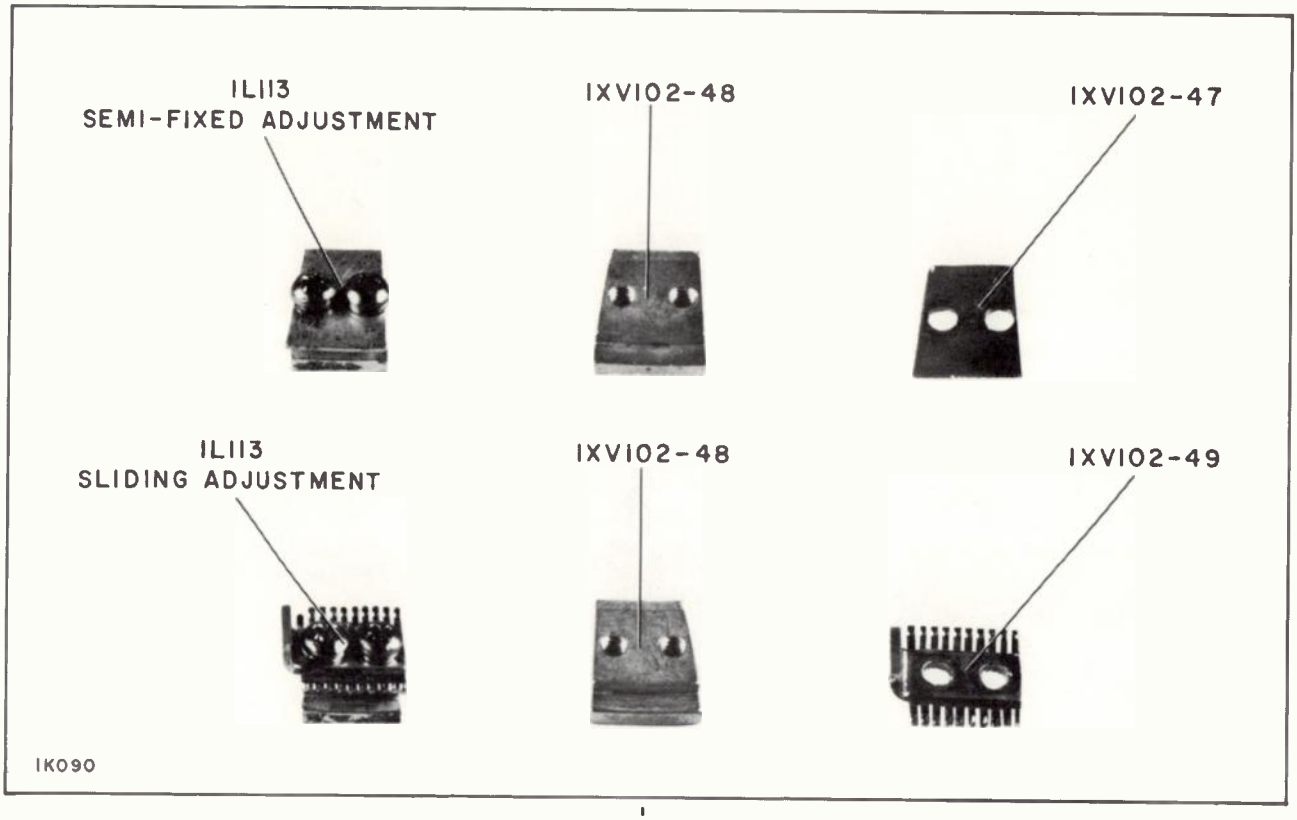


Figure 26. 1L113 Semi-Fixed and Sliding Contacts

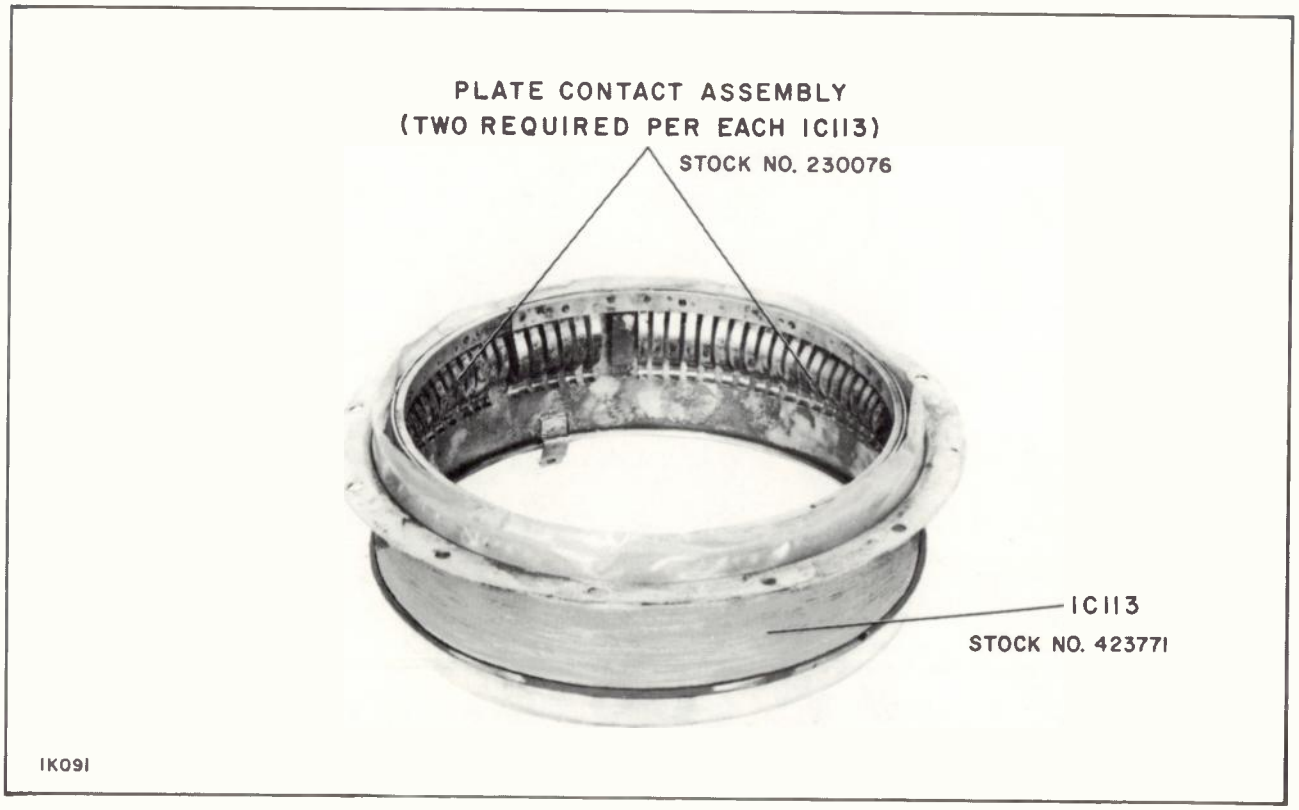


Figure 27. 1V102 Plate Contacts and Plate Blocking Capacitors

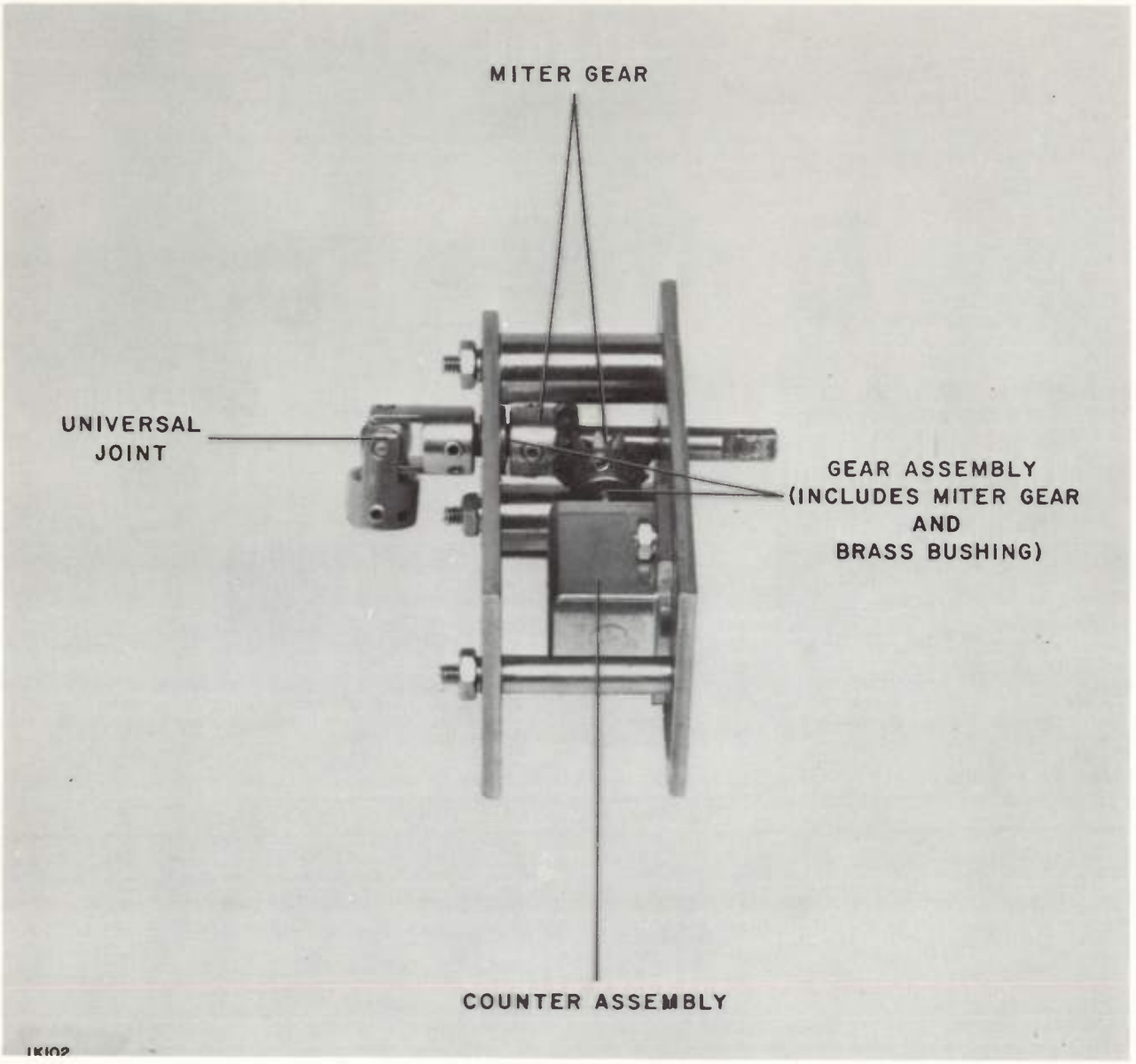


Figure 28. 1L105 and 1L106 Counter Assemblies

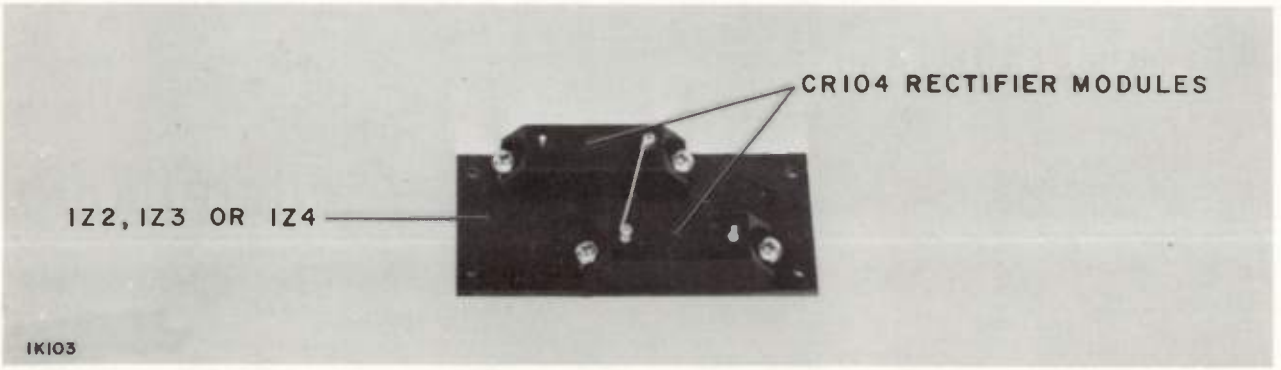
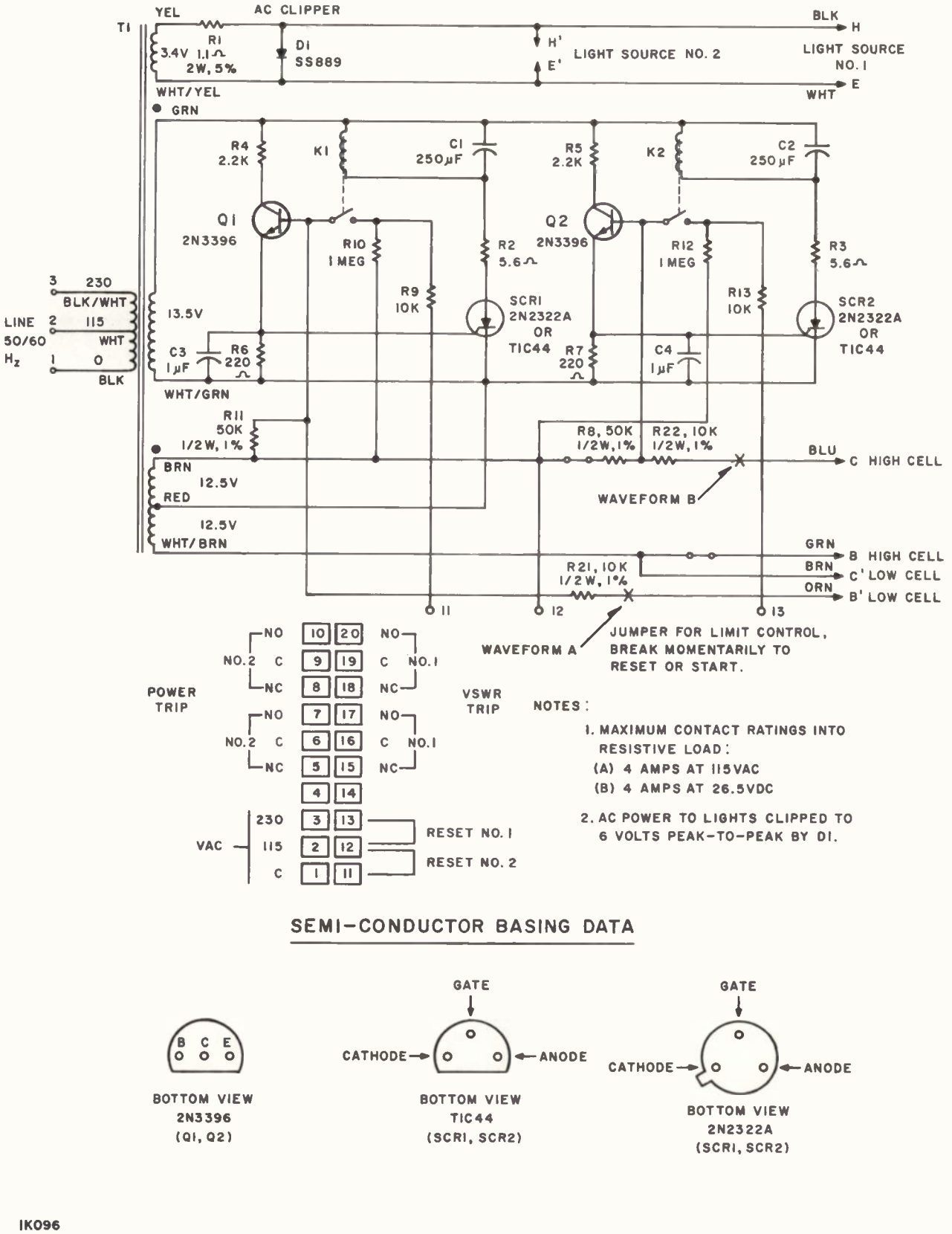


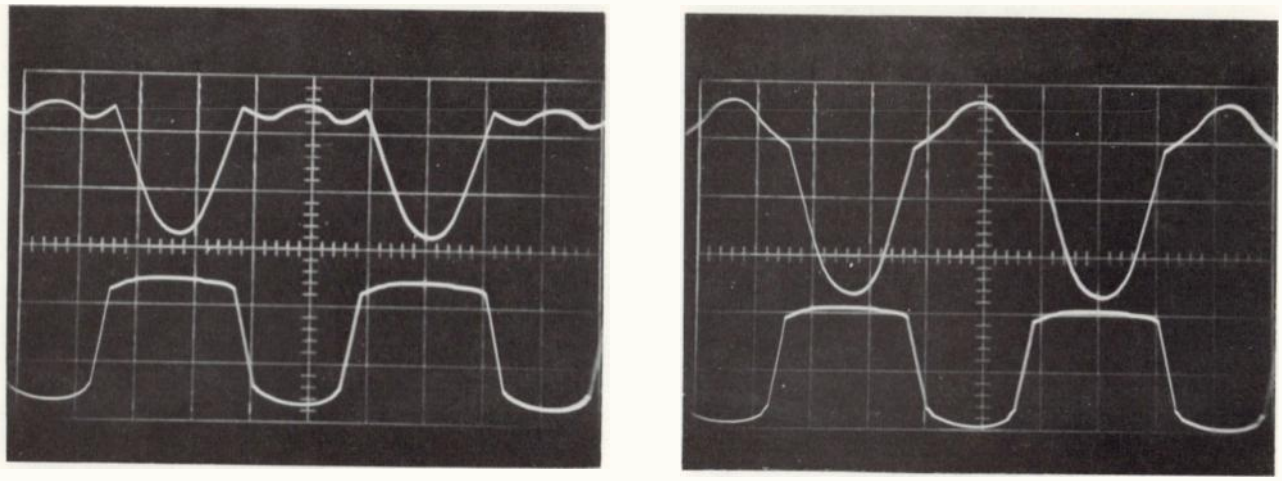
Figure 29. Low Voltage Rectifier Assembly



SEMI-CONDUCTOR BASING DATA

IK096

Figure 30. 1Z6 Control Module, Schematic Diagram



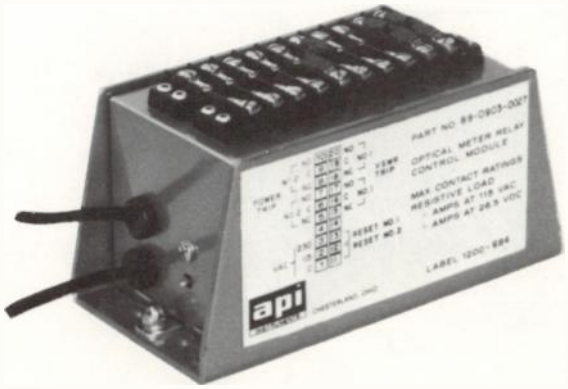
IK093

A B

NOTES:

1. WAVEFORM A IN BASE CIRCUIT OF Q1 (POWER TRIP) AT "WAVEFORM A" POINT ON FIGURE 30.
2. WAVEFORM B IN BASE CIRCUIT OF Q2 (VSWR TRIP) AT "WAVEFORM B" POINT ON FIGURE 30.
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 31. Control Module, Waveforms



