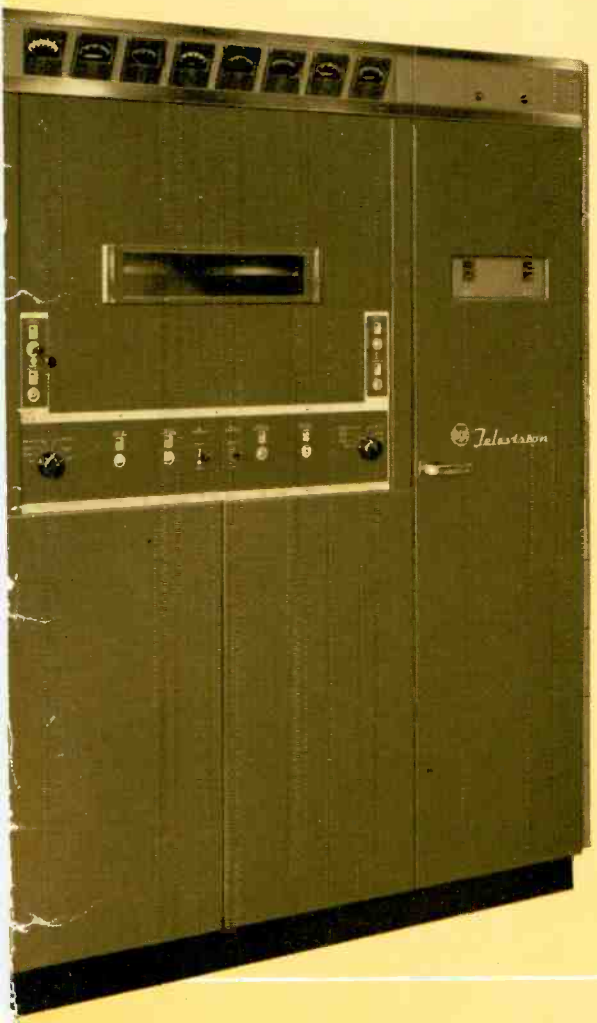


BROADCAST

TRANSMITTING

EQUIPMENT

for

VHF TELEVISION

(FOURTH EDITION)

TV TRANSMITTERS

TRANSMITTER CONSOLES

CRYSTALS

INPUT AND MONITORING

FILTERS

ACCESSORIES

BROADCAST TV TRANSMITTING EQUIPMENT FOR VHF TELEVISION

(Fourth Edition)

PRICE $1.00

RADIO CORPORATION OF AMERICA

ABOUT THIS CATALOG

This catalog provides information on RCA VHF Television Transmitting Equipment. Other RCA Broadcast Equipment Catalogs supply information on TV camera, film, tape, terminal, microwave and audio equipment; also on AM, FM and UHF TV transmitters, antennas, and transmission line.

The information contained in this catalog is intended to serve as a buying guide for the user. Complete specifications and ordering information are supplied. Readers who desire more information or individual bulletins on particular equipment items are invited to write to their RCA Broadcast Representative.

OTHER RCA TECHNICAL PRODUCTS

RCA also manufactures many other electronic products, including: two-way radio and microwave relay communications equipment; optical and magnetic film recording equipment; sound systems of all types; 16mm projectors and magnetic recorders; industrial inspection and automation equipment; scientific instruments, such as the electron microscope; closed-circuit television systems; and many types of custom-built equipment for industry, the military, educational and medical services. Information describing these products may be obtained from RCA Sales Offices in the United States and Canada or internationally from local RCA Distributors or RCA International Division.

PRICES

Domestic prices of the equipment shown in this catalog are provided in a separate price list. Prices are listed in the order in which they are shown in the catalog. To determine the price of any equipment first note the page on which it is shown in the catalog, then consult the price list in accordance with this page number. Equipments are identified by type and MI (Master Item) numbers which are used to identify apparatus on invoices and packing slips. International prices for the various equipment items shown in this catalog are available from your local RCA Distributors or RCA International Division.

HOW TO ORDER

The RCA VHF Television Transmitting Equipment shown in this catalog is sold through RCA Broadcast Representatives, who are familiar with broadcast equipment and related problems. These RCA Representatives are located in convenient offices. Domestic orders for equipment shown in this catalog, or requests for additional information, should be directed to the nearest RCA Sales Office. International Readers are invited to contact their local RCA Distributor or the RCA International Division Office.

RCA TV Transmitters

General Information

RCA VHF and UHF Television Transmitters are the result of over thirty years of continued and concentrated design and research in Television Broadcasting. From its first complete television station in New York City (1929) to present day television, RCA has designed and manufactured equipment for television broadcasting stations around the world. These VHF and UHF Television Transmitters meet FCC and European CCIR Standards. RCA pioneering in UHF Television is evidenced by the large number of UHF commercial stations. In combination with suitable RCA antennas, the complete line of television transmitters can produce Effective Radiated Powers ranging from one hundred watts to one million watts (UHF). Various combinations to achieve these powers are discussed briefly below.

The careful and considered planning of the transmitting equipment for a Television station is one of the first logical steps to be taken after early planning has been completed. Early plans usually involve such considerations as the market to be served, site selection, effective radiated power, antenna height and gain, sources of program material, station policies, personnel and extent of programming, capital investment, future expansion, and the planning of the building.

In general, the planner should consider carefully both his present and future space needs and balance this with his planned expenditure. Usually, the provision of a little extra space will be more than repaid by the ease with which later expansion can be made.

The careful planning and layout of wiring trenches or ducts is essential to every station planner, once the amount of technical equipment has been determined accurately. It is practical to plan "trench runs" to accommodate the future addition of console sections, equipment racks and transmitter cabinets. Typical transmitter and console ductwork diagrams are shown on floor plans, but final building layouts should be prepared only from drawings supplied when equipment is purchased. No attempt is made in RCA literature to illustrate complete station duct layouts. This is deemed a consideration, unique for each station, and is perhaps best jointly solved by the station engineer, a qualified systems consultant, and the TV equipment engineers involved.

Another suggestion is to compare the sizes of doorways to those of individual components to assure entrance of such items as transmitter cubicles and filterplexers.

VHF-ERP Range 100 to 500 Watts

A Type TTL-100AL/AH 100 watt transmitter used with two section super-turnstile antennas will provide Effective Radiated Powers up to 240 watts. The TTL-100AL covers channels 2 through 6 (47-88 mc CCIR) and the TTL-100AH covers channels 7 through 13 (174-223 mc CCIR). This is a combination recommended for satellite and other low power applications. Higher gain antennas may be used for powers in the order of 500 watts.

VHF-ERP Range 500 Watts to 6 KW

The TTL-500AL/AH 500 watt transmitter types cover both low and high band channels. This low cost transmitter is applicable for standby service or permits initial low cost "on air" operation. ERP is determined primarily by transmitter power less line loss multiplied by antenna gain.

VHF-ERP Range 2 to 20 KW

An economical arrangement using a Type TT-2BL/BH Transmitter with a super-turnstile antenna provides Radiated Powers to 20 KW at low cost investment. The small floor space requirements for the TT-2BL/BH make it an ideal transmitter for a combination studio and transmitter operation. The TT-2BL covers channels 2 through 6 (47-88 mc CCIR) and TT-2BH covers channels 7 through 13 (174-223 mc CCIR).

VHF-ERP Range 5 to 70 KW

A Type TT-6AL Transmitter with low or high gain antennas can provide powers to 70 KW on the low VHF channels (47-88 mc CCIR). The TT-6AL is easily converted to a higher powered transmitter by the addition of RCA amplifiers. For channels 7-13 (174-223 mc CCIR), the TT-5BH Transmitter achieves effective radiated power of 5 to approximately 90 KW on any frequency.

VHF-ERP Range 10 to 100 KW

An RCA 11 KW transmitter, when used with a high gain antenna can produce power up to 100 KW ERP. These transmitters are used as the drivers for 25 KW and 35 KW transmitters when it is desired to increase power.

VHF-ERP Range 25 to 316 KW

25 KW Transmitters are available for low and high band VHF channels. When used with the proper gain superturnstile or traveling wave antenna these transmitters can provide radiated powers of over 300 KW.

VHF-ERP Range 50 to 316 KW (Channels 7-13)

With 12-section antennas the Type TT-50DH Transmitter can easily provide the maximum of 316 KW Radiated Power on channels 7 to 13 (174-223 mc CCIR). In addition the TT-50DH provides the superior reliability of parallel operation.

UHF-ERP Range 1 to 50 KW

For cities where UHF channels are available, the TTU-1B and the TTU-2A UHF Transmitters will provide up to 20 KW ERP with standard UHF Pylons and up to 50 KW ERP with RCA custom high gain antennas. The TTU-1B Transmitter is used as a driver for higher powered UHF transmitters and the TTU-2A is the driver for the TTU-10A Transmitter.

UHF-ERP Range 10 to 250 KW

The TTU-10A UHF Transmitter combined with standard UHF antennas is capable of furnishing up to 250 KW ERP.

UHF-ERP Range 25 KW to 1 Megawatt

One megawatt of power can be obtained by using the TTU-25B 25 KW or the TTU-30A 30 KW Transmitter and a high gain UHF antenna. These antennas are provided with pattern shaping to permit the most efficient use of r-f power. A 4:1 ratio low audio TTU-30A-LA Transmitter also is available.

UHF-ERP Range 50 KW to 2 Megawatt

For the ultimate in UHF power the RCA TTU-50A with high gain UHF antennas can provide up to 2 megawatts power on channels 14-83. More powerful UHF transmitters can be supplied on a custom basis.

Summary of RCA Television Transmitters and Amplifiers

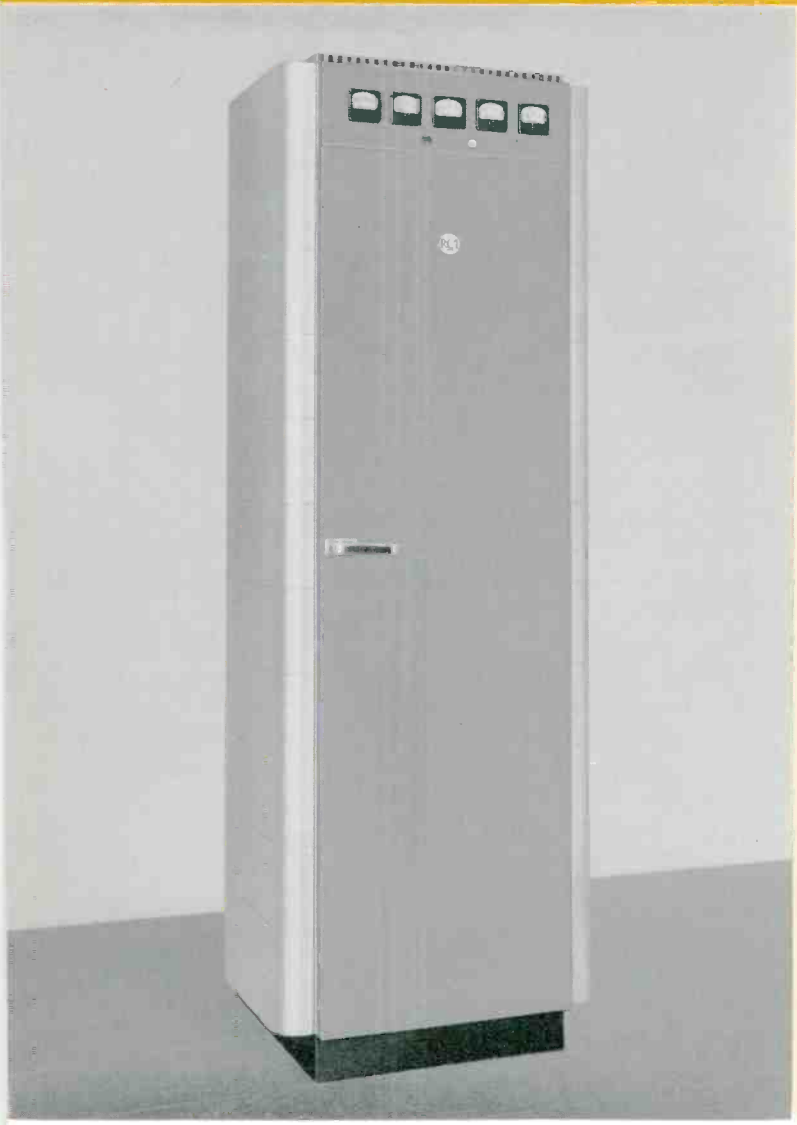
		POWER OUTPUT—KW		AC POWER INPUT REQUIREMENTS			
Type	*Channels*	*Peak Visual*	*Aural*	*Voltage*	*Phase*	*Average Picture (KW)*	*Black Picture (KW)*
TTL-100AL/AH	2-13	0.12	0.65	107/117	1	1.4	1.5
TTL-500AL/AH	2-13	0.5	0.25	107/117	1	1.4	1.5
TT-2BL	2-6	2	1.2	208/230	3	10.0	11.0
TT-2BH	7-13	2	1.2	208/230	3	10.0	11.0
TT-5BH	7-13	5	2.75	208/230	3	16.6	19.0
TT-6AL	2-6	6	3.15	208/230	3	23.2	27.2
TT-11AH	7-13	11	6	208/230	3	34.3	41.1
TT-25DL	2-6	25	7.0	208/230	3	48.0	68.0
TT-25DH	7-13	25	13.6	208/230	3	58.0	78.0
TT-50DH	7-13	50	27.2	208/230	3	116.0	156.0
TTU-1B	14-83	1	0.6	208/230	1	8.6	9.6
TTU-2A	14-83	2	1.2	208/240	3	25.0	30.0
TTU-10A	14-83	10	2.8	208/240	3	63.0	75.0
TTU-12A	14-83	12.5*	7.6*	230	3	66.0	80.0
TTU-25B	14-83	25*	15.0*	460	3	108.0	130.0
TTU-30A-LA	14-83	30	8.5	460	3	132.0	132.0
TTU-30A	14-83	30	17.0	460	3	155.0	155.0
TTU-50B	14-83	50	16.0	460	3	235.0	235.0

More detailed specifications are contained on the pages describing the individual transmitters.

*Varies with Channel —See Rating Chart.

120 Watt VHF TV Transmitter

Type TTL-100AL/AH



FEATURES

- Economical low powered installation for origination or satellite operation
- Housed in single standard audio rack—extremely compact and lightweight
- Designed for unattended operation
- Air cooled tubes used throughout. 4X250B's used in final amplifier. Tubes are easily obtainable, inexpensive and dependable
- Designed for color
- Independent circuits for visual and aural sections of transmitter
- Built-in intercarrier frequency control
- All operating controls accessible from front of unit
- Solid state rectifiers

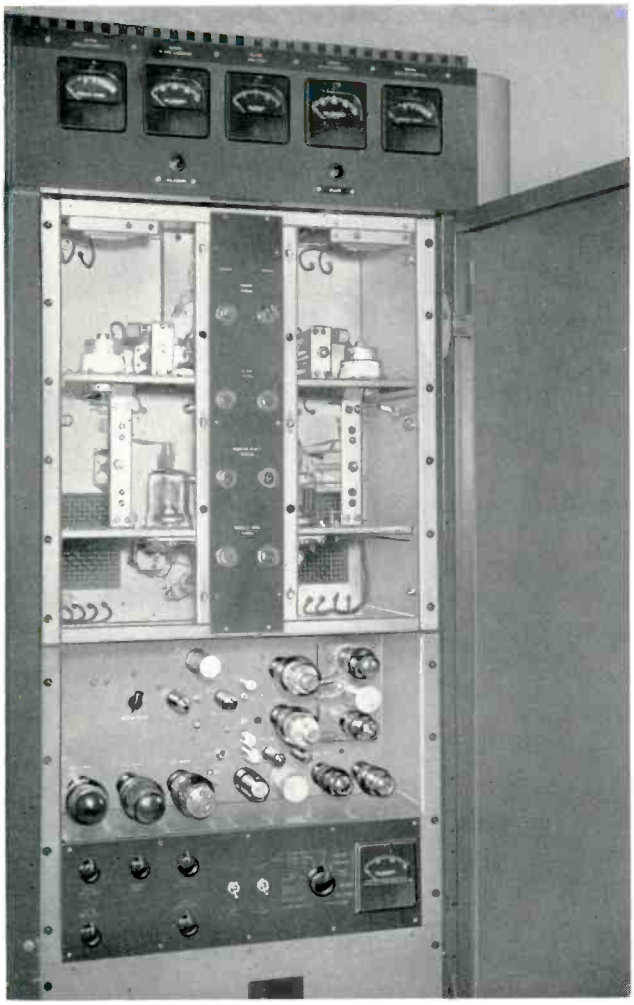
DESCRIPTION

The TTL-100AL/AH is a complete television transmitter, housed in a single audio rack, capable of developing 120 watts peak visual carrier power and 60 watts of aural carrier power on VHF channels 2 to 13. Visual carrier power is rated 100 watts on CCIR standards. It is a low-power equipment for telecasting in either monochrome or color and is designed for unattended operation. The transmitter can be operated with a minimum of attention from maintenance and operating personnel. If desired, the transmitter can be turned on and off remotely by controlling an internal transmitter relay from any convenient location. It provides an economical low power installation for origination of TV programs or for satellite operation.

The TTL-100AL/AH will meet standard FCC color specifications when normal transmitter auxiliaries such as color stabilizing amplifier, video low-pass filter, vestigial sideband filter and phase equalizers are included. Appropriate filters may be purchased to meet CCIR color standards.

The circuits employ latest design features and afford economical operation. Separate amplifier stages are used to amplify the visual and aural carriers, resulting in more efficient operation. Only standard, low-cost tubes, all of which are air-cooled and dependable, have been selected. Plate voltage is furnished by dry selenium rectifiers which are designed for a minimum of 25,000 hours of operation.

The separate amplifier stages used to develop the visual and aural carriers effect a favorable ratio of power input to total r-f power output, and equally important, the cross-



Open view of TTL-100AH VHF TV transmitter showing aural and visual r-f cubicles, and modulator chassis and control panel mounted below.

coupling between aural and visual outputs is held to a low value without the necessity for providing an exorbitant total r-f plate dissipation. Both amplifiers are air-cooled.

Exciter Circuits

The TTL-100AL/AH transmitter is driven by a common exciter containing both visual and aural chains. Accurate control of the separation of visual and aural carrier frequencies is the result of precise engineering circuit design. The visual chain is driven by either one of the two crystal controlled 6AK5 oscillator circuits as a primary source of frequency control. Oscillators may be switched by means of a d-c relay, thus making this circuit adaptable for remote control. The crystals operate at one-twelfth of the output frequency of the exciter. The aural master oscillator is a free-running 6V6 oscillator controlled by a pair of 6V6 reactance tubes which are part of the automatic-frequency control circuit used to maintain the 4.5 mc (5.5 mc CCIR) separation between carriers. An off-frequency interlock prevents uncontrolled frequency operation by cutting off plate voltage to the stages that follow the exciter. The aural master oscillator operates at one-twelfth the output of the exciter.

The automatic frequency control of the aural master oscillator is accomplished by feeding a small amount of energy from the aural and visual oscillator, amplifier or tripler into a 6AS6 mixer tube depending on whether it is a AL or AH unit. When the aural oscillator is on frequency the output of this mixer stage will be one-twelfth of the difference frequency between the aural and visual carriers or 375 kc (or 458.333 kc CCIR). The 375 kc (458.33 kc CCIR) signal mixes with the output of the 6J6 crystal controlled reference oscillator (1500 kc or 1833.33 kc CCIR) in the second 6AS6 mixer stage. The difference frequency is amplified and fed through a chain of three dividers with a total division of 100 to the frequency detector stage. This amount of division is necessary to reduce the swing at the frequency detector so that the carrier will not drop out under any modulation conditions of the aural transmitter. The 6J6 reference oscillator signal is fed through three divider stages with a total division of 80 to the frequency detector stage. By using the 6J6 reference oscillator to excite both the second mixer and the divider chain to furnish a reference frequency, considerable improvement in frequency control accuracy is obtained. Signals from both the difference frequency and the reference frequency chains are fed into the frequency detector. The frequency detector is essentially a balanced modulator with a d-c component in the output which will change polarity depending upon whether the signal frequency is above or below the reference frequency. This d-c voltage is fed back to one of the reactance tubes for the master oscillator in such a way as to correct the frequency of the master oscillator.

Aural Modulator

Frequency modulation is accomplished in the TTL-100-AL/AH exciter by a "direct modulation" process requiring less components, fewer tubes and tube types. This process, which eliminates numerous multipliers and converter stages resulting in low noise and minimum distortion, utilizes two push-pull reactance tubes connected across the frequency determining circuit of the master oscillator. The center frequency of this oscillator is precisely maintained by the automatic frequency control circuit described previously in the exciter description.

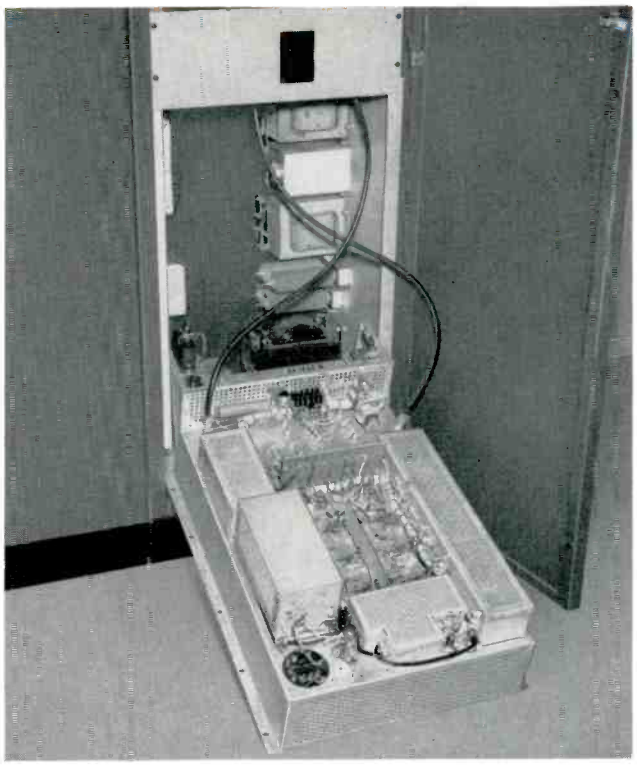
Frequency modulation is obtained by feeding the audio signal into the reactance tubes which are connected across the oscillator plate tank circuit. R-f energy from the oscillator tank is link coupled to a transformer which has a coil in the grid circuit of each reactance tube. R-f voltages on the push-pull connected grids are 180 degrees out of phase with each other and each is 90 degrees out of phase with respect to the r-f voltage at the plates. Thus, across the oscillator tank one tube appears as a capacitive reactance and the other as an inductive reactance.

The magnitude of the reactive plate current in the reactance tubes varies in direct proportion to the value of audio voltage applied to the grids. Therefore, the frequency of the oscillator is varied at an audio rate to furnish the required FM signal. The mean frequency of the oscillator is controlled by varying the grid bias of one of the reactance tubes. This bias voltage is the d-c output voltage of the frequency detector stage of the exciter.

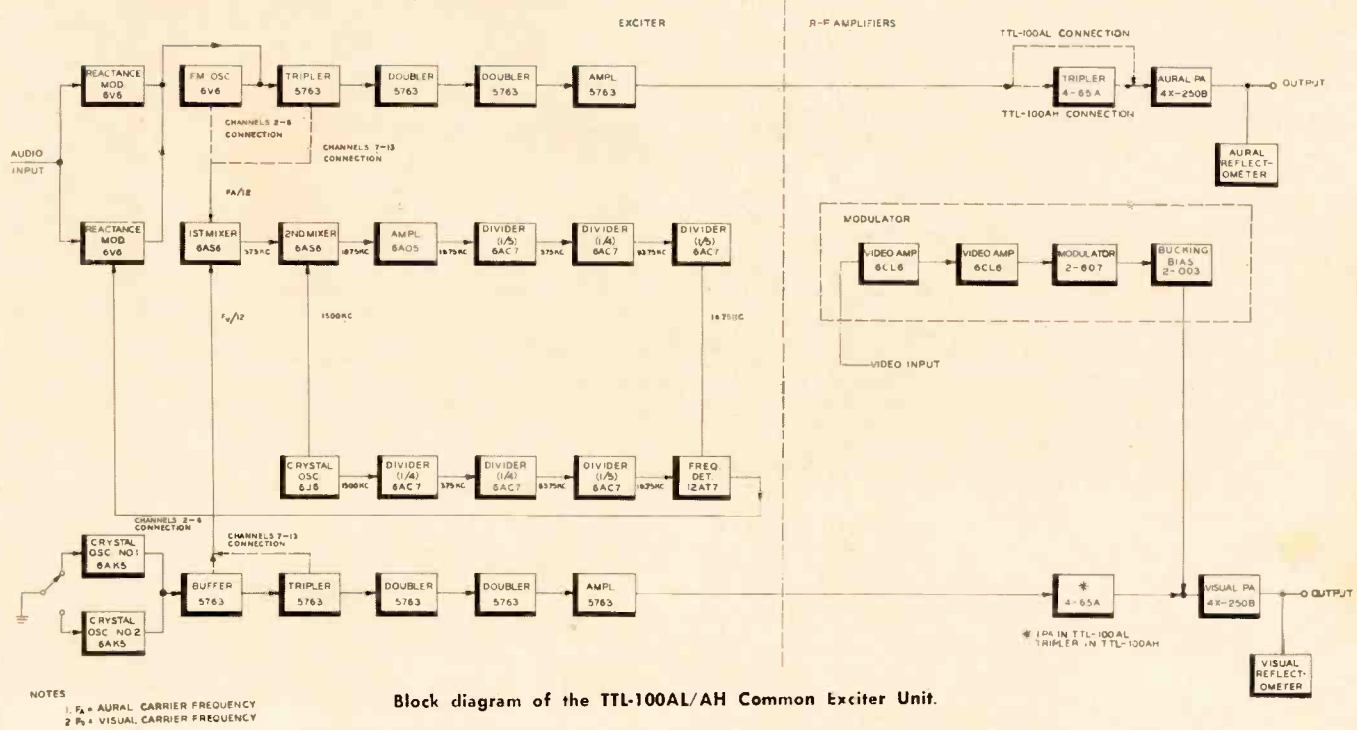
I. P. A. and Modulated Amplifier Stages

The aural and visual outputs of the common exciter are fed to separate 4-65A triplers for channels 7-13 (174-223 mc CCIR). For channels 2-6 (47-88 mc CCIR) the 4-65A stage is omitted on the aural side but is retained on the visual side where it serves as an amplifier. The output of these stages is at carrier frequency and at a power level sufficient to drive the 4X250B amplifier stages which follow. The 4-65A stages are identical, simplifying maintenance and spare part requirements. The 4X250B visual amplifier is grid modulated, and has an output circuit bandwidth suitable for color TV transmission. The aural output stage is also a 4X250B and is conventional throughout. A reflectormeter is included in each transmission line.

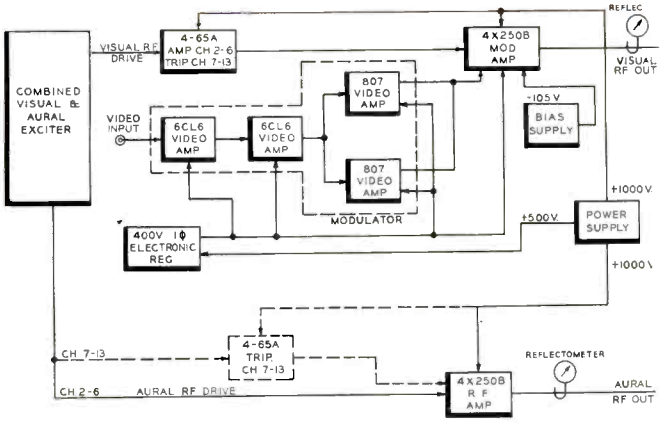
The modulator in the visual portion is a straight-forward three stage video amplifier. The amplitude response, as well as other characteristics such as differential phase, are designed to handle color TV signals.



Aural and visual exciter circuits of the TTL-100AL/AH are mounted on a single hinged chassis allowing access to transformers, filters and other components housed in bottom of transmitter cabinet.



Block diagram of the TTL-100AL/AH Common Exciter Unit.



Simplified block diagram of the TTL-100AL/AH Transmitter.

SPECIFICATIONS

Performance Specifications

	FCC Specs.	CCIR Specs.
Type of Emission:		
Visual	A5	A5
Aural	F3	F3
Frequency Range:		
Visual	Ch. 2-13	47-223 mc
Aural	Ch. 2-13	47-223 mc
Rated Power Output (measured at output fitting):		
Visual	120 watts(peak)	100 watts
Aural	65 watts	60 watts
RF Output Impedance (RG-8/U fitting)	51.5 ohms	51.5 ohms
Input Impedance:		
Visual	75 ohms	75 ohms
Aural	600/150 ohms	600/150 ohms
Input Level:		
Visual	1 volt peak-to-peak min.	0.7 volt peak-to-peak min.
Aural	+10 ±2 dbm	+16 ±2 dbm for 50 kc dev. uniform ±1 db from 50 to 15,000 cyc.
Amplitude vs. Frequency Response:		
Visual	Will meet FCC Color specs. (see note)	Will meet CCIR Color specs.
Aural	Uniform ±1 db to 15 kc	Uniform ±1 db to 15 kc
Carrier Frequency Stability	±1 kc	+.0005%
Modulation Capability:		
Visual	12.5 ±2½%	12.5 ±2½%
Aural	±50 kc	
Audio Frequency Distortion	1.5% 50-100 cps 1.0% 100-1500 cps 1.5% 7500-15,000 cps	1.5% 50-100 cps 1.0% 100-1500 cps 1.5% 7500-15,000 cps
FM Noise Below ±25 kc	—60 db	—60 db
AM Noise:		
Visual	—45 db	—45 db
Aural	—50 db	—50 db
Amplitude Variation Over One Picture Frame	5% of sync peak voltage level	5% of sync peak voltage level
Regulation of Output	7% max.	7% max.

Electrical Specifications

	FCC Specs.	CCIR Specs.
Power Line Requirements:		
Line	107/117 volts, 1 phase, 60 cps.	107/117 volts, 1 phase, 60 cps.
Slow Variations	±5%	±5%
Rapid Variations	±3%	±3%
Power Consumption	1500 watts	1500 watts
P.F. (approx.)	90%	90%
Maximum Altitude	7500 ft.	7500 ft.
Ambient Temperature	0°C-45°C	0°C-45°C

Tube Complement

Type	Function	Qty.
6V6	Reactance Tube Modulator	2
6V6	FM Master Oscillator	1
5763	1st Aural Multiplier	1
5763	2nd Aural Multiplier	1
5763	3rd Aural Multiplier	1
5763	Amplifier—Aural Output	1
6AS6	1st Mixer	1
6AS6	2nd Mixer	1
6AQ5	Amplifier—Difference Frequency	1
6AC7	1st Difference Frequency Divider	1
6AC7	2nd Difference Frequency Divider	1
6AC7	3rd Difference Frequency Divider	1
6J6	Crystal Oscillator—Reference Frequency	1
6AC7	1st Reference Frequency Divider	1
6AC7	2nd Reference Frequency Divider	1
6AC7	3rd Reference Frequency Divider	1
12AT7	Cathode Follower—Frequency Detector Drive	1
6AK5	Visual Crystal Oscillator #1	1
6AK5	Visual Crystal Oscillator #2	1
5763	Buffer Amplifier	1
5763	1st Visual Multiplier	1
5763	2nd Visual Multiplier	1
5763	3rd Visual Multiplier	1
5763	Amplifier—Visual Output	1
OD3	Voltage Regulator	3
4-65A	Visual I. P. A.	1
4-65A	Aural I. P. A. (Channels 7-13 only)	1
4X250B	Modulator and R-F Amplifier	2
6CL6	Video Amplifier	2
807	Modulator	2
OC3	Regulator	2
6SL7-GT	Regulator Amplifier	1
OA2	Regulator	2
6AS7-G	Voltage Regulator	3

Mechanical Specifications

Height	84⅞" (215.5 cm)
Width	28" (71.1 cm)
Depth (less door handle)	20½" (52 cm)
Weight	600 lbs. (approx.) (272.16 kg.)

Equipment Supplied

TTL-100AL Channels 2-6 or CCIR 47-88 mc	ES-19238
TTL-100AH Channels 7-13 or CCIR 174-223 mc	ES-19239

Optional and Accessory Equipment

Complete Set of Spare Tubes (for TTL-100AL)	MI-27835
FCC Spare Set of Tubes (for TTL-100AL)	MI-34412
Complete Set of Spare Tubes (for TTL-100AH)	MI-27836
FCC Spare Set of Tubes (for TTL-100AH)	MI-34413
Monitoring Diode	MI-19051-B
Low Pass Filter (4.75 mc)	MI-27132
Directional Coupler	MI-19396-1
Directional Coupler Line	MI-19396-3A
Reducer, Ungassed 3⅛" to Type "N"	MI-19113-C58
Exciter Modification Kit (CCIR)	MI-34405

Note: Sideband and harmonic filters not furnished as part of transmitter. The transmitter will meet FCC color visual pass band performance specifications when appropriate transmitter color input equipment auxiliaries are included (color stab. amplifier, phase equalizers, etc.)

500 Watt VHF TV Transmitter

Type TTL-500 AL/AH

FEATURES

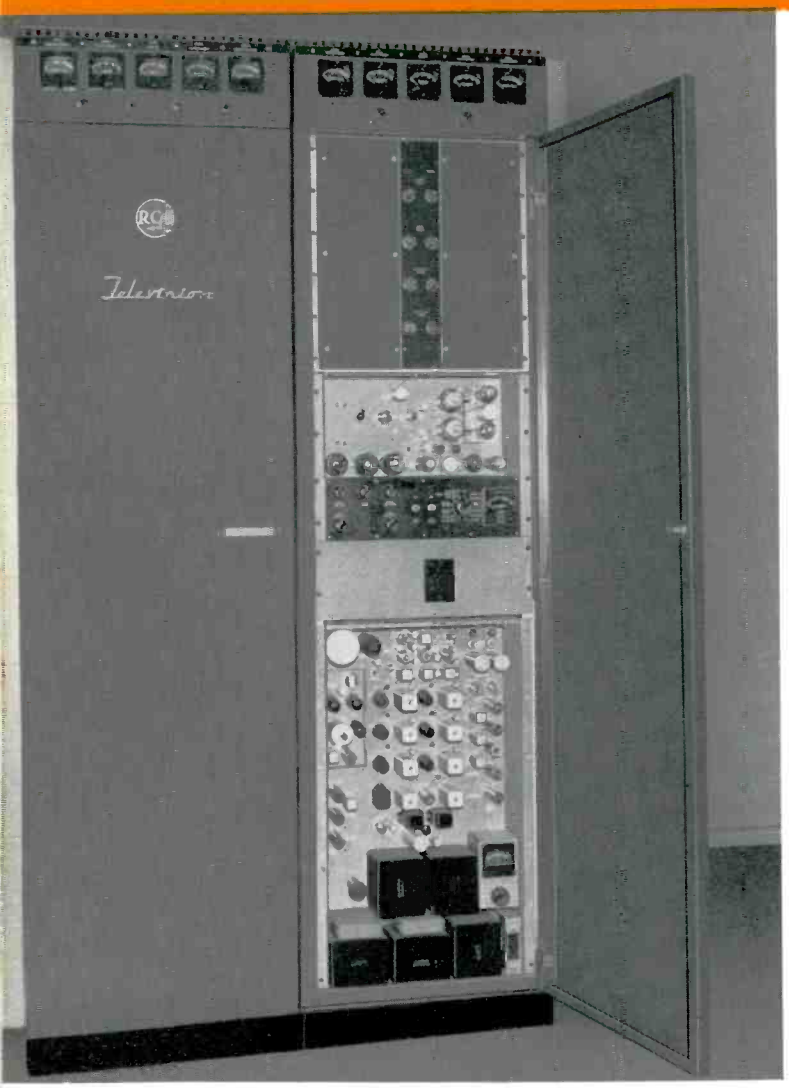
- Economical low powered installation
- Housed in two standard audio racks—extremely compact and lightweight
- Designed for unattended operation
- Air cooled tubes used throughout. 4X500A's used in final amplifier. Tubes are easily obtainable, inexpensive and dependable
- Designed for color
- Independent circuits for visual and aural sections of transmitter
- Built-in intercarrier frequency control
- All operating controls accessible from front
- Solid state rectifiers

DESCRIPTION

The TTL-500AL/AH is a complete television transmitter housed in two audio racks, capable of developing 500 watts peak visual carrier power and 300 watts of aural carrier power on VHF channels 2 to 13 (47 mc-223 mc CCIR). Visual carrier power is rated 400 watts on CCIR standards. It is a new low-power equipment for telecasting in either monochrome or color and is designed for unattended operation. The transmitter can be operated with a minimum of attention from maintenance and operating personnel. If desired, the transmitter can be turned on and off remotely by controlling an internal transmitter relay from any convenient location. It provides an economical low power installation for origination of TV programs. When desired the transmitter can be cut back with appropriate switching equipment to provide an interim output of 120 watts peak visual power and 60 watts aural. The transmitter will meet FCC color specifications when normal transmitter auxiliaries such as color stabilizing amplifier, video low-pass filter, and phase equalizers are included. Appropriate filters may be purchased to meet CCIR color standards.

The equipment is extremely compact and weighs about 1200 pounds (544 kg.). The circuit employs latest design features which permit economical operation. The equipment features standard, low-cost tubes, all of which are air-cooled and dependable. Separate amplifier stages are used to amplify the visual and aural carriers, resulting in more efficient operation.

RCA's TTL-500AL/AH Transmitter is housed in two standard type BR-84 racks and can, if desired, be mounted adjacent to terminal facilities to produce an attractive and matching equipment arrangement. The transmitter is designed for unattended operation. The TTL-500AL/AH is therefore designed for dependable and stable operation for long periods without need for adjustment. By controlling the



TTL-500AL/AH Transmitter with driver cabinet open.

a-c line breaker, an integral transmitter relay, the transmitter may be turned on and off remotely from any convenient location.

Separate amplifier stages are used to develop the visual and aural carriers. As a consequence, a favorable ratio of power input to total r-f power output is achieved, and equally important, the cross-coupling between aural and visual outputs is held to a low value without the necessity for providing an exorbitant total r-f plate dissipation. Both amplifiers are air-cooled. Plate voltage for the transmitter is furnished by dry germanium and selenium rectifiers.

All operating controls are accessible from the front, and ten meters, mounted above the hinged front doors, meter all critical circuits.

Exciter

The TTL-500AL/AH transmitter is driven by a common exciter containing both visual and aural chains. Accurate control of the separation between visual and aural carrier frequencies is the result of precise engineering circuit design. The visual chain is driven by either one of the two crystal controlled 6AK5 oscillator circuits as a primary source of frequency control. Oscillators may be switched by means of a d-c relay, thus making this circuit adaptable for remote control. The crystals operate at one-twelfth of the visual output frequency of the exciter. The aural master oscillator is a free-running 6V6 oscillator controlled by a pair of 6V6 reactance tubes which are part of the automatic-frequency control circuit used to maintain the 4.5 mc (5.5 mc CCIR) separation between carriers. An off-frequency interlock prevents uncontrolled frequency operation by cutting off plate voltage to the stages that follow the exciter. The aural master oscillator operates at one-twelfth the output of the exciter.

The automatic frequency control of the aural master oscillator is accomplished by feeding a small amount of energy from the aural and visual oscillator, amplifier or triplers into a 6AS6 mixer tube depending on whether it is an AL or AH circuit. When the aural oscillator is on frequency the output of this mixer stage will be one-twelfth of the difference frequency between the aural and visual carriers or 375 kc (458.333 kc CCIR). The 375 kc (458.333 kc CCIR) signal mixes with the output of the 6J6 crystal controlled reference oscillator (1500 kc or 1833.33 kc CCIR) in the second 6AS6 mixer stage. The difference frequency is amplified and fed through a chain of three dividers with a total division of 100 to the frequency

View showing high-band driver aural and visual r-f cubicles with modulator chassis and control panel mounted below.

detector stage. This amount of division is necessary to reduce the swing at the frequency detector so that the carrier will not drop out under any modulation conditions of the aural transmitter. The 6J6 reference oscillator signal is fed through three divider stages with a total division of 80 to the frequency detector stage. By using the 6J6 reference oscillator output to excite both the second mixer and the divider chain to furnish a reference frequency, considerable improvement in the frequency control accuracy is obtained. Signals from both the difference frequency and the reference frequency chains are fed into the frequency detector. The frequency detector is essentially a balanced modulator with a d-c component in the output which will change polarity depending upon whether the signal frequency is above or below the reference frequency. This d-c voltage is fed back to one of the reactance tubes for the master oscillator in such a way as to correct the frequency of the master oscillator.

Aural Modulator

Frequency modulation is accomplished in the TTL-500-AL/AH exciter by a "direct modulation" process requiring less components, fewer tubes and tube types. This process, which eliminates numerous multipliers and converter stages resulting in low noise and minimum distortion, utilizes two push-pull reactance tubes connected across the frequency determining circuit of the master oscillator. The center frequency of this oscillator is precisely maintained by the automatic frequency control circuit described previously in the exciter description.

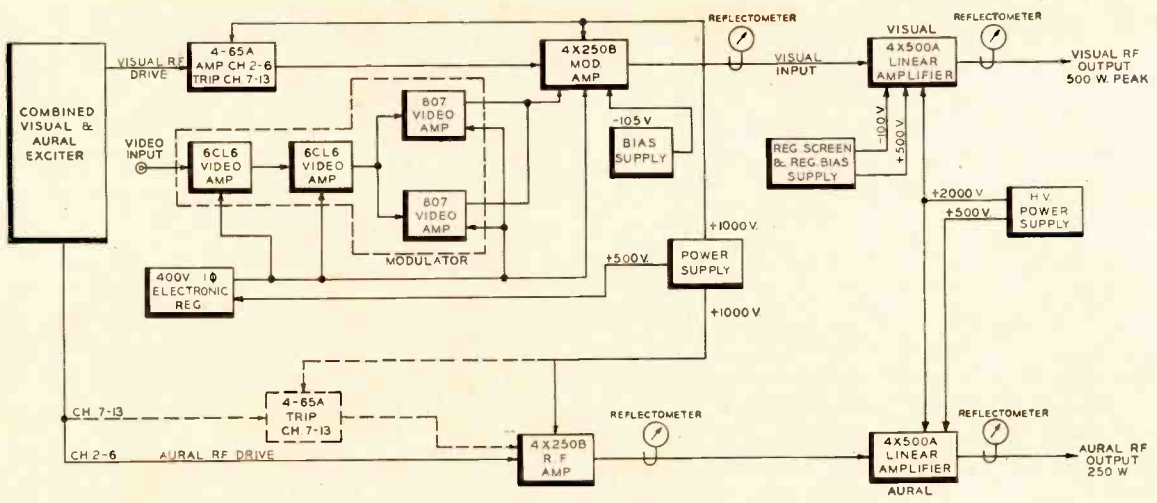
Frequency modulation is obtained by feeding the audio signal into the reactance tubes which are connected across the oscillator plate tank circuit. R-f energy from the oscillator tank is link coupled to a transformer which has a coil in the grid circuit of each reactance tube. R-f voltages on the push-pull connected grids are 180 degrees out of phase with each other and each is 90 degrees out of phase with respect to the r-f voltage at the plates. Thus, across the oscillator tank one tube appears as a capacitive reactance and the other as an inductive reactance.

The magnitude of the reactive plate current in the reactance tubes varies in direct proportion to the value of audio voltage applied to the grids. Therefore, the frequency of the oscillator is varied at an audio rate to furnish the required FM signal. The mean frequency of the oscillator is controlled by varying the grid bias of one of the reactance tubes. This bias voltage is the d-c output voltage of the frequency detector stage of the exciter.

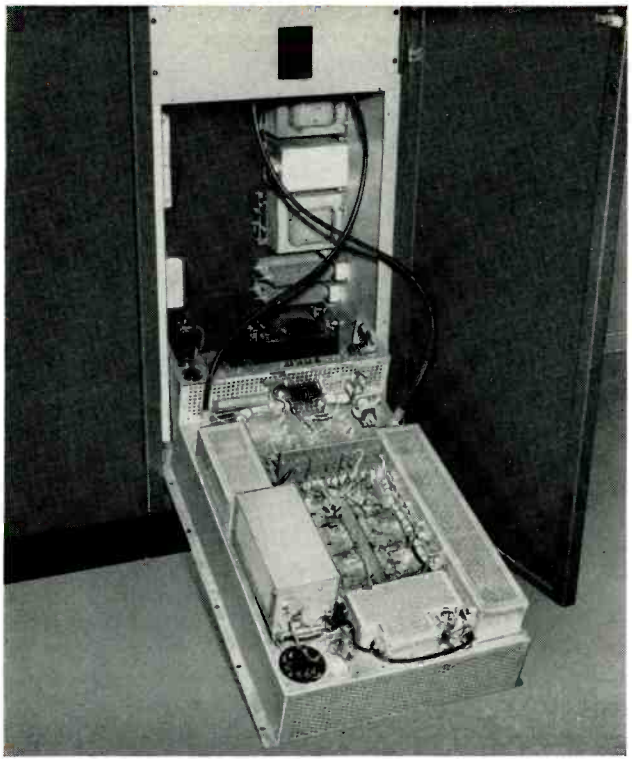
I. P. A. and Modulated Amplifier Stages

The aural and visual outputs of the common exciter are fed to separate 4-65A triplers for channels 7-13 (174 mc-223 mc CCIR). For channels 2-6 (47 mc-88 mc CCIR) the 4-65A stage is omitted on the aural side. On the visual side the 4-65A stage is an amplifier. The output of these stages is at carrier frequency and at a power level sufficient to drive the 4X250B amplifier stages which follow. The 4-65A stages are identical, simplifying maintenance and spare part requirements. The 4X250B visual modulated amplifier is grid modulated, and has an output circuit bandwidth suitable for color TV transmission. The aural driver output stage is also a 4X250B and is conventional throughout. It utilizes many identical parts used on the visual side, again simplifying maintenance and spare part requirements. A reflectometer is included in each transmission line. Both aural and visual driver outputs appear at a standard 51.5 ohm RG-8/U fitting.

Following each 4X250B is a 4X500A in a grounded-grid, grounded-screen linear amplifier circuit. The linear amplifiers are separate and identical, one developing the peak visual power output, the other 300 watts aural power output. Here again a reflectometer is included in each 1⅝" output transmission line. The r-f cabinet, power supplies, control circuitry and blower for the 500 watt amplifier are contained in one BR-84 cabinet, the driver in the other. The modulator in the visual portion is a straight-forward three stage video amplifier. The amplitude response, as well as other characteristics such as differential phase, are designed to handle color TV signals.



Block diagram of the TTL-500AL/AH Transmitter.



Aural and visual exciter circuits of the TTL-500AL/AH are mounted on a single hinged chassis allowing easy access to all components.

SPECIFICATIONS

	FCC Specs.	CCIR Specs.
Type of Emission:		
Visual	A5	A5
Aural	F3	F3
Frequency Range:		
Visual	Ch. 2-13	47-223 mc
Aural	Ch. 2-13	47-223 mc
Rated Power Output (measured at output fitting):		
Visual	500 watts (peak)	400 watts
Aural	300 watts	80 watts
RF Output Impedance (1⅝" fitting)	51.5 ohms	51.5 ohms
Input Impedance:		
Visual	75 ohms	75 ohms
Aural	600/150 ohms	600/150 ohms
Input Level:		
Visual	1 volt peak-to-peak min.	0.7 volt peak-to-peak min.
Aural	10 ±2 dbm	+16 ±2 dbm for 50 kc dev. uniform ±1 db from 50 to 15,000 cyc.
Amplitude vs. Frequency Response:		
Visual	Will meet FCC Color specs (see note)	Will meet CCIR Color specs.
Aural	Uniform ±1 db to 15 kc	Uniform ±1 db to 15 kc
Carrier Frequency Stability*	±1 kc	±1 kc
Modulation Capability:		
Visual	12.5 ±2½%	12.5 ±2½%
Aural	±50 kc	±50 kc
Audio Frequency Distortion	1.5% 50-100 cps 1.0% 100-7500 cps 1.5% 7500-15,000 cps	1.5% 50-100 cps 1.0% 100-7500 cps 1.5% 7500-15,000 cps
FM Noise Below ±25 kc	−60 db	−60 db
AM Noise:		
Visual	−45 db	−45 db
Aural	−50 db	−50 db

	FCC Specs.	CCIR Specs.
Amplitude Variation Over One Picture Frame	5% of sync peak voltage level	5% of sync peak voltage level
Regulation of Output	7% max.	7% max.

Electrical and Mechanical Specifications

Power Line Requirements:		
Line	208/230 volts 1 phase, 60 cps	208/230 volts 1 phase, 60 cps
Slow Variations	±5%	±5%
Rapid Variations	±3%	±3%
Power Consumption	3000 watts	3000 watts
P.F. (approx.)	90%	90%
Maximum Altitude	7500 ft.	7500 ft.
Ambient Temperature	0°C-45°C	0°C-45°C

Dimensions (overall) ..... 84⅞" high, 50" wide, 20½" deep (215.5 cm high, 127 cm wide, 52 cm deep)

Weight ..... 1200 lbs. (approx.) (544 kg.)

Tube Complement

Type	Function	Qty.
6V6	Reactance Tube Modulator	2
6V6	FM Master Oscillator	1
5763	1st Aural Multiplier	1
5763	2nd Aural Amplifier	1
5763	3rd Aural Amplifier	1
5763	Amplifier—Aural Output	1
6AS6	1st Mixer	1
6AS6	2nd Mixer	1
6AQ5	Amplifier—Difference Frequency	1
6AC7	1st Difference Frequency Divider	1
6AC7	2nd Difference Frequency Divider	1
6AC7	3rd Difference Frequency Divider	1
6J6	Crystal Oscillator—Reference Frequency	1
6AC7	1st Reference Frequency Divider	1
6AC7	2nd Reference Frequency Divider	1
6AC7	3rd Reference Frequency Divider	1
12AT7	Cathode Follower—Frequency Detector Drive	1
6AK5	Visual Crystal Oscillator #1	1
6AK5	Visual Crystal Oscillator #2	1
5763	Buffer Amplifier	1
5763	1st Visual Multipler	1
5763	2nd Visual Multiplier	1
5763	3rd Visual Multiplier	1
5763	Amplifier—Visual Output	1
OD3	Voltage Regulator	3
4-65A	Visual I. P. A.	1
4-65A	Aural I. P. A. (Channels 7-13 only)	1
4X250B	Modulator and R-F Amplifier	2
6CL6	Video Amplifier	2
807	Modulator	2
6SL7-GT	Regulator Amplifier	1
OA2	Regulator	2
6AS7-G	Voltage Regulator	3
OC3	Regulator	2
4X500A	R-F Amplifiers	2
5R4GY	Screen Rectifier	1
6X4	Bias Rectifiers	2
6080	Screen Regulator	1
6BL7-GT	Bias Regulator	1
6AU6	Regulator Amplifiers	2
OC3	Regulators	4
OD3	Regulator	1

Equipment Supplied

TTL-500AL Channels 2-6 or CCIR 47-88 mc ES-27259

TTL-500AH Channels 7-13 or CCIR 174-223 mc ES-27260

Optional and Accessory Equipment

Complete Set of Spare Tubes (for TTL-500AL) MI-27850/27835

FCC Set of Spare Tubes (for TTL-500AL) MI-34411/34412

Complete Set of Spare Tubes (for TTL-500AH) MI-27850/27836

FCC Set of Spare Tubes (for TTL-500AH) MI-34411/34413

Note: Sideband and harmonic filters not furnished as part of transmitter. The transmitter will meet FCC and CCIR color visual pass band performance specifications when appropriate transmitter color input equipment is included.

2 KW VHF TV Transmitter

TYPE TT-2BL/BH

Type-2BL Transmitter

FEATURES

- Designed for color—linearity correction circuits built into modulator
- New compact, floor-saving cabinet design —yet offering excellent accessibility to all components
- Single ended r-f circuits reduce number of tubes and circuit components
- Power increase possible with minimum change to existing equipment
- New common visual and aural exciter includes inter-carrier frequency control which accurately maintains frequency separation between aural and visual carriers
- Complete overload protection with indication lights grouped for quick location of faulty circuits
- Sloping illuminated meter panel
- Thermostatically controlled heaters provided for rectifier tubes allow operation at low ambient temperatures

DESCRIPTION

The TT-2BL/BH VHF Television Transmitter is designed for television stations with effective radiated power requirements ranging from 2 to 36 kilowatts. This economical, low-power transmitter will provide adequate signal strength to meet the wide range of television broadcast requirements either in color or monochrome. It is designed for operation on any channel from 2 through 13 or 47-223 mc on CCIR standards and works equally well with both RCA low and high gain type antennas.

Where remote control is authorized for television transmitters, the TT-2BL/BH can, with the addition of suitable terminal equipment, be operated from a remote location over a single telephone line. All the necessary operating functions such as starting and stopping the transmitter, resetting overloads, switching in the spare crystal oscillator or spare exciter, metering all power circuits and reflectometers, controlling power output (including black level, video gain, and excitation) can be performed at the remote location. Even when the transmitter is not remotely controlled, these built-in features make it very easy to obtain fingertip control of the transmitter from a single local position such as the transmitter console.

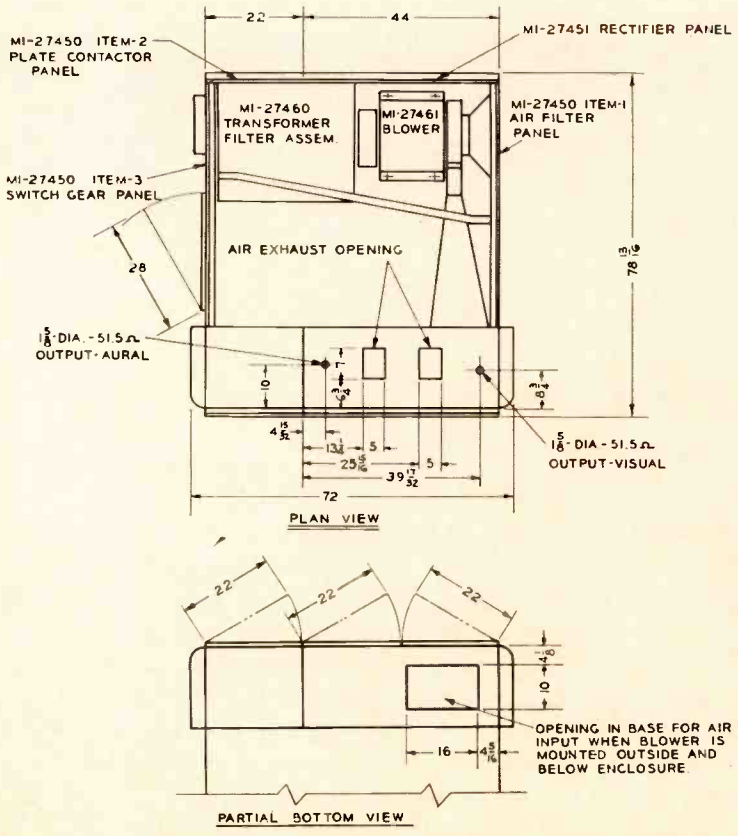
GENERAL DESCRIPTION

The RCA Type TT-2BL/BH VHF Television Transmitter is designed to conform with all FCC, CCIR and EIA standards. It will provide a nominal power output of 2 kilowatts or 1.8 kw CCIR peak visual power as measured at the output of the sideband filter or filterplexer and 1.05 kw aural power.

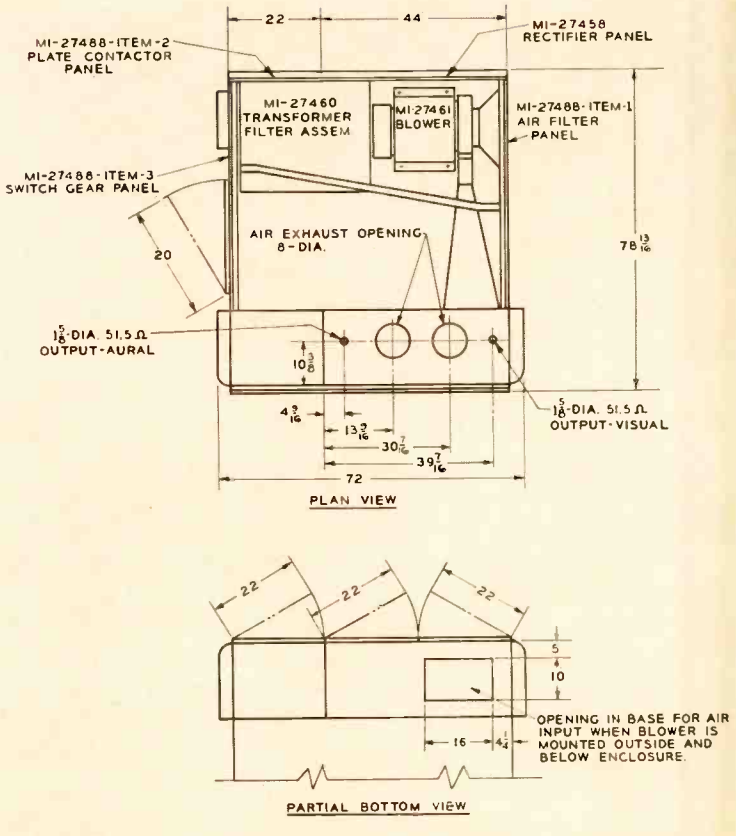
The transmitter is housed in a newly-styled cabinet having only one access door. The cabinet can be broken down for shipping into racks and panels of varying size for easy handling. The entire equipment is compact, easily accessible, and requires a minimum of floor space. All r-f circuits and control circuits are located at the front of the enclosure. The rectifier tubes are mounted on the rear wall and the heavy power components are mounted on the floor. The control unit is at the left front corner of the transmitter in a separate cabinet with status lights grouped on a panel above the door. The auxiliary switches, breakers, overload and auxiliary relays, etc. are in the control unit behind a non-interlocked door. Overload indicating lights for all the circuits of the transmitter are grouped on a single strip so they can be seen through the window in the door.

To the right of the control unit is the r-f rack. It contains the aural and visual r-f power stages, the exciter and modulator units. The modulator and exciter units are located at the bottom of the rack behind dutch doors, and are hinged at the bottom to facilitate servicing from the front of the transmitter. All important meters of the TT-2BL/BH are mounted in a sloping panel at the top of the r-f rack. Built in lights in the bottom of the meter panel provide illumination. Tuning controls for the high level stages are located just above the doors. These include all the tuning controls required for broadbanding the visual r-f circuits. Tuning controls are operated by a crank which is removable to prevent accidental misadjustment of the circuits during operation. Easily read counter dials make possible accurate logging of all the circuits. Also located on the panel above the doors are all the operating controls such as the transmitter start switch, plate switch, power operating controls and metering switches.

A single access door on the left end of the transmitter provides access to the rear of the control rack and r-f rack as well as the rectifier mounted on the rear wall of the enclosure. These rectifiers have thermostatically controlled heaters for the rectifier tubes which permit operation of the



Typical floor plan for the TT-2BL VHF Transmitter showing compact equipment unit and rectifier enclosure.



Typical floor plan for the TT-2BH VHF Transmitter showing accessible floor-saving cabinet design.

transmitter in ambient temperatures as low as 0 degrees C. All heavy units such as the plate transformers and large reactors are mounted on a base plate on the floor.

Since all operating controls and important adjustments are brought out to the front of the transmitter, it should not be necessary to enter the enclosure while power is on. Every precaution has been taken to insure the operator's safety when it is necessary to enter the enclosure for routine maintenance and service. In addition to the conventional plate interlock and high voltage grounding switches, the high voltage plate transformer disconnect switch is fitted with a long handle which extends across the door opening. This makes it difficult to enter the enclosure without opening the primary of the high voltage transformer. The versatility of the new transmitter cabinets may be seen in the floor plan shown.

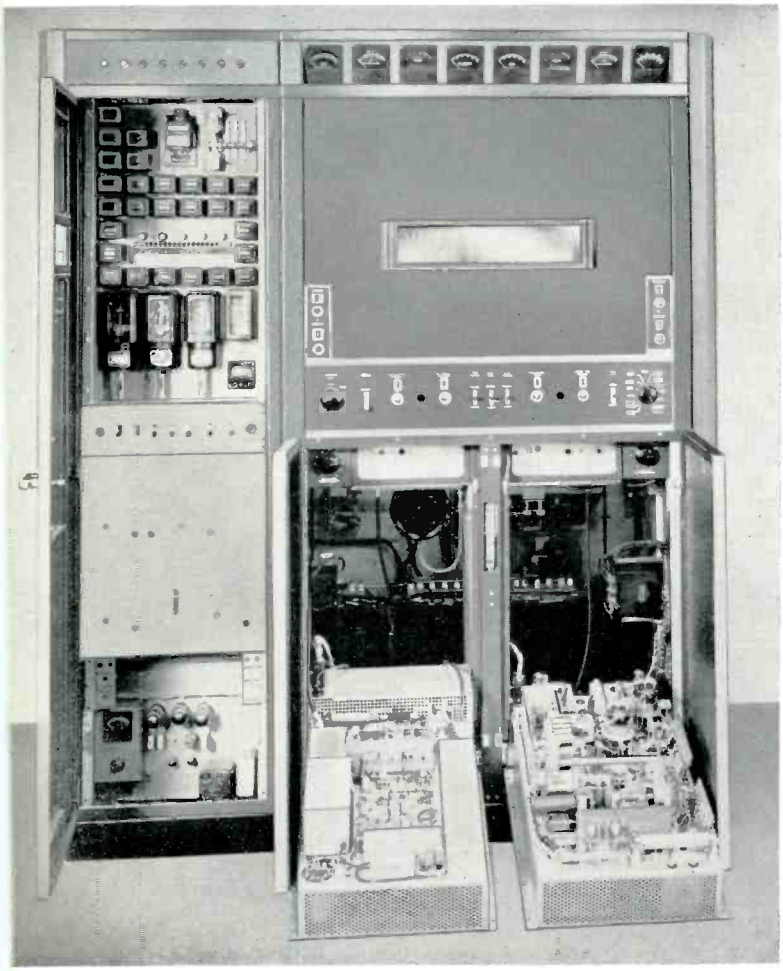
Exciter Circuit

The TT-2BL transmitter is driven by a common exciter containing both visual and aural chains. Accurate control of the separation of visual and aural carrier frequencies is the result of precise engineering circuit design. The visual chain is driven by either one of the two crystal controlled 6AK5 oscillator circuits as a primary source of frequency control. Oscillators may be switched by means of a d-c relay, thus making this circuit adaptable for remote control. The TT-2BL crystals operate at one-twelfth and the TT-2BH at one-thiry-sixth the visual carrier frequency and one-twelfth of the output frequency of the exciter. The aural master oscillator is a free-running 6V6 oscillator controlled by a pair of 6V6 reactance tubes which are part of the automatic-frequency control circuit used to maintain the 4.5 mc (or 5.5 mc CCIR) separation between carriers. An off-frequency interlock prevents uncontrolled frequency operation by cutting off plate voltage to the stages that follow the exciter.

The aural master oscillator of the TT-2BL operates at one-twelfth of the carrier frequency and that of the TT-2BH at one-thirty-sixth of the carrier frequency with the output of the exciter being one-third the carrier frequency.

In the TT-2BL automatic frequency control of the aural master oscillator is accomplished by feeding a small amount of energy from the aural oscillator and visual crystal oscillator amplifier stage into a 6AS6 mixer tube. In the TT-2BH the automatic frequency control of the aural master oscillator is accomplished by feeding the energy from the aural and visual triplers into a 6AS6 mixer tube. In both transmitters when the aural oscillator is on frequency the output of this mixer stage will be one-twelfth of the difference frequency between the aural and visual carriers or 375 kc (458.333 kc CCIR). The 375 kc (458.333 kc CCIR) signal mixes with the output of the 6J6 crystal controlled reference oscillator (1500 kc or 1833.33 kc CCIR) in the second 6AS6 mixer stage. The difference frequency is fed through a chain of three dividers with a total division of 100 to the frequency detector stage. This amount of division is necessary to reduce the swing at the frequency detector so that the carrier will not drop out under any modulation conditions of the aural transmitter. The 6J6 reference oscillator signal is fed through three divider stages with a total division of 80 to the frequency detector stage. By using the 6J6 reference oscillator output to excite both the second mixer and the divider chain for reference frequency, considerable improvement in frequency control accuracy is obtained. Signals from both the difference frequency and the reference frequency chains are fed into the frequency detector. The frequency detector is essentially a balanced modulator with a d-c component in the output which will change polarity depending upon whether the signal frequency is above or below the reference frequency. This d-c voltage is fed back to one of the reactance tubes for the master oscillator in such a way as to correct the frequency of the master oscillator.

Front view of the TT-2BH Transmitter with control cabinet door open, and exciter and modulator units on accessible hinged chassis lowered to facilitate servicing.