IK094

Figure 32. Control Module

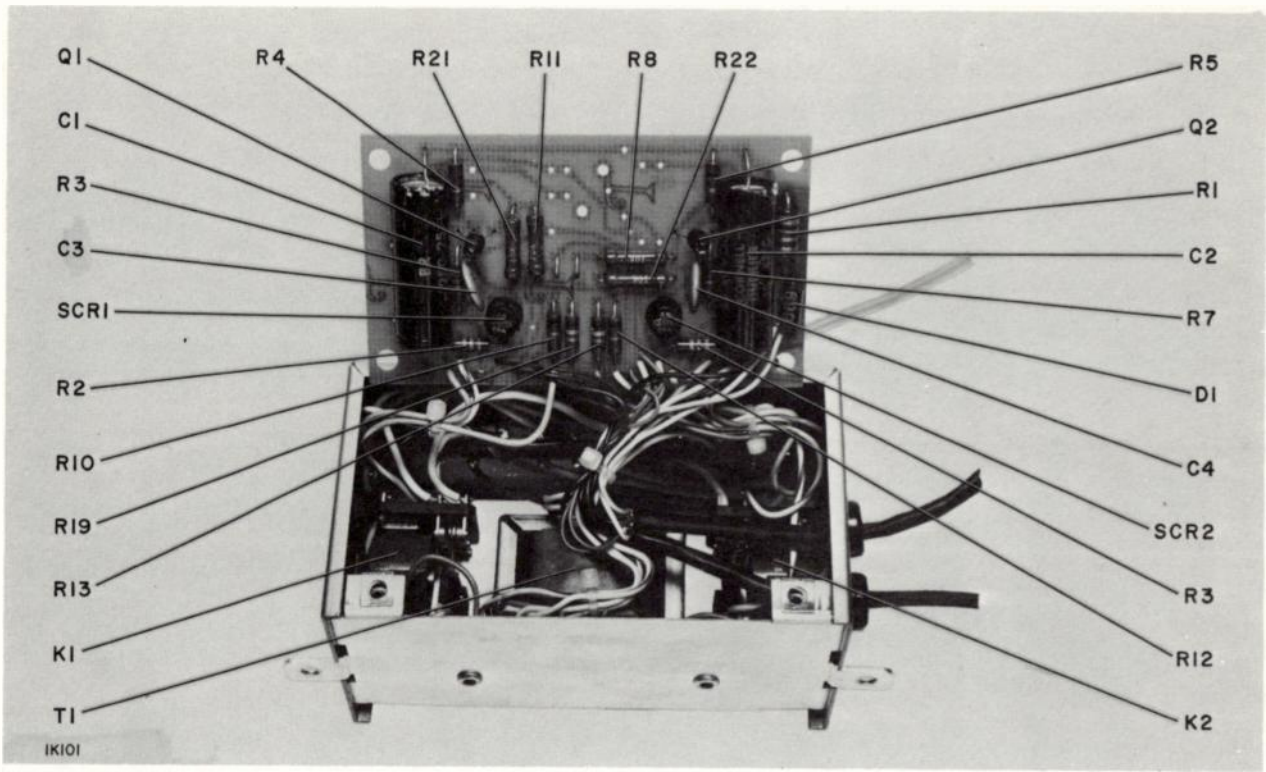


Figure 33. Control Module, Electrical Parts

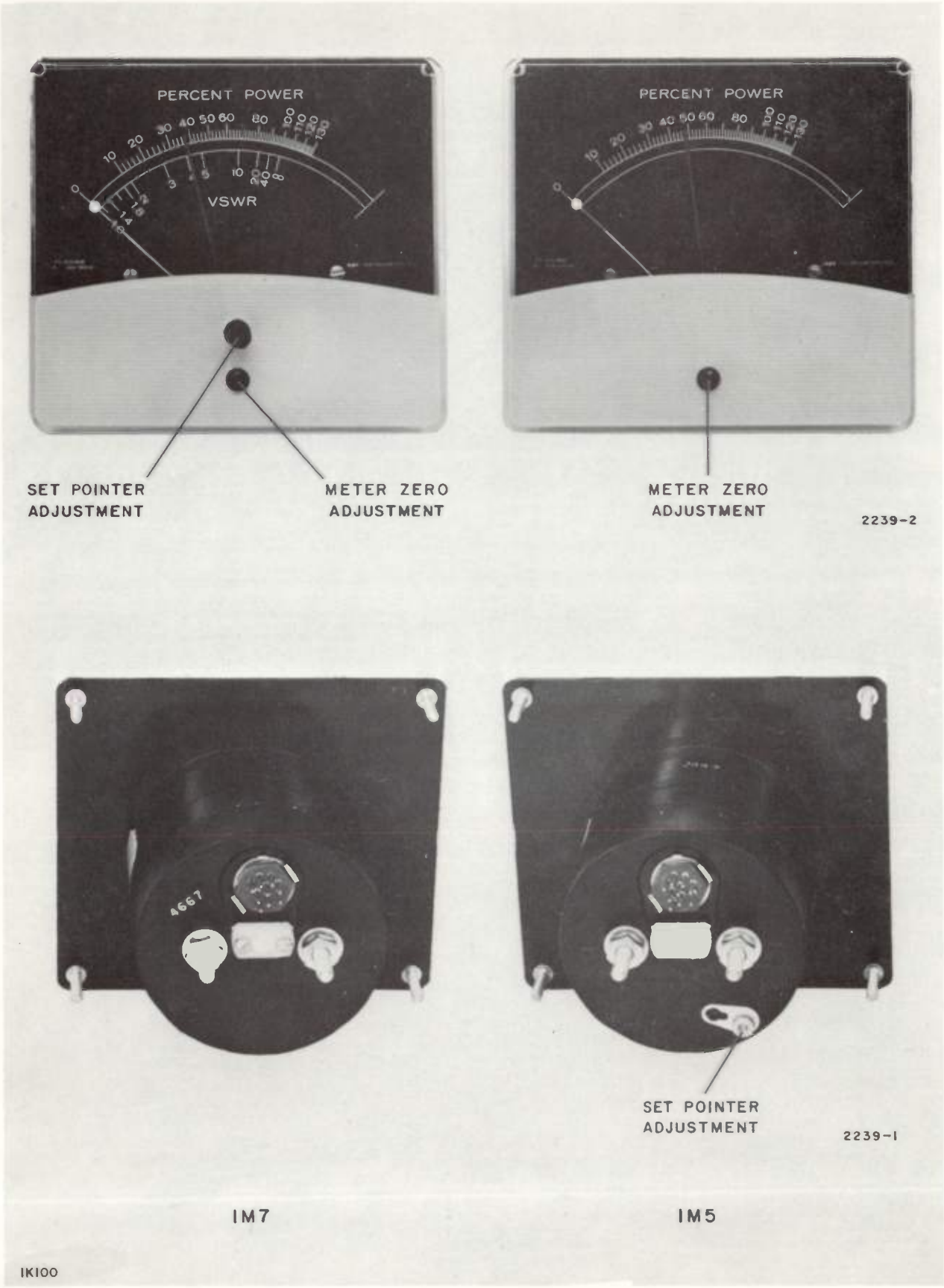


Figure 34. 1M5 and 1M7 Panel Meters

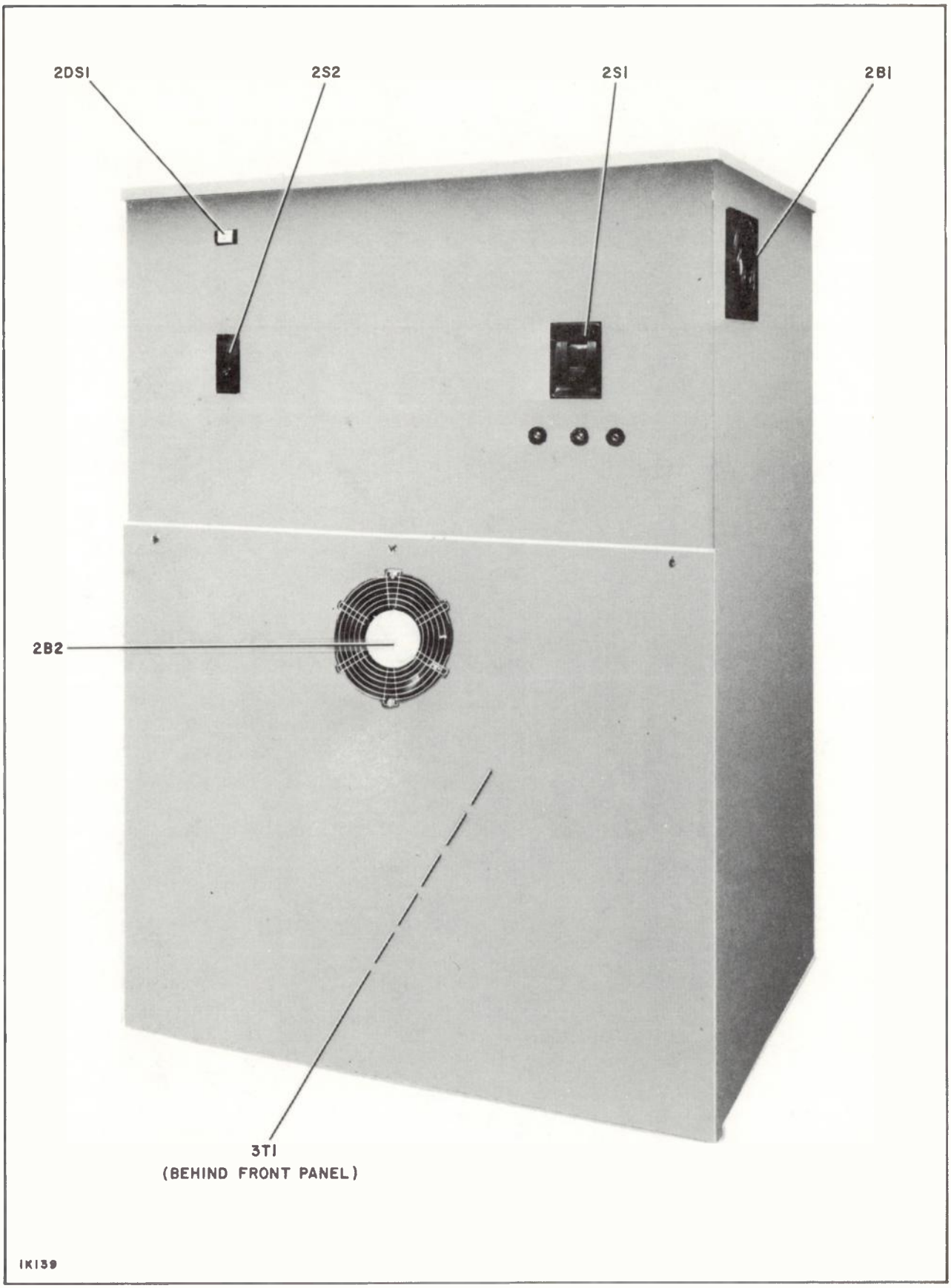


Figure 35. High Voltage Power Supply, Front View

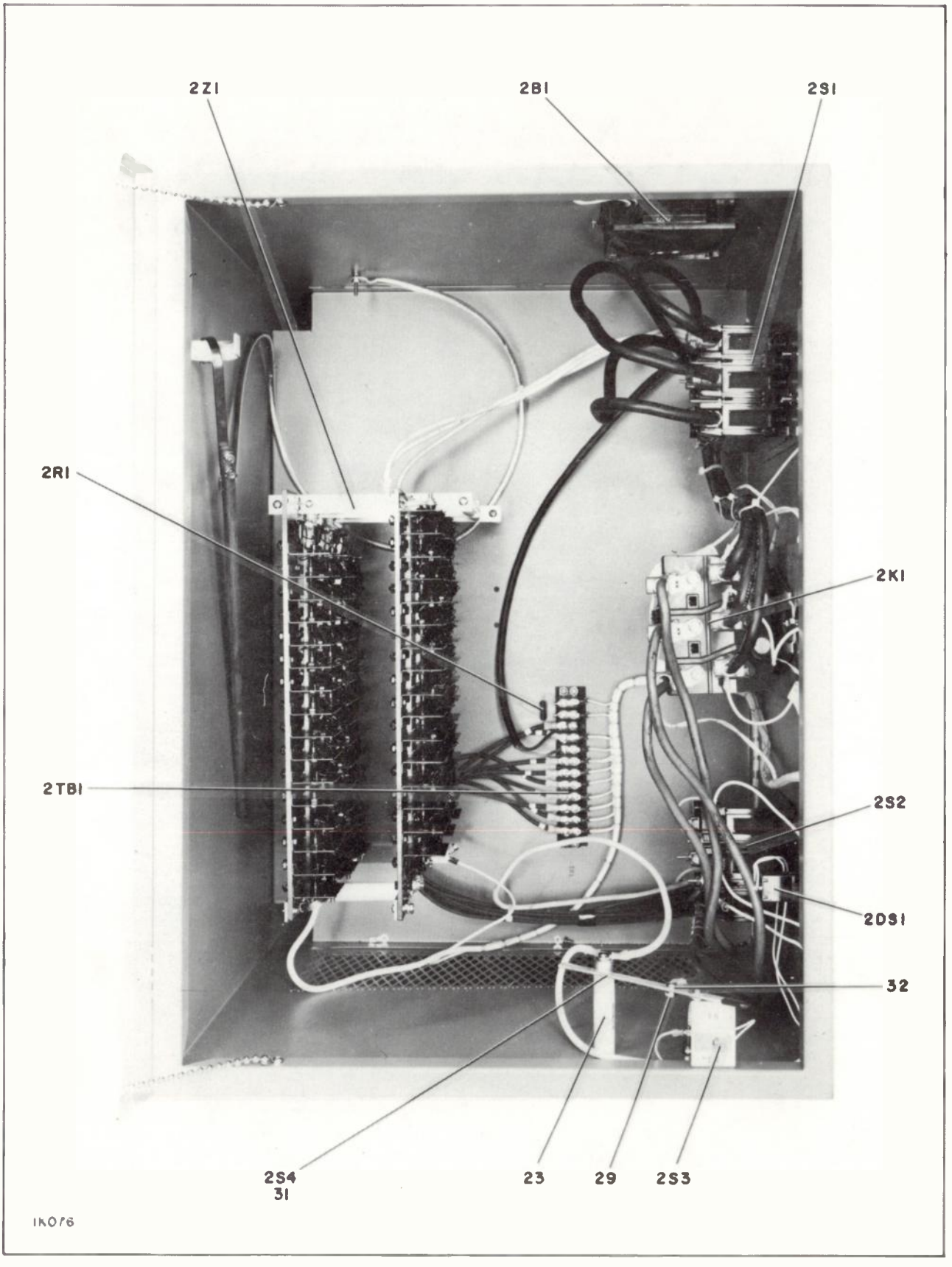


Figure 36. High Voltage Power Supply, Top View

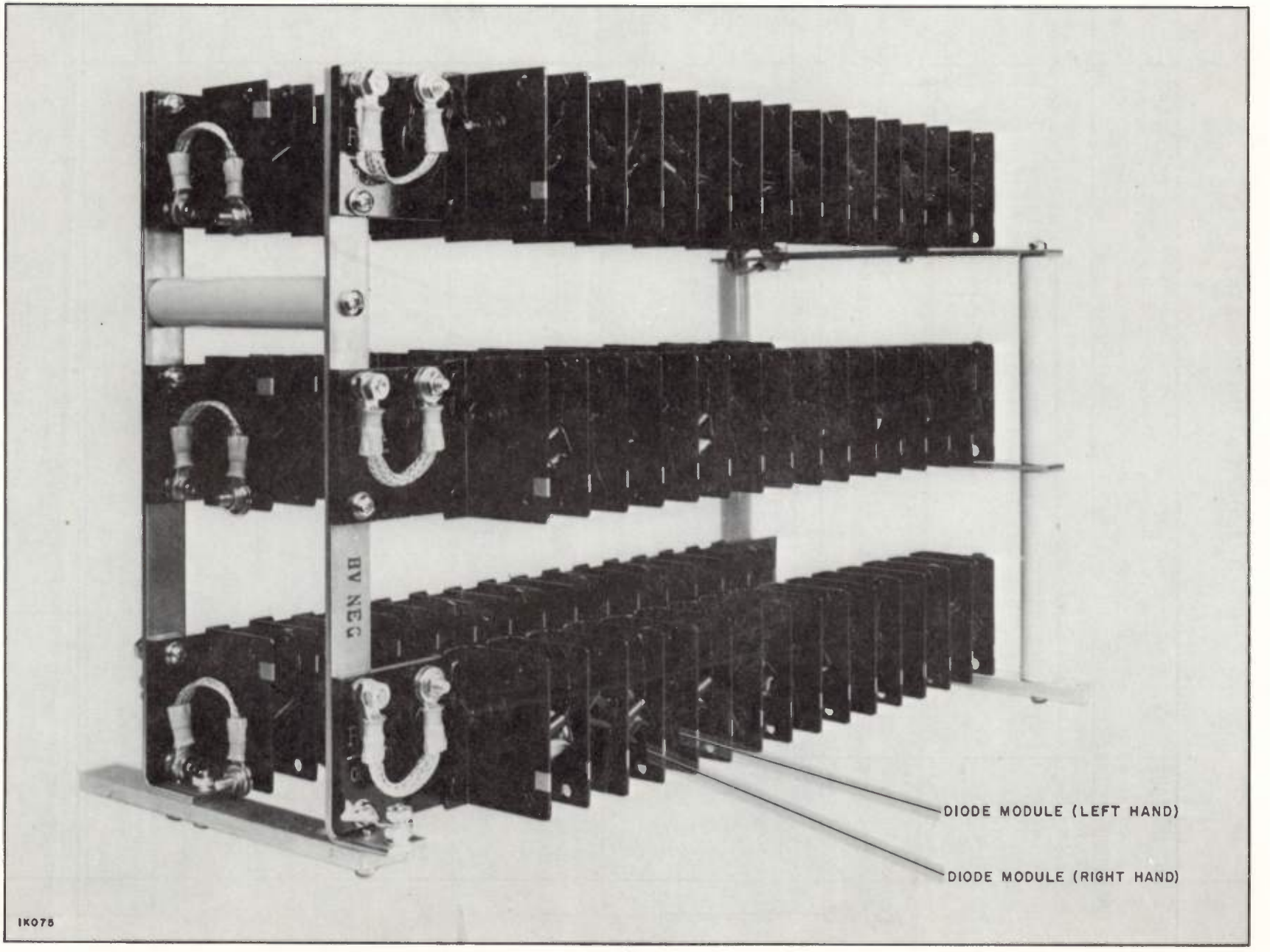


Figure 37. High Voltage Power Supply, Rectifier Stack

PARTS ORDERING INFORMATION

REPLACEMENT PARTS

Replacement parts bearing a Stock Number should be ordered by Item, Description, and Stock Number from RCA, Distributor and Special Products Division, Deptford, New Jersey 08096. Items listed under a Master Item (MI) Number should be ordered from RCA, Commercial Communications Systems Division, Camden, NJ 08102.

Because of possible products modifications and/or the unavailability of parts, the item which will be supplied against an order for a replacement part may not be an exact duplicate of the original part. As a result, some of the replacement parts received may require a mounting modification of the customer's design. In some cases, parts and/or instructions for adapting the substitute parts will be supplied. In no way will the substitute parts impair the operation or performance of the equipment.

For information regarding the use of any parts received, write RCA, Tech Alert, Bldg. 2-8, Camden, NJ 08102, or call (609) 963-8000 Extension 3434.

EMERGENCY PART SERVICE

For emergency part service during working hours, contact RCA Distributor and Special Products Division, telephone 609-963-8000 extension 3434 or 609-348-5900 extension 263. After working hours (Eastern time) telephone 609-848-5900 extension 234 or 567.

LOCATION	ORDERING INSTRUCTIONS
Continental United States including Alaska and Hawaii, and the Dominion of Canada	Replacement Parts bearing a STOCK NUMBER should be ordered from RCA Distributor and Special Products Division — 2000 Clements Bridge Road, P. O. Box 100 — Deptford, NJ 08096. Replacement Parts bearing a MASTER ITEM (MI) NUMBER should be ordered from RCA, Commercial Communications Systems Division — Camden, NJ 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.
Outside of Continental United States, Alaska Hawaii, and the Dominion of Canada	Order from your local RCA Sales Representative or from: RCA Distributor and Special Products Division — 2000 Clements Bridge Road — P. O. Box 100 — Deptford, NJ 08096. Wire: RADIOINTER TWX: 510-686-8982 **Emergency**: Cable RADIOPARTS, DEPTFORD, NJ

RETURN OF ELECTRON TUBES

If, for any reason, it is desired to return tubes, please return them through your local RCA tube distributor, or RCA Corporation Adjustment Services, New Holland Pike, Lancaster, Pa. 17604, 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, and the Dominion of Canada	Local RCA Tube Distributor.
Outside of Continental United States, Alaska, Hawaii, and the Dominion of Canada	Local RCA Tube Distributor or RCA Corporation Adjustment Services, New Holland Pike, Lancaster Pa. 17604. **Emergency**: Cable RADIOPARTS, DEPTFORD, NJ

PARTS IDENTIFICATION INFORMATION

GENERAL

The components listed in the parts list are identified by one of two methods depending on whether the component is a mechanical or electrical part. Mechanical parts are assigned a numerical symbol (12, 34, 233, etc.) that corresponds to the item number on the mechanical assembly drawing where that particular part is located. Electrical parts are assigned a standard electrical symbol and are listed in an alphanumerical sequence by major electrical assemblies (RF Assembly, Driver Assembly, Modulator Assembly, etc.). The illustrations in this book are keyed so that electrical and mechanical parts that are "called out" in the illustrations should always be consulted so that positive identification of the part can be made before referring to the parts list.

ELECTRICAL PARTS

In order to locate an electrical part in the parts list the following procedure is recommended:

a. Determine in which major electrical assembly the part is physically located.

b. With the use of the illustrations, positively identify the part and note its symbol designation.

c. In the parts list, find the heading for the major electrical assembly.

d. Under the heading in "c" above, find the symbol designation in the Symbol column of the parts list. Ali pertinent ordering information and a brief description of the item will be found to the right of the symbol designation.

MECHANICAL PARTS

In order to locate a mechanical part in the parts list the following procedure is recommended:

a. Determine in which major mechanical assembly the part is physically located (RF Box, Basic Transmitter, Tube Socket Assembly, etc.).

b. With the use of the illustrations, identify the part and note its numerical symbol designation.

c. In the parts list, find the heading for the major mechanical assembly.

d. Under the heading in "c" above, find the numerical symbol designation in the Symbol column of the parts list. All pertinent ordering information and a brief description of the item will be found to the right of the symbol designation.

TABLE 9. COMPONENT PREFIX NUMBERS

Item	Symbol Prefix	Example	Item	Symbol Prefix	Example
Basic Transmitter (MI-560507A)	1	1K8	HV Plate Transformer	3	3T1
Power Supply (MI-560342-6)	2	2S1			

TABLE 10. COMPONENT SYMBOL DESIGNATIONS

Symbol Designation	Item	Symbol Designation	Item
AT	Attenuators	R	Resistors
B	Blowers, motors, phase shifters	RV	Thyrite assembly
C	Capacitors	S	Switches or interlocks
CR	Crystal or metallic rectifiers	SCR	Silicon controlled rectifier
D	Diode	T	Transformers
DS	Indicator Lamps	TB	Terminal boards
F	Fuses	U	Nonrepairable assembly
FL	RF interference filter	V	Tubes
HY	Circulator	VR	Voltage regulators
J	Connector jacks	XC	Sockets for capacitors
K	Relays or contactors	XDS	Sockets for indicating lamps
L	Inductors	XF	Sockets for fuses
M	Meters	XV	Sockets for tubes
P	Connector plugs	Y	Crystals (oscillating)
PCB	Printed circuit board	Z	Impedance networks and cavities
Q	Transistors		

REPLACEMENT PARTS

BASIC TRANSMITTER MI-560507A

(Excluding RF Box Assembly)

P/L 8541922-504 REV 24

Symbol	Stock No.	Drawing No.	Description
ELECTRICAL PARTS			
1B1			MOTOR PART OF 1T5 (REFER TO 1T5)
1B2			BLOWER SEE MI-560347A-1
1B2			BLOWER SEE MI-560347-3 (HIGH ALTITUDE)
			CAPACITORS
1C1	205656	3724573 501	CERAMIC, METER BYPASS - 0.01 MF 500 V
1C2	229777	990196 049	PAPER, 10 MF 1500 V
1C3	922050	990196 005	PAPER, 4 MF 600 V
1C4	229777	990196 049	PAPER, 10 MF 1500 V
1C5	229778	990193 087	PAPER, 6 MF 2500 V
1C6	205656	3724573 501	CERAMIC, METER BYPASS - 0.01 MF 500 V
1C7			PAPER, PART OF POWER DETERMINING KIT
1C8			PAPER, PART OF POWER DETERMINING KIT
1C9	205656	3724573 501	CERAMIC, METER BYPASS - 0.01 MF 500 V
1C10			PAPER, PART OF POWER DETERMINING KIT
1C11	225532	990196 008	PAPER, 10 MF 600 V
1C12			PAPER, PART OF 1T5
1C13	205656	3724573 501	CERAMIC, METER BYPASS - 0.01 MF 500 V
1C14	043441	990196 011	PAPER, 20 MF 600 V
1C15	205656	3724573 501	CERAMIC, METER BYPASS - 0.01 MF 500 V
1DS1A	300449	8890654 002	LAMP - INDICATOR
1DS1B	300449	8890654 002	LAMP - INDICATOR
1DS1C	300449	8890654 002	LAMP - INDICATOR
1DS1D	300449	8890654 002	LAMP - INDICATOR
1DS2A	300449	8890654 002	LAMP - INDICATOR
1DS2B	300449	8890654 002	LAMP - INDICATOR
1DS3A	300449	8890654 002	LAMP - INDICATOR
1DS3B	300449	8890654 002	LAMP - INDICATOR
1DS3C	300449	8890654 002	LAMP - INDICATOR
1DS3D	300449	8890654 002	LAMP - INDICATOR
1DS4A	300449	8890654 002	LAMP - INDICATOR
1DS4B	300449	8890654 002	LAMP - INDICATOR
1DS5A	300449	8890654 002	LAMP - INDICATOR
1DS5B	300449	8890654 002	LAMP - INDICATOR
1DS6A	300449	8890654 002	LAMP - INDICATOR
1DS6B	300449	8890654 002	LAMP - INDICATOR
1E1	230869	8521386 003	GAP - SPARK
1HR1	243451	3456491 030	HEATER - ELEMENT, USED IN 1K22
1HR2	243451	3456491 030	HEATER - ELEMENT, USED IN 1K22
1K1	215504	754291 003	RELAY - LOW VOLTAGE OVERLOAD
1K2	215504	754291 003	RELAY - HIGH VOLTAGE OVERLOAD
1K3	229779	627511 073	RELAY - UNDERBIAS
1K4	215504	754291 003	RELAY - DRIVER OVERLOAD
1K5	219799	627511 038	RELAY - OVERLOAD INDICATOR
1K6	219799	627511 038	RELAY - OVERLOAD INDICATOR
1K7	219799	627511 038	RELAY - OVERLOAD INDICATOR
1K8	423655	627511 083	RELAY - OVERLOAD AUXILIARY
1K9	216988	8412197 003	CONTACTOR - LOW VOLTAGE RECTIFIER
1K10	217986	480003 005	RELAY - LATCHING, OVERLOAD
1K11	216991	480003 004	RELAY - LATCHING, PLATE ON-OFF
1K12	223857	8412197 006	CONTACTOR - FILAMENT
1K13	420054	8533702 003	RELAY - PLATE
1K14	229817	8544748 001	RELAY - BLOWER
1K15	243902	8707374 004	RELAY - MAGNETIC BLOWER STARTER
1K16	216991	480003 004	RELAY - LATCHING, ON-OFF
1K17	247793	3734318 001	RELAY - OVERLOAD

Symbol	Stock No.	Drawing No.	Description
1K18	219799	627511 038	RELAY - OVERLOAD, INDICATOR
1K19	219799	627511 038	RELAY - OVERLOAD, INDICATOR
1K20	243452	3730704 002	RELAY - TIME DELAY
1K21	243453	3464157 003	RELAY - AUXILIARY
1K22	243454	3456490 001	RELAY - OVERLOAD, AUXILIARY
1L1	044559	901125 001	REACTOR - LOW VOLTAGE FILTER
1L2	095794	949476 001	REACTOR - LOW VOLTAGE FILTER
1L3			REACTOR - HIGH VOLTAGE FILTER, PART OF MI-560510A
1L4	093658	949251 001	REACTOR - BIAS
1M1	420835	993058 116	METER - 0-300 VOLTS AC
1M2	229792	993064 001	METER - MULTIMETER
1M3	235725	993053 177	METER - VOLT METER 3-10 KV DC
1M4			METER - PART OF POWER DETERMINING KIT MI-560510A
1M5	243455	3467962 001	METER - RELAY, REFLECTOMETER (SEE 1Z6 CONTROL MODULE)
1M6			INDICATOR - ELAPSED TIME (OPTIONAL)
	229785	8489369 002	INDICATOR - 60 HZ 115V
	235342	8489369 004	INDICATOR - 50 HZ 115V
1M7	241749	8766828 005	METER - RELAY, REFLECTED POWER (SEE 1Z6 CONTROL MOD)
	231545	8766828 021	REPLACEMENT LAMP FOR 1M5 OR 1M7
1P1	921359	1510013 101	CONNECTOR - COAXIAL PLUG
1P2	921359	1510013 101	CONNECTOR - COAXIAL PLUG
1P5	055808	727969 008	CONNECTOR - 8 TERM, FEMALE
1P6	054254	727969 018	CONNECTOR - 12 TERM, FEMALE
1P7	211509	481799 001	CONNECTOR - AUDIO INPUT, LEFT
1P8	211509	481799 001	CONNECTOR - AUDIO INPUT, RIGHT
1P9	211509	481799 001	CONNECTOR - SCA IN, 1
1P10	211509	481799 001	CONNECTOR - SCA IN, 2
1P11	032661	878243 001	CONNECTOR - EXCITER POWER
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
1R1	229786	8986541 010	WIRE WOUND, 34.5 OHMS 2 W
1R2	043783	99027 024	WIRE WOUND, 200 OHMS 5% 25 W
1R3	229787	8986541 011	WIRE WOUND, 1.94 OHMS 2 W
1R4	229786	8986541 010	WIRE WOUND, 34.5 OHMS 2 W
1R5	229788	8986541 013	WIRE WOUND, 1.67 OHMS 2 W
1R6	229789	8541901 001	WIRE WOUND, 600,000 OHMS 1/2 W
1R7	229789	8541901 001	WIRE WOUND, 600,000 OHMS 1/2 W
1R8	229788	8986541 013	WIRE WOUND, 1.67 OHMS 2 W
1R9	044394	99037 029	WIRE WOUND, 630 OHMS 5% 200 W
1R10	205064	433196 006	VARIABLE, 10,000 OHMS
1R11	417618	433196 014	VARIABLE, 10,000 OHMS
1R12	215733	433196 051	VARIABLE, 1,000 OHMS
1R13	054608	99037 039	WIRE WOUND, 6300 OHMS 5% 200 W
1R14	054608	99037 039	WIRE WOUND, 6300 OHMS 5% 200 W
1R15	044394	99037 029	WIRE WOUND, 630 OHMS 5% 200 W
1R16	044394	99037 029	WIRE WOUND, 630 OHMS 5% 200 W
1R17	019688	99027 039	WIRE WOUND, 6300 OHMS 5% 25 W
1R18	215540	890014 019	WIRE WOUND, 16,000 OHMS 150 W
1R19	229790	415457 020	VARIABLE, 750 OHMS 25 W
1R20	219047	993007 021	WIRE WOUND, 1.0 OHMS 5 W
1R21	220319	8702674 512	WIRE WOUND, 10 MEGOHM
1R22	217614	8871557 053	WIRE WOUND, 1250 OHMS 1 W
1R23	522415	99126 088	150,000 OHMS 20% 2 W
1R24			RELAY SHUNT PART OF POWER DET. KIT MI-560510A
1R25	206006	99037 008	WIRE WOUND, 5 OHMS 10% 200 W
1R26	206006	99037 008	WIRE WOUND, 5 OHMS 10% 200 W
1R27	206006	99037 008	WIRE WOUND, 5 OHMS 10% 200 W
1R28	044394	99037 029	WIRE WOUND, 630 OHMS 200 W
1R29	094885	993007 092	WIRE WOUND, 3500 OHMS 5 W
1R30 TO 1R37	059941	993007 086	WIRE WOUND, 1800 OHMS 5 W
1R38	243456	204777 024	VARIABLE, 8000 OHMS 50 W
1R39	243457	99027 020	WIRE WOUND, 80 OHMS 25 W
1R40	243457	99027 020	WIRE WOUND, 80 OHMS 25 W
1S1	229792	8494316 001	SWITCH - METER
1S2	229793	8494316 002	SWITCH - METER