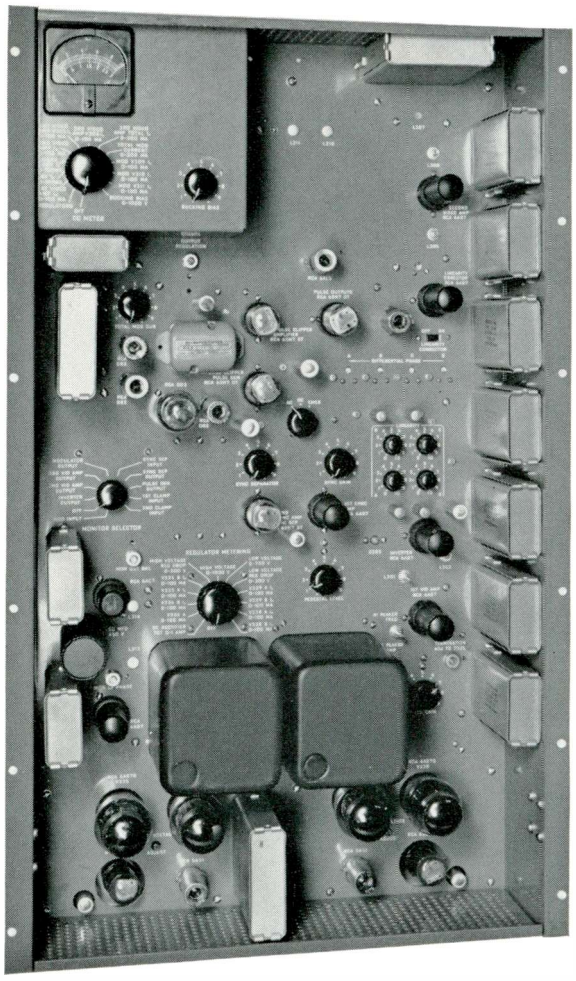


R-F Circuits

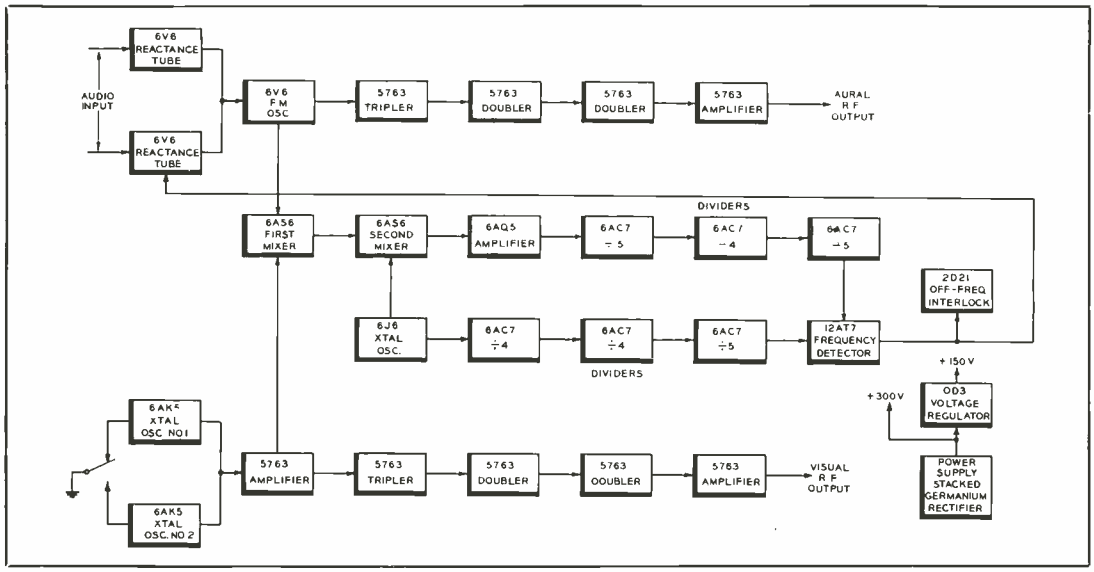
The r-f circuits employ a chain of amplifiers. In the visual chain of the TT-2BL, a 4-65A tube and a 4-250A tube operating in cascade drive a type 6076 grid modulated power amplifier. The TT-2BH employs two 7034 tubes for the same purpose. The aural chain consists of two stages: a 4-65A and a 4-1000A tube in the TT-2BL and a 7034 and 6076 tube in the TT-2BH, both operating as class "C" amplifiers. Excitation control of the visual modulated amplifier is accomplished by varying the screen voltage on the second visual amplifier stage. Power output of the aural transmitter is adjusted by varying the screen voltage on the second aural amplifier stage. Both these controls are operated by motors and therefore can be adjusted from a remote position.

Video Modulator

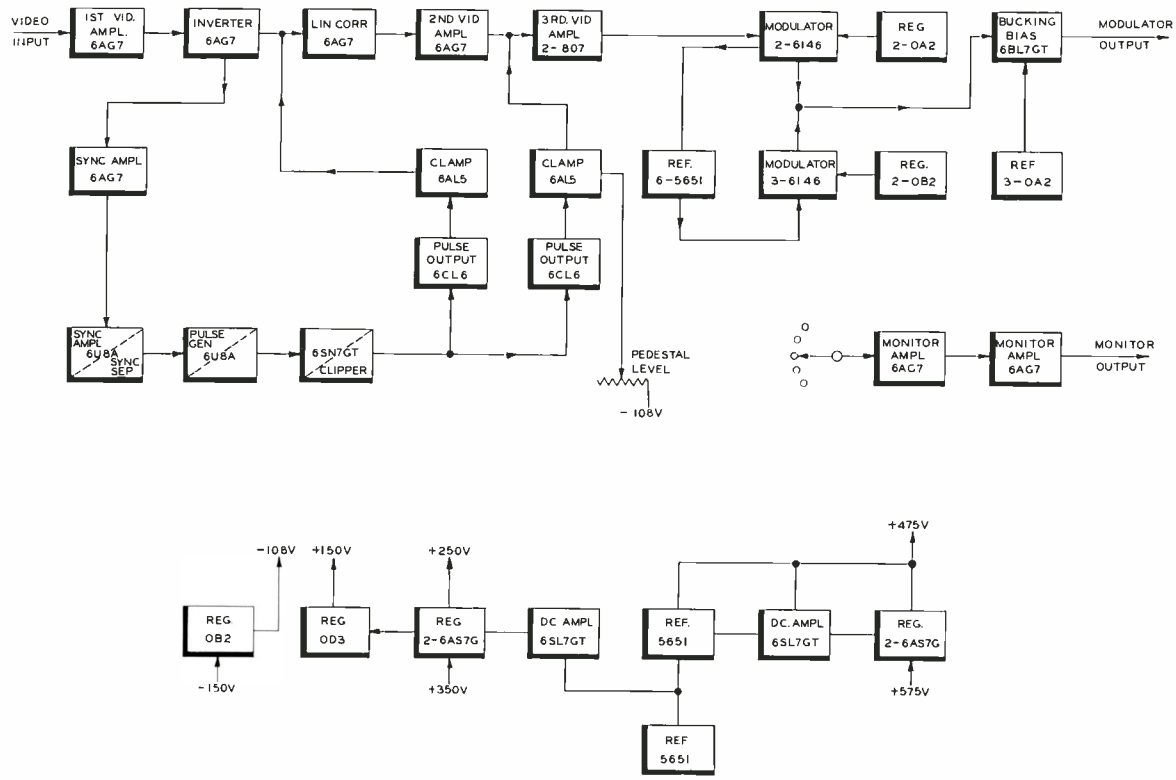
The modulator of the transmitter is designed to take a standard 0.7 volt video signal and amplify it sufficiently so that it can grid modulate the 6076 stage. This requires about 220 volts peak-to-peak from the modulator. The first stage of the modulator is a conventional shunt-series peaked video amplifier. This is followed by an inverter stage and a linearity corrector stage each of which has a gain of approximately one. The linearity corrector is designed to pre-distort the signal to compensate for the non-linearity which occurs in a grid modulated stage, and takes the form of four diodes connected in the cathode



TT-2B Modulator Chassis



Block diagram showing combined aural and visual exciter for the TT-2BL.



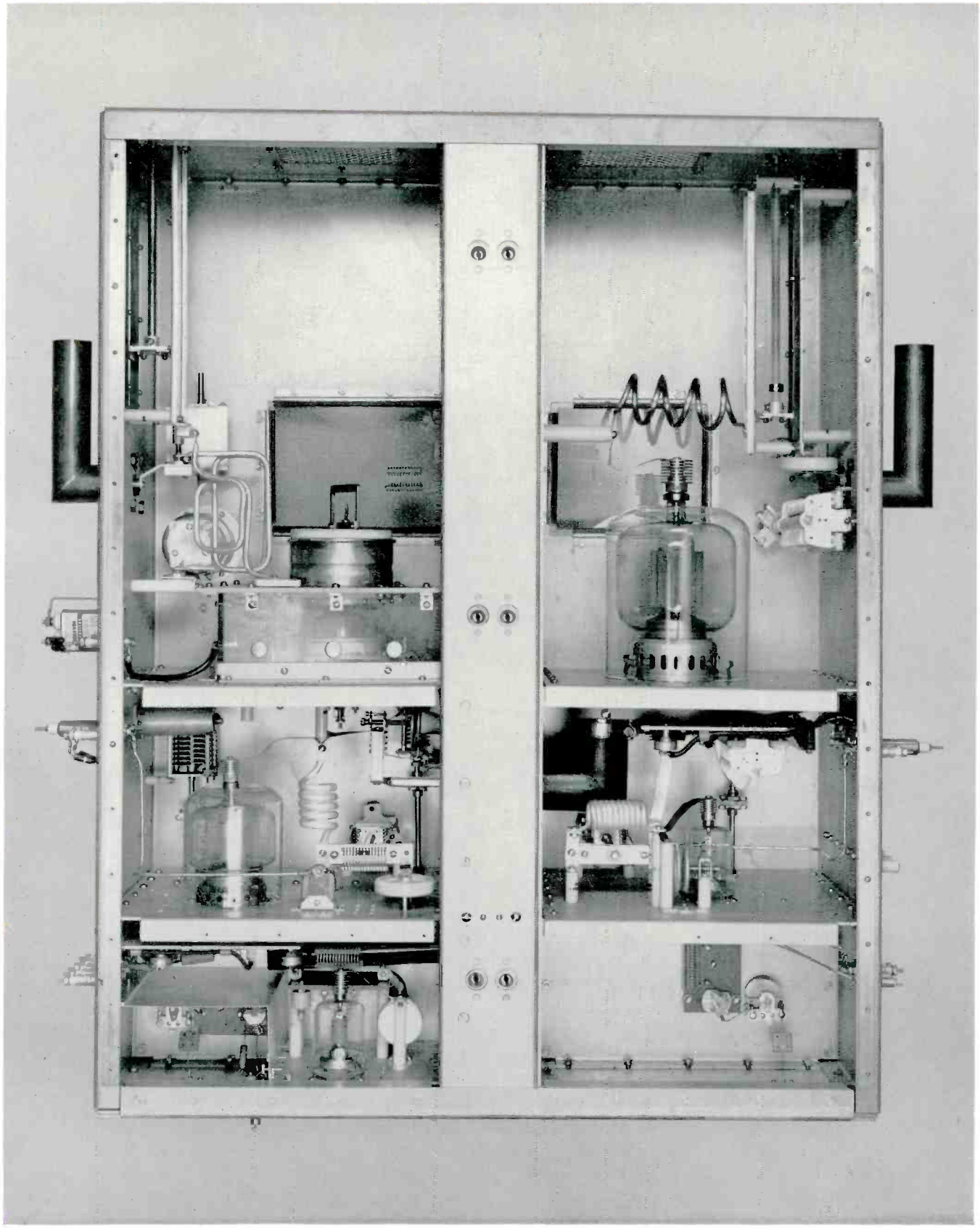
Block diagram of the TT-2BL/BH Modulator.

circuit of that stage. The bias voltage on each diode is separately adjustable and the diode can be made to start conducting at any brightness level. The grid of this stage is clamped in order to insure the same correction to the linearity characteristic regardless of the average brightness of the picture signal.

The linearity corrector is followed by a second video amplifier using a 6AG7 tube and by a third video amplifier consisting of two 807 tubes. The grids of the third video amplifier are also clamped and from this point on the circuit is d-c coupled. The output stage is a shunt regulated cathode follower. It consists of two 6146 tubes connected in a circuit very similar to a conventional cathode follower stage. The cathode resistor has been replaced by three 6146 tubes operating in parallel. The grids of these three tubes are fed with a signal from the plate load of the two cathode follower tubes. This essentially makes the circuit a feedback amplifier of high efficiency capable of delivering modulation at a high level to a large capacity load.

The modulated stage is followed by a bucking bias supply consisting of one 6BL7-GT and three OA2 tubes. This serves to transfer the signal from the positive voltage present in the output of the modulator stage to the negative voltage required to modulate the 6076 tube without losing the d-c component. Back porch clamping is employed. A carefully designed sync separator and clipper circuit provides reliable clamping even with greatly degraded input signal.

A two stage monitor amplifier is employed. It can be seen from the block diagram that this monitor amplifier can be switched to many parts of the circuit, greatly aiding in making adjustments and in servicing. Plate power for all the stages in the modulator is obtained from two electronic regulators. One supplies approximately 250 volts and the other approximately 475 volts. Although the rectifier itself is remotely located on the rear wall of the transmitter enclosure the regulators are mounted on the same chassis as the video circuit in the modulator. This greatly reduces the possibility of unwanted video resonances.



R-F Unit of the TT-2BL Transmitter

Aural Modulator

Frequency modulation is accomplished in the TT-2BL/BH exciter by a "direct modulation" process requiring less components, fewer tubes and tube types. This process, which eliminates numerous multipliers and converter stages resulting in low noise and minimum distortion, utilizes two push-pull reactance tubes connected across the frequency determining circuit of the master oscillator. The center frequency of this oscillator is precisely maintained by the automatic frequency control circuit described previously in the exciter description.

Frequency modulation is obtained by feeding the audio signal into the reactance tubes which are connected across the oscillator plate tank circuit. R-f energy from the oscillator tank is link coupled to a transformer which has a coil in the grid circuit of each reactance tube. R-f voltages on the push-pull connected grids are 180 degrees out of phase with each other and each is 90 degrees out of phase with respect to the r-f voltage at the plates. Thus, across the oscillator tank one tube appears as a capacitive reactance and the other as an inductive reactance.

The magnitude of the reactive plate current in the reactance tubes varies in direct proportion to the value of audio voltage applied to the grids. Therefore, the frequency of the oscillator is varied at an audio rate to furnish the required FM signal. The mean frequency of the oscillator is controlled by varying the grid bias of one of the reactance tubes. This bias voltage is d-c output voltage of the frequency detector stage of the exciter.

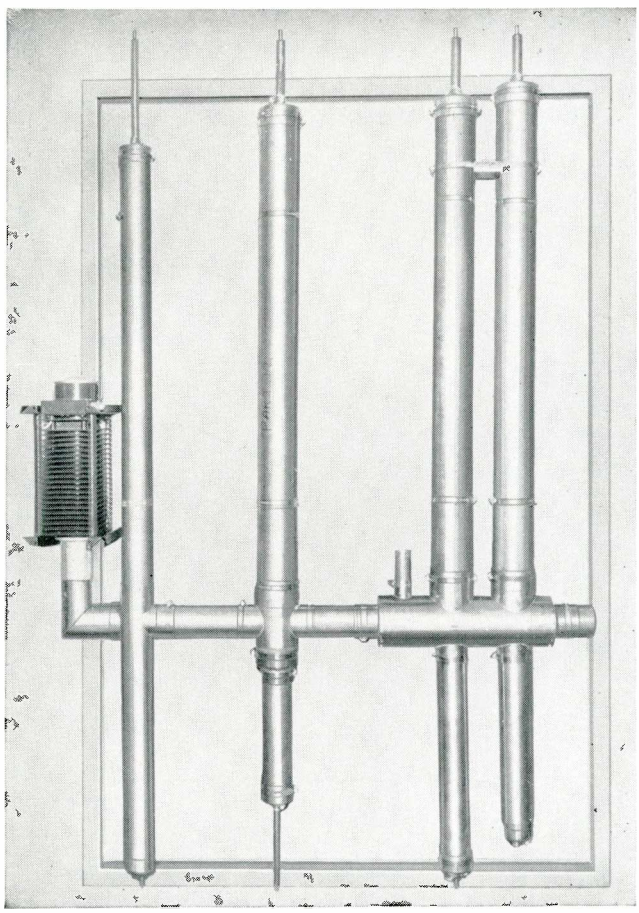
Power and Control Equipment

Wherever possible the same d-c power supplies in the TT-2BL/BH were used for both the visual and aural amplifiers. This greatly reduces the number of components in the transmitter and allows operation of the complete equipment with only four power supplies: An exciter supply built into the common exciter unit using stacked germanium diodes; a 700 volt low voltage rectifier, using two 866-A tubes, which supplies the screen voltage for all the r-f power amplifiers; a 3800 volt high voltage supply using six 8008 tubes in a 3 phase full wave circuit; and the modulator and bias supply, using two 866-A tubes and one 5R4-GY tube, which supplies the plate voltage for the modulator and the bias for all r-f stages.

A single integrated control circuit is provided for both the visual and aural transmitters. The blower, filaments, and each rectifier is protected by thermal overloads which can be adjusted to reset automatically. In addition, a main line breaker and an auxiliary breaker are provided. Each incorporates both thermal and magnetic trips. The primaries of the high voltage rectifier and each power amplifier tube are protected by instantaneous overloads which automatically recycle twice. If the fault continues on the third try the overload circuit will remain tripped until reset. Overload indicator lights are provided for each circuit. These lights have a separate reset and will remain on after the first overload thus providing a record of the circuit giving trouble even though it may be intermittent.

The equipment includes a line corrector which provides an adjustable line voltage to the filament primaries, the exciter, the modulator, and the low voltage rectifiers. Automatic filament line voltage regulators and automatic regulators capable of handling the complete transmitter are available as optional items. In localities troubled with excessive instantaneous line voltage fluctuation, an electronically controlled regulator for the low voltage supply is available as optional equipment.

The new M-derived vestigial sideband filter, ES-27233, designed for the TT-2BL Transmitter.



Special Protective Circuits

The TT-2BL/BH has reflectometer units for use in the output transmission lines of both the aural and visual amplifiers. Each unit contains a 6AL5 diode detector. The transmission line probes are installed so as to give an indication of the amount of power on meters on the front panel. Reflected power can be checked by manually rotating the reflectometer heads.

A carrier-off monitor is available as optional equipment. It acts in conjunction with the reflectometer units and is particularly useful for remote control. This unit will remove the plate voltage from all the r-f stages if the output level drops below a predetermined value, such as would be the case if an r-f arc occurred in any of the r-f stages. Sometimes such an arc does not change the plate current sufficiently to trip the d-c overload relays.

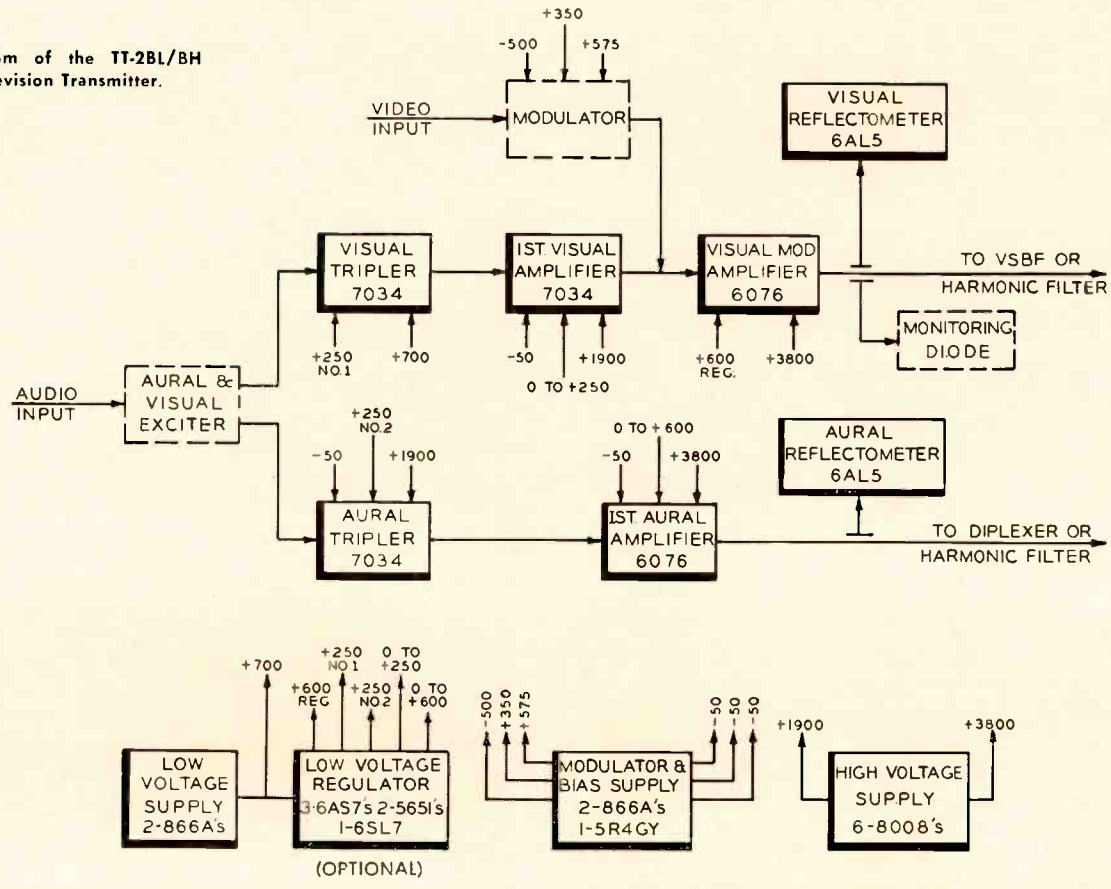
Harmonic Filter

Harmonic filters are supplied for insertion in the output transmission line. When operated in conjunction with the TT-2BL/BH Transmitter these filters are designed to attenuate all harmonics to a value at least 60 db below the peak carrier level. Electrically, each filter consists of an M-derived half-T section, several low pass filter sections, and a constant-K half-T section. The M-derived section provides rapid cut-off in the second harmonic region and a termination impedance of 51.5 ohms at one end of the filter. Attenuation of the harmonics is accomplished by a low pass filter section, while the constant-K section serves to give termination impedance of 51.5 ohms at the other end of the unit.

If operating on FCC Standards, a low pass filter is provided for insertion in the video input circuit. This filter attenuates all video frequencies above 4.75 megacycles at least 20 db. An all-pass phase equalizer is also included as part of the low pass filter. This equalizer corrects the phase distortion which is introduced as a result of the sharp cut-off. Appropriate filters covering CCIR standards are available.

A vestigial sideband filter is furnished completely assembled and adjusted for any one of the FCC VHF television channels. This filter is an integral unit designed for floor, ceiling, or wall mounting near the visual transmitter so that the input transmission line is as short as possible. The filter sections consist of lengths of coaxial line (resonant cavities), which are adjustable for tuning purposes. As the filter is pre-tuned at the factory to the channel stamped on the name plate, no operating adjustments are necessary.

Block diagram of the TT-2BL/BH VHF Television Transmitter.



SPECIFICATIONS

Performance Specifications

	TT-2BL/BH FCC Specs.	TT-2BL/BH CCIR Specs. System B
Type of Emission:		
Visual	A5	A5
Aural	F3	F3
Frequency Range:		
Visual:		
TT-2BL	Ch. 2-6	47-88 mc
TT-2BH	Ch. 7-13	174-223 mc
Aural:		
TT-2BL	Ch. 2-6	48-88 mc
TT-2BH	Ch. 7-13	174-223 mc
Rated Power Output:		
Visual	2 kw[1]	1.8 kw[1]
Aural	1.05 kw[2]	.36 kw[2]
Minimum Power Output:		
Visual	1 kw[1]	1 kw[1]
Aural	.5 kw[2]	.36 kw[2]
R.F. Output Impedance	50/51.5 ohms	50/51.5 ohms
Input Impedance:		
Visual	75 ohms	75 ohms
Aural	600/150 ohms	600/150 ohms
Input Level:		
Visual	0.7 volt peak-to-peak min.	0.7 volt peak-to-peak min. (composite video)
Aural	+10 ±2 dbm	+16 ±2 dbm for 50 kc dev. Uniform ±1 db from 50 to 15,000 cyc.
Amplitude vs. Frequency Response, Aural	Uniform ±1 db from 50 to 15,000 cyc.	——
Upper Sideband Response:[3]		
At Carrier plus 0.5 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 1.25 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 2.0 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 3.0 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 3.58 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 4.18 mc	+1, −3.0 db	——
At Carrier plus 4.75 mc	−20 db max.	——
At Carrier plus 5.0 mc	——	+1, −4.0 db
At Carrier plus 5.75 mc	——	−20 db max.
Lower Sideband Response:[4]		
At Carrier minus 0.5 mc	+1, −1.5 db	+1, −1.5 db
At Carrier minus 1.25 mc	−20 db max.	−20 db max.
At Carrier minus 3.58 mc	−42 db max.	——
Variation in Frequency Response with Brightness[5]	±1.5 db	±1.5 db
Carrier Frequency Stability:[6]		
Visual	±1 kc	±.0005%
Aural	±500 cycle[7]	±.001%
Modulation Capability:		
Visual	12.5 ±2.5% (reference white)	12.5 ±2.5% (reference white)
Aural	±50 kc	±50 kc

[1] Measured at the output of the sideband filter or filterplexer.

[2] Measured at the input to the diplexer or filterplexer.

[3] With respect to the response at 200 kc, as measured by the BW-5B Sideband Response Analyzer at transmitter mid-characteristic 4.75 mc attenuation requires use of MI-27132 LP filter in the video input circuit.

[4] With respect to the response at 200 kc at transmitter mid-characteristic.

[5] Maximum variation with respect to the response at mid-characteristic measured with the BW-5B Sideband Response Analyzer at brightness levels of 22.5% and 67.5% of sync peak, using approximately 20% (peak-to-peak) modulation.

[6] Maximum variation for a period of 30 days without circuit adjustment.

	TT-2BL/BH FCC Specs.	TT-2BL/BH CCIR Specs. System B
Audio Frequency Distortion	1.5% max. 50-100 cyc.	1.5% max. 50-100 cyc.
	1.0% max. 100-7500 cyc.	1.0% max. 100-7500 cyc.
	1.5% max. 7500-15,000 cyc.	1.5% max. 7500-15,000 cyc.
FM Noise, below ±25 kc Swing	60 db	——
FM Noise, below ±50 kc Swing	——	60 db
AM Noise, r.m.s. (Hum and Thermal):		
Visual	45 db below 100% mod.	45 db below 100% mod.
Aural	50 db below carrier	50 db below carrier
Amplitude Variation Over One Picture Frame:		
Visual	Less than 5% of the peak of sync level	Less than 5% of the peak of sync level
Regulation of Output	7% max.	7% max.
Burst vs. Subcarrier Phase[8]	±5 degrees max.	——
Subcarrier Phase vs. Brightness[9]	±7 degrees max.	——
Subcarrier Amplitude[8]	±10% max.	——
Linearity (Differential Gain)[10]	1.5 db max.	1.5 db max.
Envelope Delay vs. Frequency[11]	±.08 μsec. from 0.2 to 2.1 mc	——
	±0.4 μsec. at 3.58 mc	——
	±.08 μsec. at 4.18 mc	——
Harmonic Attenuation, ratio of any single harmonic to peak visual fundamental:		
Visual	At least 60 db[7]	At least 60 db[12]
Aural	At least 60 db[7]	At least 60 db[12]

[7] Maximum variation with respect to the standard 4.5 mc separation between aural and visual carrier.

[8] Maximum departure from the theoretical when reproducing saturated primary colors and their complements at 75% amplitude.

[9] Maximum phase difference with respect to burst, measured after the VSBF, for any brightness level between 75% and 15% of the sync peak using 10% (peak-to-peak) modulation. This is equivalent to 5% (peak-to-peak) modulation as indicated by a conventional diode demodulator. In addition, the total differential phase between any two levels shall not exceed 10°.

[10] Maximum variation in the amplitude of a 3.58 mc sine wave modulating signal as the brightness level is varied between 75% and 15% of sync peak. The gain shall be adjusted for 10% (peak-to-peak) modulation of the 3.58 mc signal when the brightness is at pedestal level. This is equivalent to 5% (peak-to-peak) modulation as indicated by a conventional diode demodulator connected after the VSBF.

[11] Maximum departure from standard curve. The tolerances vary linearly between 2.1 and 3.58 mc and between 3.58 and 4.18 mc. To meet the specification a properly terminated phase correction network, ES-34034-B is required in the video input circuit of the transmitter.

[12] Measured with harmonic filters in the visual and aural transmitter outputs.

SPECIFICATIONS (Continued)

Electrical Specifications

	TT-2BL/BH FCC Specs.	*TT-2BL/BH CCIR Specs. System B*
Power Line Requirements:		
Transmitter:		
Line	230/208 volts, 3 phase, 50/60 cyc.	230/208 volts, 3 phase, 50/60 cyc.
Slow Line Variations	±5% max.	±5% max.
Rapid Line Variations	±3% max.	±3% max.
Regulation	3% max.	—
Power Consumption	11 kw (black pix) 10 kw (average pix)	9 kw (black pix) 7 kw (average pix) (Visual vs. aural output ratio 5:1)
Power Factor (approx.)	90%	90%
Crystal Heaters:		
Line	115 volts, 1 phase, 50/60 cyc.	115 volts, 1 phase, 50/60 cyc.
Power Consumption	28 watts	28 watts

Mechanical Specifications

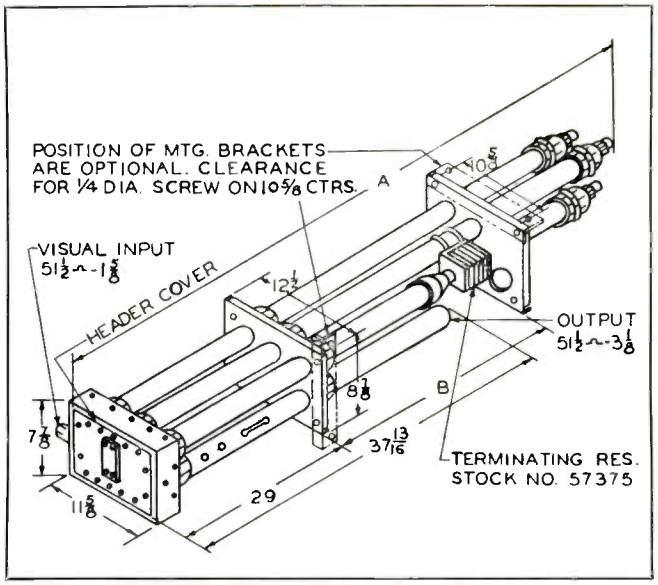
Dimensions:
- Overall Length (front line cabinets only) ..... 72" (183 cm)
- Overall Height (front line cabinets only) ..... 84" (213 cm)
- Depth (front line cabinets only) ..... 20" (51 cm)
- Overall Depth ..... $78\frac{13}{16}$" (196 cm)

Weight ..... 3800 lbs. (124 kg.)

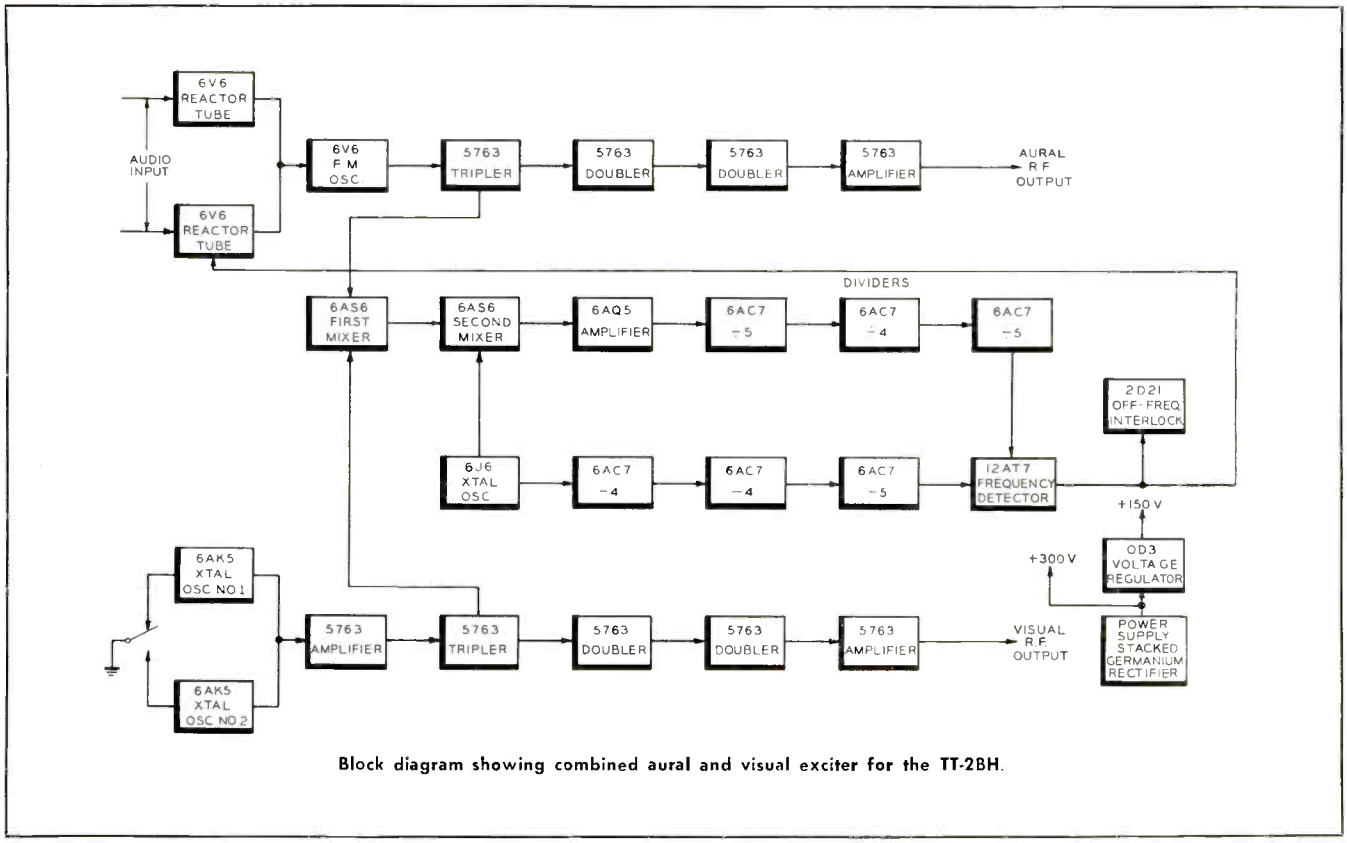
Finish ..... Two-tone umber gray, polished stainless steel trim

Maximum Altitude ..... 7500 ft.

Ambient Temperature ..... 45° C. max., 0° C. min.



Vestigial sideband filter, MI-19114-B, designed for the TT-2BH Transmitter.



Block diagram showing combined aural and visual exciter for the TT-2BH.

SPECIFICATIONS (Cont'd)

Tube Complement for TT-2BL

VISUAL SECTION

Qty.	Function	Type
1	Visual Crystal Oscillator #1	6AK5
1	Visual Crystal Oscillator #2	6AK5
1	Buffer Amplifier	5763
1	1st Visual Multiplier	5763
1	2nd Visual Multiplier	5763
1	3rd Visual Multiplier	5763
1	Visual Output Amplifier	5763
1	Visual Tripler	7034
1	1st Visual Amplifier	7034
1	Visual Modulated Amplifier	6076
1	Visual Reflectometer	6AL5
1	1st Video Amplifier	6AG7
1	Inverter	6AG7
1	Linearity Corrector	6AG7
1	2nd Video Amplifier	6AG7
2	3rd Video Amplifier	807
5	Modulator	6146
1	1st Sync Amplifier	6AG7
1	2nd Sync Amplifier-Sync Separator	6U8A
1	Pulse Generator	6U8A
1	Clipper	6SN7-GT
1	1st Clamp Diode	6AL5
1	2nd Clamp Diode	6AL5
6	Voltage Reference Tubes (D-C Coupling)	5651
1	Bias Regulator	OB2
2	Regulators (Modulator Screens)	OA2
2	Regulators (Modulator Screens)	OB2
3	Voltage Regulator Tubes (Bucking Bias)	OA2
2	Voltage Reference Tubes (L.V. and H.V. Regulators)	5651
1	D-C Amplifier (High Voltage Regulator)	6SL7-GT
2	High Voltage Regulators	6AS7-G
1	D-C Amplifier (Low Voltage Regulator)	6SL7-GT
2	Low Voltage Regulators	6AS7-GT
1	150 V Regulator	OD3
1	Monitor Amplifier	6AC7
1	Monitor Amplifier (Output)	6AG7
1	1st Clamp Pulse Output	6CL6
1	Bucking Bias	6BL7-GT
1	2nd Clamp Pulse Output	6CL6

AURAL SECTION

2	Reactance Tube Modulator	6V6
1	FM Master Oscillator	6V6
1	1st Aural Multiplier	5763
1	2nd Aural Multiplier	5763
1	3rd Aural Multiplier	5763
1	Aural Output Amplifier	5763
1	1st Mixer	6AS6
1	2nd Mixer	6AS6
1	Difference Frequency Amplifier	6AQ5
1	1st Difference Frequency Divider	6AC7
1	2nd Difference Frequency Divider	6AC7
1	3rd Difference Frequency Divider	6AC7
1	Crystal Oscillator-Reference Frequency	6J6
1	1st Reference Frequency Divider	6AC7
1	2nd Reference Frequency Divider	6AC7
1	3rd Reference Frequency Divider	6AC7
1	Cathode Follower-Frequency Detector Drive	12AT7
1	Aural Tripler	7034
1	1st Aural Amplifier	6076
1	Aural Reflectometer	6AL5

COMMON POWER SUPPLY, ETC.

1	Voltage Regulator	OD3
1	Off-Frequency Interlock Control	2D21
2	Low Voltage Rectifiers	866-A
2	Modulated Rectifiers	866-A
1	Modulator Rectifier (Bias)	5R4-GY
6	High Voltage Rectifiers	8008
†1	D-C Amplifier (Low Voltage Regulator)	6SL7-GT
†2	Voltage Reference Tubes (Low Voltage Regulator)	5651
†3	Series Regulators (Low Voltage Rectifier)	5651
†2	Regulators (Carrier-off Monitor)	OD3
†4	Amplifiers (Carrier-off Monitor)	5814-A

Tube Complement for TT-2BH

VISUAL SECTION

Qty.	Function	Type
1	Visual Crystal Oscillator #1	6AK5
1	Visual Crystal Oscillator #2	6AK5
1	Buffer Amplifier	5763
1	1st Visual Multiplier	5763
1	2nd Visual Multiplier	5763
1	3rd Visual Multiplier	5763
1	Visual Output Amplifier	5763
1	1st Visual Amplifier	4-65A
1	2nd Visual Amplifier	4-250A
1	Visual Modulated Amplifier	6076
1	Visual Reflectometer	6AL5
1	1st Video Amplifier	6AG7
1	Inverter	6AG7
1	Linearity Corrector	6AG7
1	2nd Video Amplifier	6AG7
2	3rd Video Amplifier	807
5	Modulator	6146
1	1st Sync Amplifier	6AG7
1	2nd Sync Amplifier-Sync Separator	6U8A
1	Pulse Generator	6U8A
1	Clipper	6SN7-GT
1	1st Clamp Diode	6AL5
2	2nd Clamp Diode	6AL5
6	Voltage Reference Tubes (D-C Coupling)	5651
1	Bias Regulator	OB2
2	Regulators (Modulator Screens)	OA2
2	Regulators (Modulator Screens)	OB2
3	Voltage Reference Tubes (Bucking Bias)	OA2
2	Voltage Reference Tubes (L.V. and H.V. Regulators)	5651
1	D-C Amplifier (High Voltage Regulator)	6SL7-GT
2	High Voltage Regulators	6AS7-G
1	D-C Amplifier (Low Voltage Regulator)	6SL7-GT
2	Low Voltage Regulators	6AS7-GT
1	150 V Regulator	OD3
1	Monitor Amplifier	6AC7
1	Monitor Amplifier (Output)	6AG7
1	1st Clamp Pulse Output	6CL6
1	Bucking Bias	6BL7-GT
1	2nd Clamp Pulse Output	6CL6

AURAL SECTION

2	Reactance Tube Modulator	6V6
1	FM Master Oscillator	6V6
1	1st Aural Multiplier	5763
1	2nd Aural Multiplier	5763
1	3rd Aural Multiplier	5763
1	Aural Output Amplifier	5763
1	1st Mixer	6AS6
1	2nd Mixer	6AS6
1	Difference Frequency Amplifier	6AQ5
1	1st Difference Frequency Divider	6AC7
1	2nd Difference Frequency Divider	6AC7
1	3rd Difference Frequency Divider	6AC7
1	Crystal Oscillator-Reference Frequency	6J6
1	1st Reference Frequency Divider	6AC7
1	2nd Reference Frequency Divider	6AC7
1	3rd Reference Frequency Divider	6AC7
1	Cathode Follower-Frequency Detector Drive	12AT7
1	1st Aural Amplifier	4-65A
1	2nd Aural Amplifier	4-1000A
1	Aural Driver Reflectometer	6AL5

COMMON POWER SUPPLY, ETC.

1	Voltage Regulator	OD3
1	Off-Frequency Interlock Control	2D21
2	Low Voltage Rectifiers	866-A
2	Modulated Rectifiers	866-A
1	Modulated Rectifier	5R4-GY
6	High Voltage Rectifiers	8008
†1	D-C Amplifier (Low Voltage Regulator)	6SL7-GT
†2	Voltage Reference Tubes (Low Voltage Regulator)	5651
†3	Series Regulators (Low Voltage Rectifier)	5651
†2	Regulators (Carrier-Off Monitor)	OD3
†4	Amplifiers (Carrier-Off Monitor)	5814-A

SPECIFICATIONS (Cont'd)

Equipment Supplied

TT-2BL TELEVISION TRANSMITTER (ES-19286)

Qty.	Description	Stock No.
1	Control Unit	MI-27180-A
1	2-KW Unit	MI-27181
1	Set of Panels	MI-27450
1	Rectifier Panel	MI-27451
1	Transformer-Filter Assembly	MI-27460
1	Transformer	MI-27479-A
1	Blower	MI-27461
1	Installation Material	MI-27462
1	Wiring Material	MI-27463
2	Reflectometers	MI-27464
1	Monitoring Diode	MI-19051-B
2	Harmonic Filter	MI-27317[2]
1	Vestigial Sideband Filter	ES-27233[2]
1	4.75 MC Low Pass Filter	MI-27132
2	Side Panels (End Shields)	MI-30541-G84
1	Finish Touch-Up Kit	MI-7499-A
1	Miscellaneous Hardware Kit	MI-7474
1	Set of Frequency Determining Parts	MI-27482[2]
2	Crystal Unit (Visual)	MI-27492[2]
1	Set of Operating Tubes	ES-27201
*	Transmission Line (*Sales order must specify size and quantity for installation requirements)	MI-19112/19113-C
1	Line Corrector	MI-27478[3]
1	Nameplate	MI-28180-1
1	Tool Kit	MI-27088
2	Set of Installation Drawings	8924946-501
2	Instruction Book	IB-36280

Equipment Supplied

TT-2BH TELEVISION TRANSMITTER (ES-19287)

Qty.	Description	Stock No.
1	Control Unit	MI-27180-A
1	2-KW Unit	MI-27191
1	Set of Panels	MI-27488
1	Rectifier Panel	MI-27458
1	Transformer-Filter Assembly	MI-27460
1	Transformer	MI-27479-A
1	Blower	MI-27461
1	Installation Material	MI-27193
1	Wiring Material	MI-27194
1	Monitoring Diode	MI-19051-B
2	Harmonic Filter	MI-27317[2]
1	Vestigial Sideband Filter	MI-19114-B[2]
1	4.75 MC Low Pass Filter	MI-27132
2	Side Panels (End Shields)	MI-30541-G84
1	Finish Touch-Up Kit	MI-7499-A
1	Miscellaneous Hardware Kit	MI-7474
2	Crystal Unit (Visual)	MI-27492[2]
1	Set of Operating Tubes	ES-27203
1	Line Corrector	MI-27478[3]
1	Nameplate	MI-28180-1
1	Tool Kit	MI-27088
*	Transmission Line (*Sales order must specify type and quantity for installation requirements)	MI-19112/19113-C
2	Set of Installation Drawings	8958115-501
2	Instruction Book	IB-30257

Optional or Accessory Equipment

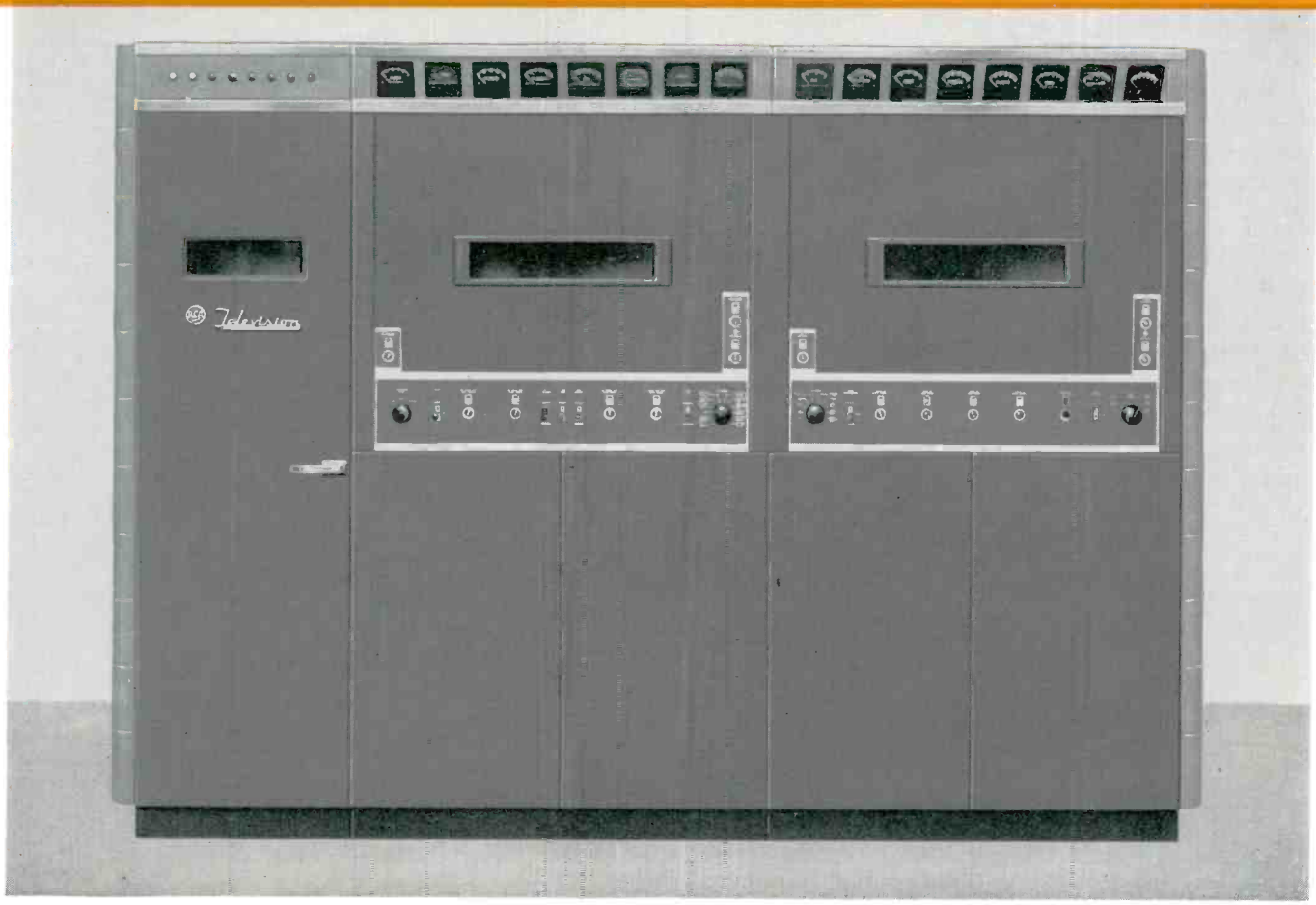
TTC-5A Control Console Equipment, with master monitor but less master monitor power supply	ES-27274-1
R-F Load and Wattmeter	MI-19196-H
Complete Set of Spare Tubes for TT-2BL	ES-27201
FCC Spare Set of Tubes for TT-2BL	ES-27202
Complete Set of Spare Tubes for TT-2BH	ES-27203
FCC Spare Set of Tubes for TT-2BH	ES-27204
Input and Monitoring Equipment, Wired/Unwired	ES-19237-E/G
50 Cycle Conversion Kit	MI-27485
Line Regulator (single phase)	MI-27472
Line Regulator Control Panel	MI-27471
Rectifier Enclosure	ES-19285
Low Voltage Regulator	MI-27469
Carrier-Off Monitor	ES-27235
BW-5B Sideband Response Analyzer	ES-34010
Plate Current Meter	MI-21200-C1
WM-71A Distortion and Noise Meter	MI-30071-A
WA-28A Audio Oscillator	MI-30028-A
Exciter Tuning Indicator	MI-27487
BW-4B VHF Visual Demodulator	MI-34057
TO-524-AD Oscilloscope	MI-26500-A

———

† Tubes for optional Low Voltage Regulator.
[1] For operation at rated power and normal plate voltage.
[2] Order to suit customer's assigned channel.
[3] Not supplied if Automatic Voltage Regulator MI-27471/MI-27472 are ordered as accessory equipment.

6 KW VHF TV Transmitter

TYPE TT-6AL



FEATURES

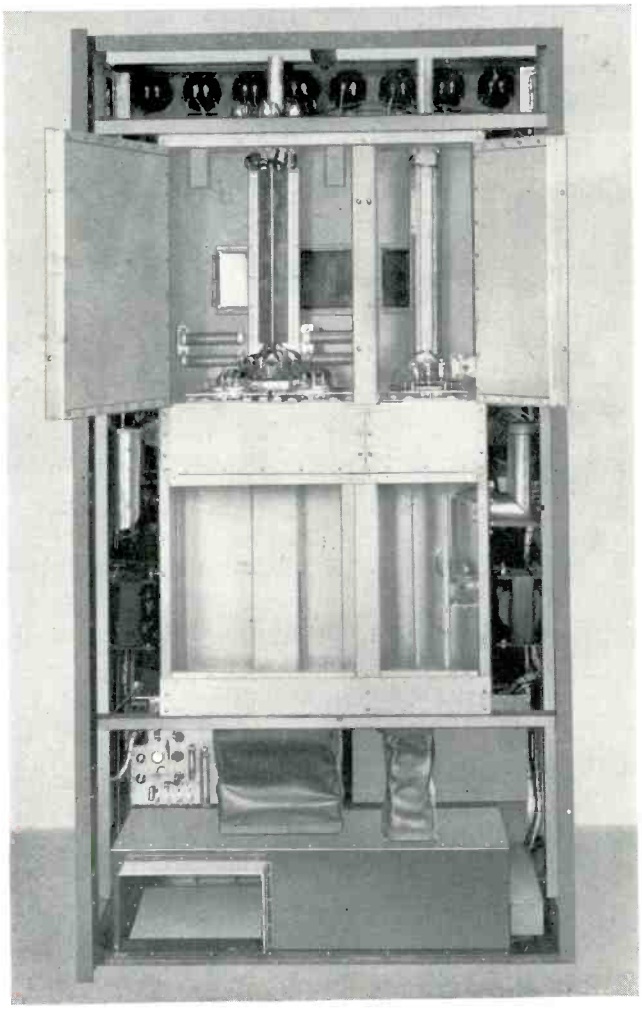
- Compact floor plan — new design cuts floor space required for transmitters
- Designed for color—linearity correction circuits built into modulator
- Low cabinet radiation—all leads from R-F compartment coupled through specially designed feed-through capacitors
- Uses Type 5762 air-cooled tubes, noted for long life and reliability
- Broadbanding tuning controls accessible without opening any doors
- Power increase can be made with minimum change to existing equipment
- Inter-carrier frequency control accurately maintains frequency separation between aural and visual carriers
- Thermostatically controlled heaters provided for rectifier tubes allow operation at low ambient temperature
- Excellent accessibility
- Circuitry included for use of remote control
- Sloping and illuminated meter panels
- Complete overload protection with indicating lights grouped for quick location of faulty circuits

DESCRIPTION

The new RCA Type TT-6AL VHF Television Transmitter is designed for television stations with effective radiated power requirements ranging from 5 to 70 kilowatts. It is an ideal medium power equipment for telecasting either in monochrome or color, and it is capable of covering large urban communities with a strong signal. This transmitter works equally well with both RCA low and high gain type antennas.

The TT-6AL transmitter has been completely restyled to afford a compact unit requiring a minimum of floor space in the transmitting station. All critical circuits such as the modulator and the exciter are completely adjusted from the front of the transmitter, while one interlocked door affords access to all other parts of the transmitter and its component parts. Unitized construction of transmitter and antenna portions of the equipment allow the broadcaster utmost latitude in arrangement layout. Two typical types of installation are shown in accompanying floor diagrams, but numerous variations will suggest themselves to the station engineer.

Rear view of PA unit showing visual and aural amplifiers, visual bias supply, filament transformers and outputs, and air cooling ducts.



Control circuits of the TT-6AL are grouped in separate cabinet with status lights on a panel above the door. Auxiliary switches, breakers, overload and auxiliary relays, and overload indicating lights are located behind door.

The TT-6AL circuits employ the latest design features and represent economy in operation. Highlighted features include air-cooled tubes such as the 5762, famous for long life and reliability; single ended r-f circuits which greatly reduce number of necessary tubes and circuit components; built-in control relays, motors for operating power output controls, and shunts for external metering circuits; complete overload protection with indicating lights grouped for quick location of faulty circuits, and linearity correction circuits. Thermostatically controlled heaters for the rectifier tubes permit operation of the transmitter in ambient temperatures as low as 0 degrees C. Inter-carrier frequency control accurately maintains frequency separation between aural and visual carriers necessary for color transmission.

Remote control as well as local operation is an added feature of the new RCA transmitter. Where remote control is authorized for television transmitters, the TT-6AL can, with the addition of suitable terminal equipment, be oper-

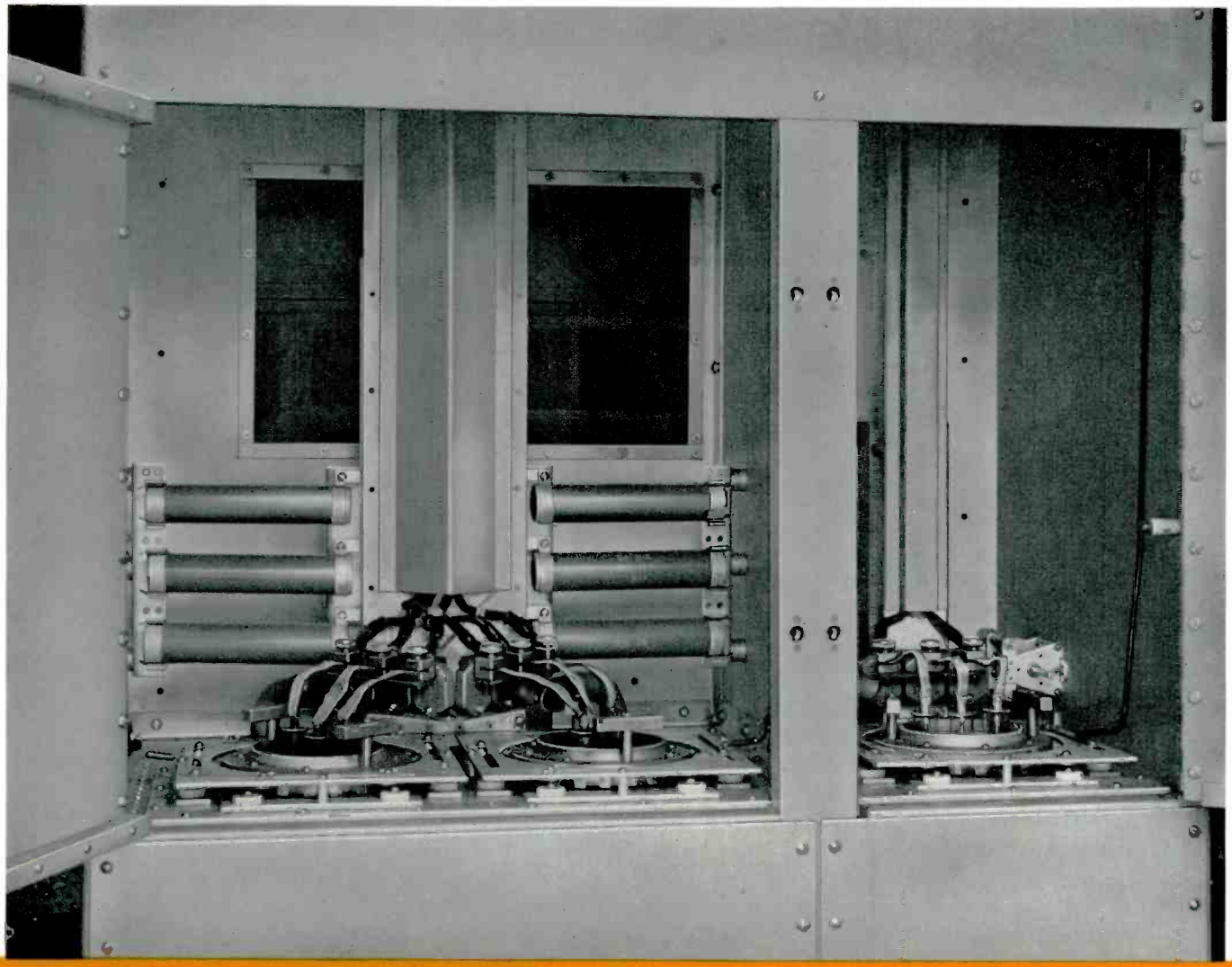
ated from a remote location over a single telephone line. All the necessary operating functions such as starting and stopping the transmitter, resetting overloads, switching in the spare crystal or spare exciter, metering all power circuits and reflectometers, controlling power output (including black level, video gain, and excitation) can be performed at the remote location. Even when the transmitter is not remotely controlled, these built-in features make it very easy to obtain fingertip control of the transmitter from a single local position such as the transmitter console.

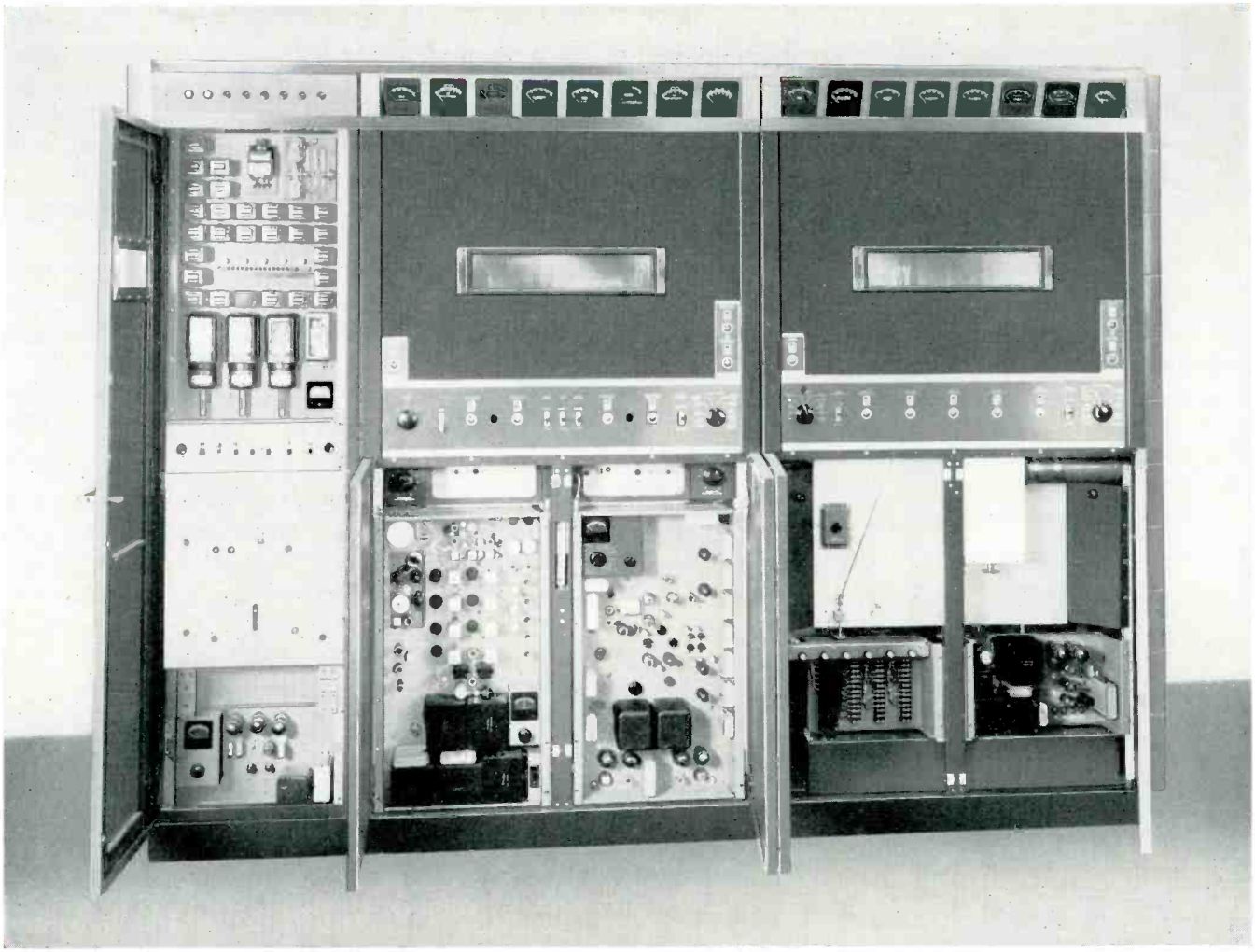
The Type TT-6AL VHF Television Transmitter is designed to conform with all FCC, CCIR and EIA standards. It will provide a nominal power output of 6 kilowatts (5.0 kw CCIR) peak visual power measured at the output of the sideband filter or filterplexer and 3.15 KW aural power. It is designed to operate on any specified channel between channel 2 and 6 (47 mc-88 mc CCIR).

The type of enclosure employed for the TT-6AL is unusual and provides a maximum of flexibility in selecting a suitable floor plan in a minimum space. The complete transmitter is housed in what is equivalent to a single cabinet with only one access door. However, it can be broken down for shipping into racks and panels of varying size for easy handling. All r-f circuit and control units are located at the front of the enclosure, thus allowing all essential adjustments to be made with the power on. The rectifier tubes are mounted on the rear wall and the heavy power components are mounted on the floor. The rear of the transmitter housing has no access door so that this side can be mounted directly against a building wall. Where space is limited, the right side of the enclosure can also be mounted against the building wall provided an opening for the air intake is made in the wall opposite the filter.

The control circuits are grouped at the extreme left of the front of the transmitter in a separate cabinet with status lights grouped on a panel above the door. The auxiliary switches, breakers, overload and auxiliary relays, etc. are located behind a non-interlocked door. Overload

R-F cabinets open revealing close up of air-cooled 5762 triodes utilized in the PA circuits of the TT-6AL.





Full view of TT-6AL transmitter, cabinet doors open revealing tuning controls and meters, control cabinet (left) 2-KW driver with exciter and modulators on accessible hinged chassis (center), and 6-KW PA cabinet with reflectometer controls and bias supply among lower components (right).

indicating lights for all the circuits of the transmitter are grouped on a single strip so that they can be seen through the window in the door.

To the right of the control unit is the low power (2 KW) rack. It contains both the aural and visual drivers as well as the exciter and modulator units and is essentially the same as the video and r-f circuits of the complete TT-2BL 2 KW VHF Transmitter. The modulator and exciter units are located at the bottom of the rack behind dutch doors. They are hinged at the bottom so that both the front and rear of these units are accessible for servicing from the front of the transmitter.

The right hand rack contains both the aural and visual amplifier units, a regulated bias supply for the visual amplifier, terminal boards, and other auxiliary controls all located behind the two bottom doors. In both the driver and the power amplifier units the tuning controls for the high level stages are located just above the doors. These include all the tuning controls required for broadbanding the visual r-f circuits. The tuning controls are operated by a crank which is removable to prevent accidental misadjustment of the circuits during operation. An easily read counter dial enables accurate logging of all the circuits. Also located on the panel above the doors are all the operating controls such as the transmitter start switch, plate switch, power operating controls, reflectometer switches and metering switches.

All important meters of the TT-6AL are mounted in sloping panels at the top of the racks. Built-in lights in the bottom of the meter panels provide excellent illumination for the meters even while the room illumination is lowered for easy monitoring of the picture signal.