Symbol	Stock No.	Drawing No.	Description
1S3	229704	8494042 001	SWITCH - METER
1S4			NOT USED
1S5	229707	482740 006	BREAKER - CIRCUIT, FILAMENT
1S6	233450	3462708 001	BREAKER - CIRCUIT, LOW VOLTAGE
1S7	229708	8543376 001	SWITCH - TRANSMITTER ON
1S8	229708	8543376 001	SWITCH - TRANSMITTER OFF
1S9	229708	8543376 001	SWITCH - PLATE ON
1S10	229708	8543376 001	SWITCH - PLATE OFF
1S11	229708	8543376 001	SWITCH - RAISE
1S12	229708	8543376 001	SWITCH - LOWER
			} FOR BREAKDOWN SEE FIGURE 47
1S13	217989	449661 108	SWITCH - SINGLE MULTIPLE TRIP
1S14	054920	8881052 001	SWITCH - INTERLOCK
1S15	054920	8881052 001	SWITCH - INTERLOCK
1S16	054920	8881052 001	SWITCH - INTERLOCK
1S17	229709	8543375 001	SWITCH - OVERLOAD RESET (FOR BREAKDOWN SEE FIG. 47)
1S18	428372	8741338 018	BREAKER - CIRCUIT
1S19	229891	8486323 501	SWITCH - GROUNDING
1S20	229891	8486323 501	SWITCH - GROUNDING
1S21	234486	3467618 003	SWITCH - AIR INTERLOCK
1T1	215512	8412123 001	TRANSFORMER - DRIVER FILAMENT
1T2			TRANSFORMER - POWER AMPLIFIER FILAMENT PART OF MI-560510A
1T3	216993	8413463 001	TRANSFORMER - FILAMENT, BUCK BOOST
1T4	218276	457084 001	TRANSFORMER - VARIABLE FILAMENT
1T5		8763254 001	TRANSFORMER - VARIABLE, LOW VOLTAGE
	231816		BRUSH ASSEMBLY RB216. FOR SUPERIOR ELECTRIC POWERSTAT 30M216U-2
	423027		BRUSH ASSEMBLY RB216B, FOR POWERSTAT 30M216BU-2
	422787		DRIVE SHAFT FOR SUPERIOR ELECTRIC POWERSTAT
	231817		COIL - ONLY, WITH LEADS, FOR 30M216U-2 POWERSTAT
	428276		COIL - ONLY, WITH LEADS, FOR 30M216BU-2 POWERSTAT
	231818		MOTOR - 1T5
	922553		RESISTOR
1C12	231815		CAPACITOR
	922556		SWITCH - LIMIT
1T6	229800	8486317 001	TRANSFORMER - LOW VOLTAGE RECTIFIER
1T7	229801	8489386 001	TRANSFORMER - BIAS
1T8	229802	8489377 001	TRANSFORMER - CONTROL
1XDS1	226123	8522913 003	INDICATOR - DRIVER OVERLOAD/CARRIER OFF
1XDS2	270023	8522913 004	INDICATOR - POWER AMPLIFIER OVERLOAD
1XDS3	226123	8522913 003	INDICATOR - LOW VOLTAGE OVERLOAD/VSWR OVRLD
1XDS4	270023	8522913 004	INDICATOR - PLATE ON (FOR BREAKDOWN SEE FIG. 47)
1XDS5	269851	8522913 001	INDICATOR - DOOR INTERLOCK
1XDS6	270023	8522913 004	INDICATOR - TRANSMITTER ON
1XDS7	270023	8522913 004	INDICATOR - POWER RAISE
1XDS8	270023	8522913 004	INDICATOR - POWER LOWER
1XDS9	270023	8522913 004	INDICATOR - TRANSMITTER OFF
1XDS10	270023	8522913 004	INDICATOR - PLATE OFF
			} FOR BREAKDOWN SEE FIGURE 47
1Z1	229803	8483890 004	RECTIFIER - BIAS
1Z2		3462813 501	RECTIFIER ASSEMBLY
	230913	8498732 004	RECTIFIER - LESS PLATE
1Z3		3462813 501	RECTIFIER ASSEMBLY
	230913	8498732 004	RECTIFIER - LESS PLATE
1Z4		3462813 501	RECTIFIER ASSEMBLY
	230913	8498732 004	RECTIFIER - LESS PLATE
	1Z2, 1Z3 AND 1Z4 EACH CONSISTS OF 2 RECTIFIER MODULES MOUNTED ON AN INSULATED MOUNTING PLATE.		
1Z5	230078	8729668 003	DIRECTIONAL COUPLER - POWER OUTPUT/VSWR PART OF MI-560510A
1Z6	243753	3730764 001	CONTROL MODULE
1Z8	243778	3464019 003	DIRECTIONAL COUPLER - I.P.A. INPUT MATCH
	067876		DIODE - RECTIFIER TYPE 1N21B, FOR USE IN DIRECTIONAL COUPLERS
MECHANICAL PARTS			P/L 8521306-504 REV 32
1B9	269689	8522915 001	BARRIER - SHORT, FOR DISPLAY SCREEN SWITCH
1H9	053325	99045 005	CLIP - FUSE, FOR 1R2, 1R17

Symbol	Stock No.	Drawing No.	Description
108	052717	7862770 001	CLIP - FUSE, FOR 1R9, 1R13 THRU 1R16, 1R18, 1R25 THRU 1R28
71	225125	888488 005	FILTER - AIR, DISPOSABLE 16 x 20 x 2
93	055081	426762 012	INSULATOR - STEATITE-CONICAL, 3 IN LG
96	211371	426766 006	INSULATOR - STEATITE,1/2 IN DIA X .75 IN LG
319	231640	426767 115	INSULATOR - STEATITE, 3/4 IN DIA X 2.5 IN LG
320	97458	426767 106	INSULATOR - STEATITE,3/4 IN DIA X 1.25 IN LG
124	208115	426765 009	INSULATOR - STEATITE,3/8 IN DIA X .75 IN LG
326	208116	426765 112	INSULATOR - STEATITE, 3/8 IN DIA X 1 IN LG
100	229806	8540155 001	KNOB - FOR 1T4
101	229807	1510900 008	KNOB - FOR 1R10
102	229808	1510900 017	KNOB - FOR 1R19 AND 1R38
266	246728	8765773 505	KNOB ASSEMBLY - FOR 1S2
267	419487	8765773 507	KNOB ASSEMBLY - FOR 1S1
265	246731	8765773 509	KNOB ASSEMBLY - FOR 1S3
265	246731	8765773 509	KNOB ASSEMBLY
266	246728	8765773 505	KNOB ASSEMBLY
267	246729	8765773 506	KNOB ASSEMBLY
169	233492	8494328 001	METER - MANOMETER (OPTIONAL)
	233493		OIL - MANOMETER
179	229809	8494089 001	SCREEN - DISPLAY DOOR INTERLOCKS
180	229810	8494089 002	SCREEN - DISPLAY TRANSMITTER OFF
181	229892	8494089 003	SCREEN - DISPLAY TRANSMITTER ON
182	229811	8494089 004	SCREEN - DISPLAY PLATE OFF
183	229893	8494089 005	SCREEN - DISPLAY PLATE ON
257	243449	3464091 008	SCREEN - DISPLAY, DRIVER OVRLD/CARRIER OFF
185	229813	8494089 007	SCREEN - DISPLAY POWER AMP OVERLOAD AND RESET
258	243450	3464091 009	SCREEN - DISPLAY, L.V. RECT. OVERLOAD/ VSWR OVERLOAD
187	229815	8494089 009	SCREEN - DISPLAY POWER LOWER
188	229816	8494089 010	SCREEN - DISPLAY POWER RAISE
178	233868	480368 006	STUD - FASTENER, METER PANEL
177	233869	8886047 003	WASHER - METER PANEL STUD

RF BOX ASSEMBLY

P/L 8543106-503 REV 13

ELECTRICAL PARTS

CAPACITORS

1C101	230423	8971908 003	VARIABLE, 4.5-102 PF
1C102	214695	8821367 002	CERAMIC, 50 PF 7500 V
1C103	214638	8864187 007	STANDOFF, 1000 PF 500 V
1C104	214638	8864187 007	STANDOFF, 1000 PF 500 V
1C105			PART OF 1XV101 (DRIVER TUBE SOCKET)
1C106	211196	459684 041	PAPER, .001 MF 600 V
1C107	211196	459684 041	PAPER, .001 MF 600 V
1C108	211196	459684 041	PAPER, .001 MF 600 V
1C109	211196	459684 041	PAPER, .001 MF 600 V
1C110	211148	8907717 001	FEED-THRU, .001 MF 5000 V
1C111	223209	8518096 001	CERAMIC, 0.001 MF 5000 V
1C112	217721	8849438 014	VACUUM, 3-30 PF 10,000 V
1C113			PART OF POWER DETERMINING KIT MI-560510A
1C114	236759	8889785 002	FEED-THRU, 1000 PF 2000 V
1C115	054643	8881825 001	PAPER, 0.01 MF 250 V
1C116	054643	8881825 001	PAPER, 0.01 MF 250 V
1C117			PART OF 1XV102 (PA TUBE SOCKET)
1C118	236759	8889785 002	FEED-THRU, 1000 PF 2000 V
1C119	230419	8494421 001	FEED-THRU, 1500 PF 15,000 V
1C120	215595	940173 102	CERAMIC, 500 PF 30,000 V
1C121	211196	459684 041	PAPER, .001 MF 600 V
1C122	211196	459684 041	PAPER, .001 MF 600 V
1C123	230422	8849438 039	VARIABLE, 8-110 PF 7.5 KV
1C124	235990	8521332 022	VACUUM, 25 PF 7500 V, FOR FREQ 87.5 THRU 93.9 MHZ, MI-560355-1
1C125	235990	8521332 022	VACUUM, 25 PF 7500 V, FOR FREQ 87.5 THRU 93.9 MHZ, MI-560355-1

Symbol	Stock No.	Drawing No.	Description
1C123	227938	8521332 018	VACUUM, 40 PF 7500 V, FOR FREQ 87.5 THRU [illegible] MHZ, MI-560355-2
1C124	227938	8521332 018	VACUUM, 40 PF 7500 V, FOR FREQ 94.1 THRU 101.9 MHZ, MI-560355-2
1C125			NOT USED, FOR FREQ 94.1 THRU 107.9 MHZ
1C126	235990	8521332 022	VACUUM, 25 PF 7500 V, FOR FREQ 102.1 THRU 107.9 MHZ, MI-560355-1
1C127	214638	8864187 007	STANDOFF, 1000 PF 500 V
1C128	214638	8864187 007	STANDOFF, 1000 PF 500 V
1C129	214638	8864187 007	STANDOFF, 1000 PF 500 V
1C130	076488	940173 102	CERAMIC, 500 PF 30,000 V
1C131			STANDOFF, 1000 PF 500 V, PART OF POWER DETERMINING KIT MI-560510A
1C132			STANDOFF, 1000 PF 500 V, PART OF POWER DETERMINING KIT MI-560510A
1C133			STANDOFF, 1000 PF 500 V, PART OF POWER DETERMINING KIT MI-560510A
1C134			STANDOFF, 1000 PF 500 V, PART OF POWER DETERMINING KIT MI-560510A
1C135			PART OF 1XV103 (DRIVER TUBE SOCKET)
1C136			STANDOFF, 1000 PF 500 V, PART OF POWER DETERMINING KIT MI-560510A
1C137			STANDOFF, 1000 PF 500 V, PART OF POWER DETERMINING KIT MI-560510A
1C138	214638	8864187 007	STANDOFF, 1000 PF 500 V
1C139	214638	8864187 007	STANDOFF, 1000 PF 500 V
1C140	232610	3726419 009	CERAMIC, 500 PF 5000 V
1C141	232610	3726419 009	CERAMIC, 500 PF 5000 V
1C142	232610	3726419 009	CERAMIC, 500 PF 5000 V
1C143	232610	3726419 009	CERAMIC, 500 PF 5000 V
1C144	209906	3726419 006	CERAMIC, 1500 PF 3500 V
1C145			PART OF 1XV102 (PA TUBE SOCKET)
1C146			NOT USED
1C147	236759	8889785 002	FEED-THRU, 1000 PF 2000 V
1J101	054890	1510013 161	CONNECTOR - COAXIAL, FEMALE RECEPTACLE
1L101	239086	8448409 503	COIL
1L102	222952	8985525 501	COIL ASSEMBLY
1L103	211198	8914884 001	COIL
1L104	211198	8914884 001	COIL
1L105	243460	3467932 001	INDUCTANCE - VARIABLE, PART OF RF BOX ASSY
1L106	230435	8766820 501	INDUCTANCE - VARIABLE, PART OF RF BOX ASSY
	429559	8766820 502	INNER CONDUCTOR - 1L106
1L107	243465	8494405 001	COIL - 11 1/2 TURNS COPPER WIRE 1 INCH ID
1L108			STRAP - PART OF RF BOX ASSEMBLY
1L109	243466	3455649 001	COIL - SOFT COPPER STRAP 1.25 ID X 4 [illegible] LG
1L110	243467	3455761 001	INDUCTANCE - DRIVER PLATE TUNING
1L111			INDUCTOR - PLATE, (SEE MECHANICAL RF BOX PARTS)
1L112			INDUCTOR - PLATE, (SEE MECHANICAL RF BOX PARTS)
1L113			INDUCTOR - VARIABLE, PA NEUTRALIZING PART OF 1XV102 (PA TUBE SOCKET)
1L114			NOT USED
1L115	423662	3721683 501	COIL ASSEMBLY
1R101	522247	99126 070	RESISTOR - COMPOSITION, 4700 OHMS 10% 2 W
1R102			NOT USED
1R103			NOT USED
1R104	922527	8849447 008	RESISTOR ASSEMBLY
	243468	8954908 349	RESISTOR - FILM, 1000 OHMS 7 W
1R105	522147	99126 151	RESISTOR - COMPOSITION, 470 OHMS 2 W
1R106	922527	8849447 008	RESISTOR - 75 OHMS 10% 36 W
1R107	922527	8849447 008	RESISTOR - 75 OHMS 10% 36 W
1S101	230421	8833178 002	SWITCH
1S102	229891	8486323 501	SWITCH - GROUNDING ASSEMBLY
	209091	426767 012	INSULATOR - STEATITE, 2 IN LG X 3/4IN DIA
1XV101	243469	464586 005	SOCKET - 7203/4CX250B

Symbol	Stock No.	Drawing No.	Description
1XV102	236438	3471557 502	SOCKET ASSEMBLY - TUBE, 4CX15000A
1XV102-46	225091	8465194 501	CONTACT ASSEMBLY - SCREEN, GRID COLLET, 2 REQUIRED PER SOCKET
1XV102-03	220958	644382 004	CONTACT - CONTROL GRID
1XV102-04	220959	644382 005	CONTACT - OUTER FILAMENT
1XV102-05	220960	644382 006	CONTACT - INNER FILAMENT
1XV102-15	225081	8446964 002	CAPACITOR - SILVER MICA, C117A
1XV102-15	225091	8446964 002	CAPACITOR - SILVER MICA, C117B | C117 - DESIGNATED
1XV102-15	225081	8446964 002	CAPACITOR - SILVER MICA, C117C | IN 4 SEGMENTS
1XV102-15	225081	8446964 002	CAPACITOR - SILVER MICA, C117D
1XV102-15	225081	8446964 002	CAPACITOR - SILVER MICA, C145A
1XV102-15	225081	8446964 002	CAPACITOR - SILVER MICA, C145B | C145 - DESIGNATED
1XV102-15	225081	8446964 002	CAPACITOR - SILVER MICA, C145C | IN 4 SEGMENTS
1XV102-15	225081	8446964 002	CAPACITOR - SILVER MICA, C145D
1XV102-49	232298	3462635 501	CONTACT ASSEMBLY - PART OF 1L113 SLIDING ADJUSTMENT
1XV102-45	236512	3467564 501	BASE ASSEMBLY, SCREEN GRID COLLET
1XV102-48	232301	3462634 001	SPACER PT OF 1L113 SEMI-FIXED ADJUSTMENT
1XV102-47	232302	3462634 002	SPACER PT OF 1L113 SEMI-FIXED ADJUSTMENT
1XV102-09	225106	8519978 001	RING - INSULATOR
1XV102-10	225087	8863044 007	WASHER - TEFLON BUSHING
1XV102-11	233405	8519977 004	INSULATOR - POST, 1/2 IN DIA X .656 IN LG
1XV102-16	097459	426763 003	INSULATOR - MS5W4001, BOTTOM OF SOCKET
1XV102-39	217719	426763 009	INSULATOR - MS5W4003, TOP OF SOCKET
1XV102-41	208115	426765 009	INSULATOR - MS5W0106
1XV103			SOCKET - 7203/4CX250B, PART OF POWER DETERM. KIT
1Z101	419265	3456497 501	SUPPRESSOR NETWORK
1Z102	419265	3456497 501	SUPPRESSOR NETWORK - PART OF MI-560510A
			P/L 8541907-505 REV 32
MECHANICAL PARTS			
173	249529	3721194 009	SCREW - PAN HEAD .090(10)-32 x .75 LONG, PLASTIC, SECURES RING (ITEM 157) TO SHELF (ITEM 11)
11	230429	8761072 001	SHELF - UPPER, FOR C113
8	243458	8486379 001	SUPPORT - PLASTIC, MOUNTS SHELF, STOCK NO. 230429, RIGHT SIDE
10	243459	8486379 003	SUPPORT - PLASTIC, MOUNTS SHELF, STOCK NO. 230429, REAR
9	243473	8494379 001	SUPPORT - PLASTIC, MOUNTS SHELF, STOCK NO. 230429, LEFT SIDE
22	099933	464586 003	CHIMNEY - FOR 1XV101 (DRIVER TUBE)
161	243460	3467932 001	SHORTING - RAIL, PART OF 1L105
29	230433	8766808 002	PLATE - BACKING, PART OF 1L105
28	230432	8766808 001	PLATE - BACKING, PART OF 1L106
156	243471	3464209 503	LEAD SCREW ASSY - PART OF 1L105 OR 1L106
155	243462	3456357 001	GUIDE - STRIP, PART OF 1L105 OR 1L106
157	243461	3730738 001	RING - SPACER, USED UNDER 1C113
158	243463	3456428 001	BLOCK - SPACER, USED AT BOTTOM OF OUTPUT LINE ASSEMBLY
39	230424	8468301 501	CONTACT ASSEMBLY - FOR 1L105 AND 1L106
167	243472	69273 183	BRASS STUD - 1/4-20 X 2.75 LG, PART OF 1L105 AND 1L106
42	230435	8766820 501	OUTPUT LINE ASSEMBLY
	429559	8766820 502	INNER CONDUCTOR
159	211081	426767 018	INSULATOR - 2 REQD, 3/4 DIA X 3.00 IN LG PART OF 1R106 HARMONIC SUPRESSOR
160	231640	426767 015	INSULATOR - STEAT., 3/4 IN DIA X 2.50 LG PART OF 1R107 HARMONIC SUPRESSOR
54	233872	480368 007	STUD - FASTENER, DOOR UPPER
55	233869	8886047 003	WASHER - RETAINING, DOOR STUD
57	233871	480368 008	STUD - FASTENER, DOOR MIDDLE
58	233870	480368 010	STUD - FASTENER, DOOR BOTTOM
59	230430	8761074 501	CONTACT ASSEMBLY - DOOR, 15.75 LONG
60	230431	8761074 502	CONTACT ASSEMBLY - DOOR, 37.00 LONG
63	233834	433422 506	DIAL - ASSEMBLY
68	233835	748586 012	DRIVE - RIGHT ANGLE
14	424622	8765764 001	PLATE - C116 MOUNTING
90	097745	990331 145	PIN - SPRING, L104, L106, C112 MOUNTING, .093 x .5LG

Symbol	Stock No.	Drawing No.	Description
69		8494371 501	COUNTER ASSEMBLY
4	220304	8986503 002	COUNTER
7	097461	8827138 002	GEAR - MITER
8	212531	8914895 501	GEAR ASSEMBLY - INCLUDES MITER GEAR AND BRASS BUSHING
10	922202	8513284 001	JOINT - UNIVERSAL
117	235298	748586 013	DRIVE - RIGHT ANGLE, DRIVES 1L105, 1L106
70		8494371 502	COUNTER ASSEMBLY
11	220303	8986503 001	COUNTER
7	097461	8827138 002	GEAR - MITER
8	212531	8914895 501	GEAR ASSEMBLY - INCLUDES MITER GEAR AND BRASS BUSHING
10	922202	8513284 001	JOINT - UNIVERSAL
72	211297	8910643 002	JOINT - UNIVERSAL, ATTACHES TO RIGHT ANGLE DRIVE FOR 1L105 AND 1L106
75	235436	1510920 017	KNOB - PA PLATE TUNING OR PA OUTPUT LOADING
76	208711	8898610 001	COUPLING - INSULATED, FLEXIBLE
79	211370	426772 003	INSULATOR - STEAT. 1/2 IN SQ X .75 IN LG
80	211423	426765 003	INSULATOR - STEAT. 3/8 IN DIA X .50 IN LG
86	230425	8491388 503	CABLE ASSEMBLY - PA TUBE SOCKET CHIMNEY (CONNECTS 1XV102 TO 1C115 AND 1C116 - 2 REQUIRED)
87	230428	8544458 001	RETAINER
107	226714	3450782 003	CONTACT - FINGERS, DOOR
108	215854	8413444 501	CONTACT - ASSEMBLY, DOOR 4.88 INCHES LONG
	243464	8544435 502	JUMPER CABLE ASSY - JUMPERS DOOR HINGES
38	243890	8489378 501	PLATE - CONTACT FINGER MOUNTING, FOR 1L105 AND 1L106
33	243903	8494375 002	BLOCK - SPACER, FOR TOP OF 1L105
32	243904	8494375 001	BLOCK - SPACER, FOR TOP OF 1L106
52	243889	8543110 001	DOOR - HINGE, FOR RF BOX
1L111			INDUCTOR - VARIABLE, FRONT
101	243892	3455763 001	SHORTING BLOCK, 87.5 MHZ TO 101.9 MHZ
101	243891	3455763 002	SHORTING BLOCK, 102.1 MHZ TO 107.9 MHZ
102	243893	3455135 001	PLATE - GRID TUNING INDUCTOR, 87.5 MHZ TO 89.9 MHZ, MI-560356-5
102	243894	3455764 001	PLATE - GRID TUNING INDUCTOR, 90.1 MHZ TO 101.9 MHZ, MI-560356-1
102	243896	3462864 001	PLATE - GRID TUNING INDUCTOR, 102.1 MHZ TO 107.9 MHZ, MI-560356-3
1L112			INDUCTOR - VARIABLE, REAR
101	243892	3455763 001	SHORTING BLOCK, 87.5 MHZ TO 101.9 MHZ
101	243891	3455763 002	SHORTING BLOCK, 102.1 MHZ TO 107.9 MHZ
103	423694	3724280 001	PLATE - GRID TUNING INDUCTOR, 87.5 MHZ TO 89.9 MHZ, MI-560356- 6
103	243895	3455764 002	PLATE - GRID TUNING INDUCTOR, 90.1 MHZ TO 101.9 MHZ, MI-560356-2
103	243896	3462864 001	PLATE - GRID TUNING INDUCTOR, 102.1 MHZ TO 107.9 MHZ, MI-560356-3
134	243897	3455147 001	HARMONIC SUPRESSOR, INCLUDES 1R106
133	243898	3455156 001	TUBING - 2 REQUIRED, 1 1/8 DIA X 8 3/8 LG
			CLAMP - 2 REQUIRED
			RESISTOR - 1R106, SEE ELECTRICAL PARTS
134	243897	3455147 001	HARMONIC SUPRESSOR, INCLUDES 1R107
133	243898	3455156 001	TUBING - 2 REQUIRED, 1 1/8 DIA X 8 3/8 LG
160	231640	426767 015	CLAMP - 2 REQUIRED
			INSULATOR - 2 REQD, 3/4 DIA X 2.50 IN LG
109	215854	69273 183	RESISTOR - 1R107, SEE ELECTRICAL PARTS
	438580		STUD - 250 - 20 x 2.75 LONG
			ITEMS 38 & 156 ASSEMBLED - FOR 1L105 & 1L106
			POWER DETERMINING COMPONENTS MI-560510A
			REV 11
1C7	430229	3726200 046	PAPER, HV FILTER, 1.4 MF 10% 15,000 V
1C8	230070	990194 061	PAPER, HV FILTER, 1.5 MF 10% 10,000 V
1C10	205656	3724573 501	MICA, METER BYPASS .010 MF 500 V
1C113	423771	8642607 507	P.A. BLOCKING
	230076	8761062 501	CONTACT ASSEMBLY (2 REQUIRED) PART OF 1C113

Symbol	Stock No.	Drawing No.	Description
	NOTE - SEVERAL CONTACTOR TYPES HAVE BEEN SUPPLIED FOR PLATE CONTACTOR 2K1. SELECT SPARE PARTS REQUIRED FROM THE FOLLOWING LISTING, DEPENDING ON CONTACTOR IN USE.		
2K1	247449	3730651 001	CONTACTOR - PLATE, 120V COIL, 150 A, WESTINGHOUSE CATALOG NO. A201K4CA, SIZE 4
	426552		COIL - 120 VAC
	426550		KIT-CONTACT - CONSISTS OF MOVING CONTACTS, STATIONARY CONTACTS AND SPRINGS.
2K1	426551	3732697 001	CONTACTOR - PLATE, 120V COIL, 135 A, ALLEN BRADLEY CATALOG NO. 702EOD93, BULLETIN 702, SIZE 4
	426558		COIL - 120 VAC
	426557		CONTACT - STATIONARY, FRONT AND REAR
	426556		SET OF STATIONARY CONTACTS AND SPRINGS.
2K1			CONTACTOR - PLATE, 120V COIL, CLARK CONTROLLER TYPE NO. CY, CATALOG NO. 77U34, BULLETIN 7707
	426265		COIL - 120 VAC. , (CLARK PART NO. TB105-1)
	426266		STATIONARY CONTACTS, MOVEABLE CONTACTS AND SPRINGS. } CLARK KIT NO. CY34-1
			NOTE: IF REPLACEMENT OF 2K1 IS NECESSARY, REPLACE WITH WESTINGHOUSE OR ALLEN-BRADLEY CONTACTOR LISTED ABOVE
	NOTE: THE FOLLOWING CONTACTOR IS USED ONLY IN EARLY PRODUCTION POWER SUPPLY MI-560342-3 AND WILL NOT MOUNT IN LATER EQUIPMENT.		
2K1	217766	8838005 012	CONTACTOR - PLATE, 110V COIL, WESTINGHOUSE CLASS 15-825 N4, STYLE 1490455, SIZE 4
	217767		COIL - 110 VAC
	097055		CONTACT - MOVEABLE
	097056		CONTACT - STATIONARY
	097057		SPRING - CONTACT
1L3	230071	8486310 001	REACTOR - HIGH VOLTAGE FILTER
	432514		TERMINAL BOARD - PART OF 1L3
1M4	230072	993052 155	AMMETER - PLATE. 0-5 AMP
1R24	230073	8491308 001	RESISTOR - RELAY SHUNT, WIRE WOUND 0.167 OHMS 1% 90W
2S1	230081	8486384 001	BREAKER-CIRCUIT
1T2	230074	8486311 001	TRANSFORMER - P.A. FILAMENT
1Z5	230078	8729668 003	COUPLER - DIRECTIONAL
1Z7	243470	3467965 003	COUPLER - DIRECTIONAL
1Z102	419265	3456497 501	SUPPRESSOR NETWORK
9	230079	8491388 501	CONNECTOR - FILAMENT (CONNECTS 1T2 TO 1C115- 8 IN. LONG)
10	230080	8491388 502	CONNECTOR - FILAMENT (CONNECTS 1T2 TO 1C116 - 11 IN. LONG)
20	233726	897258 005	CLAMP - 3 1/16 TO 4 IN DIA
15		3730873 501	SOCKET ASSEMBLY - DRIVER TUBE
XV103	243469	464586 005	SOCKET
C131	214638	8864187 007	STAND-OFF, 1000 PF 500 V
C132	214636	8864187 007	STAND-OFF, 1000 PF 500 V
C133	214638	8864187 007	STAND-OFF, 1000 PF 500 V
C134	214638	8864187 007	STAND-OFF, 1000 PF 500 V
C136	214638	8864187 007	STAND-OFF, 1000 PF 500 V
C137	214638	8864187 007	STAND-OFF, 1000 PF 500 V
	099933	464586 003	CHIMNEY
	230428	8544458 001	RETAINER , CHIMNEY
	437941	2010868 004	WIRE - SINGLE CONDUCTOR, SHIELDED
			POWER SUPPLY MI-560342-6
			M/L 3724456-502 REV 10
2B1	219272	8766831 001	FAN ONLY - BLOWER
	227686	8537176 001	INJECTOR (FOR OILING ROTRON FAN 2B1)
2B2	440025	3729414 002	FAN - BLOWER
	440022	3729414 201	MOUNTING CLIPS -FAN, FLUSH MOUNTING
	440023	3729414 101	FINGER GUARD - FAN
	440024	3734675 001	FAN GUARD - REAR
2DS1	426071	3724582 101	LAMP - INDICATOR
2K1			CONTACTOR - PLATE, 110 VOLTS, PART OF MI-560510A

Symbol	Stock No.	Drawing No.	Description
2R1	059941	993007 086	RESISTOR - WIREWOUND, 1800 OHMS, 5 WATTS
2B1			BREAKER - CIRCUIT, PART OF MI-560510A
2S2	229890	8434081 004	BREAKER - CIRCUIT, LOW POWER, 30 A
2S3	425208	3724238 002	SWITCH - INTERLOCK
2S4			SWITCH - HIGH VOLTAGE GROUNDING
29	432038	3724531 168	SPACER - GROUNDING SWITCH
31	432037	3720249 005	BAR - SHORTING
32	432036	3454962 502	STRAP - FLEXIBLE
2XDS1	426072	3724582 001	SOCKET - INDICATOR LIGHT
2Z1		MI-560340-4	RECTIFIER ASSEMBLY
23	211081	426767 118	INSULATOR - 3/4 IN. DIA x 3 IN. LONG
37	426164	890405 010	MOUNT - RESILIENT, FOR 2B2
			RECTIFIER MI-560340-4
			P/L 3746645-501 REV 4 (SEE FIGURE 37)
2Z1		3746645 501	RECTIFIER - ASSEMBLY, MI-560340-4
	208525	426768 142	INSULATOR - STEATITE 1 IN DIA x 4 IN LONG
451.55 445769	~~426162~~	3722794 007	RECTIFIER STACK - 9.6 KV PIV
	235119		MODULE-DIODE RIGHT HAND, QR2900
	235120		MODULE-DIODE, LEFT HAND, QR2901
			BLOWER MI-560347A-1
1B2	426110	3746607 001	MOTOR ONLY
			BLOWER MI-560347-3
1B2	428277	8642662 011	MOTOR ONLY (USED ONLY IN HIGH ALTITUDE INSTALLATIONS)
			PLATE TRANSFORMER MI-560341-1
3T1	243888	8486314 001	TRANSFORMER - RECTIFIER 208/240V 3 PHASE 50/60 HZ
	249402		PRIMARY TERMINAL BOARD ONLY
3T1	428279	3734100 001	TRANSFORMER - RECT., WITH REDUCED VOLTAGE WINDING
	~~432453~~		PRIMARY TERMINAL BOARD ONLY
			PLATE TRANSFORMER MI-560341-7
3T1	428279	3734100 001	TRANSFORMER - RECTIFIER 208/240V 3 PHASE 50/60 HERTZ 7500/6300V TAPS
	432453		PRIMARY TERMINAL BOARD ONLY
			INSTALLATION MATERIAL MI-560515
1	057077	887449 501	ARM ASSEMBLY TUNING
2	070180	86183 502	TRIMMER ADJUSTING TOOL
3	230082	8535851 001	LAMP CHANGING TOOL
8	236025	1510020 103	CONNECTOR -COAXIAL
6	425769	2010853 141	WIRE - #14 AWG, 15,000 V WHITE (SPECIFY LENGTH IN FEET)
4	428364	990820 099	WIRE - #14 BLACK (SPECIFY LENGTH IN FEET)
5	428367	2010751 009	WIRE - #2/0 BLACK (SPECIFY LENGTH IN FEET)
			1Z6 CONTROL MODULE
1Z6	243753	3730764 001	CONTROL MODULE
C1	300763		CAPICATOR-ELECTROLYTIC, 250 MF 25V
C2	300763		CAPACITOR-ELECTROLYTIC, 250 MF 25V
C3	248662		CAPACITOR-ELECTROLYTIC, 1 MF 3 V
C4	248662		CAPACITOR-ELECTROLYTIC, 1 MF 3 V
D1	248663		DIODE - TYPE SS889
K1	232416		RELAY - LOW POWER POINT
K2	232416		RELAY - HIGH POWER POINT
	248673	8766828 022	PHOTOCELL FOR M5 and M7
Q1	248664		TRANSISTOR - TYPE 2N3396
Q2	248664		TRANSISTOR - TYPE 2N3396
			RESISTORS - FIXED CARBON, UNLESS NOTED
R1	248665		WIREWOUND, 1.1 OHMS 5% 2 W

Symbol	Stock No.	Drawing No.	Description
R2	243448	82283 569	5.6 OHMS 5% 1/2 W 2.2
R3	243448	82283 569	5.6 OHMS 5% 1/2 W
R4	502222	82283 167	2200 OHMS 5% 1/2 W
R5	502222	82283 167	2200 OHMS 5% 1/2 W
R6	502122	82283 143	220 OHMS 5% 1/2 W
R7	502122	82283 143	220 OHMS 5% 1/2 W
R8	265507	990464 468	FILM, 49,900 OHMS 1% 1/2W
R9	502310	82283 183	10,000 OHMS 5% 1/2 W
R10	502510	82283 234	1,000,000 OHMS 5% 1 2 W
R11	265507	990464 468	FILM, 49,900 OHMS 1% 1/2 W
R12	502510	82283 231	1,000,000 OHMS 5% 1/2W
R13	502310	82283 183	10,000 OHMS 5% 1/2 W
R21	236087	990476 041	FILM, 10,000 OHMS 1% 1/2 W
R22	236087	990476 041	FILM, 10,000 OHMS 1% 1/2 W
SCR1	248666		SCR - TYPE 2N2322A
SCR2	248666		SCR - TYPE 2N2322A
PCB			PRINTED CIRCUIT BOARD-API PART NO.1649-41
T1	248667		TRANSFORMER - POWER
			BLOWER MOUNTING KIT MI-560517 (USED WITH STANDARD BLOWER MI-560347-A1)
2	248620	8820789 006	BOOT - 2 1/2 IN x 44 IN
5	248622	3730683 001	MOUNT - SHOCK, 6 LB
6	248623	3730683 006	MOUNT - SHOCK, 20 LB
			BLOWER MOUNTING KIT MI-560705 (USED WITH HIGH ALTITUDE BLOWER MI-560347-3)
	248623	3730683 006	MOUNT - SHOCK, 20 LB
	428280	3730683 009	MOUNT - SHOCK, 33 LB
	428281	8707374 103	RELAY, THERMAL OVERLOAD - PART OF MAGNETIC STARTER RELAY, 1K15
			AM NOISE REDUCTION KIT MI-560307-31
	225532	990196 008	CAPACITOR - 10 MF 600V
	413826	990196 011	CAPACITOR - 20 MF 600V
	43441	990193 071	CAPACITOR - 15 MF 200V
	93658	949251 001	REACTOR - FILTER, 10H
	95794	949476 001	REACTOR - FILTER, 4H
	413825	890015 022	RESISTOR - 630 OHMS 200W TAPPED
	94841	433464 009	RHEOSTAT - 10 OHMS 100 W
			PA NEUTRALIZING COMPONENTS
	MI-74A		CABLE - COAXIAL, RG/8U (SPECIFY LENGTH IN FEET)
	MI-27791K-5A		CONE - REDUCER, 3-1/8" dia. COAXIAL LINE TO TYPE N CONNECTOR
	236025	1510020 103	CONNECTORS - TYPE N

SUGGESTED STATION SPARES (BTF-20E1)

Description	Symbol	Quantity	Stock No.
Capacitor, ceramic, 500 PF, 5000 V	1C140 thru 1C143	1	232610
Capacitor, ceramic, 1500 PF, 3500 V	1C144	1	209906
Capacitor, feed-thru, 1000 PF, 2000 V	1C114, 1C118, 1C147	1	236759
Capacitor, feed-thru, .001 MF, 5000 V	1C110	1	211148
Capacitor, feed-thru, 1500 PF, 15,000 V	1C119	1	230419
Capacitor, paper, .001 MF, 600 V	1C106 thru 1C109 1C121, and 1C122	2	211196
Capacitor, paper, 6 MF, 2500 V	1C5	1	229778
Capacitor, paper, 1.4 MF, 15,000V	1C7	1	430229
Capacitor, paper, 1.5 MF, 10,000V	1C8	1	230070
Capacitor, silvered mica	1C117A thru D, 1C145A thru D (Part of 1XV102)	4	225081
Capacitor, stand-off, 1000 PF, 500 V	1C103, 1C104, 1C127, 1C128, 1C129, 1C131, 1C132, 1C133, 1C134, 1C136 thru 1C139	6	214638
Capacitor, vacuum, 40 PF, 7500 V	1C124*, 1C126*	1	227938
Capacitor, vacuum, 25 PF, 7500 V	1C124*, 1C125*	1	235990
Lamp (for use in optic meter relay)	Part of 1M5 or 1M7	3	231545
Capacitor, PA plate blocking	1C113	1	423771
Contact Assembly, PA plate blocking	Part of 1C113	2	230076
Contact, control grid	Part of 1XV102	1	220958
Contact, inner filament	Part of 1XV102	1	220960
Contact, outer filament	Part of 1XV102	1	220959
Contact, PA neutralizing slider	Part of 1L113	3	232298
Spacer (used with Stock No. 232298)	Part of 1L113	3	232301
Filter	Air filter for 1B2	3	225125
Lamp, indicator	1DS1A thru 1DS6B and	3	300449
Lamp, indicator	2DS1	3	42607-1
Rectifier Stack (9.6 kV PIV CR 307	Part of Rectifier 2Z1	1	426162
Individual diode module for 2Z1 (right hand)	Part of Rectifier 2Z1	6	235119
Individual diode module for 2Z1 (left hand)	Part of Rectifier 2Z1	6	235120
Rectifier, low voltage (Diode Module only)	1Z2, 1Z3, and 1Z4	3	230913
Rectifier, bias	1Z1	1	229803
Contact Assembly (contacts mounted on metal strip for 1L105, 1L106)	Part of 1L105, 1L106	4	230424

*Values of 1C124, 1C125, 1C126 vary with frequency.

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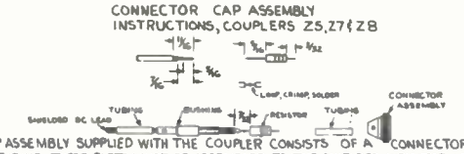
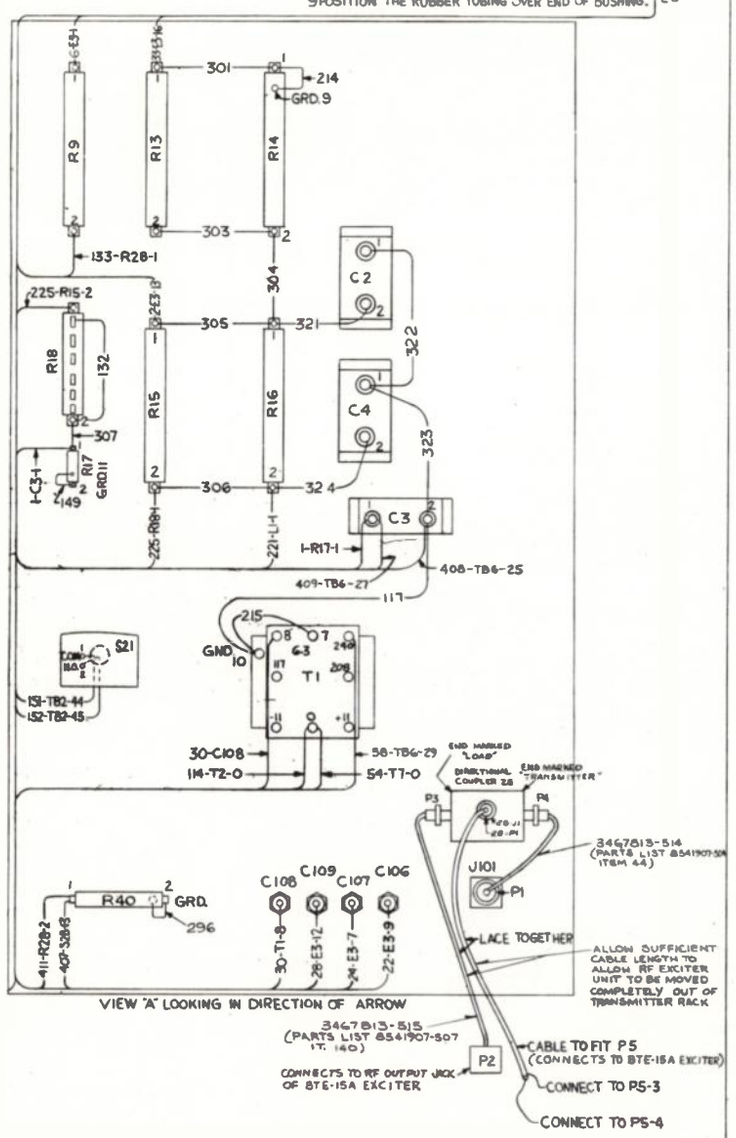
Figure 38. BTF-20E1 Schematic Diagram

CONNECTOR CAP ASSEMBLY INSTRUCTIONS, COUPLERS Z5, Z7 & Z8

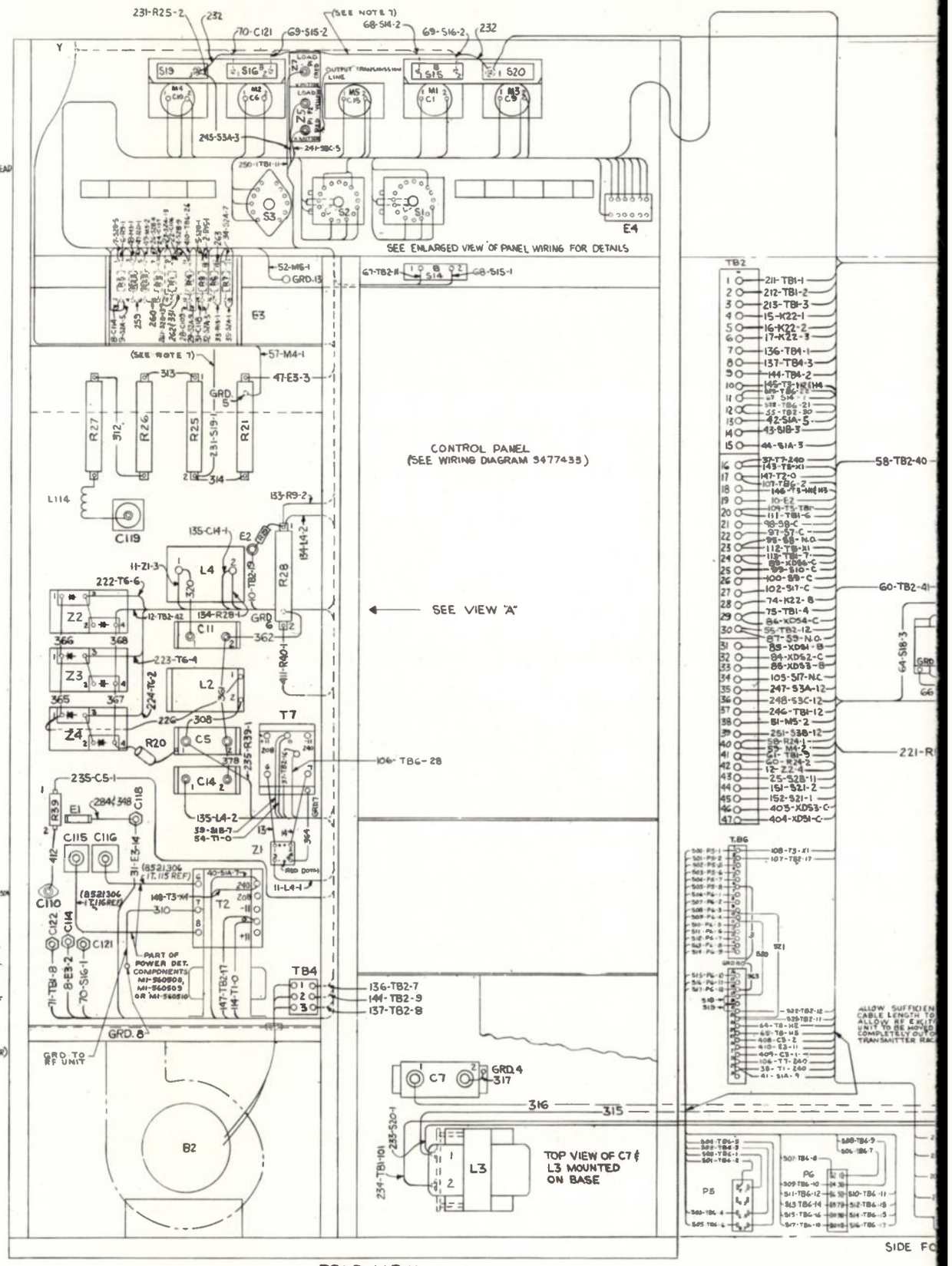


ASSEMBLY PROCEDURE - THE CAP ASSEMBLY SUPPLIED WITH THE COUPLER CONSISTS OF A CONNECTOR BUSHING RESISTOR AND TWO LENGTHS OF TUBING. THESE PARTS MUST BE ASSEMBLED TO THE SHIELDED INDICATOR LEAD AS OUTLINED USING THE ABOVE ILLUSTRATION AS A GUIDE

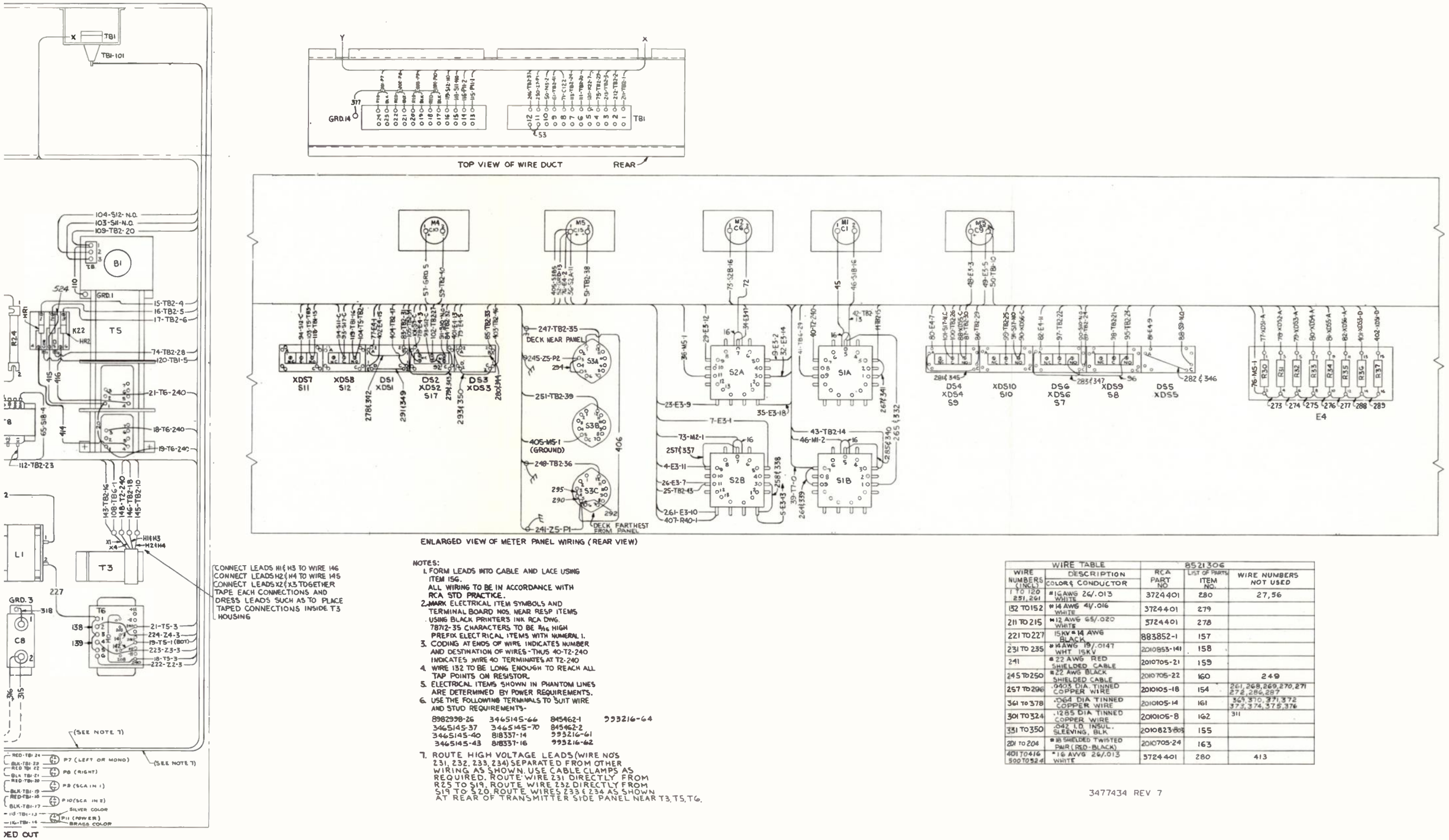
1. STRIP THE SHIELDED INDICATOR LEAD AS SHOWN.
2. TRIM THE RESISTOR WIRES TO THE DIMENSIONS GIVEN.
3. SLIDE THE LONGER TUBING & BUSHING ONTO THE SHIELDED LEAD
4. LOOP, CRIMP, SOLDER THE RESISTOR WIRE TO CONDUCTOR OF SHIELDED LEAD
5. POSITION SHORTER TUBING OVER RESISTOR AND SOLDERED CONNECTION.
6. SOLDER OPPOSITE RESISTOR WIRE TO TERMINAL IN CONNECTOR.
7. SEAT BUSHING IN CONNECTOR BODY AND TIGHTEN SET SCREW.
8. SOLDER SHIELDING OF INDICATOR LEAD TO BUSHING THROUGH HOLES IN BUSHING.
9. POSITION THE RUBBER TUBING OVER END OF BUSHING.



VIEW "A" LOOKING IN DIRECTION OF ARROW



REAR VIEW.



ENLARGED VIEW OF METER PANEL WIRING (REAR VIEW)

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 1/16 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-

8982998-26	3465145-66	845462-1	993216-64
3465145-37	3465145-70	845462-2	
3465145-40	818337-14	993216-61	
3465145-43	818337-16	993216-62	

7. ROUTE HIGH VOLTAGE LEADS (WIRE NO'S 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 S20. ROUTE WIRES 233 & 234 AS SHOWN AT REAR OF TRANSMITTER SIDE PANEL NEAR T3, T5, T6.