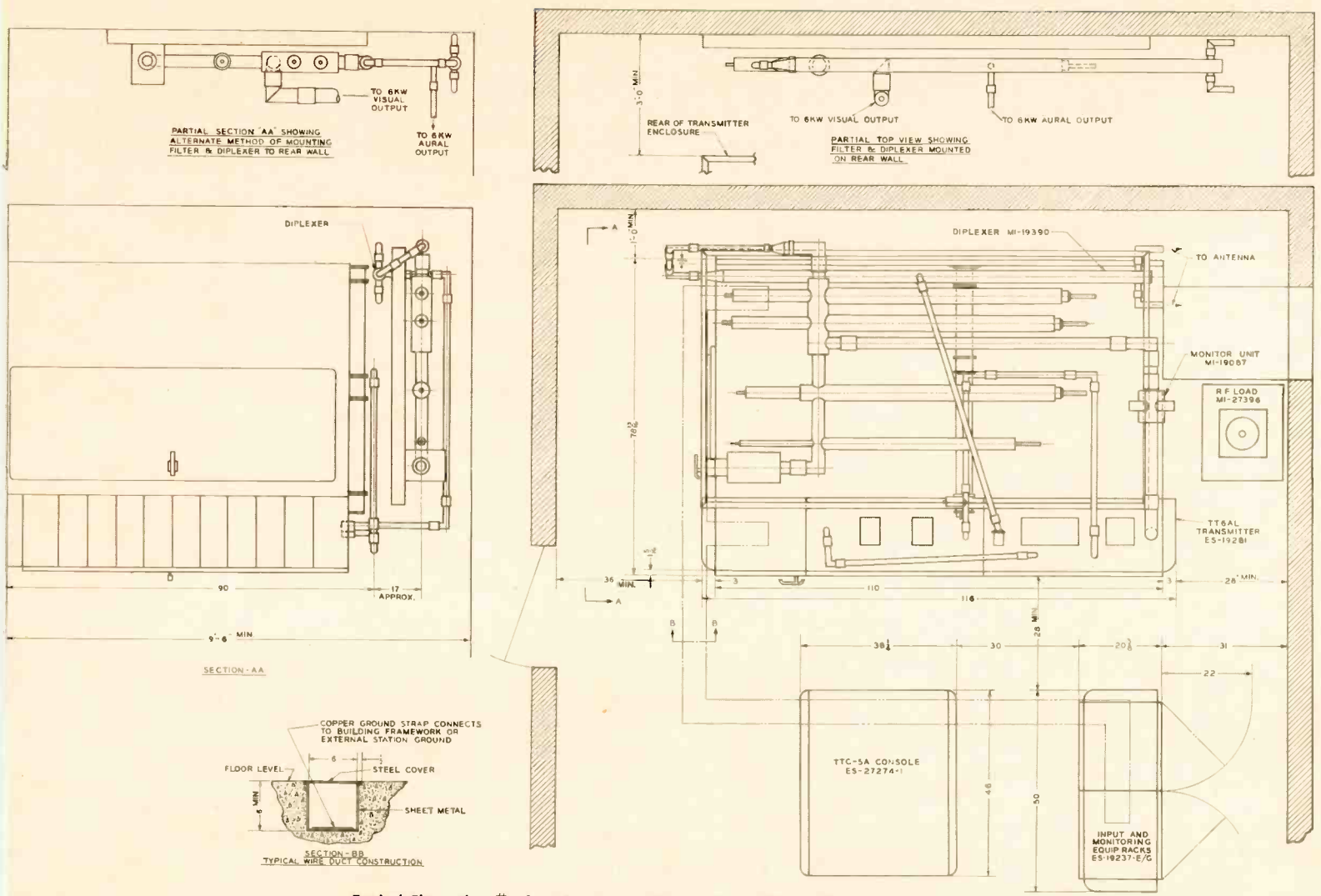
A single access door on the left end of the transmitter provides access to the rear of the control rack and r-f racks as well as the rectifier mounted on the rear wall of the enclosure. This rectifier has thermostatically controlled heaters for the rectifier tubes which permit operation of the transmitter in ambient temperatures as low as 0 degrees C.

Heavy units such as the plate transformers and large reactors are mounted on a base plate on the floor. This makes them easily accessible for servicing.

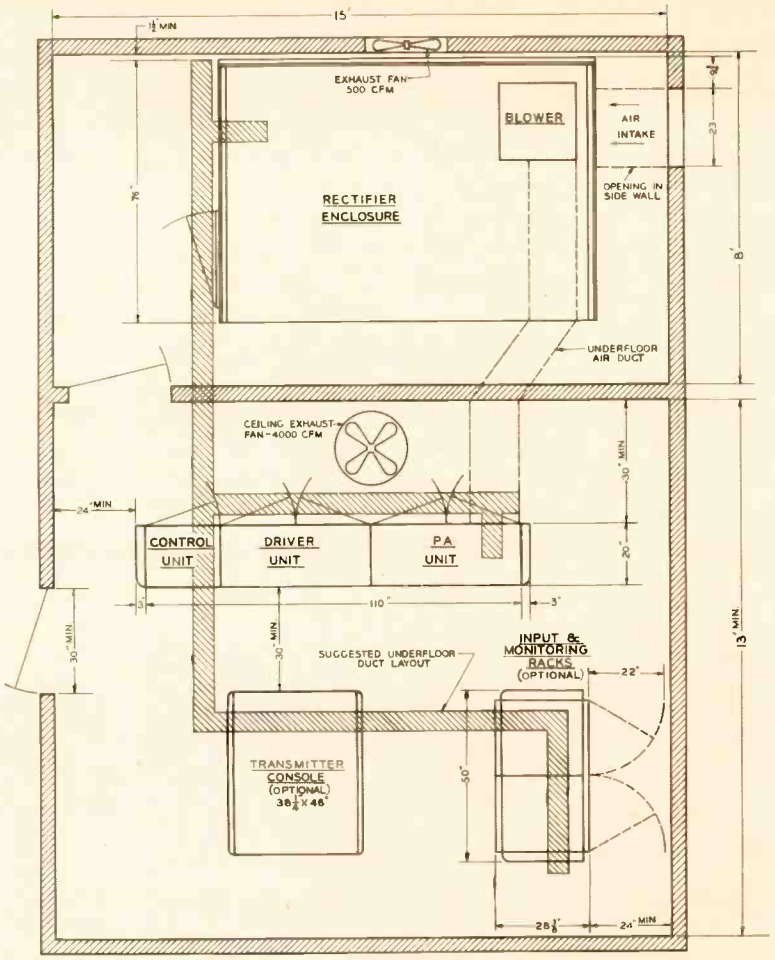
The versatility of the new transmitter cabinets is seen in floor plans No. 1 and No. 2. The latter shows an arrangement of the TT-6AL in which doors have been added to the rear of the control and r-f racks and a front wall added to the rectifier enclosure. Since this enclosure now contains no meters, operating controls or adjustments, it can be located conveniently in an adjacent room or even in the basement. If this is done, special air ducts and wiring ducts will, of course, be required to connect the rectifier to the other racks of the equipment. The arrangement will considerably reduce the amount of space required in the operating room, and will also reduce the noise in the operating room due to blower vibration, etc.

Exciter Description

The TT-6AL transmitter is driven by a common exciter containing both visual and aural chains. Accurate control of the separation of visual and aural carrier frequencies is the result of precise engineering circuit design. The visual chain is driven by either one of the two crystal controlled 6AK5 oscillator circuits as a primary source of frequency control. Oscillators may be switched by means of a d-c relay, thus making this circuit adaptable for remote control. The crystals operate at one-twelfth the visual carrier frequency and one-twelfth of the output frequency of the exciter. The aural master oscillator is a free-running 6V6 oscillator controlled by a pair of 6V6 reactance tubes which are part of the automatic-frequency control circuit used to maintain the 4.5 mc (5.5 mc CCIR) separation between carriers. An off-



Typical Floor Plan #1 for TT-6AL transmitter with rectifier enclosure attached.



Alternate floor plan #2 for the TT-6AL transmitter with rectifier enclosure set up in an adjacent room. The new transmitter is a versatile equipment allowing the rectifier enclosure to be located on the same or on another floor, thus occupying a minimum of space in the operating room.

frequency interlock prevents uncontrolled frequency operation by cutting off plate voltage to the stages that follow the exciter. The aural master oscillator operates at one-twelfth of the carrier frequency with the output of the exciter being on the carrier frequency.

The automatic frequency control of the aural master oscillator is accomplished by feeding a small amount of energy from the aural FM oscillator and the visual 5763 amplifier following the crystal oscillator stage into a 6AS6 mixer tube. When the aural oscillator is on frequency the output of this mixer stage will be one-twelfth of the difference frequency between the aural and visual carriers or 375 kc (458.333 kc CCIR). The 375 kc (458.333 kc CCIR) signal mixes with the output of the 6J6 crystal controlled reference oscillator (1500 kc FCC or 1833.33 kc CCIR) in the second 6AS6 mixer stage. The difference frequency is fed through a chain of three dividers with a total division of 100 to the frequency detector stage. This amount of division is necessary to reduce the swing at the frequency detector so that the carrier will not drop out under any modulation conditions of the aural transmitter. The 6J6 reference oscillator signal is fed through three divider stages with a total division of 80 to the frequency detector stage. By using the 6J6 reference oscillator output to excite both the second mixer and the divider chain for reference frequency, considerable improvement in frequency control accuracy is obtained. Signals from both the difference frequency and the reference frequency chains are fed into the frequency detector. The frequency detector is essentially a balanced modulator with a d-c component in the output which will change polarity depending upon whether the signal frequency is above or below the reference frequency. This d-c voltage is fed back to one of the reactance tubes for the master oscillator in such a way as to correct the frequency of the master oscillator.

R-F Circuits

The r-f circuits employ a chain of amplifiers. In the visual chain a 4-65A tube and a 4-250A tube operating in cascade, drive a type 6076 grid modulated power amplifier. This is followed by two type 5762 tubes operating in parallel in a class "B" linear circuit. The aural chain consists of three stages: a 4-65A, a 4-1000A and a type 5762 tube all operating as class "C" amplifiers. Excitation control of the visual modulated amplifier is accomplished by varying the screen voltage on the 4-250A stage. Power output of the aural transmitter is adjusted by varying the

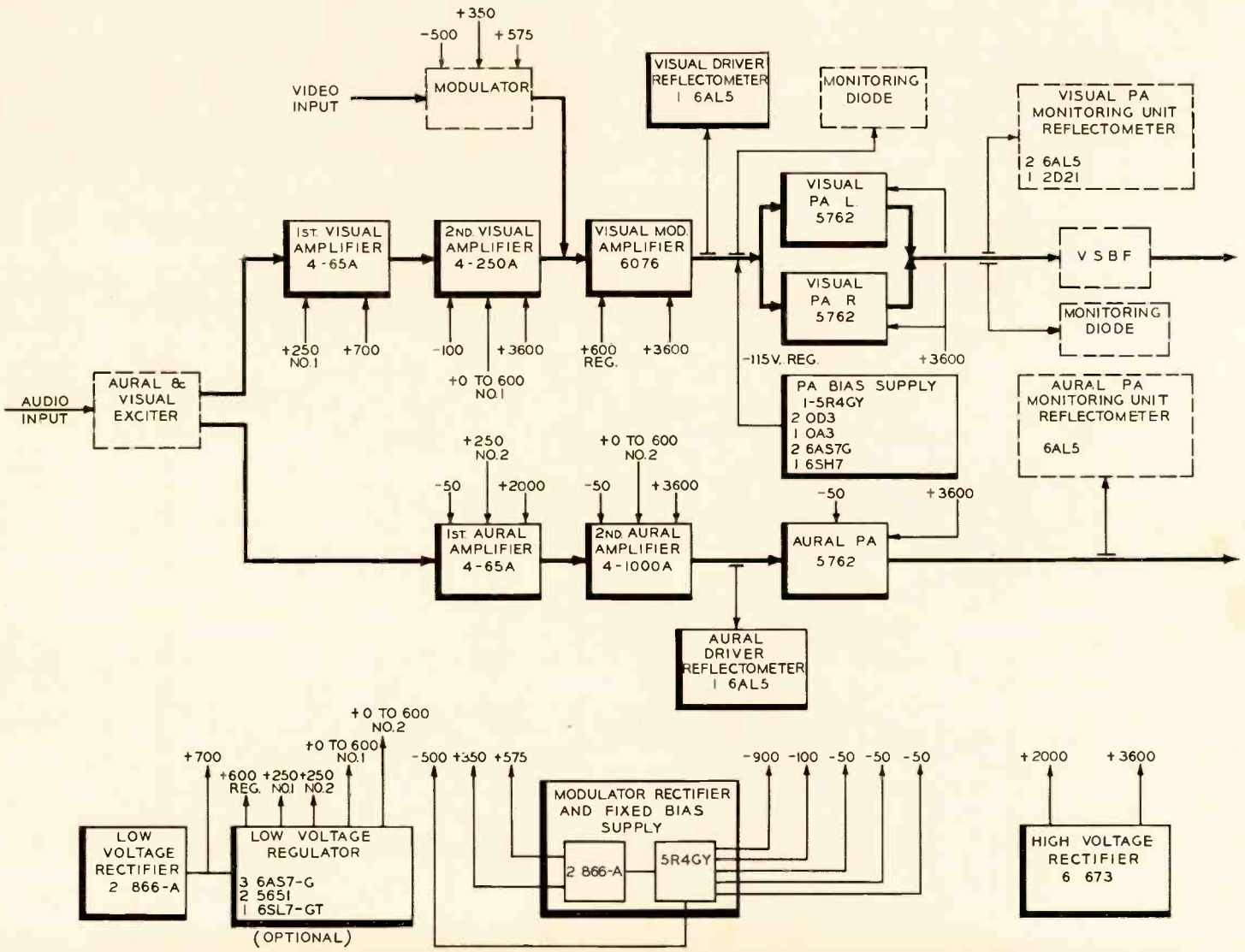
screen voltage on the 4-1000A stage. Both these controls are operated by motors and therefore can be adjusted from a remote position.

Power and Control Equipment

Wherever possible the same d-c power supplies were used for both the visual and aural amplifiers of the TT-6AL. This greatly reduces the number of components in the transmitter and allows operation of the complete equipment with only five power supplies as follows: An exciter supply built into the common exciter unit using stacked germanium diodes; a 700 volt low voltage rectifier, using two 866-A tubes, which supplies the screen voltage for all the pentode amplifiers; a 3600 volt high voltage supply using six 673 tubes in a 3 phase full wave circuit; the modulator rectifier and bias supply, using two 866-A tubes and one 5R4GY tube, which supplies the plate voltage for the modulator and the bias for all the r-f stages except for the visual linear amplifier; and a bias supply for the visual linear amplifier.

A single integrated control circuit is provided for both the visual and aural transmitters. The blower, filaments, and each rectifier are protected by thermal overloads which can be adjusted to reset automatically. In addition, a main line breaker and an auxiliary are provided. Each includes both thermal and magnetic trips. The primaries of the high voltage rectifier and each power amplifier tube including the 4-65A stages are protected by instantaneous overloads. The overload circuit automatically recycles twice. If the fault continues on the third try the overload circuit will remain tripped until reset. Overload indicator lights are provided for each circuit. These lights have a separate reset and will remain on after the first overload thus providing a record of the circuit giving trouble even though it is intermittent. The equipment includes a line corrector which pro-

Block Diagram of the TT-6AL VHF Television Transmitter.

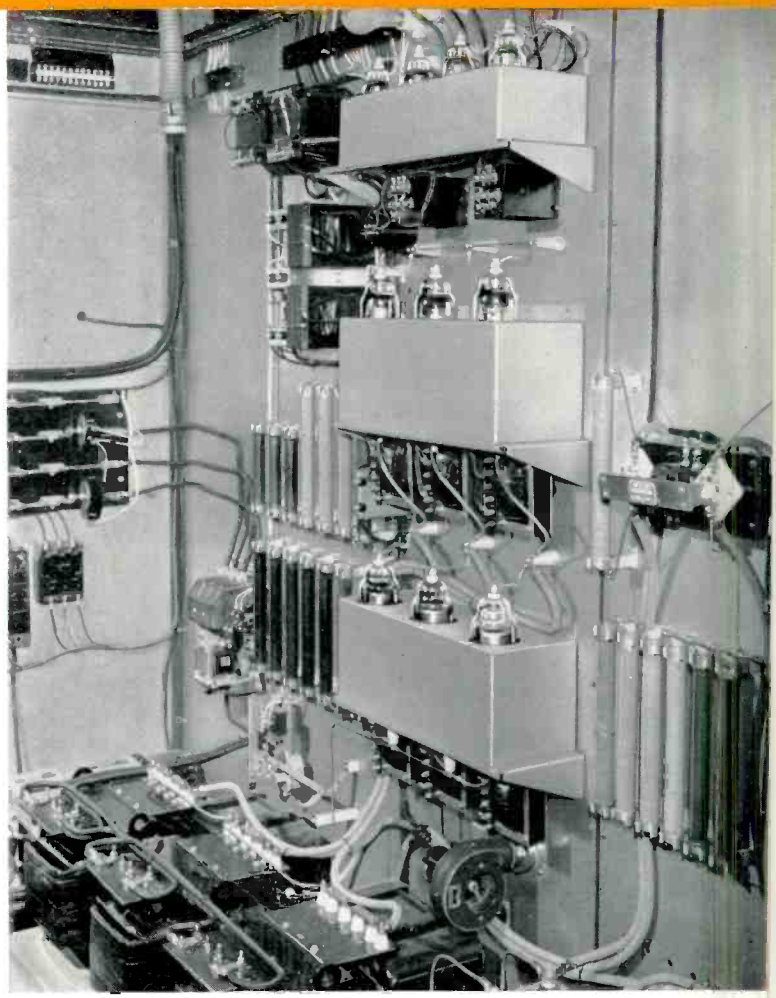


vides an adjustable line voltage to the filament primaries, exciter, modulator, low voltage rectifiers and bias supply. Automatic filament line voltage regulators and automatic regulators capable of handling the complete transmitter are available as optional items.

Video Modulator

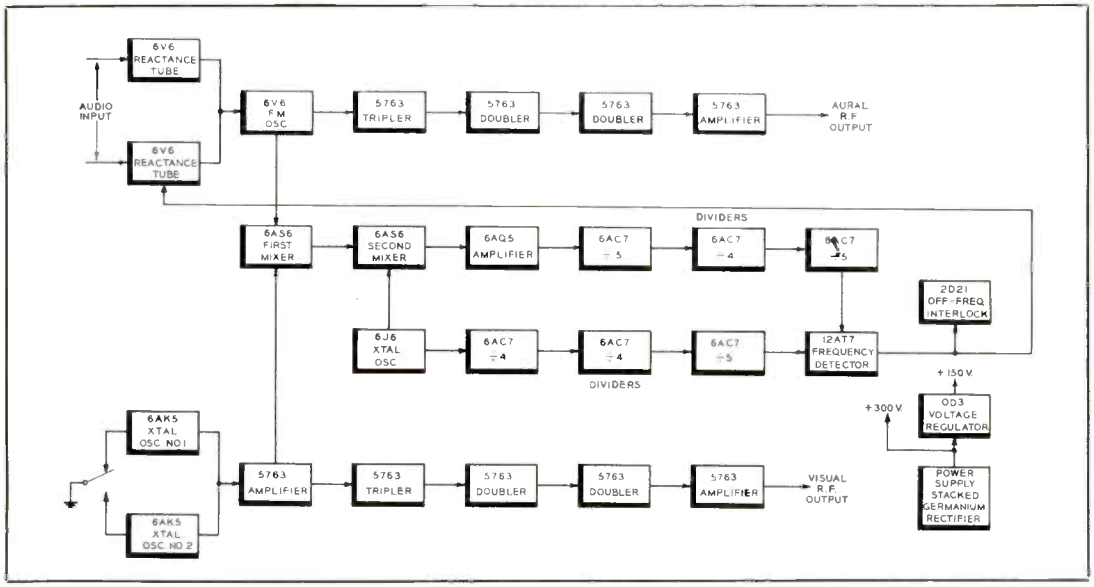
The modulator of the transmitter is designed to take a standard 0.7 volt video signal and amplify it sufficiently so that it can grid modulate the 6076 stage. This requires about 220 volts peak-to-peak from the modulator. The first stage of the modulator is a conventional shunt-series peaked video amplifier. This is followed by an inverter stage and a linearity corrector stage each of which has a gain of approximately one. The linearity corrector is designed to pre-distort the signal to compensate for the non-linearity which occurs in a grid modulated stage, and takes the form of four diodes connected in the cathode circuit of that stage. The bias voltage on each diode is separately adjustable and the diode can be made to start conducting at any brightness level. The grid of this stage is clamped in order to insure the same correction to the linearity characteristic regardless of the average brightness of the picture signal.

The linearity corrector is followed by a second video amplifier using a 6AG7 tube and by a third video amplifier consisting of two 807 tubes. The grids of the third video amplifier are also clamped and from this point on the circuit is d-c coupled. The output stage is a shunt regulated cathode follower. It consists of two 6146 tubes connected in a circuit very similar to a conventional cathode follower stage. The cathode resistor has been replaced by three 6146 tubes operating in parallel. The grid of these



Interior view of rectifier enclosure. Rectifiers are mounted on back wall of the enclosure in heating units which permit operation of the transmitter at lower ambient temperatures.

Block Diagram showing combined aural and visual exciter for the TT-6AL Transmitter.



three tubes are fed with a signal of opposite polarity from the plate load of the two cathode follower tubes. This essentially makes the circuit a feed-back amplifier of high efficiency capable of delivering modulation at a high level to a large capacity load.

The modulator stage is followed by a bucking bias supply consisting of one 6BL7-GT and three OA2 tubes. This serves to transfer the signal from the positive voltage present in the output of the modulator stage to the negative voltage required to modulate the 6076 stage without losing the d-c component. Back porch clamping is employed. A carefully designed sync separator and clipper circuit provides reliable clamping even with greatly degraded input signal.

A two stage monitor amplifier is employed. It can be noted from the block diagram that this monitor amplifier can be switched to many parts of the circuit greatly aiding in making adjustments and in servicing. Plate power for all the stages in the modulator is obtained from two electronic regulators. One supplies approximately 250 volts and the other approximately 475 volts. Although the rectifier itself is located on the rear wall of the transmitter enclosure the regulators are mounted on the same chassis as the video circuit in the modulator. This greatly reduces the possibility of unwanted video resonances.

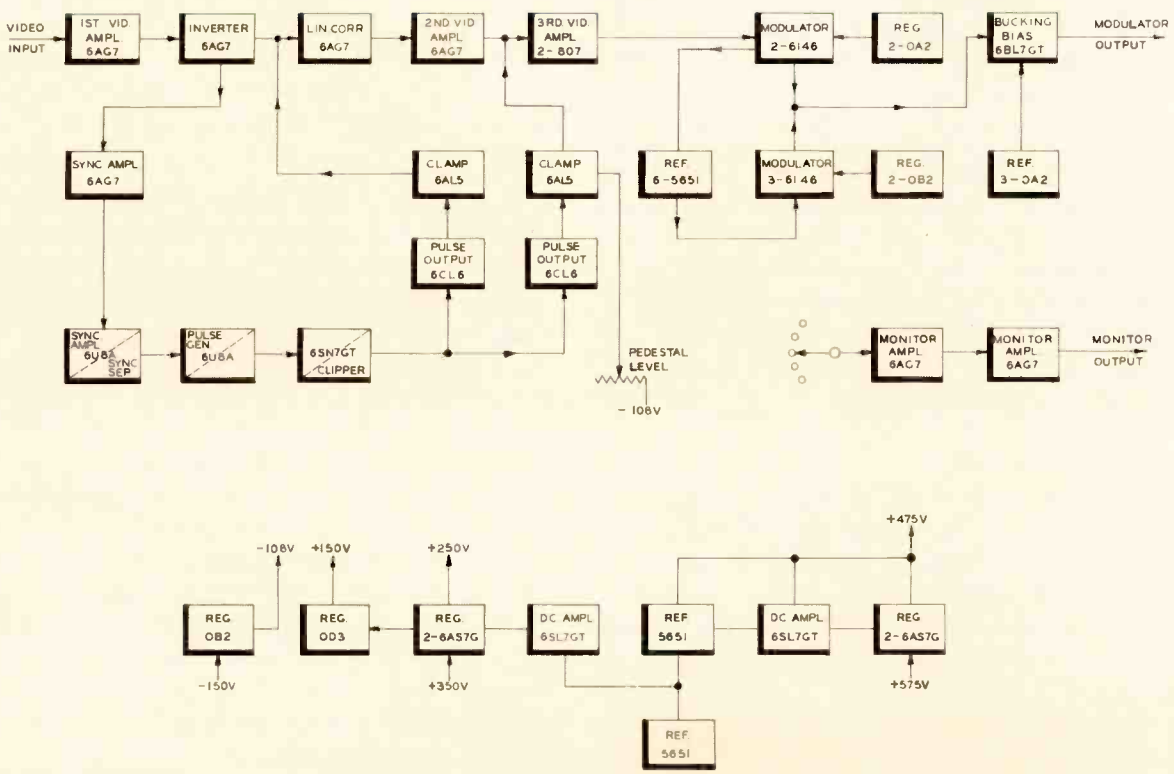
Aural Modulator

Frequency modulation is accomplished in the TT-6AL exciter by a "direct modulation" process requiring less components, fewer tubes and tube types. This process, which eliminates numerous multipliers and converter stages resulting in low noise and minimum distortion, utilizes two push-pull reactance tubes connected across the frequency determining circuit of the master oscillator. The center frequency of this oscillator is precisely maintained by the automatic frequency control circuit described previously in the exciter description.

Frequency modulation is obtained by feeding the audio signal into the reactance tubes which are connected across the oscillator plate tank circuit. R-f energy from the oscillator tank is link coupled to a transformer which has a coil in the grid circuit of each reactance tube. R-f voltages on the push-pull connected grids are 180 degrees out of phase with each other and each is 90 degrees out of phase with respect to the r-f voltage at the plates. Thus, across the oscillator tank one tube appears as a capacitive reactance and the other as an inductive reactance.

The magnitude of the reactive plate current in the reactance tubes varies in direct proportion to the value of audio voltage applied to the grids. Therefore, the fre-

Block Diagram of the TT-6AL Modulator.



quency of the oscillator is varied at an audio rate to furnish the required FM signal. The mean frequency of the oscillator is controlled by varying the grid bias of one of the reactance tubes. This bias voltage is the d-c output voltage of the frequency detector stage of the exciter.

Special Protective Circuits

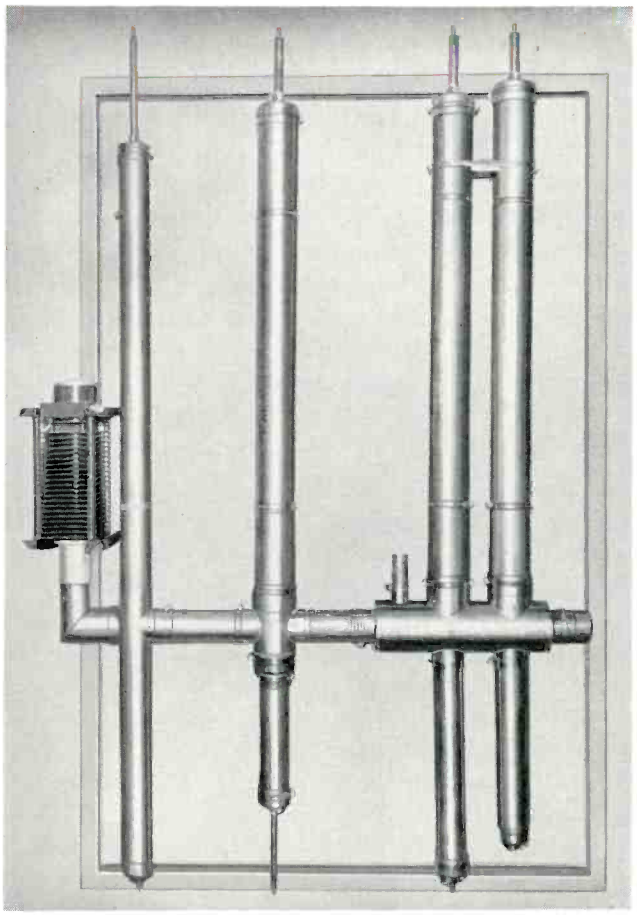
Included as part of the TT-6AL is a MI-19087 Monitoring Unit for use in the output transmission line of the visual amplifier. This unit contains two 6AL5 diode detectors or reflectometers. The transmission line probes are installed so as to give an indication of either forward or reflected power. A meter on the front panel can be switched between the two diode circuits. Power output is read in percent peak power which can be calibrated to read 100% for rated power. The standing-wave ratio is read directly on a specially calibrated scale. In the monitoring unit a type 2D21 thyratron tube operates in conjunction with a relay to remove the high voltage plate power from the complete transmitter when the SWR exceeds a predetermined value as would be the case if an arc occurred in the transmission line or antenna system following the monitoring unit.

A single unit reflectometer is provided for the aural amplifier. This normally is connected to read power output. Standing wave ratio can be measured by manually rotating the reflectometer head. If desired, a complete MI-19087 monitoring unit can be supplied for the aural output as optional equipment. This unit provides two reflectometer heads as well as the SWR monitor. However, since an antenna fault will trip the visual monitor and thus interrupt the common power supply a monitoring unit in the aural line is not necessary to protect the normal antenna system.

A carrier-off monitor is available as optional equipment. It acts in conjunction with the reflectometer units and is particularly useful for remote control. This unit will remove the plate voltage from all the r-f stages if the output level drops below a predetermined value, such as would be the case if an r-f arc occurred in any of the r-f stages. Sometimes such an arc does not change the plate current sufficiently to trip the d-c overload relays.

Harmonic Filter

Harmonic filters are supplied for insertion in the output transmission line. When operated in conjunction with the TT-6AL Transmitter these filters are designed to attenuate all harmonics to a value at least 60 db below the peak carrier level. Electrically, each filter consists of an M-derived half-T section, several low pass filter sections, and a constant-K half-T section. The M-derived section provides rapid cut-off in the second harmonic region and a termination impedance at one end of the filter of 51.5 ohms. Attenuation of the harmonics is accomplished by a low pass filter section, while the constant-K section serves to give termination impedance of 51.5 ohms at the other end of the unit.



The new M-derived vestigial sideband filter, ES-27234, designed for the TT-6AL transmitter.

A low pass filter is provided for insertion in the video input circuit. This filter attenuates all video frequencies above 4.75 megacycles at least 20 db. An all-pass phase equalizer is also included as part of the low pass filter. This equalizer corrects the phase distortion which is introduced as a result of the sharp cut-off. Appropriate filters are available for CCIR Standards.

Sideband Filter (FCC Standard)

A vestigial sideband filter is furnished completely assembled and adjusted for any one of the low band VHF television channels. This filter is an integral unit designed for floor, ceiling, or wall mounting near the visual transmitter so that the input transmission line is as short as possible. It also can be mounted to the top of the transmitter enclosure. The purpose of the filter is to attenuate the lower sideband output of a double sideband visual transmitter in conformance with the FCC regulations.

SPECIFICATIONS

Performance

	FCC Specs.	CCIR Specs.
Type of Emission:		
Visual	A5	A5
Aural	F3	F3
Frequency Range	Ch. 2-6	47-88 mc
Rated Power Output:		
Visual[1]	6 kw	5 kw
Aural[2]	3.15 kw	1.0 kw
Minimum Power Output:		
Visual[1]	2 kw	2 kw
Aural[2]	1 kw	1 kw
R-F Output Impedance	50/51.5 ohms	50/51.5 ohms
Input Impedance:		
Visual	75 ohms	75 ohms
Aural	600/150 ohms	600/150 ohms
Input Level:		
Visual	0.7 volt peak-to-peak min.	0.7 volt peak-to-peak min. (composite video)
Aural	+10 ±2 dbm	+16 ±2 dbm for 50 kc dev. Uniform ±1 db from 50 to 50,000 cyc.
Amplitude vs. Frequency Response	Uniform ±1 db from 50 to 15,000 cyc.	——
Upper sideband Repsonse:[3]		
At Carrier plus 0.5 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 1.25 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 2.0 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 3.0 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 3.58 mc	+1, −1.5 db	——
At Carrier plus 4.18 mc	+1, −3.0 db	+1, −1.5 db
At Carrier plus 4.75 mc	−20 db max.	——
At Carrier plus 5.0 mc	——	+1, −4.0 db
At Carrier plus 5.75 mc	——	−20 db max.
Lower Sideband Response:[4]		
At Carrier minus 0.5 mc	+1, −1.5 db	+1, −1.5 db
At Carrier minus 1.25 mc	−20 db max.	−20 db max.
At Carrier minus 3.58 mc	−42 db max.	——
Variation in Frequency Response with Brightness[5]	±1.5 db	±1.5 db
Carrier Frequency Stability[6]		
Visual	±1 kc	±.0005%
Aural	±500 cps[7]	±.001%
Modulation Capability:		
Visual	12.5 ±2.5% (reference white)	12.5 ±2.5% (reference white)
Aural	±50 kc	±50 kc
Audio Frequency Distortion	1.5% max. 50-100 cyc. 1.0% max. 100-7500 cyc. 1.5% max. 7500-15,000 cyc.	1.5% max. 50-100 cyc. 1.0% max. 100-7500 cyc. 1.5% max. 7500-15,000 cyc.

[1] Measured at the output of the sideband filter or filterplexer.

[2] Measured at the input to the diplexer or filterplexer.

[3] With respect to the response at 200 kc, as measured by the BW-5B Sideband Response Analyzer at transmitter mid-characteristic. 4.75 mc attenuation requires use of MI-27132 LP filter in the video input circuit.

[4] With respect to the response at 200 kc at transmitter mid-characteristic.

[5] Maximum variation with respect to the response at mid-characteristic measured with the BW-5B Sideband Response Analyzer at brightness levels of 22.5% and 67.5% of sync peak, using approximately 20% (peak-to-peak) modulation.

[6] Maximum variation for a period of 30 days without circuit adjustment.

[7] Maximum variation with respect to the standard 4.5 mc separation between aural and visual carriers.

	FCC Specs.	CCIR Specs.
FM Noise, below ±25 kc Swing	60 db	60 db
AM Noise, r.m.s.:		
Visual	45 db below 100% mod.	45 db below 100% mod. (hum and thermal)
Aural	50 db below carrier	50 db below carrier
Amplitude Variation Over One Picture Frame	Less than 5% of the peak of sync level	Less than 5% of the peak of sync level
Regulation of Output	7% max.	7% max.
Burst vs. Subcarrier Phase[8]	±5 degrees max.	——
Subcarrier Phase vs. Brightness[9]	±7 degrees max.	——
Subcarrier Amplitude[8]	±10% max.	——
Linearity (Differential Gain)[10]	1.5 db max.	1.5 db max.
Envelope Delay vs. Frequency[11]	±.08 μsec. from 0.2 to 2.1 mc ±.04 μsec. at 3.58 mc ±.08 μsec. at 4.18 mc	——
Harmonic Attenuation, ratio of any single harmonic to peak visual fundamental	At least 60 db	At least 60 db[12]

Electrical

	FCC Specs.	CCIR Specs.
Power Line Requirements:		
Transmitter:		
Line	230/208 volts, 3 phase, 50/60 cyc.	230/208 volts, 3 phase, 50/60 cyc.
Slow Line Variations	±5% max.	±5% max.
Rapid Line Variations	±3% max.	±3% max.
Power Consumption	See Curve	——
Power Factor approx.)	90%	90%
Crystal Heaters:		
Line	115 volts, single phase, 50/60 cyc.	115 volts, single phase, 50/60 cyc.
Power Consumption	28 watts	28 watts

[8] Maximum departure from the theoretical when reproducing saturated primary colors and their complements at 75% amplitude.

[9] Maximum phase difference with respect to burst, measured after the VSBF, for any brightness level between 75% and 15% of the sync peak using 10% (peak-to-peak) modulation. This is equivalent to 5% (peak-to-peak) modulation as indicated by a conventional diode demodulator. In addition, the total differential phase between any two levels shall not exceed 10 degrees.

[10] Maximum variation in the amplitude of a 3.58 mc sine wave modulating signal as the brightness level is varied between 75% and 15% of sync peak. The gain shall be adjusted for 10% (peak-to-peak) modulation of the 3.58 mc signal when the brightness is at pedestal level. This is equivalent to 5% (peak-to-peak) modulation as indicated by a conventional diode demodulator connected after the VSBF.

[11] Maximum departure from standard curve. The tolerances vary linearly between 2.1 and 3.58 mc and between 3.58 mc and 4.18 mc. To meet the specification a properly terminated phase correction network, ES-34034-B is required in the video input circuit of the transmitter.

[12] Measured with harmonic filters in the visual and aural transmitter outputs.

Tube Complement

VISUAL SECTION

Qty.	Function	Type
1	Visual Crystal Oscillator #1	6AK5
1	Visual Crystal Oscillator #2	6AK5
1	Buffer Amplifier	5763
1	1st Visual Multiplier	5763
1	2nd Visual Multiplier	5763
1	3rd Visual Multiplier	5763
1	Visual Output Amplifier	5763
1	1st Visual Amplifier	4-65A
1	2nd Visual Amplifier	4-250A
1	Visual Modulated Amplifier	6076
1	Visual Driver Reflectometer	6AL5
1	Visual PA (Left)	5762
1	Visual PA (Right)	5762
1	Visual PA Forward Power Detector	6AL5
1	Visual PA Reflected Power Detector	6AL5
1	Reflectometer Thyratron	2D21
1	1st Video Amplifier	6AG7
1	Inverter	6AG7
1	Linearity Corrector	6AG7
1	2nd Video Amplifier	6AG7
2	3rd Video Amplifier	807
5	Modulator	6146
1	1st Sync Amplifier	6AG7
1	2nd Sync Amplifier-Sync Separator	6U8A
1	Pulse Generator	6U8A
1	Clipper	6SN7-GT
1	1st Clamp Diode	6AL5
1	2nd Clamp Diode	6AL5
6	Voltage Reference Tubes (D-C Coupling)	5651
1	Bias Regulator	OB2
2	Regulators (Modulator Screens)	OA2
2	Regulators (Modulator Screens)	OB2
3	Voltage Reference Tubes (Bucking Bias)	OA2
2	Voltage Reference Tubes (L.V. and H.V. Regulators)	5651
1	D-C Amplifier (High Voltage Regulator)	6SL7-GT
2	High Voltage Regulators	6AS7-G
1	D-C Amplifier (Low Voltage Regulator)	6SL7-GT
2	Low Voltage Regulators	6AS7-GT
1	150 V Regulator	OD3
1	Monitor Amplifier	6AC7
1	Monitor Amplifier (Output)	6AG7
1	1st Clamp Pulse Output	6CL6
1	Bucking Bias	6BL7-GT
1	2nd Clamp Pulse Output	6CL6

AURAL SECTION

2	Reactance Tube Modulator	6V6
1	FM Master Oscillator	6V6
1	1st Aural Multiplier	5763
1	2nd Aural Multiplier	5763
1	3rd Aural Multiplier	5763
1	Aural Output Amplifier	5763
1	1st Mixer	6AS6
1	2nd Mixer	6AS6
1	Difference Frequency Amplifier	6AQ5
1	1st Difference Frequency Divider	6AC7
1	2nd Difference Frequency Divider	6AC7
1	3rd Difference Frequency Divider	6AC7
1	Crystal Oscillator-Reference Frequency	6J6
1	1st Reference Frequency Divider	6AC7
1	2nd Reference Frequency Divider	6AC7
1	3rd Reference Frequency Divider	6AC7
1	Cathode Follower-Frequency Detector Driver	12AT7
1	1st Aural Amplifier	4-65A
1	2nd Aural Amplifier	4-1000A
1	Aural PA Reflectometer	6AL5
1	Aural PA	5762

COMMON POWER SUPPLY, ETC.

1	Voltage Regulator	OD3
1	Off-Frequency Interlock Control	2D21
1	Bias Rectifier	5R4GY
2	Voltage Regulators (PA Bias Supply)	OD3
1	Voltage Regulator (PA Bias Supply)	OA3
1	D-C Amplifier (PA Bias Supply)	6SH7
2	Bias Regulators (PA Bias Supply)	6AS7-G
2	Low Voltage Rectifiers	866-A
2	Modulator Rectifiers	866-A
1	Modulator Rectifier (Bias)	5R4GY
6	High Voltage Rectifiers	673

Qty.	Function	Type
†1	D-C Amplifier (Low Voltage Regulator)	6SL7-GT
†2	Voltage Reference Tubes (Low Voltage Regulator)	5651
†3	Series Regulators (Low Voltage Regulator)	5651
†2	Regulators (Carrier-Off Monitor)	OD3
†4	Amplifiers (Carrier-Off Monitor)	5814-A

Mechanical Specifications

Dimensions:

Overall Length (front line cabinets only)	116" (294.6 cm)
Overall Height (front line cabinets only)	84" (213.4 cm)
Depth (front line cabinets only)	20" (50.8 cm)
Overall Depth	$78\frac{13}{16}$" (200 cm)
Weight (approx.)	4300 lbs. (1950.5 kg.)
Finish	Two-tone umber gray, polished stainless steel trim
Maximum Altitude[1]	7500 ft.
Ambient Temperature	45° C. max., 0° C. min.

Equipment Supplied

TT-6AL TELEVISION TRANSMITTER (ES-19281)

Qty.	Description	Stock No.
1	Control Unit	MI-27180-A
1	2-KW Driver (Ch. 2-6)	MI-27181
1	6-KW Power Amplifier Unit (Ch. 2-6)	MI-27182
1	Set of Panels	MI-27450
1	Rectifier Panel	MI-27451
1	Resistor Panel	MI-27452
1	Transformer—Filter Assembly	MI-27465
3	Transformers	MI-27477
1	Blower	MI-27466
1	Installation Material	MI-27467
1	Wiring Material	MI-27468
2	Reflectometers	MI-27464
1	Monitoring Unit	MI-19087
1	Monitoring Diode	MI-19051-B
2	Harmonic Filter	MI-27317[2]
1	Vestigial Sideband Filter	ES-27234[2]
1	4.75 MC Low Pass Filter	MI-27132
2	Side Panels (End Shields)	MI-30541-G84
1	Finish Touch-Up Kit	MI-7499-A
1	Miscellaneous Hardware Kit	MI-7474
1	Set of Frequency Determining Parts for Driver	MI-27482[2]
1	Set of Frequency Determining Parts for Amplifier	MI-27483[2]
2	Crystal Unit (Visual)	MI-27492[2]
1	Set of Operating Tubes	ES-27205
5	Transmission Line Coupling (90° Miter Elbow)	MI-19112-18NF
12	Transmission Line (Ungassed, Straight)	MI-19112-8
1	Nameplate	MI-28180-1
1	Line Corrector	MI-27478[3]
1	Low Voltage Regulator	MI-27469
1	Tool Kit	MI-27088
2	Set of Installation Drawings	8924927-501
2	Installation Instructions	IB-30266-1
2	Instruction Book	IB-36279
*	Transmissin Line (*Sales order must specify quantity for installation requirements)	MI-19113-B

Optional or Accessory Equipment

TTC-5A Control Console Equipment, with master monitor but less master monitor power supply	MI-27274-1
R-F Load and Wattmeter	MI-27396
Complete Set of Spare Tubes	ES-27205
FCC Spare Set of Tubes	ES-27206
Input and Monitoring Equipment, Wired/Unwired	ES-19237-G/E
50 Cycle Conversion Kit	MI-27486
Line Regulator (3 phase)	MI-27473-A
Line Regulator Control Panel	MI-27471
Rectifier Enclosure	ES-19279
Carrier-Off Monitor	ES-27235
BW-5B Sideband Response Analyzer	ES-34010-B
Plate Current Meter	MI-21200-C1
WM-71A Distortion and Noise Meter	MI-30071-A
TO-524-AD Oscilloscope	MI-26500-A
WA-28A Audio Oscillator	MI-30028-A
Exciter Tuning Indicator	MI-27487
BW-4B VHF Visual Demodulator	MI-34057
Exciter Modification Kit (CCIR)	MI-34405

† Tubes for optional Low Voltage Regulator and Carrier-Off Monitor Equipment.

[1] For operation at rated power and normal plate voltage.

[2] Order to suit customer's assigned channel.

[3] Not supplied if Line Regulator, MI-27473-A is ordered.

5 KW VHF TV Transmitter

TYPE TT-5BH

FEATURES

- Solid state rectifiers
- Simplified tuning—only one broadband R-F stage
- Inclined and illuminated meters offer excellent visibility
- Built-in remote control features including motor driven controls and remote metering circuits
- Minimum space requirement (40 sq. ft.) without sacrificing maintenance or operating convenience
- Complete overload protection

DESCRIPTION

The RCA Type TT-5BH for the first time in television transmitter design uses solid state rectifiers throughout. The new TT-5BH in combination with a modern antenna, achieves effective radiated powers of 5 to approximately 90 kilowatts on any channel from 7 through 13 (or 174 mc-216 mc on CCIR standards) while conforming to all FCC, CCIR and EIA standards. It provides a nominal power output of 5 kilowatts (4.5 kw CCIR) peak visual power as measured at the output of the sideband filter or filterplexer and 2.75 kw aural power.

The design of the TT-5BH is simple and straightforward. Tuning is simple, and only one broadband stage is used. All other r-f stages are operated as Class "C" amplifiers. This efficiency, together with use of silicon rectifiers, offers considerable reduction in power requirements, thus effecting a lower operating cost. Space has been conserved to the utmost without sacrificing maintenance or operating convenience. The entire transmitter requires less than 40 square feet of floor space.

TT-5BH can, with the addition of suitable terminal equipment, be operated from a remote location. All the necessary operating functions such as starting and stopping the transmitter, resetting overloads, switching in the spare crystal oscillator or spare exciter, metering all power circuits and reflectometers, controlling power output (including black level, video gain, and excitation) can be performed at the remote location. Even when the transmitter is not remotely controlled, these built-in features make it very easy to obtain fingertip control of the transmitter from a single local position such as a transmitter console.

The transmitter is housed in a compact cabinet having only one access door. The cabinet can be broken down for shipping into racks and panels of varying size for easy handling. All r-f circuits and control circuits are located

at the front of the enclosure. The rectifier tubes are mounted on the rear wall and the heavy power components are mounted on the floor. The control unit is at the left front corner of the transmitter in a separate cabinet with status lights grouped on a panel above the door. The auxiliary switches, breakers, overload and auxiliary relays, etc. are in the control unit behind a non-interlocked door. Overload indicating lights for all the circuits of the transmitter are grouped on a single strip so they can be seen through the window in the door.

To the right of the control unit is the r-f rack. It contains aural and visual r-f power stages, the exciter and modulator units. The modulator and exciter units are located at the bottom of the rack behind dutch doors, hinged at the bottom to facilitate servicing from the front of the transmitter. All important meters of the TT-5BH are mounted in a sloping panel at the top of the r-f rack. Built-in lights in the bottom of the meter panel provide illumination. Tuning controls for the high level stages are located just above the doors. These include all the tuning controls required for broadbanding the visual r-f circuits. Tuning controls are operated by a crank which is removable to prevent accidental misadjustment of the circuits during operation. Easily read counter dials make possible accurate logging of all the circuits. Also located on the panel above the doors are all the operating controls such as the transmitter start switch, plate switch, power operating controls and metering switches.

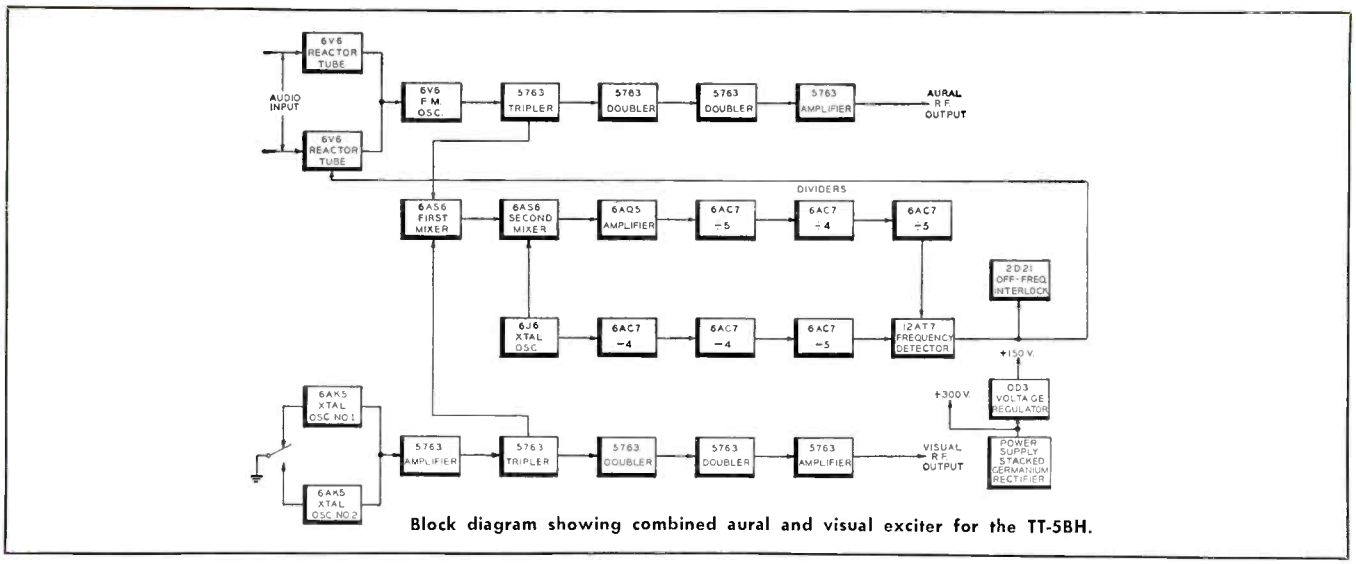
A single access door on the left end of the transmitter provides access to the rear of the control rack and r-f rack as well as the rectifiers mounted on the rear wall of the enclosure. All heavy units such as the plate transformers and large reactors are mounted on a base plate on the floor.

Since all operating controls and important adjustments are brought out to the front of the transmitter, it should not be necessary to enter the enclosure while power is on. Every precaution has been taken to insure the operator's safety when it is necessary to enter the enclosure for routine maintenance and service. In addition to the conventional plate interlock and high voltage grounding contactor, the high voltage plate transformer disconnect switch is fitted with a long handle which extends across the door opening. This makes it difficult to enter the enclosure without opening the primary of the high voltage transformer. The versatility of the new transmitter cabinets may be seen in the floor plan shown.

Exciter Circuit

The TT-5BH transmitter is driven by a common exciter containing both visual and aural chains. Accurate control of the separation of visual and aural carrier frequencies is the result of precise engineering circuit design. The visual chain is driven by either one of the two crystal controlled 6AK5 oscillator circuits as a primary source of frequency control. Oscillators may be switched by means of a relay, thus making this circuit adaptable for remote control. The crystals operate at one-thirty-sixth the visual carrier frequency and one-twelfth of the output frequency of the exciter. The aural master oscillator is a free-running 6V6 oscillator controlled by a pair of 6V6 reactance tubes which are part of the automatic-frequency control circuit used to maintain the 4.5 mc (5.5 mc CCIR) separation between carriers. An off-frequency interlock prevents uncontrolled frequency operation by cutting off plate voltage to the stages that follower the exciter. The aural master oscillator operates at one-thirty-sixth of the carrier frequency with the output of the exciter being one-third the carrier frequency.

Photo of the rectifier panel showing completely siliconized power supplies. At the lower right are the silicon diodes that make up the 4800-volt rectifier thus eliminating all mercury-vapor rectifiers.



Block diagram showing combined aural and visual exciter for the TT-5BH.

The automatic frequency control of the aural master oscillator is accomplished by feeding a small amount of energy from the aural and visual triplers into a 6AS6 mixer tube. When the aural oscillator is on frequency the output of this mixer stage will be one-twelfth of the difference frequency between the aural and visual carriers or 375 kc (458.333 kc CCIR). The 375 kc (458.333 kc CCIR) signal mixes with the output of the 6J6 crystal controlled reference oscillator (1500 kc or 1833.33 kc CCIR) in the second 6AS6 mixer stage. The sum frequency is fed through a chain of three dividers with a total division of 100 to the frequency detector stage. This amount of division is necessary to reduce the swing at the frequency detector so that the carrier will not drop out under any modulation conditions of the aural transmitter. The 6J6 reference oscillator signal is fed through three divider stages with a total division of 80 to the frequency detector stage. By using the 6J6 reference oscillator output to excite both the second mixer and the divider chain for reference frequency, considerable improvement in frequency control accuracy is obtained. Signals from both the difference frequency and the reference frequency chains are fed into the frequency detector. The frequency detector is essentially a balanced modulator with a d-c component in the output which will change polarity depending upon whether the signal frequency is above or below the reference frequency. This d-c voltage is fed back to one of the reactance tubes for the master oscillator in such a way as to correct the frequency of the master oscillator.

R-F Circuits

The r-f circuits employ a chain of multipliers and amplifiers. In the visual chain a 7034 tube operates as a tripler driving a 4CX300A amplifier which in turn drives a type 4CX5000A grid modulated power amplifier. The aural chain consists of a type 4CX300A tripler driving a type 4CX5000A class "C" power amplifier. Excitation control for the visual modulated amplifier is accomplished by varying the screen voltage on the 4CX300A amplifier stage. Power output of the aural transmitter is adjusted by varying the screen voltage on the 4CX5000A stage. Both these controls are operated by motors and therefore can be adjusted from a remote position.

Visual Modulator

The 4CX5000A visual modulated amplifier is grid modulated by the video modulator. A modulator output signal of approximately 300 volts peak-to-peak is required for full modulation of the visual transmitter. The modulator amplifies a standard 1 volt video signal to the required level. A linearity correction circuit is included, as well as motor-driven operating controls for use when remote control is incorporated.

The first amplifier stage in the video modulator is a conventional shunt-series peaked video amplifier. This is followed by an inverter stage and a linearity corrector stage, each of which has a gain of approximately unity. The linearity corrector is designed to predistort the signal to compensate for the non-linearity which always occurs in a grid modulated stage. Linearity correction is accomplished by the use of four biased diodes connected in the linearity corrector cathode circuit. The bias voltage on each diode is separately adjustable. Any one of the diodes can be made to start conducting at any brightness level. The grid of the linearity corrector is clamped in order to insure the same correction to the linearity characteristic regardless of the average brightness of the picture signal. The linearity corrector is followed by a second video amplifier using a 6CL6 tube and then by a third video amplifier consisting of two 5933 tubes. The grids of the third video amplifier are also clamped and from this point on the circuit is d-c coupled. The output (modulator) stage is a shunt regulated cathode follower. It consists of three 6146 tubes connected in a circuit very similar to a conventional cathode follower, except that the cathode resistor is replaced by four 6146 tubes operating in parallel. The

grids of these four tubes are fed with a signal from the plate load of the three cathode follower tubes. This makes the circuit essentially a feedback amplifier of high efficiency capable of delivering modulation at a high level to a large capacitive load.

A carefully designed clamp circuit assures reliable clamping even with greatly degraded input signal. Back porch clamping is employed.

Two power supplies are used. One supplies 250 volts to the low level stages while the other supplies 575 volts to the third video and modulator stages. The use of a negative 575 volt supply makes the use of a bucking bias supply unnecessary.

The outputs of both supplies are electronically regulated by regulators mounted on the modulator chassis. This greatly reduces the possibility of unwanted video resonances in power supply leads. The modulator rectifiers are located on the rear wall of the transmitter enclosure.

A monitor amplifier is provided for monitoring the modulator output signal. Numerous test jacks are also provided to simplify trouble-shooting and modulator alignment.

Aural Modulator

Frequency modulation is accomplished in the TT-5BH exciter by a "direct modulation" process requiring less components, fewer tubes and tube types. This process, which eliminates numerous multipliers and converter stages resulting in low noise and minimum distortion, utilizes two push-pull reactance tubes connected across the frequency determining circuit of the master oscillator. The center frequency of this oscillator is precisely maintained by the automatic frequency control circuit described previously in the exciter description.

Frequency modulation is obtained by feeding the audio signal into the reactance tubes which are connected across the oscillator plate tank circuit. R-F energy from the oscillator tank is link coupled to a transformer which has a coil in the grid circuit of each reactance tube. R-F voltages on the push-pull connected grids are 180 degrees out of phase with each other and each is 90 degrees out of phase with respect to the r-f voltage at the plates. Thus,

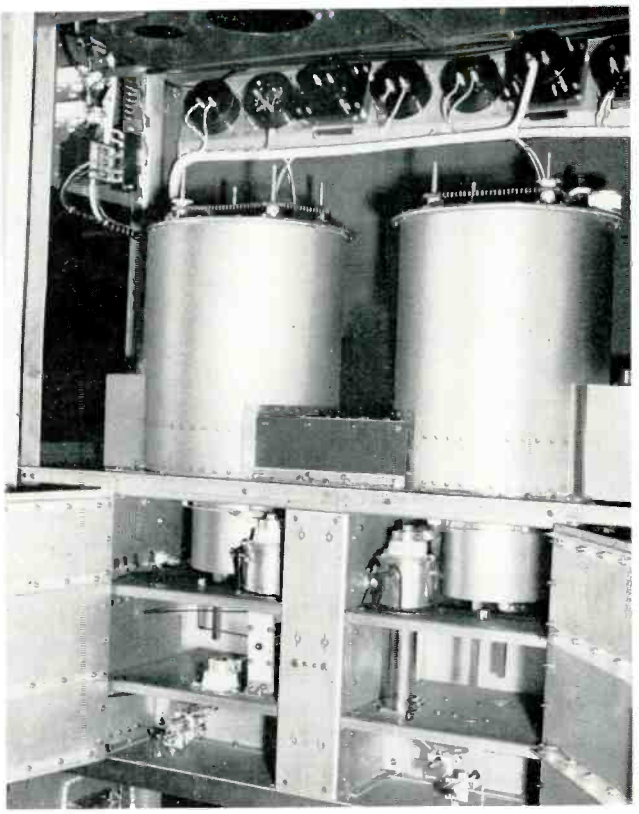
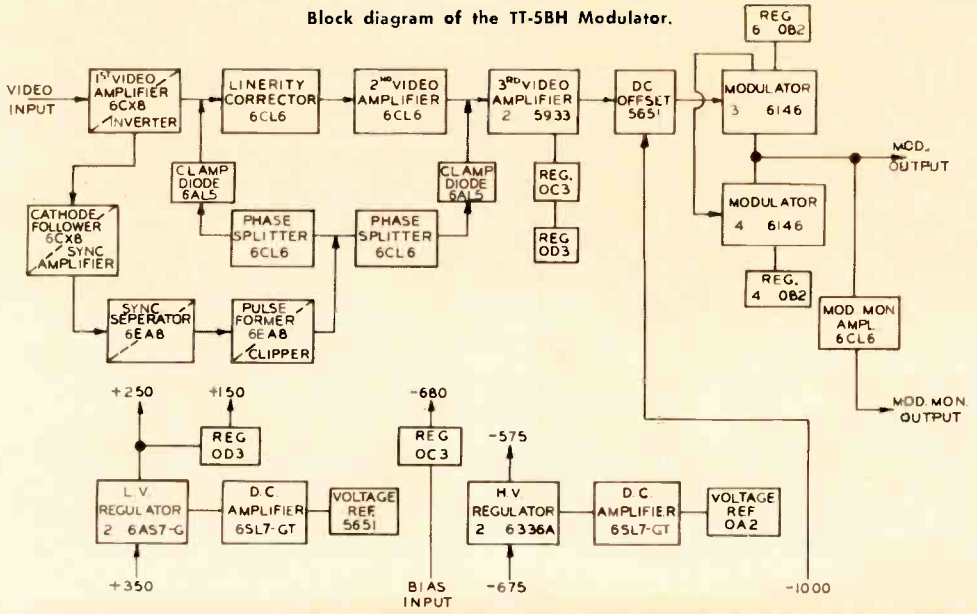
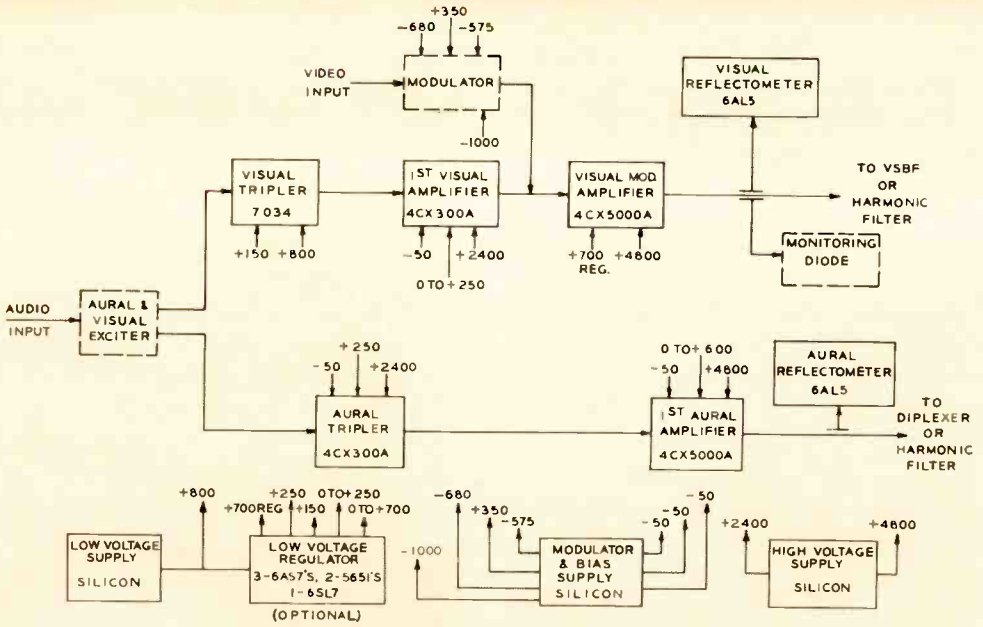


Photo showing the rear of the r-f circuitry—visual left and aural right—with the excellently shielded lower-level stages. Note that each stage occupies its own compartment. This compartment technique eliminates parasitic and other possible interactions between stages.

Block diagram of the TT-5BH Modulator.





Block diagram of the TT-5BH VHF Television Transmitter.

across the oscillator tank one tube appears as a capacitive reactance and the other as an inductive reactance. The magnitude of the reactive plate current in the reactance tubes varies in direct proportion to the value of audio voltage applied to the grids. Therefore, the frequency of the oscillator is varied at an audio rate to furnish the required FM signal. The mean frequency of the oscillator is controlled by varying the grid bias of one of the reactance tubes. This bias voltage is the d-c output voltage of the frequency detector stage of the exciter.

Power and Control Equipment

Wherever possible in this transmitter, the same d-c power supplies were used for both the visual and aural amplifiers. This greatly reduces the number of components in the transmitter and allows operation of the complete equipment with only five power supplies. An exciter supply is built into the common exciter unit using stacked germanium diodes. The other four supplies, all using silicon diodes, are located on the rectifier panel at the rear of the enclosure. An 800-volt supply furnishes all screen voltages as well as the 7034 plate voltage. The high-voltage supply has a 4800-volt output for the 4CX5000A plates and a 2400-volt output for the 4CX300A plates. All voltages for the visual modulator are furnished by the remaining two supplies. One has an output of +350 volts, and the other has several outputs, all negative with respect to ground, which supply the high-level video stages as well as bias for the modulator and r-f stages.

A single integrated control circuit is provided for both the visual and aural transmitters. The blower, filaments, and each rectifier is protected by thermal overloads which can be adjusted to reset automatically. In addition, a main line breaker and an auxiliary breaker are provided. Each incorporates both thermal and magnetic trips. All rectifiers and r-f stages following the exciter are protected by instantaneous overload relays which automatically recycle twice. If the fault continues on the third try the overload circuit will remain tripped until reset. Overload indicator lights are provided for each circuit. These lights have a separate reset and will remain on after the first overload thus providing a record of the circuit giving trouble even though it may be intermittent.

The equipment includes a line corrector which provides an adjustable line voltage to the filament primaries, the exciter, the modulator, and the low voltage rectifiers. Automatic filament line voltage regulators and automatic regulators capable of handling the complete transmitter are available as optional items. In localities troubled with excessive instantaneous line voltage fluctuation, an electronically controlled regulator for the low voltage supply is available as optional equipment.

Special Protective Circuits

The TT-5BH has reflectometer units for use in the output transmission lines of both the aural and visual amplifiers. Each unit contains a 6AL5 diode detector. The transmission line probes are installed so as to give an indication of the amount of power on meters on the front panel. Reflected power can be checked by manually rotating the reflectometer heads.

A carrier-off monitor is available as optional equipment. It acts in conjunction with the reflectometer units and is particularly useful for remote control. This unit will remove the plate voltage from all the r-f stages if the output level drops below a predetermined value, such as would be the case if an r-f arc occurred in any of the r-f stages. Sometimes such an arc does not change the plate current sufficiently to trip the d-c overload relays.