WIRE TABLE — 8521306

WIRE NUMBERS (INCL)	DESCRIPTION COLOR & CONDUCTOR	RCA PART NO	LIST OF PARTS ITEM NO.	WIRE NUMBERS NOT USED
1 TO 120, 251, 261	#16 AWG 26/.013 WHITE	3724401	280	27, 56
132 TO 152	#14 AWG 41/.016 WHITE	3724401	279	
211 TO 215	#12 AWG 65/.020 WHITE	3724401	278	
221 TO 227	15KV #14 AWG BLACK	883852-1	157	
231 TO 235	#14 AWG 19/.0147 WHT 15KV	2010853-141	158	
241	#22 AWG RED SHIELDED CABLE	2010705-21	159	
245 TO 250	#22 AWG BLACK SHIELDED CABLE	2010705-22	160	249
257 TO 296	.0403 DIA. TINNED COPPER WIRE	2010105-18	154	261, 268, 269, 270, 271 272, 286, 297
361 TO 378	.064 DIA TINNED COPPER WIRE	2010105-14	161	369, 370, 371, 372 373, 374, 375, 376
301 TO 324	.1285 DIA TINNED COPPER WIRE	2010105-8	162	311
351 TO 350	.042 I.D. INSUL. SLEEVING, BLK	2010823-[illegible]	155	
201 TO 204	#18 SHIELDED TWISTED PAIR (RED-BLACK)	2010705-24	163	
401 TO 416, 500 TO 524	#16 AWG 26/.013 WHITE	3724401	280	413

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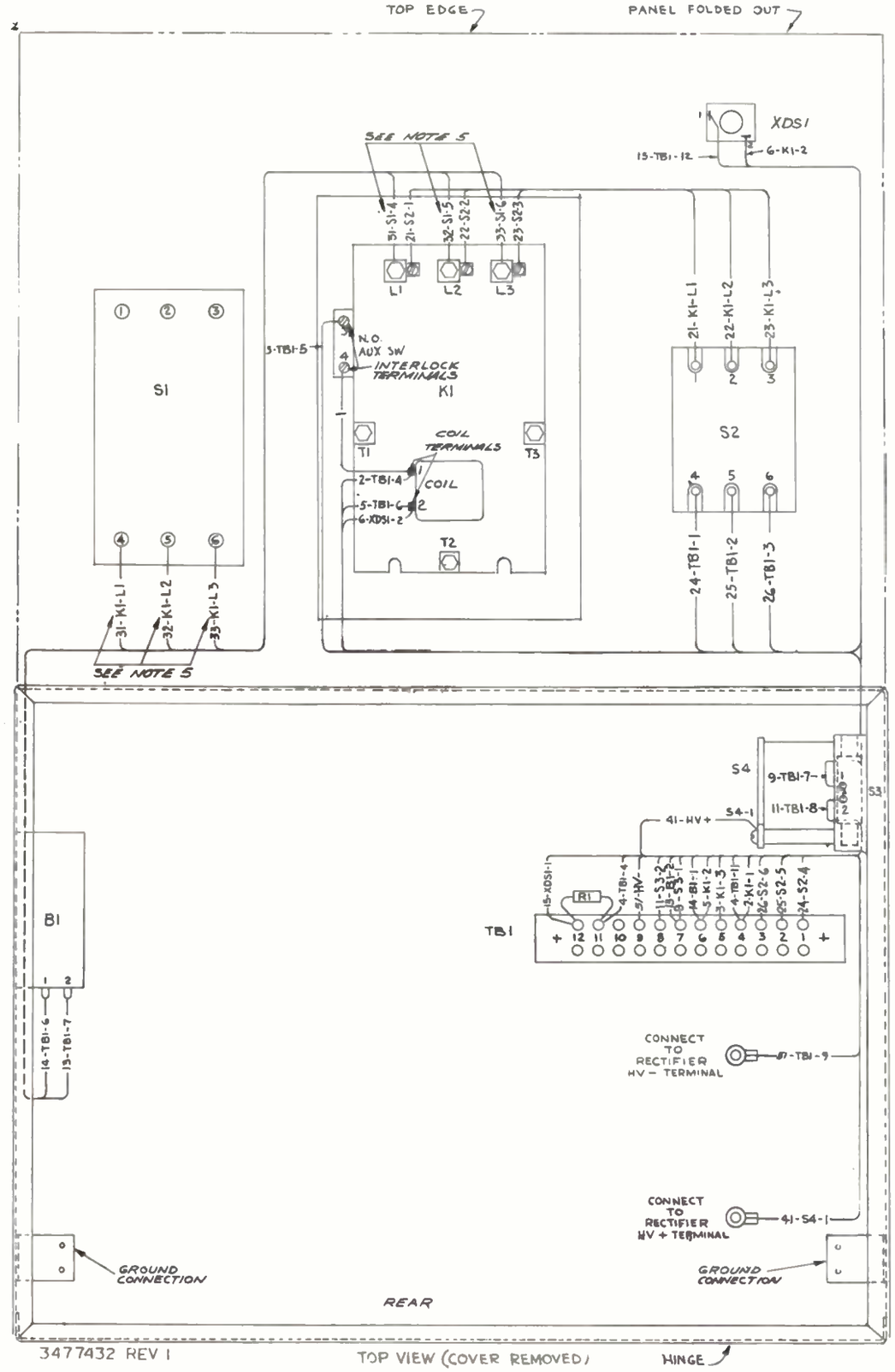
Figure 39. BTF-20E1 Wiring Diagram



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TOP VIEW (COVER REMOVED)

EARLY PRODUCTION

WIRE TABLE		3724456-501		
WIRE NOS. (INCL)	DESCRIPTION COLOR & CONDUCTOR	R.C.A. PART NUMBER	LIST OF PARTS ITEM NUMBER	WIRE NOS. NOT USED
1 TO 15	WHITE #16 AWG 19/.013 600V	3724401-11	46	7,10,12
21 TO 26	WHITE #12 AWG 19/.020 1000V	3724401-13	47	
31 TO 33	SIZE 2/0 AWG BLACK 600V		PART OF MI-5605A	SEE NOTE 5
41	19/.0147 #14 AWG WHITE 10KV	2010853-141	48	
31 TO 33	7/.0772 #4 AWG BLACK 600V		PART OF MI-5605A	SEE NOTE 5
31 TO 33	7/.0486 #8 AWG BLACK 600V		PART OF MI-5605A	SEE NOTE 5
51	WHITE #16 AWG 19/.027 600V.	3724401-12	50	

NOTES

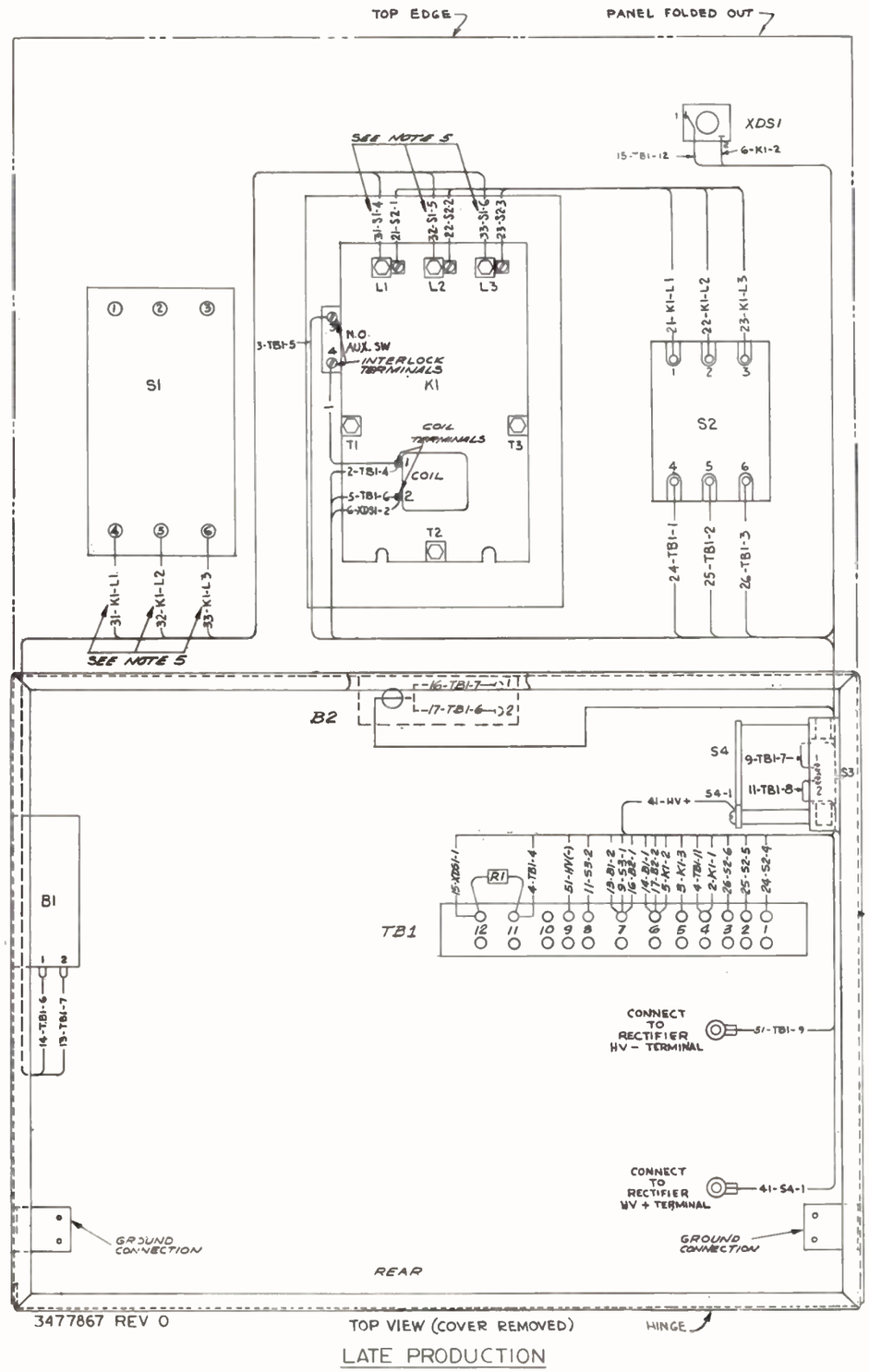
1- FORM WIRES INTO CABLE AND LACE USING ITEM-175 ALL WIRING TO BE IN ACCORDANCE WITH RCA STD PRACTICE.

2- CODING AT ENDS OF WIRES INDICATE NUMBER AND DESTINATION OF WIRE-THUS WIRE 24 TERMINATES AT TB1-1 AND S2-4.

3- MARK ELECTRICAL ITEM SYMBOLS NEAR RESP ITEMS USING BLACK PRINTERS INK, RCA DRG 7871 2-35. CHARACTERS TO BE STD 3/16 HIGH ADD PREFIX 2 TO ELECTRICAL SYMBOLS.

4- USE THE FOLLOWING TERMINALS TO SUIT REQUIREMENTS
8982998-26
8982998-42
8982998-53
} SOLDERLESS
845462-2 #1

5. WIRES NO. 31,32,33 SHOWN FOR REFERENCE ONLY. THESE WIRES ARE INSTALLED DURING TRANSMITTER TEST PERIOD. MATERIAL (WIRE) IS SUPPLIED AS PART OF MI-5605D8A, MI-5605D9A, OR MI-5605/10A. THESE WIRES NOT TO BE FACTORY INSTALLED.



LATE PRODUCTION

WIRE TABLE		3724456-502		
WIRE NOS. (INCL)	DESCRIPTION COLOR & CONDUCTOR	R.C.A. PART NUMBER	LIST OF PARTS ITEM NUMBER	WIRE NOS. NOT USED
1 TO 17	WHITE #16 AWG 19/.013 600V.	3724401-11	46	7,10,12
21 TO 26	WHITE #12 AWG 19/.020 1000V	3724401-13	47	
31 TO 33	SIZE 2/0 AWG BLACK 600V		PART OF MI-5605A	SEE NOTE 5
41	19/.0147 #14 AWG WHITE 10KV	2010853-141	48	
31 TO 33	7/.0772 #4 AWG BLACK 600V		PART OF MI-5605A	SEE NOTE 5
31 TO 33	7/.0486 #8 AWG BLACK 600V		PART OF MI-5605A	SEE NOTE 5
51	WHITE #16 AWG 19/.027 600V	3724401-12	50	

NOTES

1- FORM WIRES INTO CABLE AND LACE USING ITEM-175 ALL WIRING TO BE IN ACCORDANCE WITH RCA STD PRACTICE.

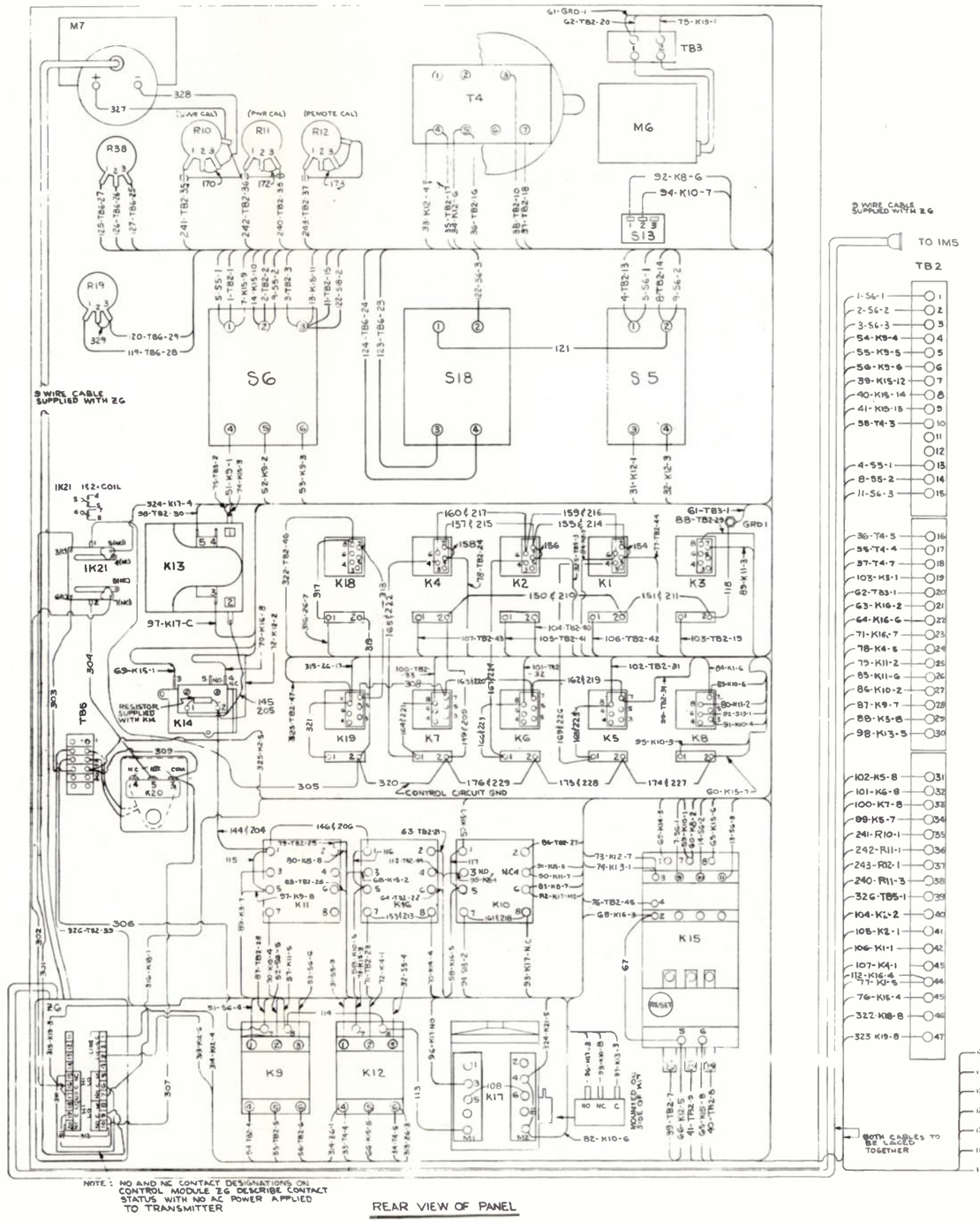
2- CODING AT ENDS OF WIRES INDICATE NUMBER AND DESTINATION OF WIRE-THUS WIRE 24 TERMINATES AT TB1-1 AND S2-4.

3- MARK ELECTRICAL ITEM SYMBOLS NEAR RESP ITEMS USING BLACK PRINTERS INK, RCA DRG 7871 2-35. CHARACTERS TO BE STD 3/16 HIGH ADD PREFIX 2 TO ELECTRICAL SYMBOLS.

4- USE THE FOLLOWING TERMINALS TO SUIT REQUIREMENTS
8982998-26
8982998-42
8982998-53
} SOLDERLESS
845462-2 #1

5. WIRES NO. 31,32,33 SHOWN FOR REFERENCE ONLY. THESE WIRES ARE INSTALLED DURING TRANSMITTER TEST PERIOD. MATERIAL (WIRE) IS SUPPLIED AS PART OF MI-5605D8A, MI-5605D9A, OR MI-5605/10A. THESE WIRES NOT TO BE FACTORY INSTALLED.

Figure 40. Power Supply, Wiring Diagram



REAR VIEW OF PANEL

WIRE TABLE		8521306		
WIRE NOS. (INCL)	DESCRIPTION COLOR & CONDUCTOR	RCA PART NUMBERS	LIST OF PARTS ITEM NO	WIRE NOS NOT USED
1 TO 14	WHITE # 12 AWG 19/.020 1000V	3724401	278	
31 TO 41	WHITE # 14 AWG 19/.016 600V	3724401	279	
51 TO 127	WHITE # 16 AWG 19/.013 600V	3724401	280	109 TO 113 81
141 TO 176	.0403 DIA. TINNED COPPER	2010108-18	261	141 TO 143 147,148,152
201 TO 229	INSULATING TUBING .042 I.D. BLACK	2010828-805	263	201 TO 203 207,208,212
240 TO 243	BLACK #20 AWG SHIELDED WIRE	2010868-3	246	
301 TO 307, 309, 312 314, 315, 316, 322, 324 325, 326, 327, 328 329, 330, 331, 332 333, 334	WHITE # 16 AWG 19/.013 600V	3724401	280	
308, 310, 311, 313, 321 317, 318, 319	.0403 DIA. TINNED COPPER	2010105-18	261	

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.

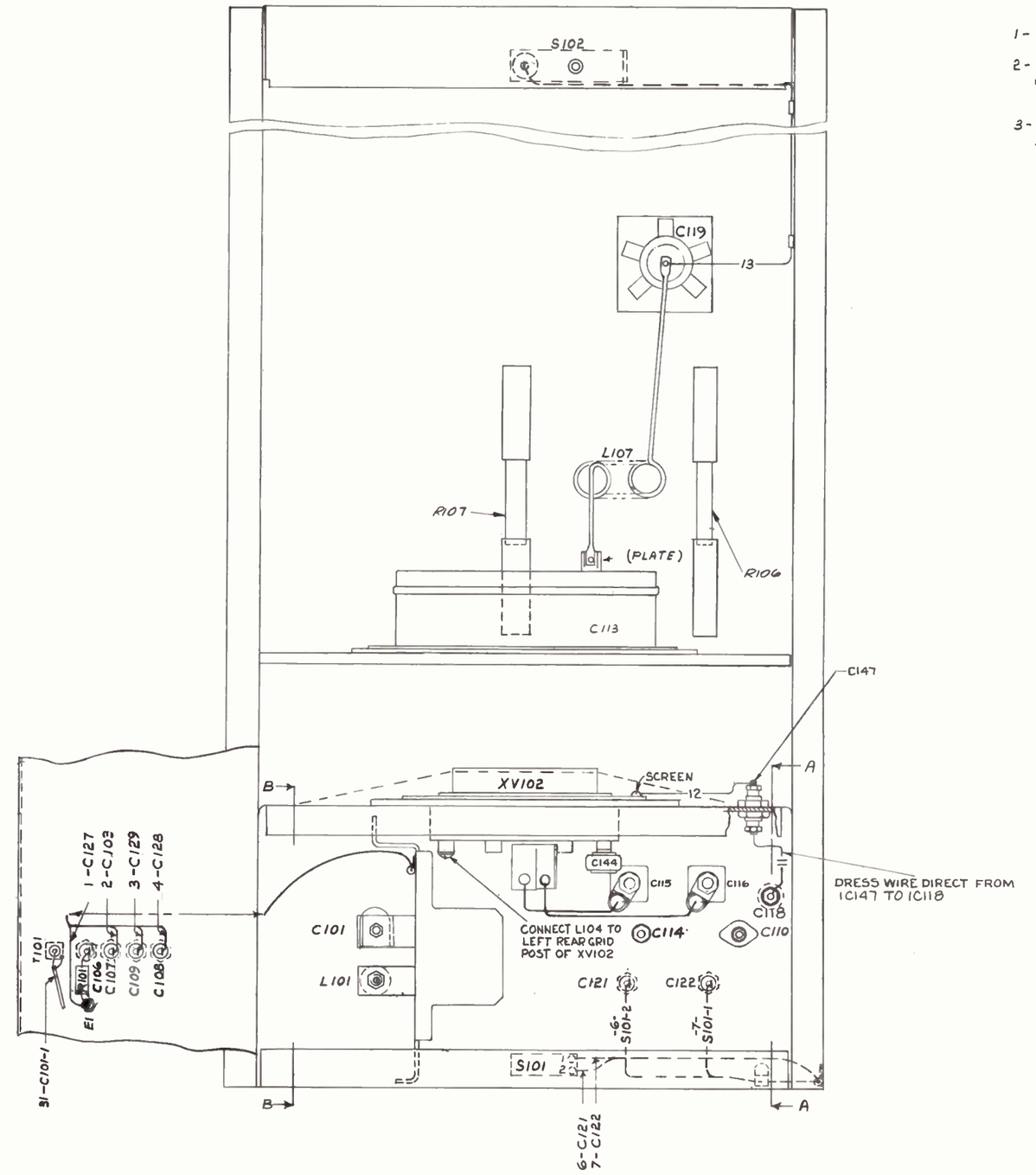
4— USE THE FOLLOWING TERMINALS TO SUIT REQUIREMENTS

8882998-24	3465145-66	993216-61
3465145-37	3465145-70	993216-62
3465145-40	818387-14	993216-64
3465145-43	818387-16	

TB6 (LOCATED BELOW TB2)

DWG NO. 3477433 REV 3

Figure 41. Control Panel, Wiring Diagram

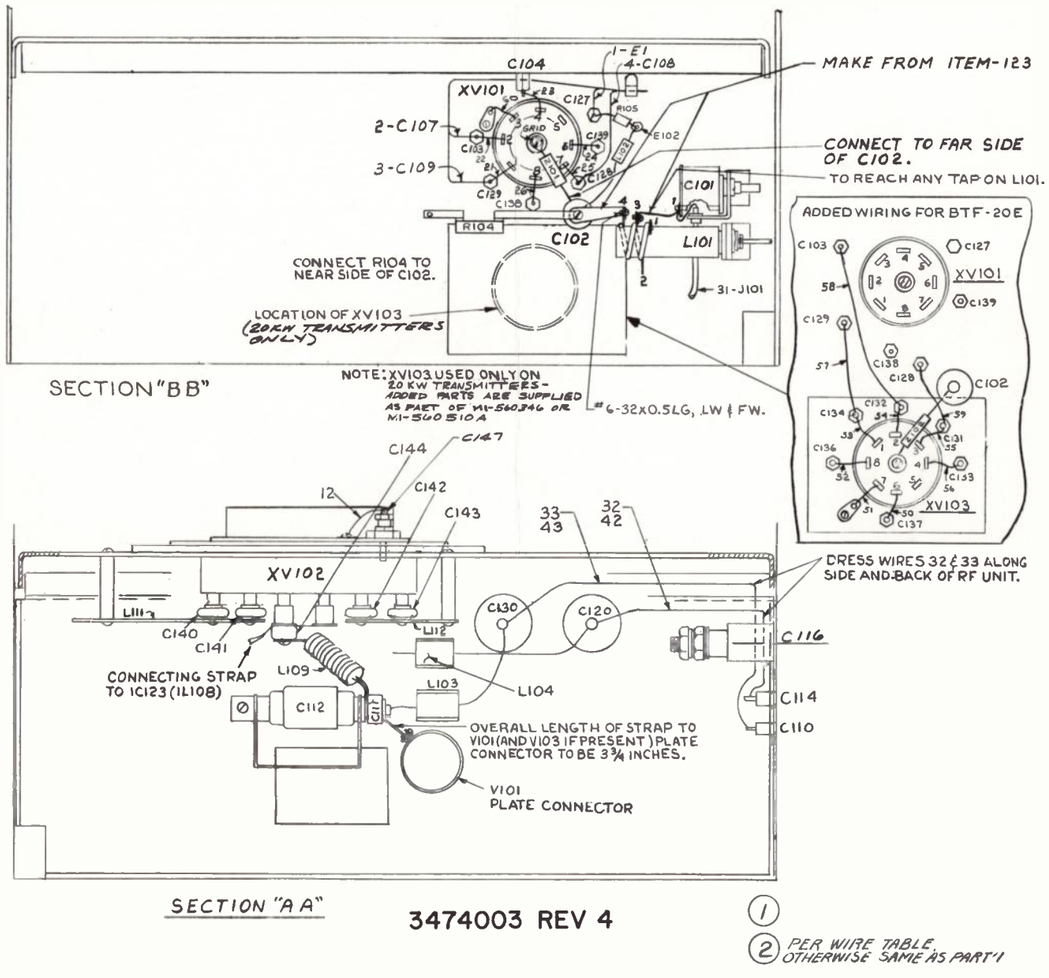


1- CABLE WIRES AS SHOWN AND LACE USING ITEM-121.

2- MARK ELECTRICAL SYMBOLS 3/16 HIGH, STANDARD CHARACTERS USING BLACK PRINTERS INK. 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).

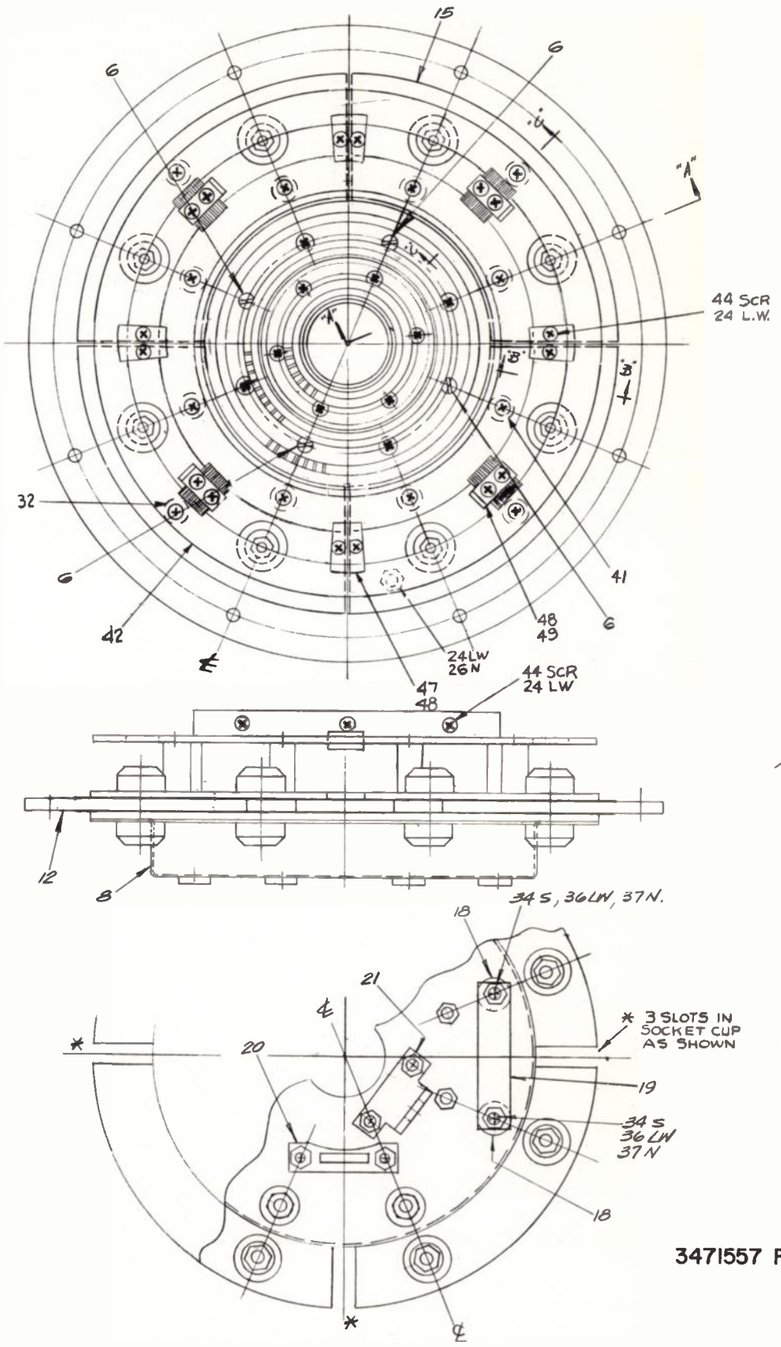
WIRE TABLE			8541907		
WIRE NOS INCL		DESCRIPTION	RCA PART NO.	LIST OF PARTS ITEM NO.	WIRE NOS NOT USED
1707	(1)	BLK. #18 AWG. 16/.010-600V	2010592-29	125	5
1707	(2)	WHT. #18 AWG. 19X30T/C-600V	3724401-10	119	
11&12	(1)	BLK. #14 AWG. 19/.047-30KV DC	2010706-35	126	
11&12	(2)	WHT. #14 AWG. 19X27T/C-600V	3724401-12	120	
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 #10 AWG. 19/0234 15KVDC	2010853 -145	131	
31		COAXIAL CABLE RG-58 A/U	2010745 -458		

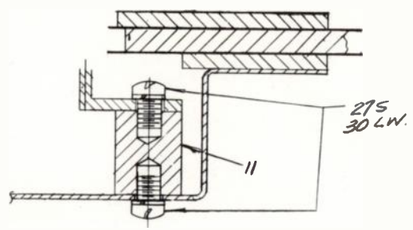


3474003 REV 4

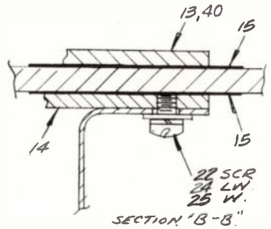
(1)
(2) PER WIRE TABLE. OTHERWISE SAME AS PART 1

Figure 42. RF Box, Wiring Diagram

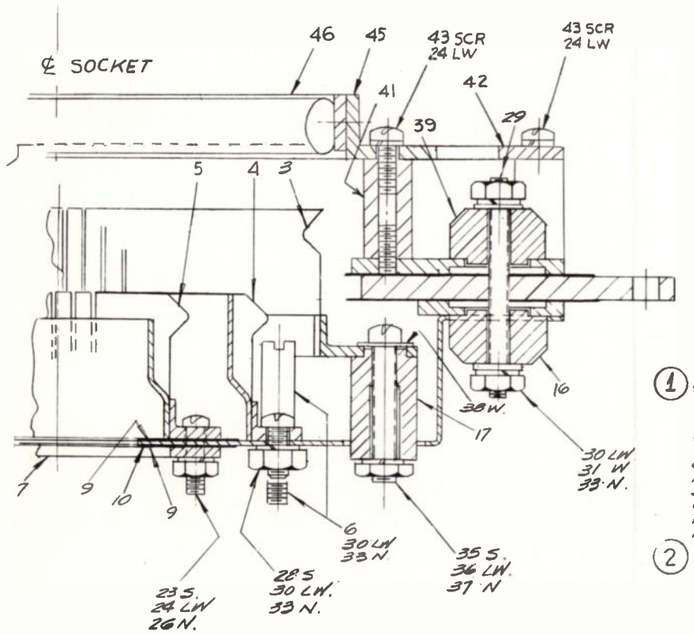




SECTION "C-C"



SECTION "B-B"



SECTION "A-A"

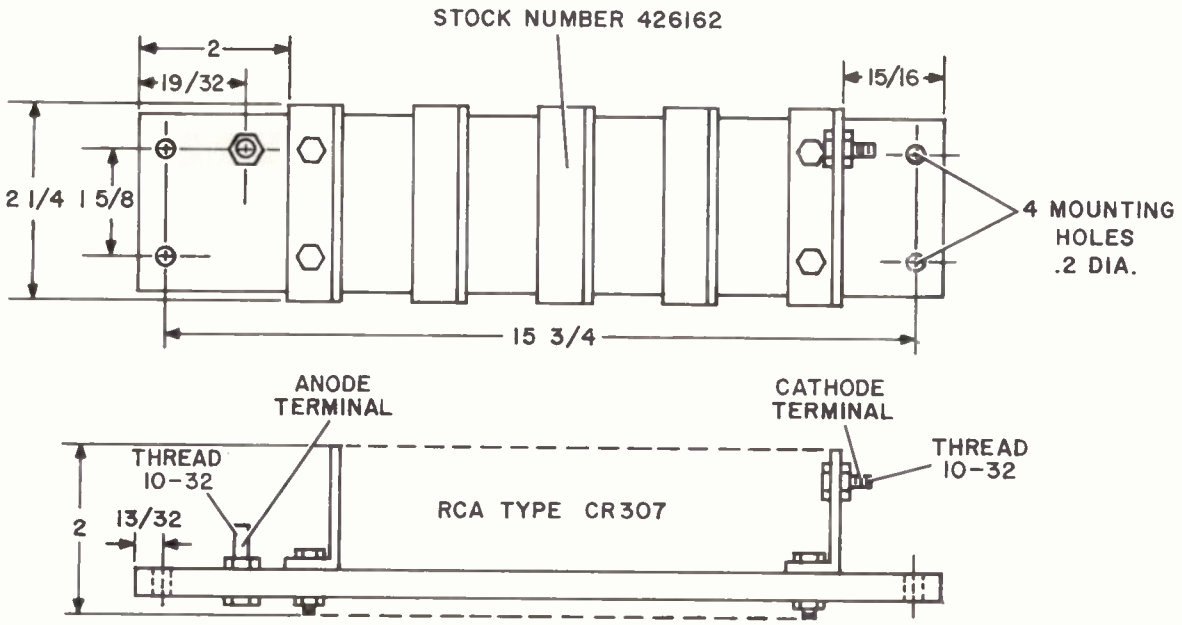
GROUP NO.				ITEM OR SYMBOL	REFERENCE DRAWING OR SPECIFICATION	FIRST OR GROUP	LIST OF PARTS DESCRIPTION
501	502	503	504				
QUANTITY							
			X	1			ASSEMBLY.
		X		2			ASSEMBLY
		1	1	3	644382	4	COLLET, CONTROL GRID.
		1	1	4	644382	5	COLLET, OUTER FIL.
		1	1	5	644382	6	COLLET, INNER FIL.
		4	4	6	644382	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	8863044	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	3455755	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	16	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 .31LG.
		4	4	28	990108	159	SCR, PAN HD. .164(#8)-32 X .38LG.
		8	8	29	69271	172	STUD .164(#8)-32 X 1.69 LG.
		32	24	30	93620	159	LOCKWASHER #8
		16	8	31	82278	156	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 1.12LG
		8	8	36	93620	162	LOCKWASHER #10
		8	8	37	57435	156	NUT, HEX. #10-32
		8	8	38	82278	171	WASHER (PLAIN) #10 (LARGE HOLE)
		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)-32 X .38 LG.
		24		44	990106	155	SCR. PAN. HD. .138(6)-32 X .25 LG.
		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, 15 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 32,750 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 GR 502 SAME AS PART 1 EXCEPT AS SHOWN

Figure 43. 1XV102 Assembly Diagram



DIMENSIONS IN INCHES

RCA TYPE NO.	DESCRIPTION	STOCK NO.
QR2900	INDIVIDUAL RIGHT HAND MODULE FOR CR307 INCLUDES DIODE, HEAT SINK, R-C NETWORK AND ASSOCIATED HARDWARE.	235119
QR2901	INDIVIDUAL LEFT HAND MODULE FOR CR307 INCLUDES DIODE, HEAT SINK, R-C NETWORK AND ASSOCIATED HARDWARE.	235120

RCA TYPE NO.	WORKING P.R.V.	TRANSIENT P.R.V.	MAXIMUM FORWARD CURRENT	50° C
CR307	9.6KV	11.5KV	5A	1 Ø
			4.4A	3 Ø

DETAILS OF CR307 RECTIFIER STACKS USED IN HIGH VOLTAGE RECTIFIER ASSEMBLY MI-560340-4.

IK087

Figure 44. High Voltage Rectifier Assembly

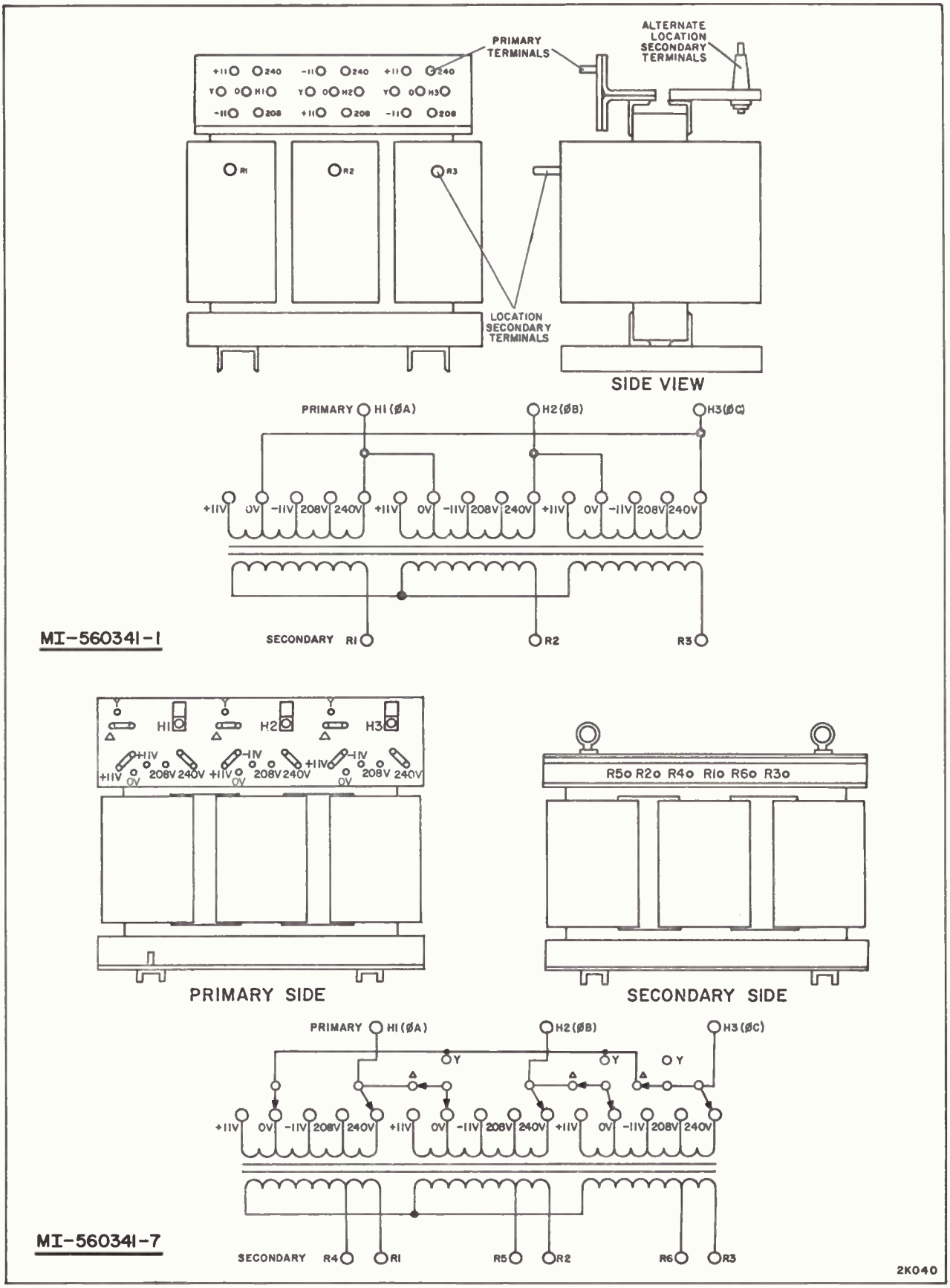
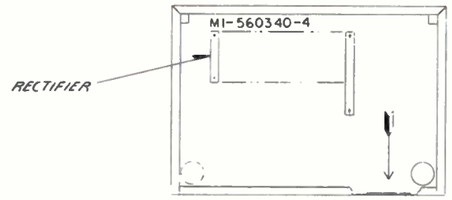
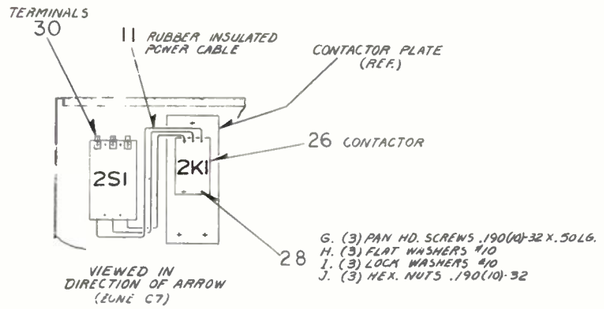


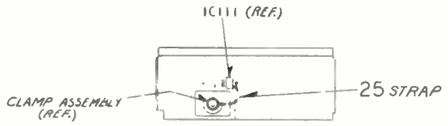
Figure 45. High Voltage Plate Transformer Terminals



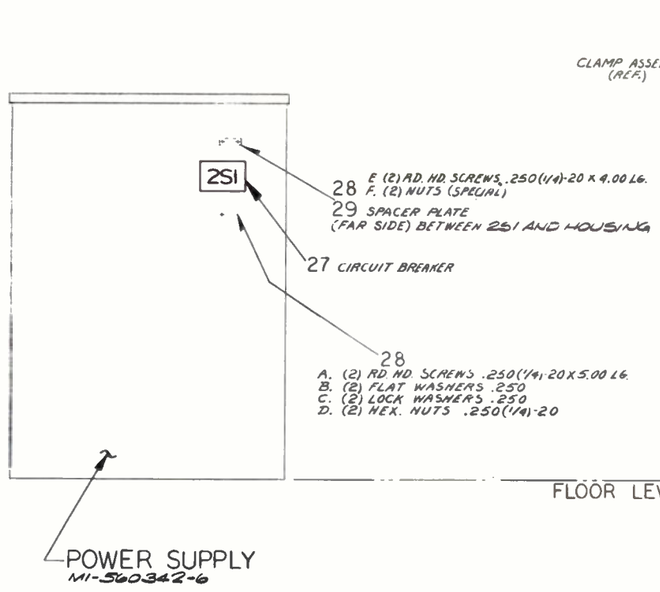
TOP VIEW
WITH COVER REMOVED

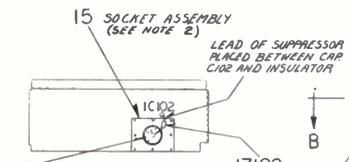


VIEWED IN DIRECTION OF ARROW (ZONE C7)

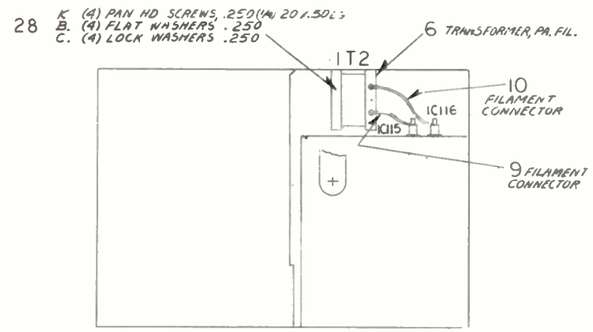


SECTION "E-E"

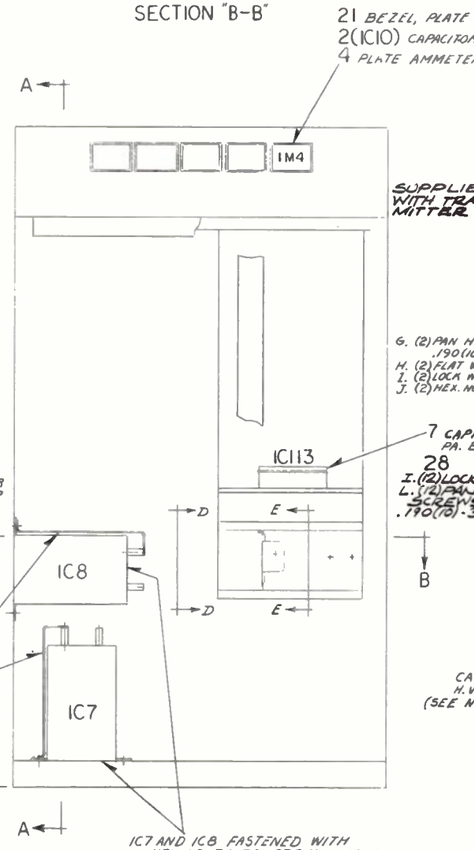




SECTION "D-D"

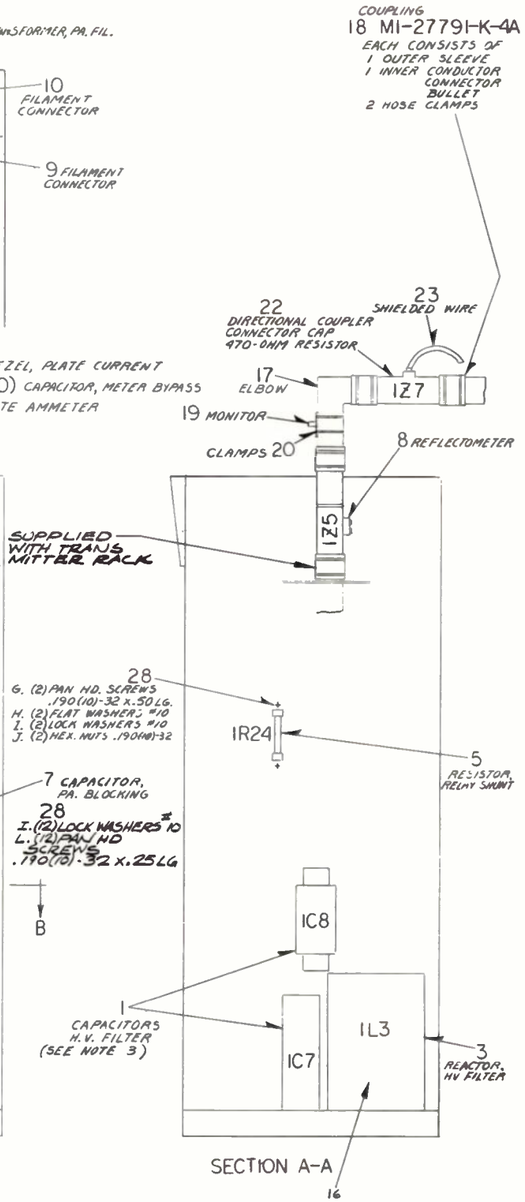


SECTION "B-B"



TRANSMITTER

3746700 REV 3



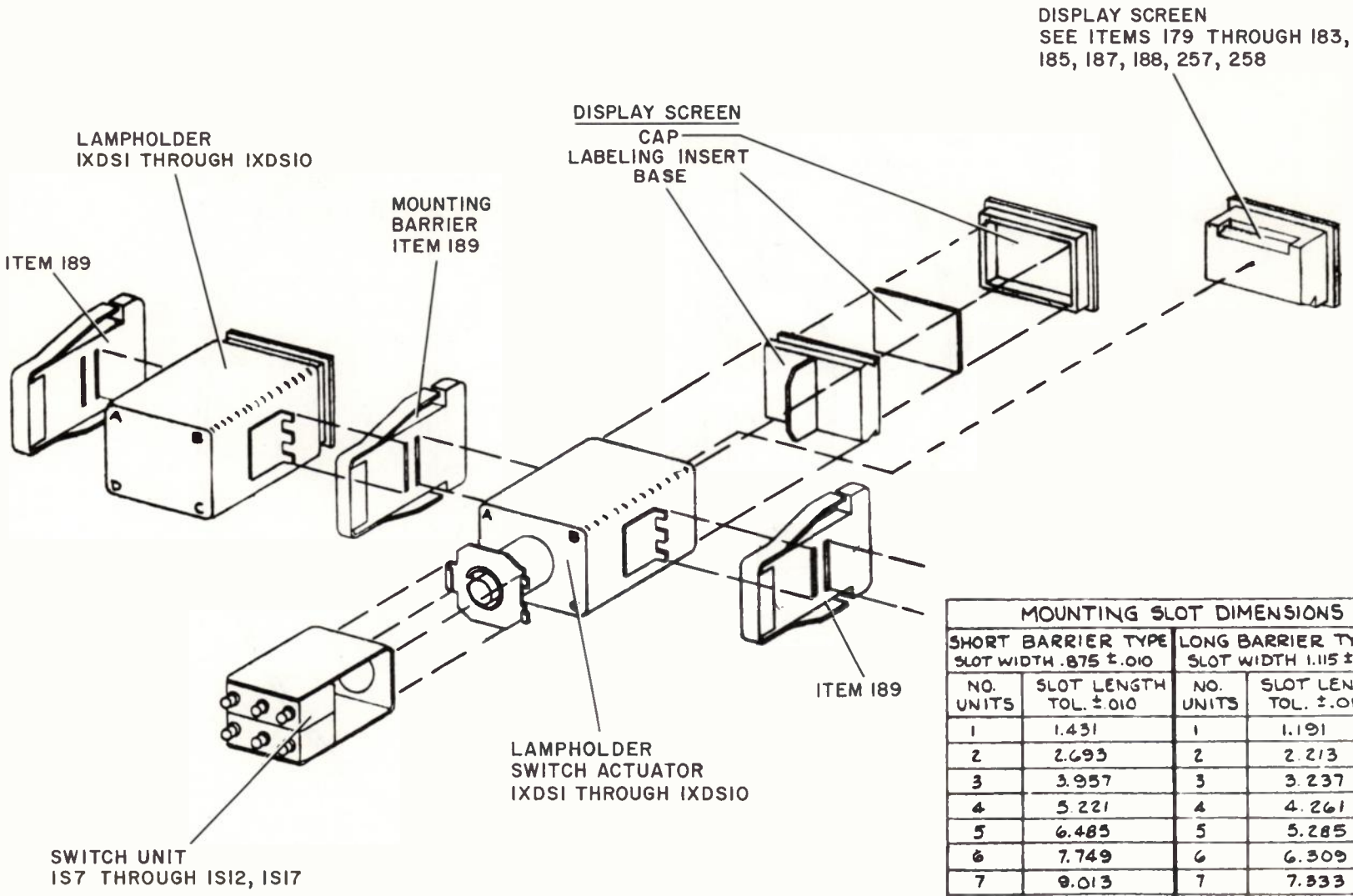
SECTION A-A

POWER DETERMINING COMPONENTS

NOTE:-

1. NUMBERS REFER TO ITEMS LISTED ON MI-560510A
2. REMOVE PLATE, ITEM 25 OF R.F. BOX ASSEMBLY 8541907 AND REPLACE WITH ITEM 15 PER SECTION D-D
3. EARLY PRODUCTION UNITS MAY HAVE HARDWARE IN PLACE