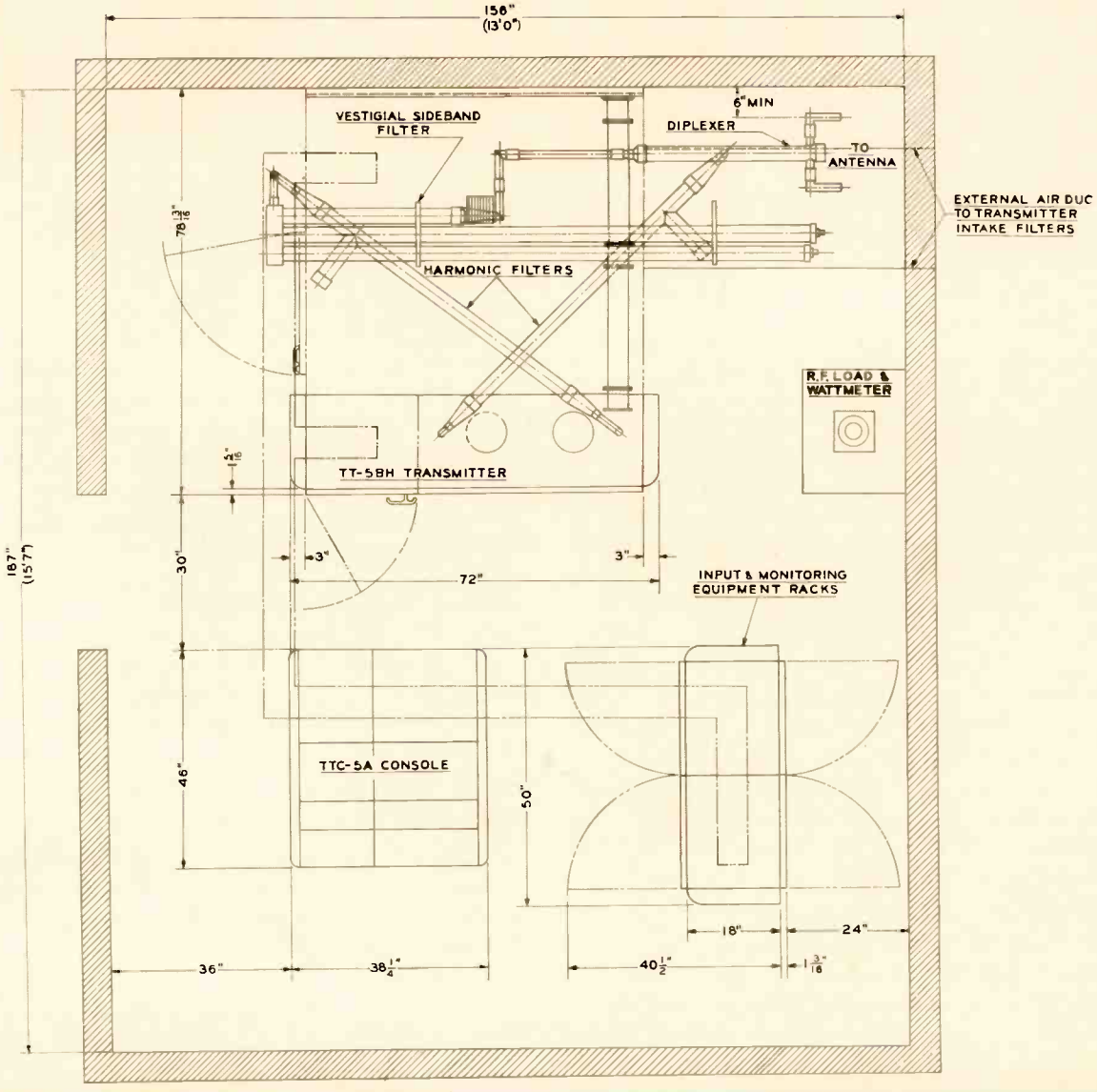
Harmonic Filter

Harmonic filters are supplied for insertion in the output transmission line. When operated in conjunction with the TT-5BH Transmitter these filters are designed to attenuate all harmonics to a value at least 60 db below the peak carrier level. Electrically, each filter consists of an M-derived half-T section, several low pass filter sections, and a constant-K half-T section. The M-derived section provides rapid cut-off in the second harmonic region and a termination impedance of 51.5 ohms at one end of the filter. Attenuation of the harmonics is accomplished by a low pass filter section, while the constant-K section serves to give termination impedance of 51.5 ohms at the other end of the unit.

A low pass filter is provided for insertion in the video input circuit for FCC standards. This filter attenuates all video frequencies above 4.75 megacycles at least 20 db. An all-pass phase equalizer is also included as part of the low pass filter. This equalizer corrects the phase distortion which is introduced as a result of the sharp cut-off. Appropriate filters are available for CCIR standards.

A vestigial sideband filter is available completely assembled and adjusted for any one of the high band VHF television channels. This filter is an integral unit designed for floor, ceiling, or wall mounting near the visual transmitter so that the input transmission line is as short as possible. The filter sections consist of lengths of coaxial line (resonant cavities), which are adjustable for tuning purposes. As the filter is pre-tuned at the factory to the channel stamped on the name plate, no operating adjustments are necessary.

Typical floor plan for the TT-5BH Transmitter.



SPECIFICATIONS

Performance Specifications

	FCC Specs.	CCIR Specs.
Type of Emission:		
Visual	A5	A5
Aural	F3	F3
Frequency Range	Ch. 7-13	174-216 mc
Rated Power Output:		
Visual	5 kw[1]	4.5 kw[1]
Aural	2.75 kw[2]	0.9 kw[2]
Minimum Power Output:		
Visual	2 kw[1]	2 kw[1]
Aural	1 kw[2]	0.9 kw[2]
R.F. Output Impedance	50/51.5 ohms	50/51.5 ohms
Input Impedance		
Visual	75 ohms	75 ohms
Aural	600/150 ohms	500/150 ohms
Input Level:		
Visual	0.7 volt peak-to-peak min.	0.7 volt peak-to-peak min. (composite video)
Aural	+10 ±2 dbm	+16 ±2 dbm for 50 kc dev. Uniform ±1 db from 50 to 15,000 cyc.
Amplitude vs. Frequency Response, Aural	Uniform +1 db from 50 to 15,000 cyc.	——
Upper Sideband Response:[3]		
At Carrier plus 0.5 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 1.25 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 2.0 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 3.0 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 3.58 mc	+1, −1.5 db	——
At Carrier plus 4.18 mc	+1, −3.0 db	+1, −1.5 db
At Carrier plus 4.75 mc	−20 db max.	——
At Carrier plus 5.0 mc	——	+1, −4.0 db
At Carrier plus 5.75 mc	——	−20 max.
Lower Sideband Response:[4]		
At Carrier minus 0.5 mc	+1, −1.5 db	+1, −1.5 db
At Carrier minus 1.25 mc	−20 db max.	−20 db max.
At Carrier minus 3.58 mc	−42 db max.	
Variation in Frequency Response with Brightness[5]	±1.5 db	±1.5 db
Carrier Frequency Stability:[6]		
Visual	±1 kc	±.0005%
Aural	±500 cyc.[7]	±.001%
Modulation Capability:		
Visual	12.5 ±2.5% (reference white)	12.5 ±2.5% (reference white)
Aural	±50 kc	±50 kc
	FCC Specs.	CCIR Specs.
Audio Frequency Distortion	1.5% max. 50-100 cyc. 1.0% max. 100-7500 cyc. 1.5% max. 7500-15,000 cyc.	1.5% max. 50-100 cyc. 1.0% max. 100-7500 cyc. 1.5% max. 7500-15,000 cyc.

[1] Measured at the output of the sideband filter or filterplexer.
[2] Measured at the input to the diplexer or filterplexer.
[3] With respect to the response at 200 kc, as measured by the BW-5B Sideband Response Analyzer at transmitter mid-characteristic 4.75 mc attenuation requires use of MI-27132 LP filter in the video input circuit.
[4] With respect to the response at 200 kc at transmitter mid-characteristic.
[5] Maximum variation with respect to the response at mid-characteristic measured with the BW-5B Sideband Response Analyzer at Brightness levels of 22.5% and 67.5% of sync peak, using approximately 20% (peak-to-peak) modulation.
[6] Maximum variation for a period of 30 days without circuit adjustment.
[7] Maximum variation with respect to the standard 4.5 mc separation between aural and visual carrier.

	FCC Specs.	CCIR Specs.
FM Noise, below ±25 kc Swing	60 db	——
FM Noise, below ±50 kc Swing	——	60 db
AM Noise, r.m.s. (Hum and Thermal):		
Visual	45 db below 100% mod.	45 db below 100% mod.
Aural	50 db below carrier	50 db below carrier
Amplitude Variation Over One Picture Frame:		
Visual	Less than 5% of the peak of sync level	Less than 5% of the peak of sync level
Regulation of Output	7% max.	7% max.
Burst vs. Subcarrier Phase[8]	±5 degrees max.	——
Subcarrier Phase vs. Brightness[9]	±7 degrees max.	——
Subcarrier Amplitude[8]	±10% max.	——
Linearity (Differential Gain)[10]	1.5 db max.	1.5 db max.
Envelope Delay vs. Frequency[11]	±.08 μsec. from 0.2 to 2.1 mc ±0.4 μsec. at 3.58 mc ±.08 μsec. at 4.18 mc	—— —— ——
Harmonic Attenuation, ratio of any single harmonic to peak visual fundamental:		
Visual	At least 60 db[7]	At least 60 db[12]
Aural	At least 60 db[7]	At least 60 db[12]

Electrical Specifications

	FCC Specs.	CCIR Specs.
Power Line Requirements:		
Transmitter:		
Line	230/208 volts, 3 phase, 50/60 cyc	230/208 volts, 3 phase, 50/60 cyc
Slow Line Variations	±5% max.	±5% max.
Rapid Line Variations	±3% max.	±3% max.
Regulation	3% max.	——
Power Consumption	19 kw (black pix) 16.6 kw (average pix)	15.5 kw (black pix) 13.2 kw (average pix)
Power Factor (approx.)	90%	90%
Crystal Heaters:		
Line	115 volts, 1 phase, 50/60 cyc.	115 volts, 1 phase, 50/60 cyc.
Power Consumption	28 watts	28 watts

[8] Maximum departure from the theoretical when reproducing saturated primary colors and their complements at 75% amplitude.
[9] Maximum phase difference with respect to burst, measured after the VSBF, for any brightness level between 75% and 15% of the sync peak using 10% (peak-to-peak) modulation. This is equivalent to 5% (peak-to-peak) modulation as indicated by a conventional diode demodulator. In addition, the total differential phase between any two levels shall not exceed 10°.
[10] Maximum variation in the amplitude of a 3.58 mc sine wave modulating signal as the brightness level is varied between 75% and 15% of sync peak. The gain shall be adjusted for 10% (peak-to-peak) modulation of the 3.58 mc signal when the brightness is at pedestal level. This is equivalent to 5% (peak-to-peak) modulation as indicated by a conventional diode demodulator connected after the VSBF.
[11] Maximum departure from standard curve. The tolerances vary linearly between 2.1 and 3.58 mc and between 3.58 and 4.18 mc. To meet the specification a properly terminated phase correction network, ES- 34034-B is required in the video input circuit of the transmitter.
[12] Measured with harmonic filters in the visual and aural transmitter outputs.

SPECIFICATIONS (Continued)

TT-5BH Tube Complement

EXCITER

Qty.	Function	Type
1	Visual Crystal Oscillator #1	6AK5
1	Visual Crystal Oscillator #2	6AK5
1	Buffer Amplifier	5763
1	1st Visual Multiplier	5763
1	2nd Visual Multiplier	5763
1	3rd Visual Multiplier	5763
1	Visual Output Amplifier	5763
2	Reactance Tube Modulator	6V6
1	FM Master Oscillator	6V6
1	1st Aural Multiplier	5763
1	2nd Aural Multiplier	5763
1	3rd Aural Multiplier	5763
1	Aural Output Amplifier	5763
1	1st Mixer	6AS6
1	2nd Mixer	6AS6
1	Difference Frequency Amplifier	6AQ5
1	1st Difference Frequency Divider	6AC7
1	2nd Difference Frequency Divider	6AC7
1	3rd Difference Frequency Divider	6AC7
1	Crystal Oscillator-Reference Frequency	6J6
1	1st Reference Frequency Divider	6AC7
1	2nd Reference Frequency Divider	6AC7
1	3rd Reference Frequency Divider	6AC7
1	Cathode Follower-Frequency Detector Drive	12AT7
1	Off-Frequency Detector	6AS6
2	Off-Frequency Interlock Control	2D21
1	Voltage Regulator	OD3

MODULATOR

1	1st Video Amplifier and Inverter	6CX8
1	Linearity Corrector	6CL6
1	2nd Video Amplifier	6CL6
2	3rd Video Amplifier	5933
7	Modulator	6146
1	Modulator Monitor	6CL6
1	Sync Cathode Follower and Amplifier	6CX8
1	Sync Separator	6EA8
1	Pulse Former and Clipper	6EA8
1	Phase Splitter #1	6CL6
1	Phase Splitter #2	6CL6
1	Clamp Diode #1	6AL5
1	Clamp Diode #2	6AL5
1	Voltage Regulator	OA2
10	Voltage Regulators (Modulator Screens)	OB2
2	Voltage Regulators	OC3
2	Voltage Regulators	OD3
2	Voltage Reference	5651
2	Low Voltage Regulators	6AS7-GA
2	High Voltage Regulators	6336-A
2	DC Amplifiers	6SL7-GT

R-F UNIT

1	Visual Tripler	7034
1	1st Visual Amplifier	4CX300A
1	Visual Modulated Amplifier	4CX5000A
1	Aural Tripler	4CX300A
1	1st Aural Amplifier	4CX5000A
2	Reflectometer Detectors	6AL5

Mechanical Specifications

Dimensions:	
Overall Length (front line cabinets only)	72" (182.9 cm)
Overall Height (front line cabinets only)	84" (213.4 cm)
Depth (front line cabinets only)	20" (50.8 cm)
Overall Depth	78 13/16" (200 cm)
Weight	5000 lbs. (2268 kg.)
Finish	Two-tone umber gray, polished stainless steel trim
Maximum Altitude[1]	7500 ft.
Ambient Temperature	45° C. max., 0° C. min.

Equipment Supplied

TT-5BH TELEVISION TRANSMITTER (ES-34258)

Qty.	Description	Stock No.
1	Control Unit	MI-27180-A
1	R-F and Modulator Unit	MI-34460
1	Set of Panels	MI-34472
1	Rectifier Panel	MI-34461
1	Transformer-Filter Assembly	MI-34462
1	Transformer	MI-27636-C
1	Blower	MI-34463
1	Blower Enclosure and Filter Panel	MI-34464
1	Installation Material	MI-34465
1	Wiring Material	MI-34466
1	Monitoring Diode	MI-19051-B
2	Harmonic Filter	MI-27317[2]
1	Vestigial Sideband Filter	MI-19114-B[2]
1	4.75 MC Low Pass Filter	MI-27132
2	Side Panels (End Shields)	MI-30541-G84
1	Finish Touch-Up Kit	MI-7499-A
1	Miscellaneous Hardware Kit	MI-7474
2	Crystal Unit (Visual)	MI-27492[2]
1	Set of Operating Tubes	ES-34259
1	Line Corrector	MI-27478[3]
1	Nameplate	MI-28180-1
1	Tool Kit	MI-27088
*	Transmission Line (*Sales order must specify type and quantity for installation requirements)	MI-19112/19313
1	Set of Installation Drawings	8528129-501/IB-30295
2	Instruction Book	IB-30296

Optional or Accessory Equipment

TTC-5A Control Console Equipment, with master monitor but less master monitor power supply	ES-27274-1
R-F Load and Wattmeter	MI-27396
Complete Set of Spare Tubes	ES-34259
FCC Spare Set of Tubes	ES-34260
Input and Monitoring Equipment	ES-19237-E
50 Cycle Conversion Kit	MI-34467
Line Corrector (for manual control)	MI-27478
Line Regulator (single phase)	MI-27472
Line Regulator Control Panel	MI-27471
Rectifier Enclosure	ES-19285
Low Voltage Regulator	MI-27469
Carrier-Off Monitor	ES-27235
BW-5B Sideband Response Analyzer	ES-34010-B
WM-71A Distortion and Noise Meter	MI-30071-A
WA-28A Audio Oscillator	MI-30028-A
Exciter Tuning Indicator	MI-27487
BW-4B VHF Visual Demodulator	MI-34057
TO-524-AD Oscilloscope	MI-26500-A
Exciter Modification Kit (CCIR)	MI-34405

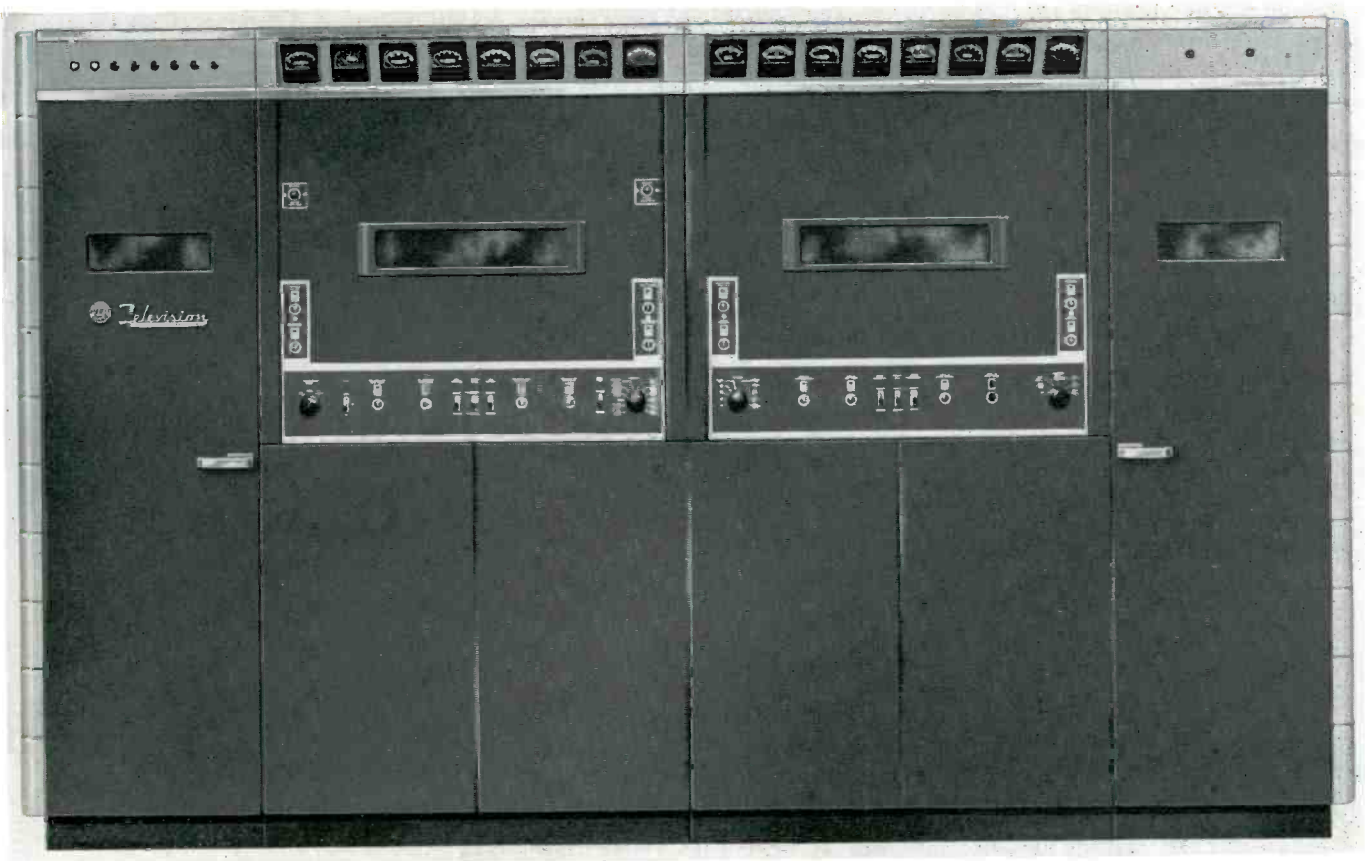
[1] For operation at rated power and normal plate voltage.

[2] Order to suit customer's assigned channel.

[3] Not supplied if Automatic Voltage Regulator MI-27471/MI-27472 are ordered as accessory equipment.

11 KW VHF TV Transmitter

TYPE FT-11AH



FEATURES

- Intercarrier frequency control automatically maintains carrier separation within ±500 cycles
- DC filament supply—AM hum on visual carrier now better than 45 db below 100 percent modulation
- Space saving cabinet design — up to 40 percent saving over previous 10 kw transmitter space requirements
- Extensive metering and overload circuits afford complete supervisory control of operation
- Compatability with power amplifiers makes power increase easy
- Lower tube costs—same proven tube types used in aural and visual circuits
- Designed for color — built-in linearity correction circuits
- Remote operation—Tuning motors and remote metering facilities are built-in

DESCRIPTION

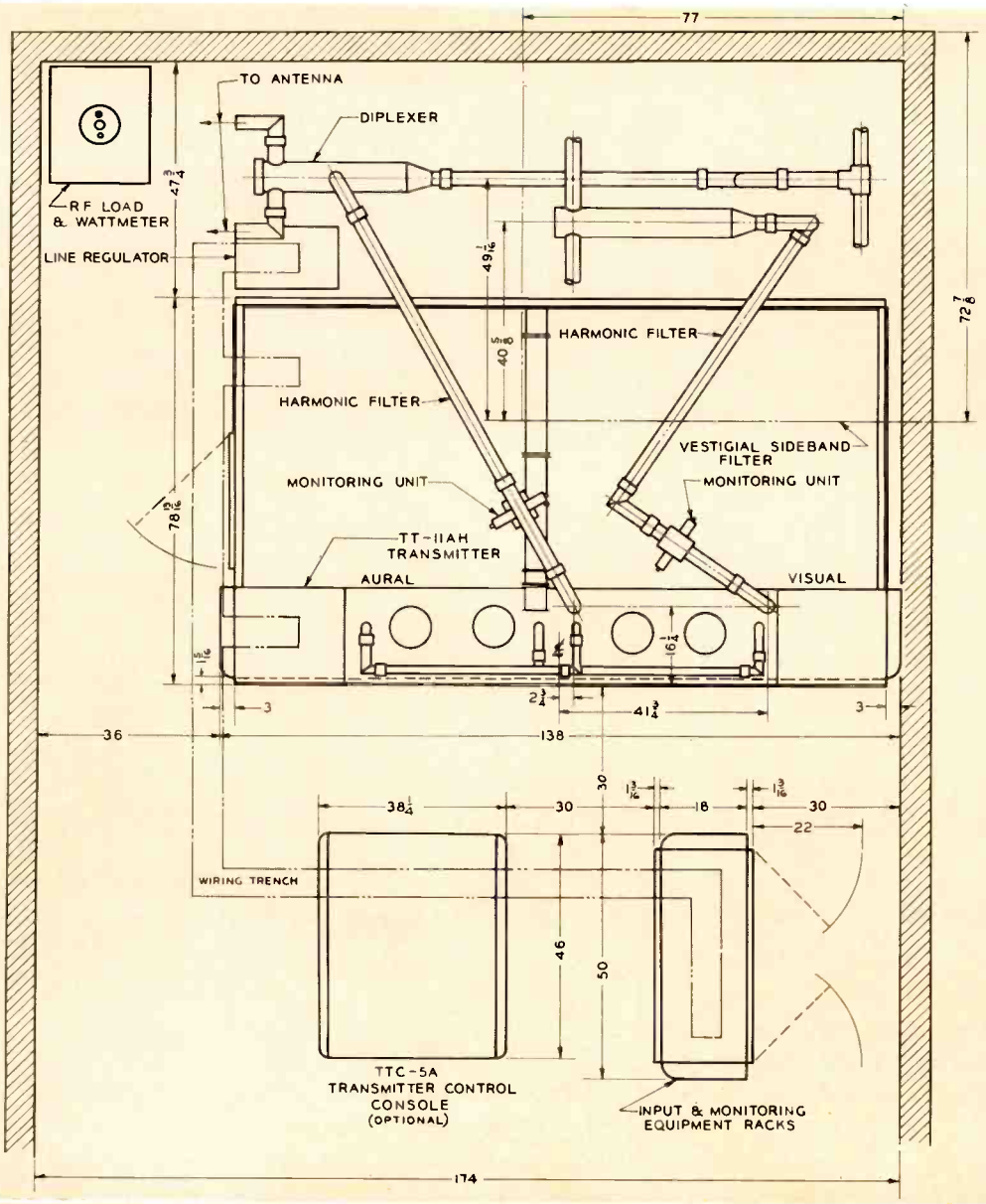
The RCA Type TT-11AH VHF Television Transmitter is a newly designed medium-power television transmitter for channels 7 to 13 (174 mc-223 mc CCIR). It will, in combination with RCA antennas, provide ERP ranging from 2 KW to 18 KW for effective coverage of large urban areas. The TT-11AH provides an excellent low cost standby transmitter for existing high power stations.

A medium power station with plans for future expansion will find the TT-11AH an excellent choice since the transmitter may later be complemented with an RCA TT-25BH amplifier for reaching high power status with a minimum of expense and conversion.

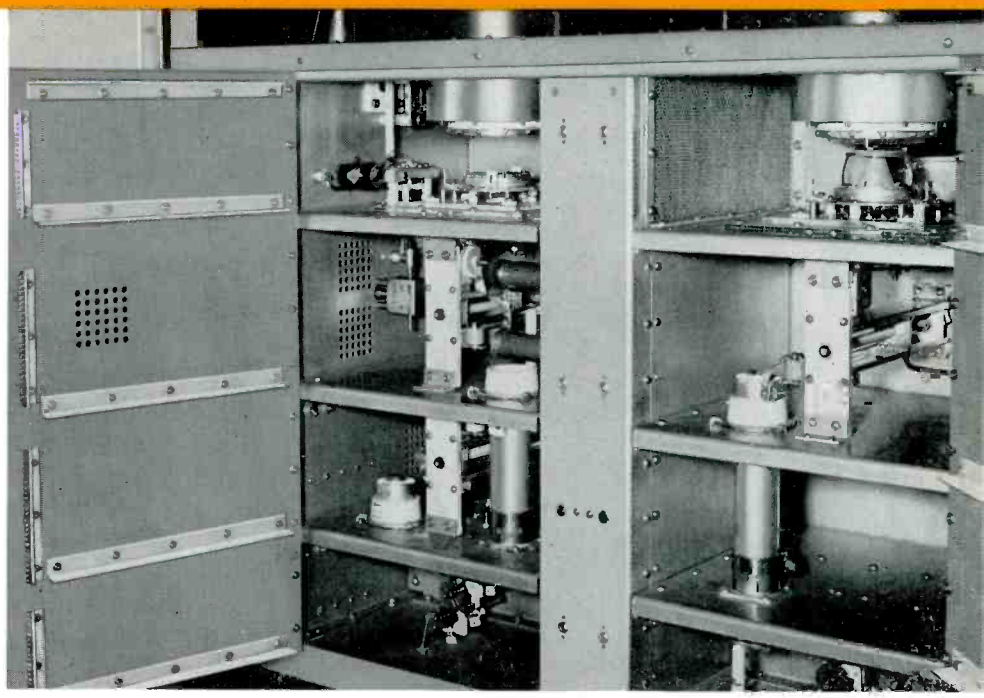
The transmitter operates from a 208-230 volt, 3-phase, 60-cycle power source, and the heaters from a single-phase, 117-volt, 60 cycle line. Operation from a 50-cycle source can be provided with slight modification.

The Type TT-11AH VHF Television Transmitter is designed to conform with all FCC, CCIR systems, and EIA standards. It will provide a nominal power output of 11 kilowatts (10 kw CCIR) peak visual power measured at the output of the sideband filter or filterplexer and 6 KW aural power.

The 11-KW transmitter has been completely restyled to afford a compact unit requiring a minmum of floor space in the transmitting station. All critical circuits such as the modulator and the exciter are completely adjusted from the front of the transmitter, while one interlocked door affords access to all other parts of the transmitter and its component parts. Unitized construction of transmitter allows the broadcaster utmost latitude in arrangement layout. A typical installation is shown, but numerous variations will suggest themselves to the station engineer.



Typical floor plan arrangement for the TT-11AH Transmitter. The rectifier enclosure is shown placed immediately behind the front line of cabinets; however, it may be placed in other convenient locations to meet specific building requirements.



Visual r-f driver unit on the left and aural r-f driver unit on the right emphasize complete accessibility and straightforward unitized construction of the TT-11AH Transmitter.

The TT-11AH's circuits employ the latest design features and represent economy in operation. Highlighted features include air-cooled tubes such as the 6166, famous for long life and reliability; single ended r-f circuits which greatly reduce number of necessary tubes and circuit components; built-in control relays, motors for operating power output controls, and shunts for external metering circuits; complete overload protection with indicating lights grouped for quick location of faulty circuits, and linearity correction circuits. Thermostatically controlled heaters for the rectifier tubes permit operation of the transmitter in ambient temperatures as low as 0 degrees C. Inter-carrier frequency control accurately maintains frequency separation between aural and visual carriers necessary for color transmission.

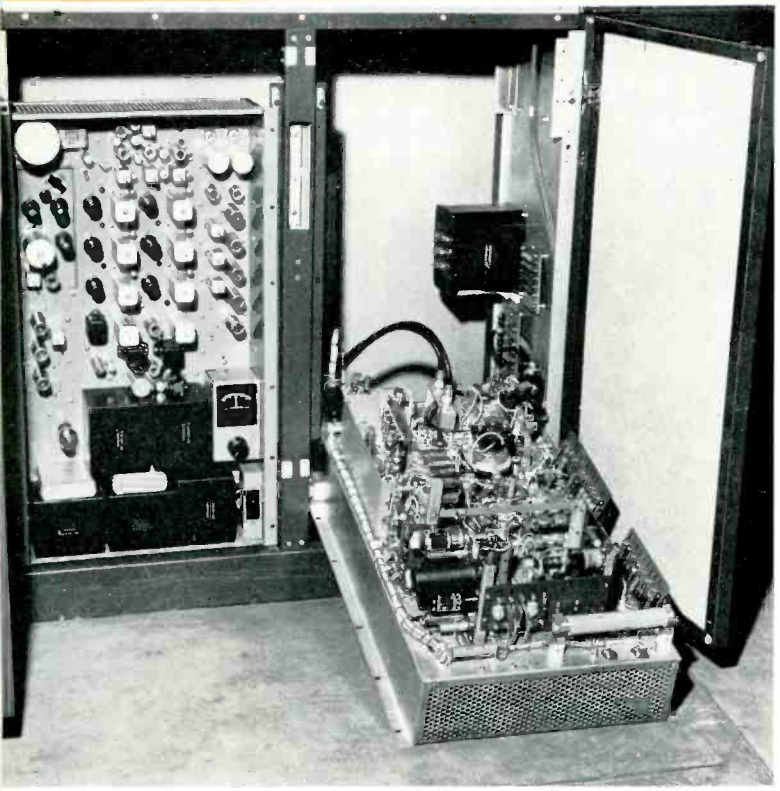
Remote control as well as local operation is an added feature of the new RCA transmitter. Where remote control is authorized for television transmitters, the TT-11AH can, with the addition of suitable terminal equipment, be operated from a remote location over a single telephone line. All the necessary operating functions such as starting and stopping the transmitter, resetting overloads, switching in the spare crystal oscillator or spare exciter, metering all power circuits and reflectometers, controlling power output (including black level, video gain, and excitation) can be performed at the remote location. Even when the transmitter is not remotely controlled, these built-in features make it very easy to obtain fingertip control of the transmitter from a single local position such as the RCA TTC-5A Transmitter Console.

The type of enclosure employed for the TT-11AH is unusual and provides a maximum of flexibility in selecting a suitable floor plan in a minimum space. The complete transmitter is housed in what is equivalent to a single cabinet with only one access door. However, it can be broken down for shipping into racks and panels of varying size for easy handling. All r-f and control circuits are located at the front of the enclosure, thus allowing all essential adjustments to be made with the power on. The rectifier tubes are mounted on the rear wall and the heavy power components are mounted on the floor. The rear panel of the transmitter housing has no access door so that this side can be mounted directly against a building wall. Where space is limited, the right side of the enclosure can also be mounted against the building wall provided an opening for the air intake is made in the wall adjacent to the filter.

The control unit is located at the left front corner of the transmitter in a separate cabinet with status lights grouped on a panel above the door. The auxiliary switches, breakers, overload and auxiliary relays, etc. are located behind a non-interlocked door. Overload indicating lights for all the circuits of the transmitter are grouped on a single strip so that they can be seen through the window in the door.

To the right of the control unit is the low power (2 KW) rack. It contains both the aural and visual drivers as well as the exciter and modulator units and is essentially the same as the video and r-f circuits of the complete TT-2BH 2 KW VHF Transmitter. The modulator and exciter units are located at the bottom of the rack behind dutch doors. They are hinged at the bottom so that both the front and rear of these units are accessible for servicing from the front of the transmitter.

The third cabinet contains both the aural and visual amplifier units. In the right-hand rack is located the PA regulated bias supply for the visual amplifier, terminal boards, DC filament voltage controls and other auxiliary controls. Space is reserved in this rack for a spare exciter. In both the driver and the power amplifier units the tuning controls for the high level stages are located just above the doors. These include all the tuning controls required for broadbanding the visual r-f circuits. The tuning controls are operated by cranks which are removable to prevent accidental



Transmitter exciter unit (left), and modulator unit (right) are mounted on hinged chassis which tilt forward for ease of servicing.

misadjustment of the circuits during operation. An easily read counter dial enables accurate logging of all the circuits. Also located on the panel above the doors are all the operating controls such as the transmitter start switch, plate switch, power operating controls, reflectometer switches and metering switches.

All important meters of the TT-11AH are mounted in sloping panels at the top of the racks. Built-in lights in the bottom of the meter panels provide excellent illumination for the meters even while the room illumination is lowered for easy monitoring of the picture signal.

A single access door on the left side of the transmitter provides access to the rear of the control racks and r-f racks as well as the rectifier mounted on the rear wall of the enclosure. These rectifiers have thermostatically controlled heaters for the rectifier tubes which permit operation of the transmitter in ambient temperatures as low as 0 degrees C. All heavy units such as the plate transformers and large reactors are mounted on a base plate on the floor. This makes them easily accessible for servicing.

The rectifier enclosure can be separated from the front-line cabinets and placed in an adjoining room or in a basement, if desired. This feature makes the TT-11AH Transmitter readily adaptable to existing buildings where there is no single room large enough to accommodate a complete transmitter of this power level. In such a case, all meters, operating controls, and tubes, except rectifier tubes are located in the operating room.