Figure 46. Power Determining Components, Installation



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

1K080

SIMILAR TO 8494047 REV 1

NOTE: 1. LAMP STOCK NO.-300449,
LAMP TOOL STOCK NO.-230082

Figure 47. Pushbutton Switch Assembly

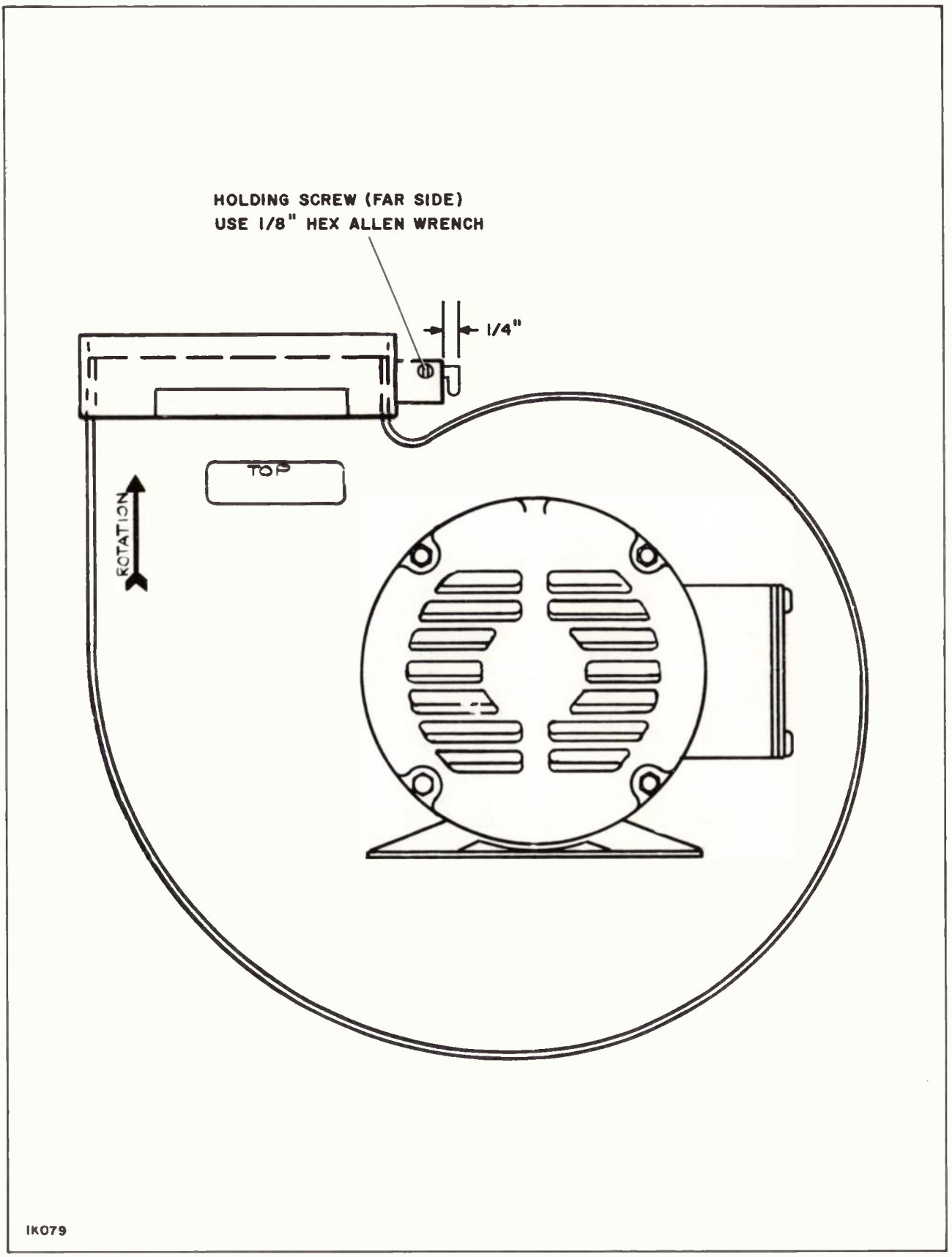
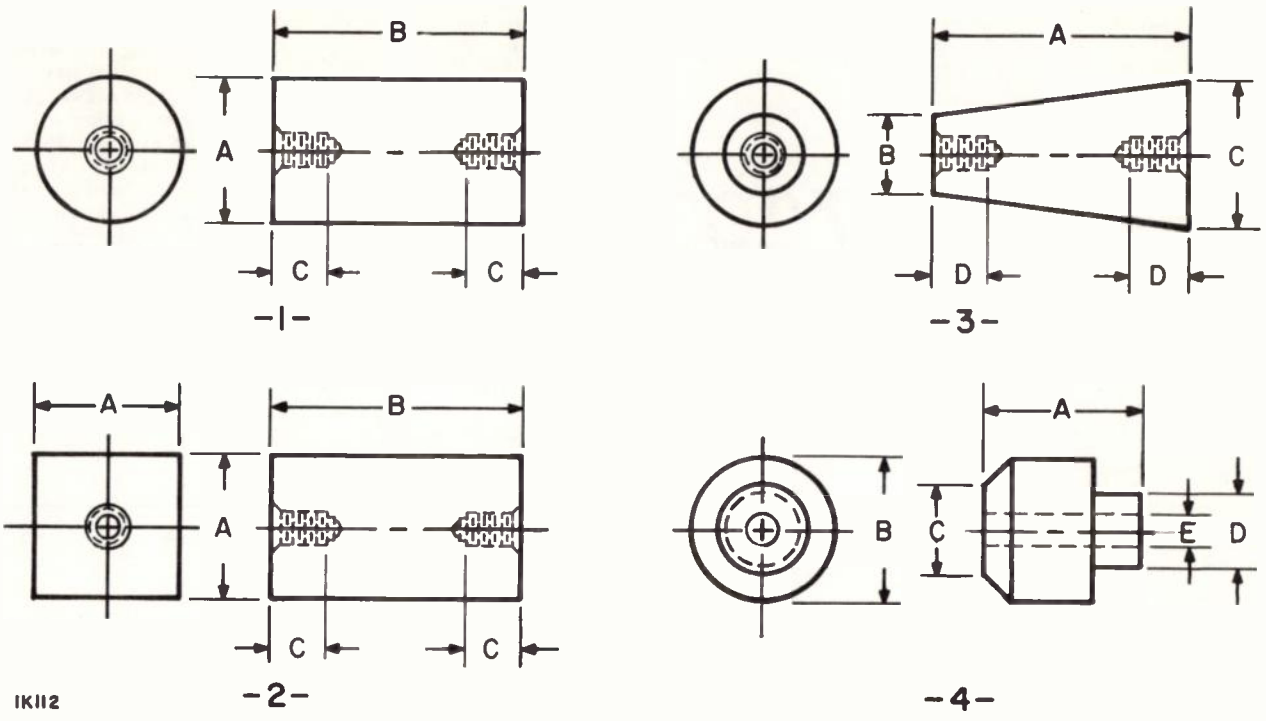


Figure 48. Blower Vane Setting



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	0.173	–
426765-3	211423	1	3/8	1/2	0.16	–	–	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
426767-121	208325	1	3/4	4.0	3/8	–	–	10-32
426767-12	209091	1	3/4	2.0	3/8	–	–	10-32
426767-118	211081	1	3/4	3.0	3/8	–	–	10-32
426763-9	217719	4	0.438	3/4	1/2	15/32	0.200	–
426765-112	208116	2	3/8	1/0	3/8	–	–	6-32
426772-3	211370	2	1/2	3/4	1/4	–	–	8-32
426767-106	97458	2	3/4	1-1/4	3/8	–	–	10-32
426767-115	231640	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 49. 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

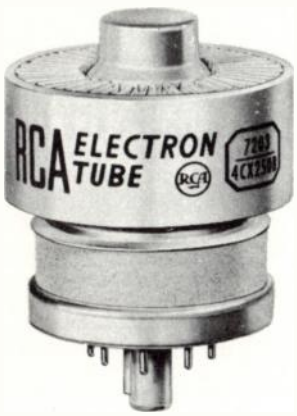
BEAM POWER TUBE

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 20° 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 20° 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	-32	-46	volts
Type 7204.	2,3,7,8			
Grid-No.2 Current:				
Type 7203.	1,3,7,8	-7	+3	ma
Type 7204.	2,3,7,8			
Useful Power Output:				
Type 7203.	5,7,8	225	-	watts
Type 7204.	6,7,8			

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.

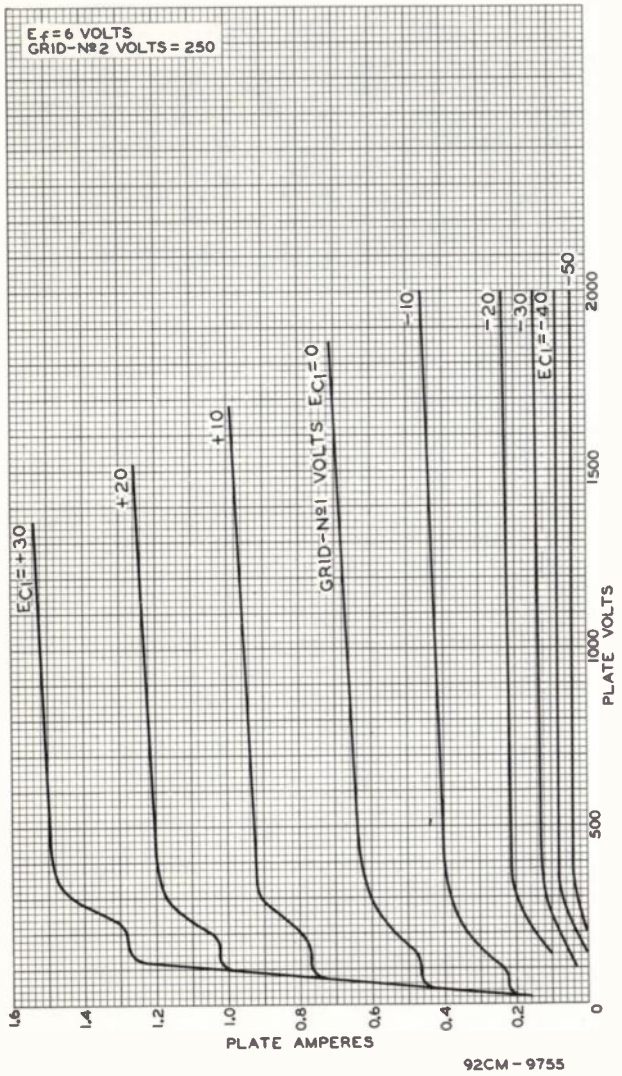


Fig. 1 - Typical Plate Characteristics of Type 7203.

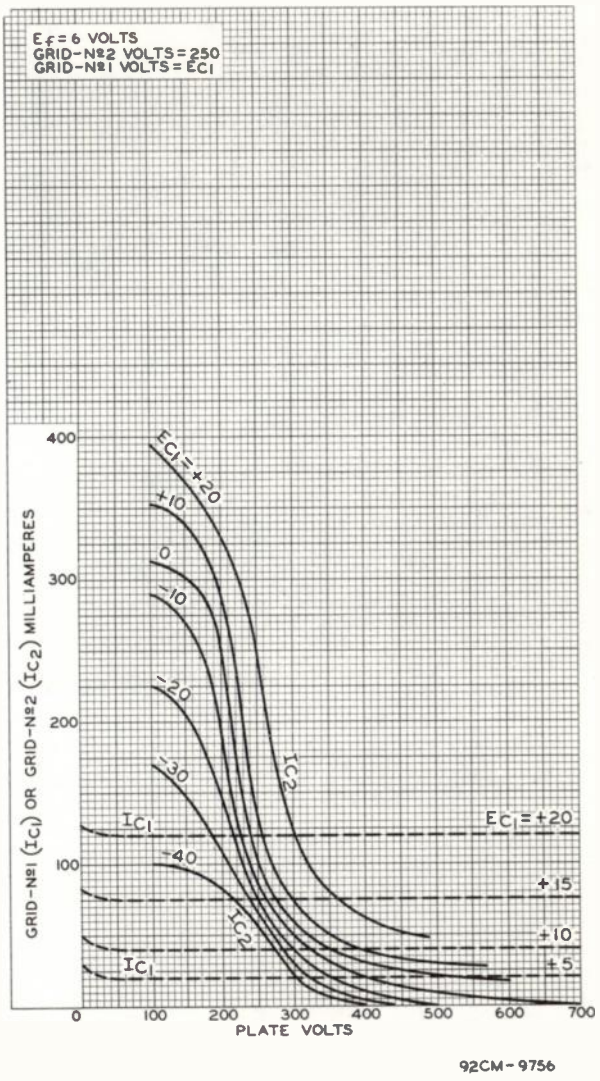


Fig. 2 - Typical Characteristics of Type 7203.

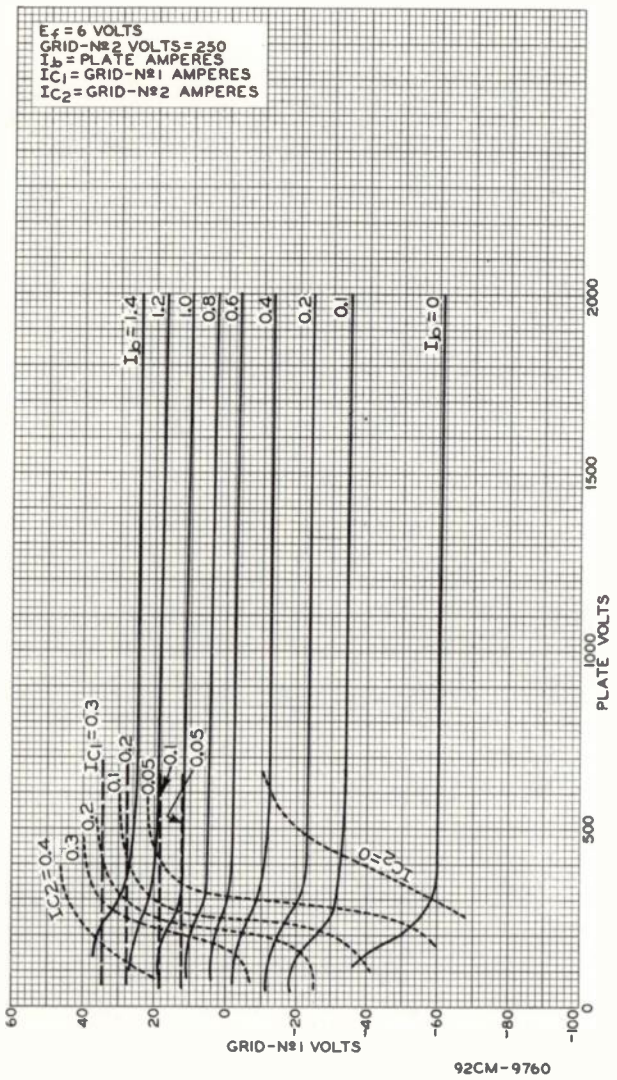


Fig. 3 – Typical Constant-Current Characteristics of Type 7203.

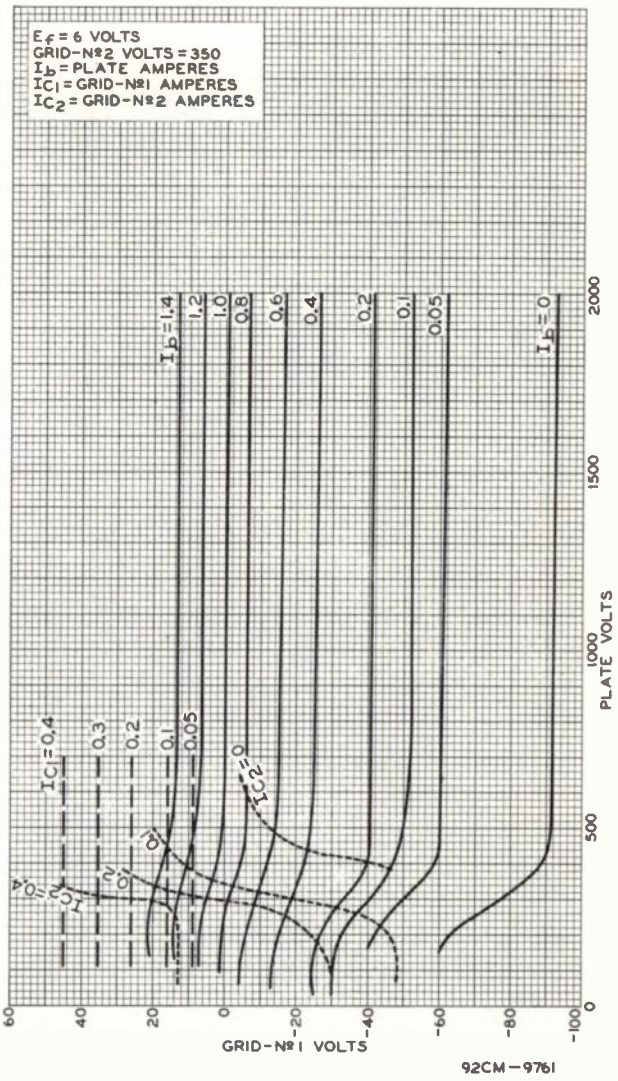
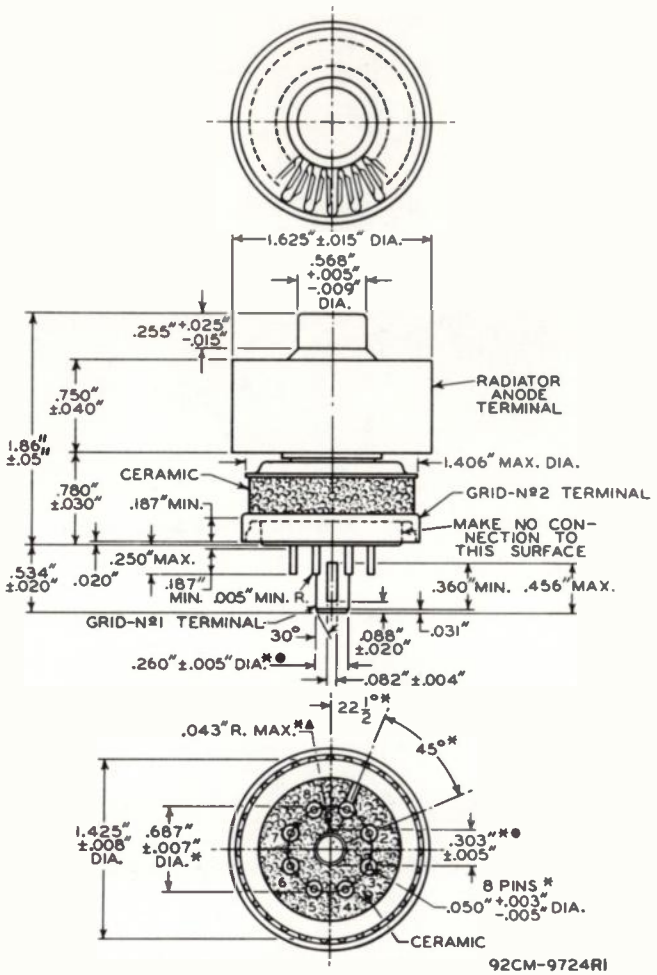


Fig. 4 – Typical Constant-Current Characteristics of Type 7203.

DIMENSIONAL OUTLINE



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:

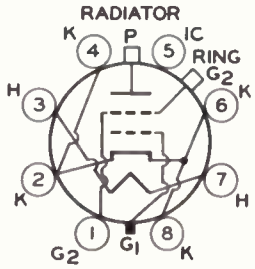
▲ GAUGES G_1-1, G_1-2, G_1-3, AND G_1-4:
USING ONLY SLOT C, TRY THESE GAUGES IN NUMERICAL ORDER UNTIL ONE IS FOUND THAT WILL ACCEPT THE ENTIRE GRID-No.1 PLUG. USING THE FIRST GAUGE THUS FOUND, IT WILL NOT BE POSSIBLE TO INSERT THE GRID-No.1 PLUG IN SLOT B.

● 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.

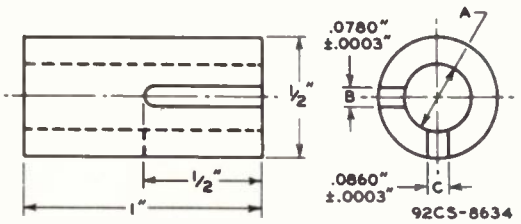
BASING DIAGRAM

Bottom View



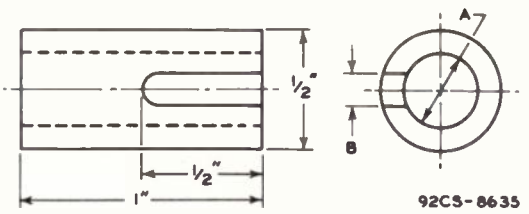
PIN 1: GRID No.2 (For use at the lower frequencies)
PIN 2: CATHODE
PIN 3: HEATER
PIN 4: CATHODE
PIN 5: INTERNAL CONNECTION--DO NOT USE
PIN 6: CATHODE
PIN 7: HEATER
PIN 8: CATHODE
BASE INDEX PLUG: GRID No.1
RADIATOR: PLATE
RING TERMINAL: GRID No.2 (For use at the higher frequencies)

Gauge Sketch G_1



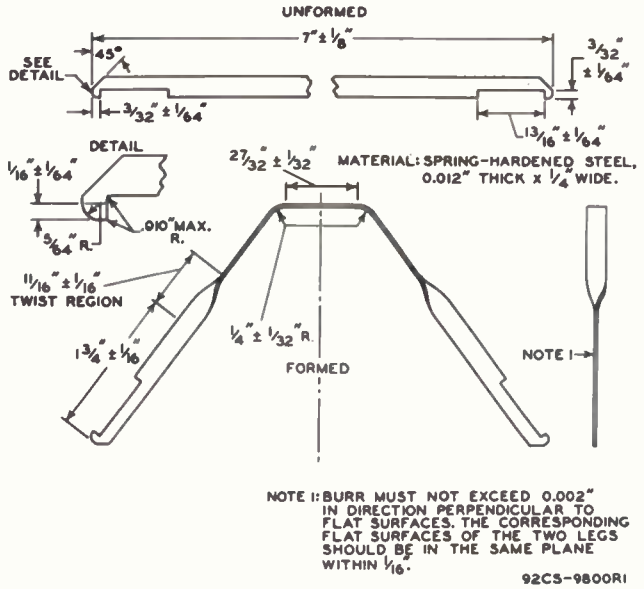
Gauge	Dimension A
G_1-1	.2575" $^{+\ .0000"}_{-\ .0005"}$
G_1-2	.2600" $^{+\ .0000"}_{-\ .0005"}$
G_1-3	.2625" $^{+\ .0000"}_{-\ .0005"}$
G_1-4	.2650" $^{+\ .0000"}_{-\ .0005"}$

Gauge Sketch G_2

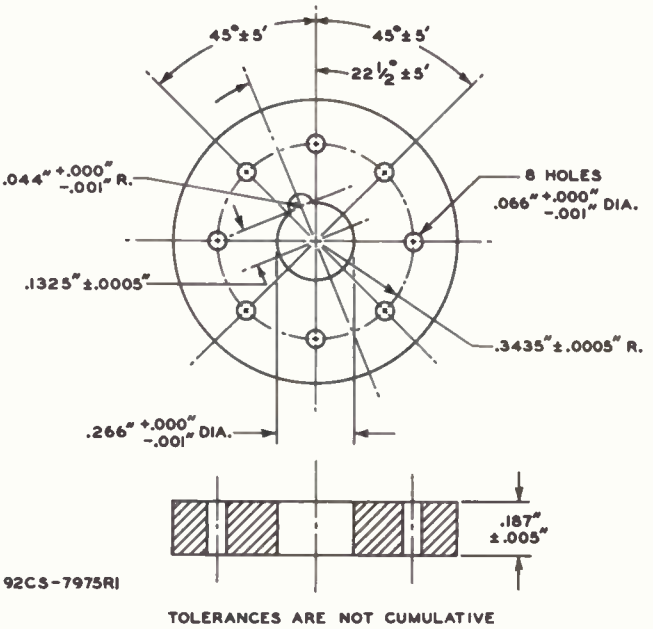


Gauge	Dimension	
	A	B
G_2-1	.2550" $^{+\ .0000"}_{-\ .0005"}$	.125"
G_2-2	.2980" $^{+\ .0000"}_{-\ .0005"}$	none
G_2-3	.3080" $^{+\ .0000"}_{-\ .0005"}$	none

Suggested Design for Extractor to Remove Tube from Cavity



Gauge Sketch G_3



TOLERANCES ARE NOT CUMULATIVE

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.

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.

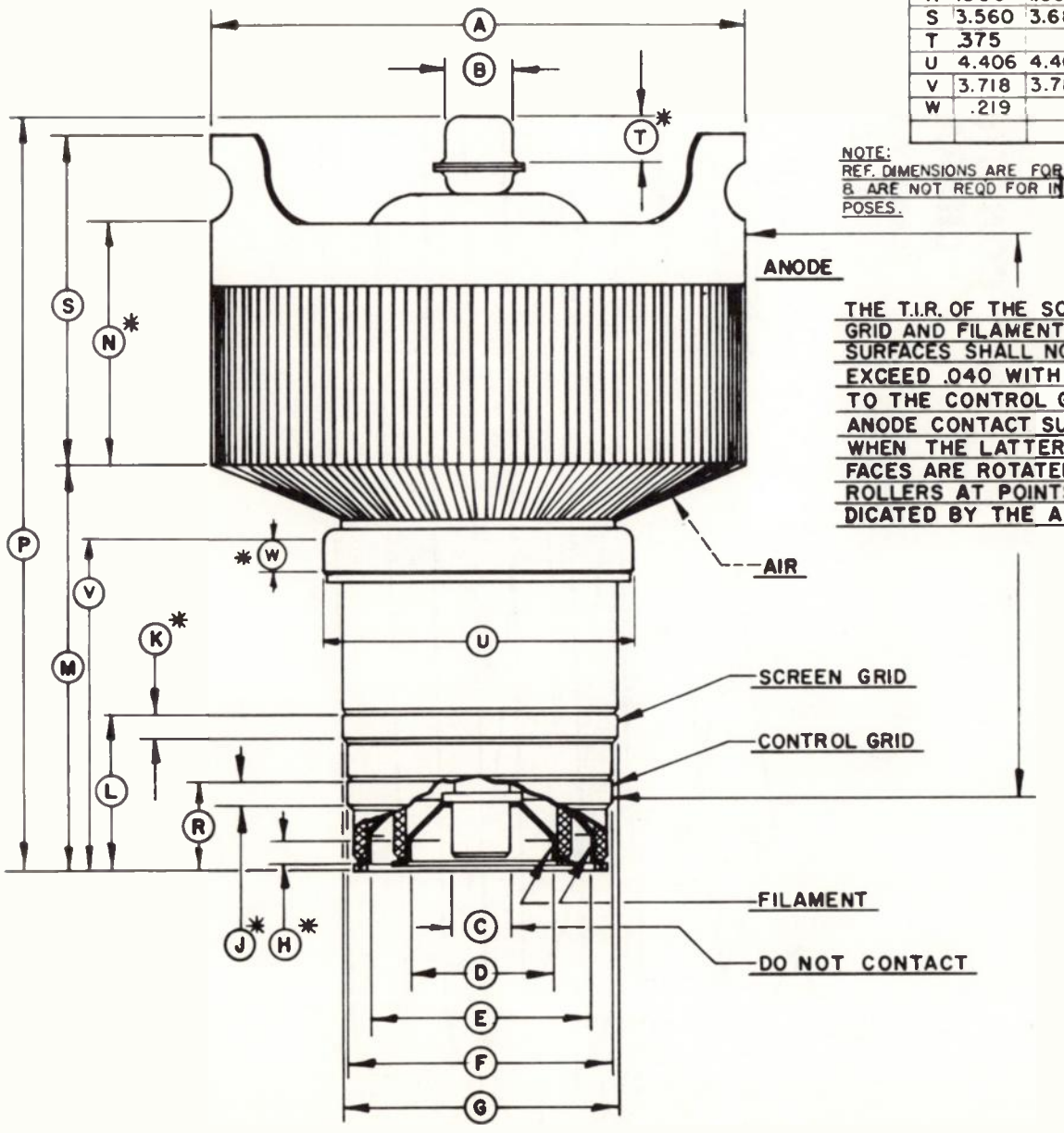
When the 4CX15,000A is operated as a plate-modulated r-f power amplifier, the input power is limited by conditions not connected with the plate efficiency, which is quite high. Therefore, except during tuning there is little possibility that the 10,000 watt maximum plate dissipation rating will be exceeded.

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

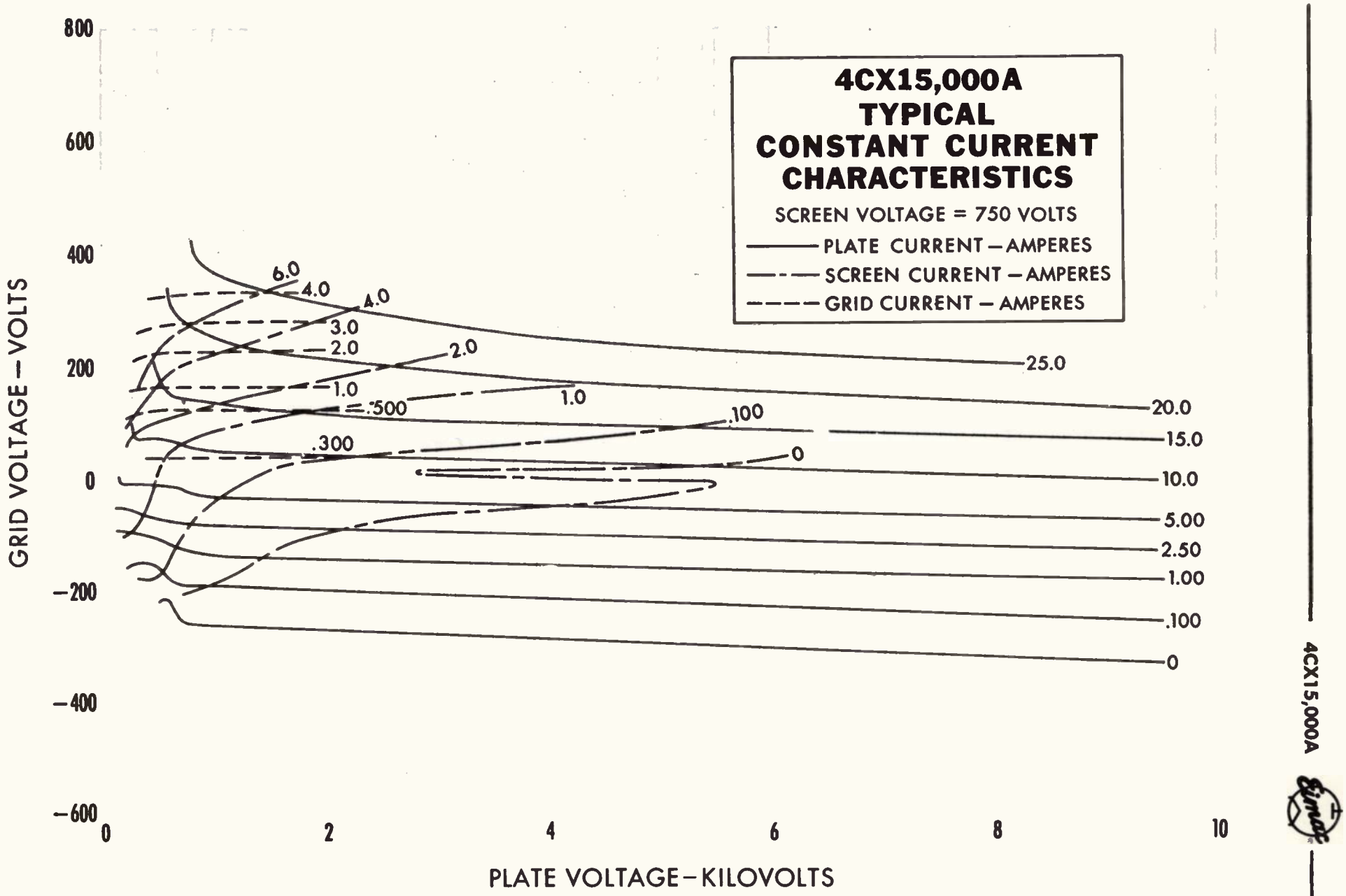
DIMENSIONAL DATA			
DIM	MIN.	MAX.	REF.
A	7.460	7.580	
B	.855	.895	
C	.720	.760	
D	1.896	1.936	
E	3.133	3.173	
F	3.792	3.832	
G	3.980	4.020	
H	.188		
J	.188		
K	.188		
L	1.764	1.826	
M	4.659	4.783	
N	2.412	2.788	
P	9.000	9.375	
R	.986	1.050	
S	3.560	3.684	
T	.375		
U	4.406	4.468	
V	3.718	3.781	
W	.219		

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



* CONTACT SURFACE

4CX 15,000 A


4CX15,000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 750 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE – VOLTS
800
600
400
200
0
–200
–400
–600
0
2
4
6
8
10
PLATE VOLTAGE – KILOVOLTS
6.0
4.0
4.0
3.0
2.0
2.0
1.0
1.0
.500
.100
.300
0
25.0
20.0
15.0
10.0
5.00
2.50
1.00
.100
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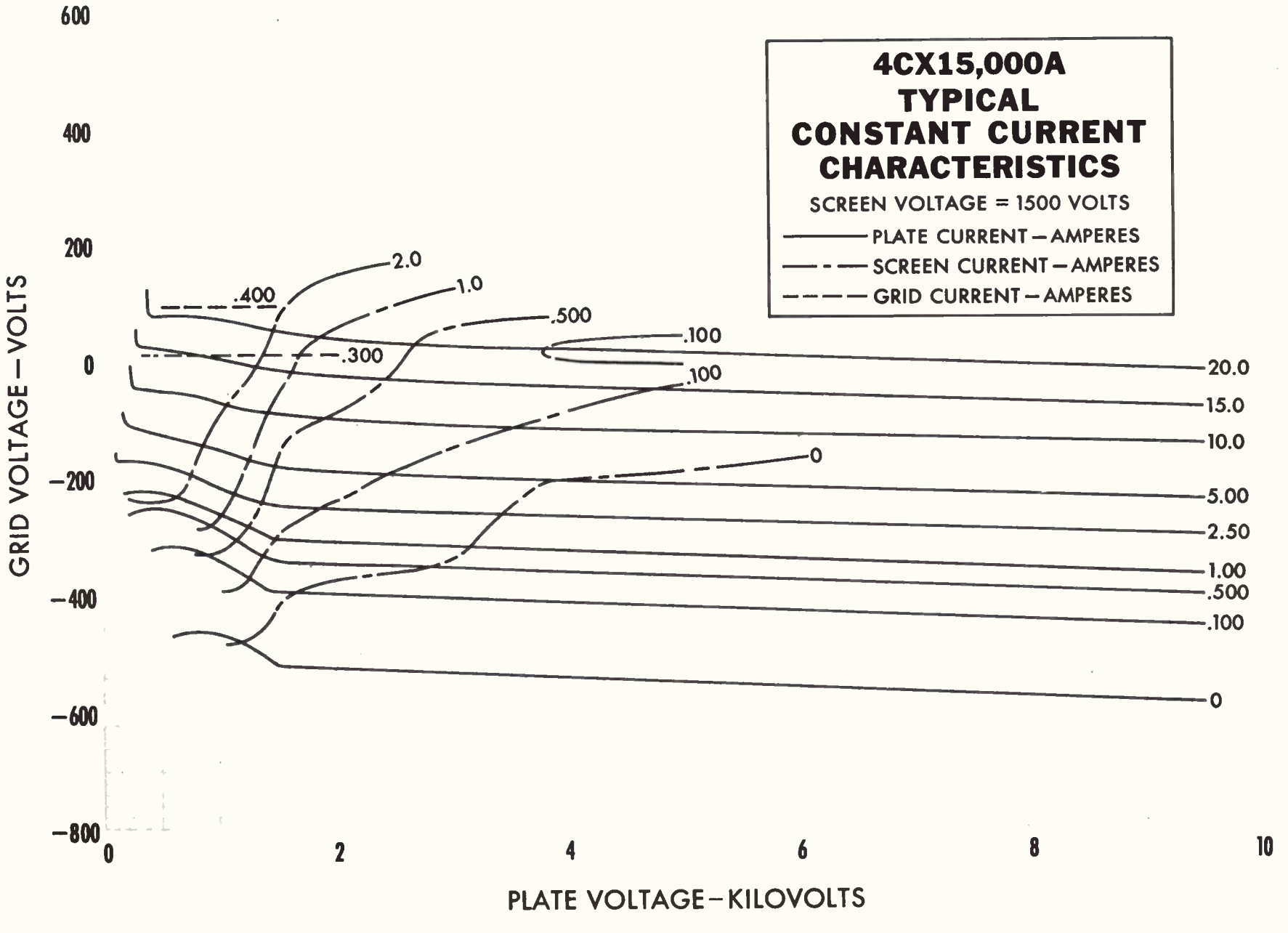

4CX15,000A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE = 1500 VOLTS
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE – VOLTS
600
400
200
0
−200
−400
−600
−800
2.0
1.0
.500
.400
.300
.100
.100
0
20.0
15.0
10.0
5.00
2.50
1.00
.500
.100
0
0
2
4
6
8
10
PLATE VOLTAGE – KILOVOLTS

RCA Technical Bulletin
Maintenance and modification notes on equipment supplied
by RCA Commercial Electronic Systems Division

BTF-20E1
TB-334-3
IB-8027531

February 4, 1972
Page 1 of 2

EXTENDING TUBE LIFE IN FM TRANSMITTERS

Proper attention to the filament voltage of the 4CX5000A/8170, 4CX10,000D/8171 and 4CX15,000A/8281 tubes used in RCA FM broadcast transmitters can result in greatly increased tube life.

Excessive filament voltage causes rapid deterioration of the filament resulting in limited tube life. An Eimac Engineering Newsletter states "Theoretically it is estimated that a 3% increase in filament voltage will result in a 20°K increase in temperature, a 20% increase in peak emission, and a 50% decrease in life due to carbon loss".

Note that at the normal 7.5 volts for the 4CX5000A and 4CX10,000D, this 3% is an increase of only 0.225 volts. The normal 4CX15,000A filament voltage is 6.3 volts.

The newsletter suggests that for "extended life in broadcast and communication service" the filament voltage be 7.2 volts for the 4CX5000A and 4CX10,000D tubes. The list suggests 6.0 volts for the 4CX15,000A. Naturally it is assumed that a voltmeter of sufficient accuracy will be used.

However, many stations have reported to us that when the filament voltage is adjusted to the lowest value that does not limit the power, when the new tube is first installed and is very carefully maintained at that point by regular and careful adjustment of the filament voltage, several extra thousands of hours are obtained.

A further increase in tube life may be realized by using a constant voltage transformer to regulate the filament voltage. This is particularly true where there are line voltage fluctuations such as may be experienced at the top of tall buildings or at the end of long rural lines. The line voltage variations may prevent maintaining the filament voltage at the optimum value. There are a number of satisfactory units available to control these fluctuations of filament voltage. One such satisfactory unit where the line frequency is maintained closely is the "Sola" constant-voltage transformer.

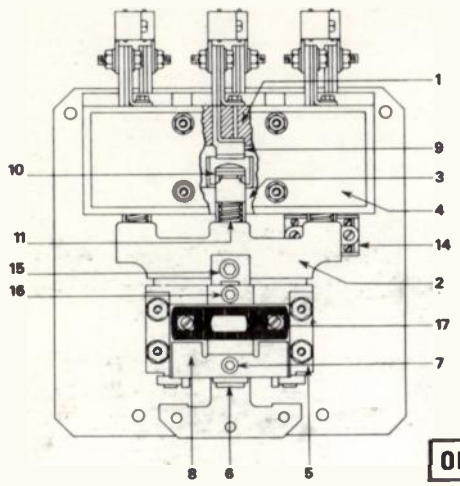
Further, the Sola types listed have sufficient capacity to also handle the bias supply in the present RCA transmitter. The following chart lists the various types for 50 and 60 Hertz.

Tube Type	60 Hz Type	50 Hz Type
4CX5000A or 4CX10,000D	23-25-210	23-25-710
4CX15,000A	23-25-215	23-25-720

Connection instructions are available for using the Sola type constant voltage transformers indicated. Please write to:

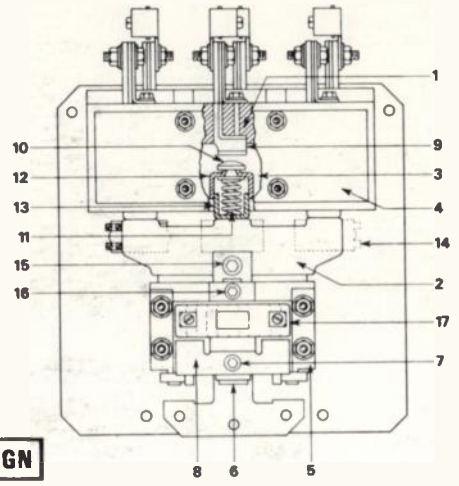
RCA FM Merchandising
RCA Corporation
Building 2-7
Camden, New Jersey 08102
U. S. A.

AC CONTACTORS • SIZE 4



OLD STYLE
(With Contact Spring Exposed)

ORIGINAL DESIGN



NEW STYLE
(With Contact Spring Enclosed)

Item	Description of Part	OLD STYLE			NEW STYLE		
		2 Pole	3 Pole	4 Pole	2 Pole	3 Pole	4 Pole
		Part No.	Part No.	Part No.	Part No.	Part No.	Part No.
1	Contact Block Complete w/Contacts	X-119640	X-119643	[1] X-119640	X-119640	X-119643	[1] X-119640
	Contact Block Less Contacts	F-12962	F-12896	[1] F-12962	F-12962	F-12896	[1] F-12962
2	Cross Bar Complete w/Contacts	[2] NA	[2] NA	[2] NA	X-119612	X-119615	X-119618
	Cross Bar Less Contacts	[2] NA	[2] NA	[2] NA	X-157815	X-157816	X-157817
3	Arc Hood Base	[2] NA	[2] NA	[2] NA	X-117343	X-117342	[1] X-117343
4	Arc Hood Cover	[2] NA	[2] NA	[2] NA	X-119638	X-119639	[1] X-119638
5	Solenoid Assembly	X-146552	X-298371	X-73619	X-146552	X-298371	X-73619
6	Plunger Guide	X-146551	X-70367	X-73616	X-146551	X-70367	X-73616
7	Coil Clamp Assembly	X-182000			X-182000		
8	Coil Clamp (only)	E-10822			E-10822		
9	Stationary Contact w/Terminals	X-74596			X-74596		
	Stationary Contact (only)	X-67541			X-67541		
10	Movable Contact	[2] NA			X-119624		
11	Contact Spring	[2] NA			B-17381		
12	Upper Spring Cup	———			B-17379		
13	Lower Spring Cup	———			B-17380		
14	Auxiliary Switch	[2] NA			See Table Back Page		
15	Cross Bar Screw Assembly	X-225001			X-225001		
16	Plunger Screw Assembly	X-181999			X-181999		
17	Operating Coil	See Table Back Page			See Table Back Page		

[1] Two of these parts used on 4 pole contactors.

[2] If noted parts require replacement, an "old style" contactor (with contact spring exposed) can be converted to the "new style" contactor (with contact spring enclosed) by simultaneously replacing all the noted "old style" parts with corresponding "new style" parts i.e., cross bar complete w/contacts, arc hood cover, arc hood base and auxiliary switch

NA — Not Available.

Renewal Parts List 702-705 — January, 1975
Supersedes Parts List 702-705 Dated June 1, 1961

AUXILIARY SWITCHES

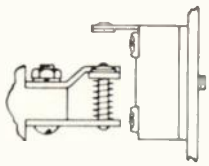


Figure 1

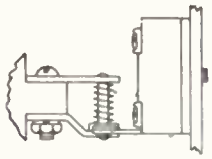


Figure 2

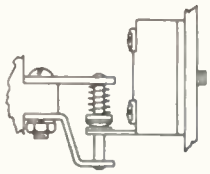


Figure 3

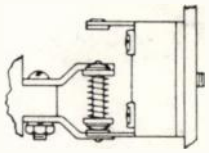


Figure 4

Description of Contact	See Fig.	Part No.
Right Hand Normally Open (Standard and Reduced Travel)	1	Z-8336
Left Hand Normally Open (Standard and Reduced Travel)	1	Z-8337
Right Hand Normally Closed (Standard Travel)	2	Z-8338
Left Hand Normally Closed (Standard Travel)	2	Z-8339
Right Hand Normally Closed (Late Break - Standard Travel)	3	Z-8370
Left Hand Normally Closed (Late Break - Standard Travel)	3	Z-8371
Normally Open and Normally Closed (Used on Right Hand, Left Hand or Middle Position of Contactor)	4	Z-8358

OPERATING COILS

Volts	Hz	Coil Number	Volts	Hz	Coil Number	Volts	Hz	Coil Number	Volts	Hz	Coil Number
110	60	4A01	220	60	4A06	440	60	4A11	550	60	4A16
	50	4A02		50	4A07		50	4A12		50	4A17
	25	4A06		25	4A11		25	4A15		25	4A20

ORDERING INFORMATION – Your order cannot be entered unless the following information is given: Part number, description of part, catalog number and series letter of contactor. This renewal parts list applies also to these contactors when used on control apparatus listed under other Bulletin numbers.

ALLEN-BRADLEY
Industrial Control Division
Milwaukee, Wisconsin 53204

RCA Technical Bulletin

Maintenance and modification notes on equipment supplied by
RCA Communications Systems Division, Camden, New Jersey, 08102

Technical Bulletin Number: TB-FM-1002

August 3, 1979

Subject: Low Power and VSWR Protection Circuitry in RCA BTF-E Line Transmitter

Applicable to:

Transmitter Type	Bulletin Sequence	Transmitter Type	Bulletin Sequence
BTF-5E	10	BTF-40E1	14
BTF-10E	10	BTF-5+5E1	3
BTF-20E	10	BTF-10+10E1	3
BTF-40E	7	BTF-5ES1	1
BTF-5+5E	5	BTF-10ES1	1
BTF-5E1	13	BTF-20ES1	1
BTF-10E1	14	BTF-40ES1	1
BTF-20E1	16	BTF-10+10ES1	1

Over the number of years the BTF-5/10/20 and 40E "line" Transmitters have been in service, there has been some confusion concerning the operation and maintenance of its Low Power and VSWR Protection Circuitry. This circuitry affords positive protection against transmitter damage which can be caused by arcing in the transmitter RF circuits, output transmission line or by a defective antenna.

It is recommended that each operator turn to the applicable Instruction Book of the transmitter and re-read the sections dealing with this protection circuitry.

The protection circuitry is designed to read both the forward power (REFLECTOMETER meter 1M5) and reflected power (VSWR meter 1M7) as sensed by directional coupler 1Z5, and to give protection by removing the transmitter plate and screen voltages in the event that:

1. Power output drops below a preset percentage of licensed power.
2. Transmission line VSWR exceeds a preset value.

The trip points where this circuitry activates are determined by the transmitter operator by setting the adjustable set point markers on the faces of the reflectometer meter 1M5 and reflected power meter 1M7.

REFLECTOMETER switch 1S3 allows the operator to disable temporarily this protection circuitry in order to calibrate reflected power meter 1M7 by switching to CALIBRATE position, and to make routine tuning adjustments to the transmitter by placing the switch in the DISABLE position.

CAUTION:

> After calibration and tuning is carried out, it is mandatory that the reflectometer switch 1S3 be set to NORMAL position and left at this setting except when performing calibration or tuning functions. In any other position of 1S3, the protection circuit is disabled and the transmitter is open to serious damage.

The reflectometer and reflected power meters are optical meter-relay devices consisting of precision D'Arsonval meter mechanisms with a vane or shutter mounted on the meter moving element. At set point, the vane interrupts the light from an internal lamp to a photo-conductive cell. The resulting change in cell resistance is utilized in the control circuitry (including the 1Z6 control module) to achieve the desired protection.

The circuitry is fail safe, i.e. failure of the internal lamp will also shut off the light to the photo-conductive cell and remove transmitter power. If transmitter forward power fails below the set point value in meter 1M5 or if the output transmission line VSWR rises above the set point value in meter 1M7, the optical meter-relay involved activates and operates a relay in control module 1Z6. The transmitter plate and screen voltage will be removed and an over-load status light will be activated until the overload reset push-button switch 1S17 is depressed.

The REFLECTOMETER (carrier-off) circuit can be checked by manually reducing power until the indication on 1M5 reaches approximately the set point (red needle) value, when the normal transmitter overload

sequence should be initiated automatically. Power can be restored as described in the Instruction Book, and transmitter output power readjusted to the licensed power level. VSWR protection circuitry can be checked simply by moving the set point needle to a lower scale position until it reaches approximately the same position as the VSWR indication, when the transmitter overload sequence should be initiated. (This method may not cause overload trip if the normal VSWR is below 1.3:1; see the Instruction Book for the procedure to follow if this occurs).

For normal operation, the VSWR set point position on 1M7 should be set sufficiently above the VSWR reading so that normal day-to-day variations of VSWR do not trip the protection circuit. 1.5:1 is recommended. The set point of the Reflectometer meter relay 1M5 must be between 50% and 70% of the licensed transmitter power output as stated in the Instruction Book for each transmitter. 60% is recommended.

CAUTION:

> It will be particularly noted that the Instruction Book state that the position of REFLECTOMETER switch 1S3 shall be the NORMAL position when not calibrating or tuning the transmitters and that the protection circuitry be checked weekly to be certain the protection is operative.

If in spite of careful and regular maintenance of this Reflectometer and reflected power control circuitry, "nuisance tripping" occurs, do not place switch 1S3 in the DISABLE position because these so called "nuisance trips" are frequently a real indication of otherwise unobserved problems either in the transmitter or in the transmission line and antenna system. Leaving the switch in DISABLE position will leave the transmitter open to extensive damage.

Some causes of tripping of the protection circuits that have been reported are discussed in the following paragraphs. It is suggested that these possible causes be investigated thoroughly, as well as any other symptoms that may be exhibited by the transmitter, if tripping of the protection circuits is occurring.

1. Inspect REFLECTOMETER switch 1S3 for good contact closures. Also, if there are no jumpers between terminals 3 and 4, 4 and 5, and 5 and 6 on deck "C" (farthest from the panel), install them. Without the jumpers, the output power signal to meter 1M5 can be interrupted long enough when 1S3 is rotated, to cause the meter indication to fall below the set point, tripping the low power protection circuit. See the transmitter wiring diagram in the Instruction Book for location of these terminals.

2. Inspect meters 1M5 and 1M7.

   (a) Lamp life is normally in excess of 10,000 hours. To avoid unscheduled downtime due to lamp burn-out, it is suggested that lamps be changed annually on a routine basis. The lamp is available from:

   RCA Corporation
   D&SPD
   2000 Clements Bridge Rd
   Deptford, NJ 08096

   as stock #231545.

   (b) Look for distortion of the meter housing or lamp connections. Inadequate cooling may result from improper installation of the transmitter; heat build-up near the meters could be high enough to cause mechanical distortion and malfunction of the meters. If overheating is suspected, see RCA Technical Bulletin 334-11 on Transmitter Cooling System.

(c) Photocells in 1M5 meter may be faulty. The cell resistance across terminals B and C of connector on the back of the meter should be about 45,000 ohms when the meter indication and the set point are coincident. The cell resistance varies from less than 25,000 ohms when fully illuminated to greater than 750,000 ohms when light is completely cut off. Also check that the connector contacts at the back of 1M5 are clean and free from corrosion. If the cell or meter contacts are defective, the meter should be replaced. See the IB for stock numbers.

(d) Under unusually dusty conditions particularly when combined with high humidity, it is possible over a period of time for the prism that directs light to the photocell inside the 1M5 meter to accumulate a dust film. If this is suspected, the meter should be replaced. The original meter can be returned to the manufacturer for repair, using it as a spare when refurnished.

3. Check the control unit 1Z6 in the transmitter. Check for proper waveforms as shown in the transmitter Instruction Book. Also, it is possible for the SCR's to become defective and cause malfunction of the 1Z6 control unit. Defective parts should be replaced.

4. Occasionally a faulty time delay relay 1K20 will cause the CARRIER OFF status lamp to activate when the PLATE OFF pushbutton is depressed. (The relay may not open fast enough to disarm the protection circuit before the output power drops to the set point). This lamp might be interpreted later as indication of an overload, when in fact none occurred. A replacement relay is available from RCA, Deptford, NJ as stock #243452.

5. Undetermined overload trips can occur as a result of arcing from the terminal of capacitor 1C119 to cabinet ground. 1C119 is the feed-through capacitor for the high voltage lead into the RF box. Other than the trips of the low power protection circuit, there may be no visible indication of this arcing, i.e. no carbon marks on the capacitor. Regular cleaning of this capacitor is recommended on a weekly basis. If cleaning does not eliminate arcing at 1C119, replace the capacitor. The capacitor is available as stock #230419.

6. Faulty diodes in Directional Coupler 1Z5 can cause protection circuit trips. Clean the contact surfaces between the diode and diode socket on a regular basis or replace the diode to clear this problem

7. Poor power line regulation and/or transients on the power line can cause tripping of this protection circuitry. Information on power line transient suppression is available from RCA, CSD, Front & Cooper Streets, Camden, NJ 08102, Attention: W. W. Warren, Building 2-5. Request RCA Drawing #3729279.

8. Do not overlook the distinct possibility that VSWR trips can be caused by a fault in transmission line or antenna. If VSWR trips are suspected to be caused by the transmission line or antenna, they must be tested and inspected for bad joints, broken elements, or other possible sources of intermittent high VSWR.