Circuit Description

The visual and aural exciter circuits of the TT-11AH are mounted on a single chassis. Two separate crystal oscillators are employed. This allows switching from a remote point by a relay in a d-c circuit. No relays are then necessary in the r-f circuit. A special 5763 buffer amplifier allows the crystal oscillators to be operated at a low level. This reduces internal heating of the crystal and allows the oscillator frequency to stabilize very quickly after the plate power is applied. The buffer stage is followed by a tripler, two doublers, and an amplifier, all using 5763 tubes. The output power of the exciter is approximately 5 watts at ⅓ the carrier frequency. The aural chain starts with a 6V6 master oscillator frequency modulated by two 6V6 reactance tubes. The multipliers and amplifiers which follow the master oscillator are identical to those used in the visual side. A unique feature of this exciter is the frequency control circuit for the aural master oscillator. This circuit is designed to accurately maintain the difference between the aural and visual carrier frequencies. This is accomplished by feeding a small amount of the energy from the aural and visual triplers to a 6AS6 mixer tube. When the aural oscillator is on frequency the output of this mixer will be 1/12 of the difference between the aural and visual carrier or 375 kc (458.333 kc CCIR).

This 375 kc (458.333 kc CCIR) signal combines with the output of a 6J6 crystal oscillator in a second mixer. The sum of these two frequencies is amplified and fed to a chain of three dividers with a total division of 100. This amount of division is necessary in order to reduce the swing at the frequency detector to a point where the carrier will not drop out under any conditions of modulation of the aural transmitter. A crystal controlled reference frequency is also fed to the frequency detector. By making the 6J6 crystal oscillator function both as a heterodyne oscillator and as a frequency reference source, considerable improvement in frequency control accuracy is obtained. Three dividers with a total division of 80 are also employed in the reference frequency circuit. The frequency detector is essentially a balanced modulator with a d-c component in the output which will change polarity depending upon whether the signal frequency is above or below the reference frequency. This d-c voltage is fed back to one of the reactance tubes for the master oscillator in such a way as to correct the frequency of the master oscillator. A frequency interlock circuit connected to the output of another frequency detector will prevent the application of plate power to the power amplifiers until the frequency control circuit is locked in.

R-F Circuits

The r-f circuits employ a chain of amplifiers. In the visual chain a 7034 tripler driver drives a 7034 amplifier which

in turn drives a type 6076 grid modulated stage. This is followed by a single type 6166 class "B" linear amplifier.

In the aural chain the exciter output is fed to a type 7034 tripler stage. This stage is followed by a type 6076 class "C" amplifier which then drives a type 6166 also operating class "C."

Plate voltage for the 6166 tubes is furnished from a high voltage supply employing six type 673 mercury vapor rectifiers. This same rectifier supplies plate voltage for the two type 6076 tubes. A voltage supply using four 8008 tubes supplies plate voltage for the type 7034 tubes. Regulated supplies are used for screen and bias voltages.

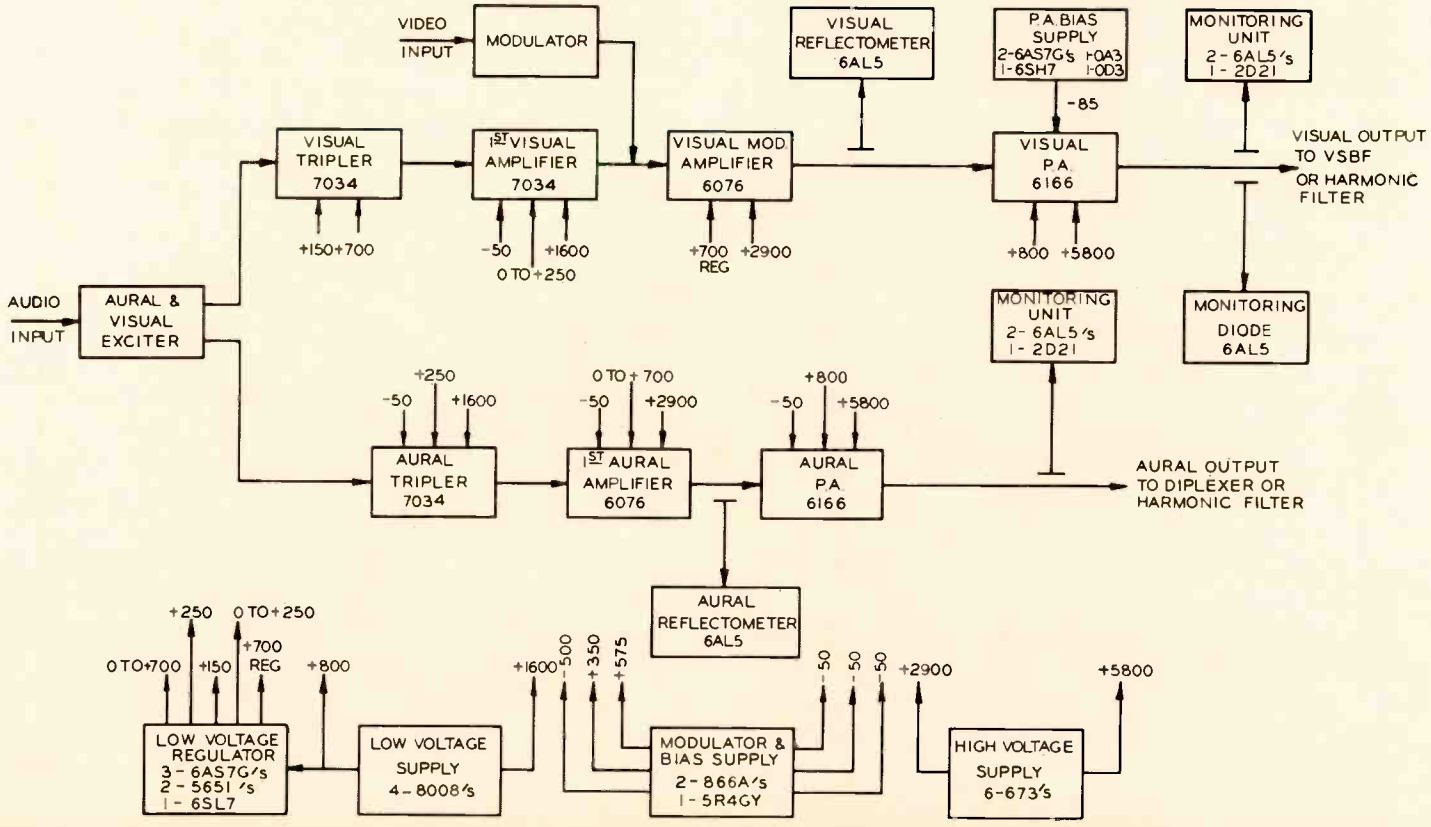
Control Equipment

A single integrated control circuit is provided for both the visual and aural transmitters. The blower, filaments, and each rectifier is protected by thermal overloads which can be adjusted to reset automatically. In addition, a main line breaker and an auxiliary breaker are provided. Each incorporates both thermal and magnetic trips. The high voltage rectifier and each power amplifier tube including the 7034 stages are protected by instantaneous overloads which automatically recycle twice. If the fault continues on the third try the overload circuit will remain tripped until reset. Overload indicator lights are provided for each circuit. These lights have a separate reset and will remain on after the first overload thus providing a record of the circuit giving trouble even though it may be intermittent. A three phase line regulator which automatically regulates the line input to the entire transmitter is supplied as standard equipment.

Visual Modulator

The modulator of the transmitter is designed to take a standard 0.7 volt video signal and amplify it sufficiently so that it can grid modulate the 6076 stage. This requires about 220 volts peak-to-peak from the modulator. The first stage of the modulator is a conventional shunt-series peaked video amplifier. This is followed by an inverter stage and a linearity corrector stage each of which has a gain of approximately one. The linearity corrector is designed to pre-distort the signal to compensate for the non-linearity which occurs in a grid modulated stage, and takes the form of four diodes connected in the cathode circuit of that stage. The bias voltage on each diode is separately adjustable and the diode can be made to start conducting at any brightness level. The grid of this stage is clamped in order to insure the same correction to the

Simplified block diagram of the TT-11AH Television Transmitter.



linearity characteristic regardless of the average brightness of the picture signal.

The linearity corrector is followed by a second video amplifier using a 6AG7 tube and by a third video amplifier consisting of two 807 tubes. The grids of the third video amplifier are also clamped and from this point on the circuit is d-c coupled. The output stage is a shunt regulated cathode follower. It consists of two 6146 tubes connected in a circuit similar to a conventional cathode follower stage. The cathode resistor has been replaced by three 6146 tubes operating in parallel. The grids of these three tubes are fed with a signal of opposite polarity from the plate load of the two cathode follower tubes. This essentially makes the circuit a feed-back amplifier of high efficiency capable of delivering modulation at a high level to a large capacity load.

The output stage is followed by a bucking bias supply consisting of one 6BL7-GT and three OA2 tubes. This serves to transfer the signal from the positive voltage present in the output of the modulator stage to the negative voltage required to modulate the 6076 tube without losing the d-c component. Back porch clamping is employed. A carefully designed sync separator and clipper circuit provides reliable clamping even with greatly degraded input signal.

A two stage monitor amplifier is employed. It can be seen from the block diagram that this monitor amplifier can be switched to many parts of the circuit, greatly aiding in making adjustments and in servicing. Plate power for all the stages in the modulator is obtained from two electronic regulators. One supplies approximately 250 volts and the other approximately 475 volts. Although the rectifier itself is remotely located on the rear wall of the transmitter enclosure the regulators are mounted on the same chassis as the video circuit in the modulator. This greatly reduces the possibility of unwanted video resonances.

Proved R-F Circuits

The tube line-up of the TT-11AH Transmitter is indicated in the block diagram shown. The TT-2BH, with reduced voltages on the r-f stages, is used as a driver for the type 6166 output stages. Since the driving power required is only approximately 600 watts aural and 1-kw peak visual, the TT-2BH voltages were reduced to permit combining of its power supplies with those of the power amplifiers.

The aural and visual power amplifier stages each utilize a Type 6166 Tube operating grounded-grid and grounded-screen. This type of operation with the 6166 tube not only gives high stability and long life, as has been proven in the TT-50AH Transmitter, but also permits simplification of the circuit design since the screen and control grids can be bypassed directly to a common ground plane. The input and output circuits can then be constructed on opposite sides of the ground plane. By using rectangular cavities so that one side can be removed, all parts of the cavity are made readily accessible.

No Neutralization Adjustment

The power amplifiers are effectively neutralized over the entire band and require no neutralizing adjustment. The simplified circuitry makes the amplifiers very easy to tune to any high-band channel, and the quality of either color or monochrome picture reproduction is excellent. The picture quality is further enhanced by the use of d-c on the power amplifier filaments to reduce the AM hum to a level where it is not noticeable in a color picture.

Special Protective Circuits

Included as part of the TT-11AH are two MI-19088 Monitoring Units for use in the output transmission line of the visual and aural amplifiers. The transmission line probes are installed so as to give an indication of the amount of forward or reflected power. A meter on the front panel can be switched between the two diode circuits. Power output is read in percent peak power which can be calibrated to read 100 percent for rated power. The standing-wave ratio is read directly on a specially calibrated scale. In the monitoring unit a type 2D21 thyratron tube operates in conjunction with a relay to remove the high voltage plate power from the complete transmitter when the SWR exceeds a predetermined value as would be the case if an arc occurred in the transmission line or antenna system.

A carrier-off monitor, ES-27235, is available as optional equipment. It acts in conjunction with the reflectometer units and is particularly useful for remote control. This unit will remove the plate voltage from all the r-f stages if the output level drops below a predetermined value, such as would be the case if an r-f arc occurred in any of the r-f stages. Sometimes such an arc does not change the plate current sufficiently to trip the d-c overload relays.

Harmonic Filter

Harmonic filters are supplied for insertion in the output transmission line. When operated in conjunction with the TT-11AH Transmitter these filters are designed to attenuate all harmonics to a value at least 60 db below the peak carrier level. Electrically, each filter consists of an M-derived half-T section, several low pass filter sections, and a constant-K half-T section. The M-derived section provides rapid cut-off in the second harmonic region and a termination impedance of 51.5 ohms at one end of the filter. Attenuation of the harmonics is accomplished by a low pass filter section, while the constant-K section serves to give termination impedance of 51.5 ohms at the other end of the unit.

A low pass filter is provided for insertion in the video input circuit. This filter attenuates all video frequencies above

4.75 megacycles by at least 20 db. An all-pass phase equalizer is also included as part of the low pass filter. This equalizer corrects the phase distortion which is introduced as a result of the sharp cut-off. Appropriate filters for CCIR standards are also available.

Sideband Filter

A vestigial sideband filter, is furnished completely assembled and adjusted for any one of the high band VHF television channels. This filter is an integral unit designed for floor, ceiling, or wall mounting near the visual transmitter so that the input transmission line is as short as possible. It also can be mounted to the top of the transmitter enclosure. The purpose of the filter is to attenuate the lower sideband output of a double sideband visual transmitter in conformance with the FCC regulations. In order to minimize reflections on the transmission line between the visual transmitter and the filter, the visual input of the filter is designed to have a constant input impedance over the band of frequencies produced by the visual transmitter including the reject band. The filter sections consists of lengths of coaxial line (resonant cavities), which are adjustable for tuning purposes. As the filter is pre-tuned at the factory to the desired channel, no operating adjustments are necessary.

SPECIFICATIONS

Performance

	FCC Specs.	CCIR Specs.
Type of Emission:		
Visual	A5	A5
Aural	F3	F3
Frequency Range	Ch. 7-13	174 mc-223 mc
Rated Power Output:		
Visual	11 kw[1]	10 kw[1]
Aural	6 kw[2]	2 kw[2]
Minimum Power Output:		
Visual	2 kw[1]	1.8 kw[1]
Aural	1 kw[2]	1 kw[2]
R-F Output Impedance	50/51.5 ohms	50/51.5 ohms
Input Impedance:		
Visual	75 ohms	75 ohms
Aural	600/150 ohms	600/150 ohms
Input Level:		
Visual	0.7 volt peak-to-peak min.	0.7 volt peak-to-peak min. (composite video)
Aural	+10 ±2 dbm	+16 ±2 dbm for 50 kc dev. Uniform ±1 db from 50 to 15,000 cyc.
Amplitude vs. Frequency Response	Aural—Uniform ±1 db from 50 to 15,000 cyc.	
Upper Sideband Response:[3]		
At Carrier plus 0.5 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 1.25 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 2.0 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 3.0 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 3.58 mc	+1, −1.5 db	——
At Carrier plus 4.18 mc	+1, −3.0 db	+1, −1.5 db
At Carrier plus 4.75 mc	− 20 db max.	——
At Carrier plus 5.0 mc	——	+1, −4.0 db
At Carrier plus 5.75 mc	——	−20 db max.
Lower Sideband Response:[4]		
At Carrier minus 0.5 mc	+1, −1.5 db	+1, −1.5 db
At Carrier minus 1.25 mc	−20 db max.	−20 db max.
At Carrier minus 3.58 mc	−42 db max.	——
Variation in Frequency Response with Brightness[5]	±1.5 db	±1.5 db
Carrier Frequency Stability:[6]		
Visual	±1 kc	±.0005%
Aural	±500 cps[7]	±.001%
Modulation Capability:		
Visual	12.5 ±2.5% (reference white)	12.5 ±2.5% (reference white)
Aural	±50 kc	±50 kc
Audio Frequency Distortion	1.5% max. 50-100 cyc. 1.0% max. 100-7500 cyc. 1.5% max. 7500-15,000 cyc.	1.5% max. 50-100 cyc. 1.0% max. 100-7500 cyc. 1.5% max. 7500-15,000 cyc.
FM Noise, below ±25 kc Swing	60 db	60 db
AM Noise, r.m.s.:		
Visual	45 db below 100% mod.	45 db below 100% mod.
Aural	50 db below carrier	50 db below carrier (hum and thermal)
Amplitude variation over one picture frame—Visual	Less than 5% of the peak of sync level	Less than 5% of the peak of sync level
Burst vs. Subcarrier Phase[8]	±5° max.	——
Subcarrier Phase vs. Brightness[9]	±7° max.	——
Subcarrier Amplitude[8]	±10° max.	——
Linearity (Differential Gain)[10]	1.5 db max.	1.5 db max.

[1] Measured at the output of the sideband filter or filterplexer.

[2] Measured at the input to the diplexer or filterplexer.

[3] With respect to the response at 200 kc, as measured by the BW-5B Sideband Response Analyzer at transmitter mid-characteristic. 4.75 mc attenuation requires use of MI-27132 LP filter in the video input circuit.

[4] With respect to the response at 200 kc at transmitter mid-characteristic.

[5] Maximum variation with respect to the response of mid-characteristic measured with the BW-5B Sideband Response Analyzer at brightness levels of 22.5% and 67.5% of sync peak, using approximately 20% (peak-to-peak) modulation.

[6] Maximum variation for a period of 30 days without circuit adjustment.

[7] Maximum variation with respect to the standard 4.5 mc separation between aural and visual carriers.

[8] Maximum departure from the theoretical when reproducing saturated primary colors and their complements at 75% amplitude.

[9] Maximum phase difference with respect to burst, measured after the VSBF, for any brightness level between 75% and 15% of the sync peak using 10% (peak-to-peak) modulation. This is equivalent to 5% (peak-to-peak) modulation as indicated by a conventional diode demodulator. In addition, the total differential phase between any two levels shall not exceed 10°.

[10] Maximum variation in the amplitude of a 3.58 mc sine wave modulating signal as the brightness level is varied between 75% and 15% of sync peak. The gain shall be adjusted for 10% (peak-to-peak) modulation of the 3.58 mc signal when the brightness is at pedestal level. This is equivalent to 5% (peak-to-peak) modulation as indicated by a conventional diode demodulator connected after the VSBF.

SPECIFICATIONS (Continued)

	FCC Specs.	CCIR Specs.
Envelope Delay vs. Frequency[11]	±.08 μsec. from 0.2 to 2.1 mc ±.04 μsec.at 3.58 mc ±.08 μsec. at 4.18 mc	——
Regulation of Output	7% max.	7% max.
Harmonic Attenuation, ratio of any single harmonic to peak visual fundamental[12]	At least 60 db	At least 60 db

[11] Maximum departure from standard curve. The tolerances vary linearly between 2.1 and 3.58 mc and between 3.58 mc and 4.18 mc. To meet the specification a properly terminated phase correction network, ES-34034-B is required in the video input circuit of the transmitter.

[12] Measured with harmonic filters in the visual and aural transmitter outputs.

Electrical

	FCC Specs.	CCIR Specs.
Power Line Requirements:		
Transmitter:		
Line	208/230 volts, 3 phase, 50/60 cyc.	208/230 volts, 3 phase, 50/60 cyc.
Slow Line Variations	±5% max.	±5% max.
Rapid Line Variations	±3% max.	±3% max.
Regulation	3% max.	——
Power Consumption	42 kw (black pix) 38 kw (average pix)	22 kw (visual) 12.5 (aural) See Curve—for 4.4 kw aural reduce consumption 14 kw
Power Factor (approx.)	90%	90%
Crystal Heaters:		
Line	117 volts, single phase, 50/60 cyc.	115 volts, single phase, 50/60 cyc.
Power Consumption	28 watts	28 watts

Tube Complement

Exciter Unit:		
3—6V6	6—6AC7	2—6AK5
9—5763	1—6J6	1—OD3
3—6AS6	1—12AT7	1—2D21
1—6AQ5		
Modulator Unit:		
6—6AG7	2—6AL5	5—OA2
2—807	2—6U8A	2—6SL7-GT
5—6146	2—6CL6	4—6AS7-G
1—6BL7-GT	8—5651	1—OD3
1—6SN7-GT	3—OB2	1—6AC7
IPA & Power Amplifier:		
3—7034	2—6076	2—6166
Rectifier Panel:		
2—866-A	1—5R4-GY	6-673
Reflectometers:		
2—6AL5		
Resistor Panel:		
4—8008		
Bias Supply:		
1—5R4-GY	1—OA3	2—6AS7-G
2—OD3	1—6SH7	
L.V. Regulator:		
1—6SL7-GT	2—5651	3—6AS7-G
Monitoring Units:		
4—6AL5	2—2D21	

Mechanical Specifications

Dimensions:
- Overall Length (front line cabinets only) ..... 138" (350.5 cm)
- Overall Height (front line cabinets only) ..... 84" (213.4 cm)
- Depth (front line cabinets only) ..... 20" (50.8 cm)
- Overall Depth ..... 78 13/16 (200 cm)

Weight (approx.) ..... 7000 lbs. (3175.2 kg.)
Finish ..... Two-tone umber gray, polished stainless steel trim
Maximum Altitude[1] ..... 7500 ft.
Ambient Temperature ..... 45° C. max., 0° C. min

Equipment Supplied

TT-11AH 11-KW VHF Television Transmitter, Channels 7-13 (ES-19282)

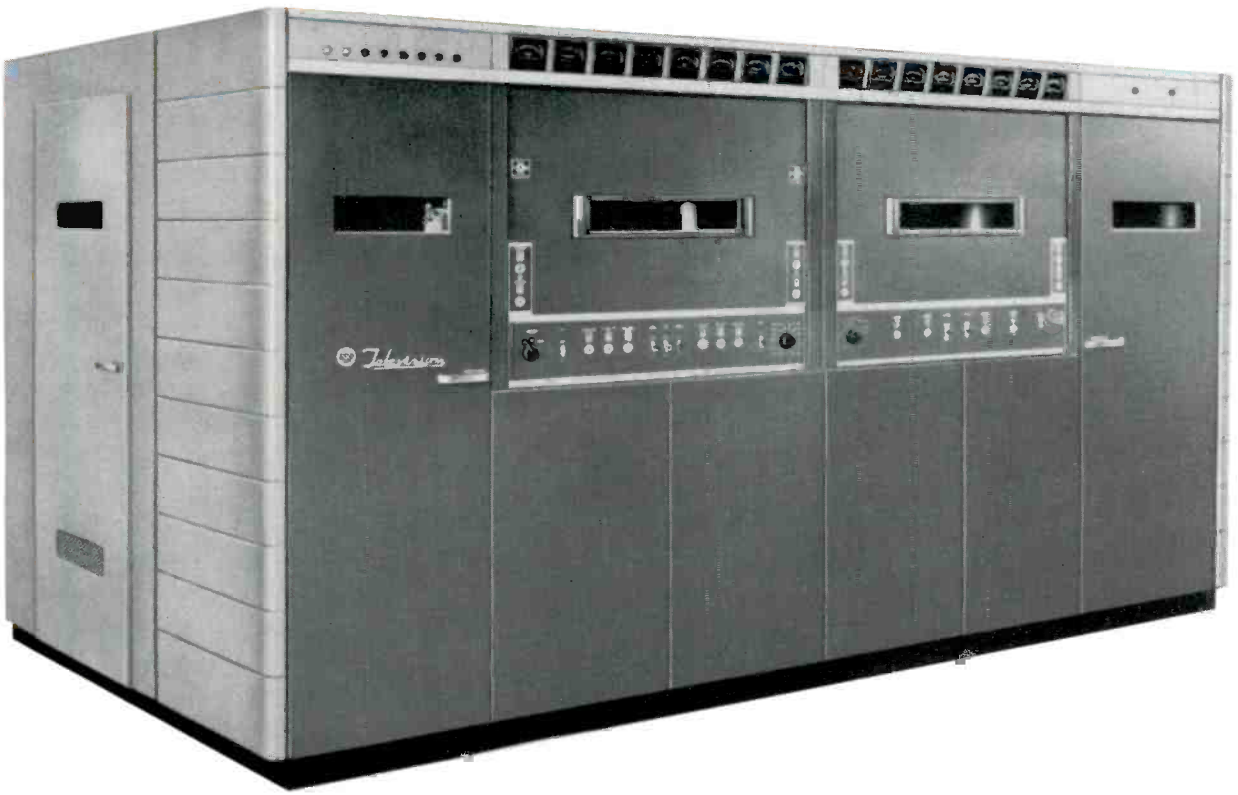
Qty.	Description	Stock No.
1	Control Unit	MI-27180-A
1	2-KW Unit	MI-27191
1	11-KW Unit	MI-27192
1	Auxiliary Control Unit	MI-27190
1	Set of Panels	MI-27198
1	Blower Enclosure & Filter Panel	MI-27199
1	Rectifier Panel	MI-27459
1	Resistor Panel	MI-27196
1	Transformer Filter Assembly	MI-27197
1	H.V. Plate Transformer	MI-27187
1	Blower	MI-27195
1	Low Voltage Regulator	MI-27469
1	Installation Material	MI-27185
1	Wiring Material	MI-27186
1	line Regulator Control Panel	MI-27471
1	Line Regulator, 3-Phase, 25 KVA	MI-27473-A
2	Crystal Unit (Visual)	MI-27492*
	*Select Type to suit customer's channel.	
2	Side Panel (End Shield)	MI-30541-G84
1	Monitoring Diode	MI-19051-B
2	Monitoring Unit	MI-19088
1	4.75 mc Low Pass Filter	MI-27132
2	Harmonic Filter (Select to suit customer's channel):	
	Channels 7, 8 or 9	MI-27317-7
	Channels 10, 11, 12 or 13	MI-27317-10
1	Vestigial Sideband Filter (Select to suit customer's channel)	MI-27799
1	Finish Touch-Up Kit	MI-7499-A
1	Miscellaneous Hardware Kit	MI-7474
1	Tool Kit	MI-27088
1	Set of Operating Tubes	ES-27207
1	Nameplate	MI-28180-1
8	90° Mitre Elbow Couplings	MI-19112-18C
12	Couplings, Sleeve with Clamps	MI-19112-8
*	Transmission Line (*Sales order to specify quantity to meet installation requirements)	MI-19113-C
1	Set of Installation Drawings	8976380-501
2	Instruction Books	IB-30265-1
2	Installation Books	IB-30267

Optional or Accessory Equipment

- TTC-5A Control Console Equipment ES-27274-1
- R-F Load and Wattmeter MI-27396
- Complete Set of Spare Tubes ES-27207
- FCC Spare Set of Tubes ES-27208
- Input and Monitoring Equipment, Wired/Unwired ES-19237-G/E
- 50 Cycle Conversion Kit MI-34418
- Separate Rectifier Enclosure ES-27299
- Carrier-Off Monitor ES-27235
- BW-5B Sideband Response Analyzer ES-34010-B
- BW-4B VHF Visual Sideband Demodulator MI-34057
- Plate Current Meter MI-21200-C1
- WM-71A Distortion and Noise Meter MI-30071-A
- TO-524-AD Oscilloscope MI-26500-A
- Tuning Indicator for MI-27475/H Exciter MI-27487
- WA-28A Audio Oscillator MI-30028-A
- Spare Exciter MI-27475-H
- Exciter Modification Kit (CCIR) MI-34405

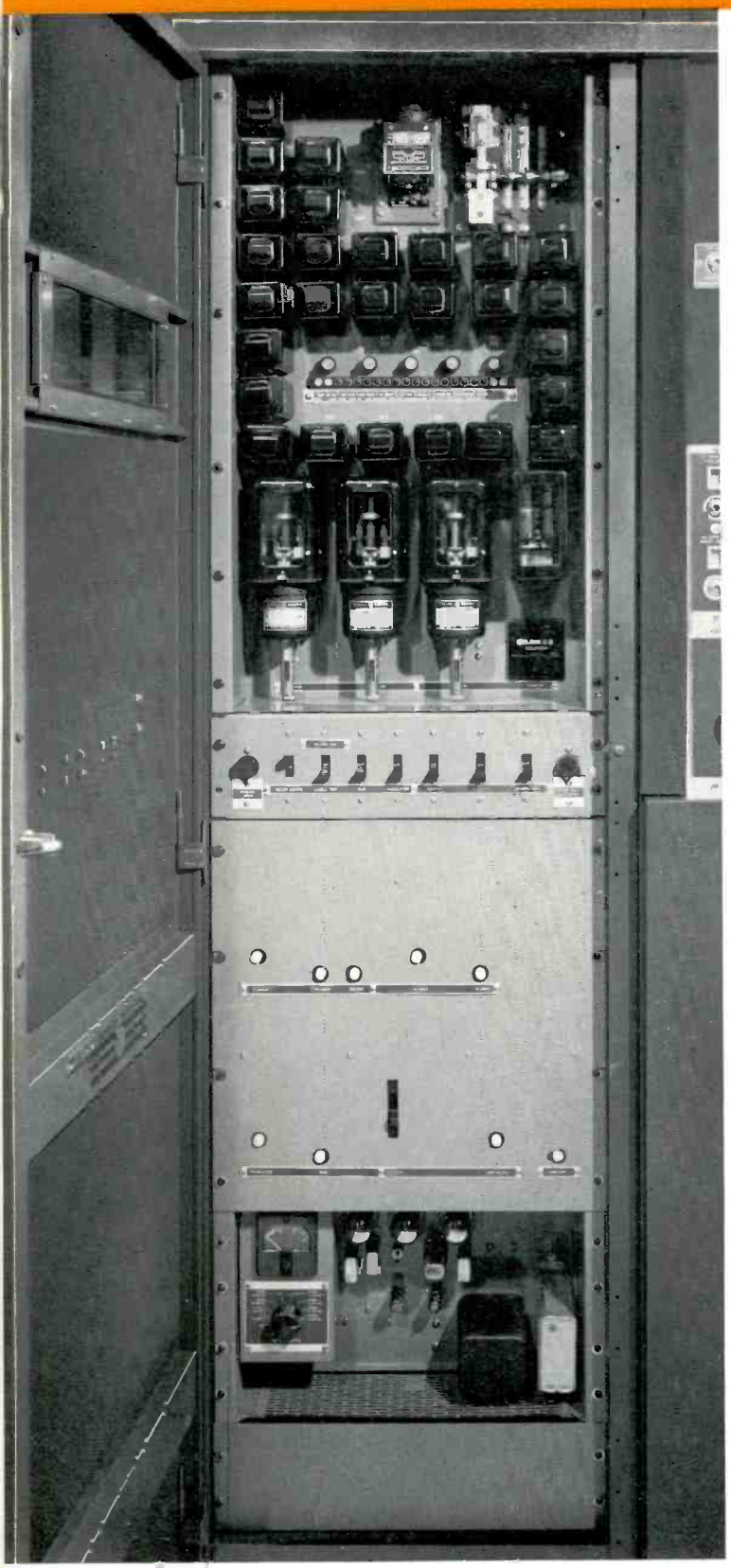
25 KW VHF TV Transmitter

TYPE TT-25DL



FEATURES

- Visual power output 25 kw measured at output of sideband filter or filterplexer
- Designed for color—linearity correction circuits built into modulator
- Superior reliability through diplexed circuitry
- Completely siliconized power supply
- Economical installation
- Improved picture quality—antenna reflections absorbed in reject load
- Remote control provisions
- "Localizer indicators" provide overload protection
- Vestigial sideband characteristics determined by fixed-tuned, trouble-free, factory adjusted sideband filter or filterplexer
- Inter-carrier frequency control accurately maintains frequency separation between aural and visual carriers
- Completely air-cooled
- Space requirements reduced 40 percent



Control cabinet with door open showing auxiliary switches, breakers, overload and auxiliary relays. Overload indicating lights for all TT-25DL circuits are grouped on strip that can be seen through window when door is closed.

DESCRIPTION

The TT-25DL Television Transmitter operates on VHF channels 2 through 6 or 47 mc-88 mc on CCIR standards, with a peak visual power output of 25 kw (22.5 kw CCIR). When used with one of the current VHF antennas, it is possible to obtain the maximum allowable 100,000 watts of effective radiated power. The TT-25DL may be purchased as a complete 25 kw high-power transmitter, or may be the result of a building-block program starting with a 6 kw transmitter (TT-6BL), then adding a 25 kw amplifier. A minimum of conversion is necessary to change from one power level to the next as the station grows.

The TT-25DL circuits employ the latest design features and represent economy in operation. Highlighted features include air-cooled tubes such as the 6166-A for long life and reliability. Single ended r-f circuits reduce the number of necessary tubes and circuit components. Extensive overload protection with indicating lights aid in quick location of faulty circuits. Inter-carrier frequency control accurately maintains separation between aural and visual carriers.

The TT-25DL Transmitter is designed for up to 7 kw aural power output. This makes it possible to reduce the tube complement and physical size of the transmitter.

The equipment provides separate visual and aural amplifiers—with a common power supply—for use with the driver. This equipment includes air-cooled linear broadband amplifiers for the visual carrier, and air-cooled class "C" amplifiers for the aural carrier. Each amplifier consists of a single power stage utilizing a Type 6166-A Tetrode in a grounded-grid, grounded-screen circuit. The transmitter is housed in a compact cabinet having only one access door. The cabinet can be broken down for shipping into racks and panels of varying size for easy handling. All r-f circuits and control circuits are located at the front of the enclosure. The rectifiers are mounted on the rear wall and the heavy power components are mounted on the floor. The control unit is at the left front corner of the transmitter in a separate cabinet with status lights grouped on a panel above the door. The auxiliary switches, breakers, overload and auxiliary relays, etc. are in the control unit behind a non-interlocked door. Overload indicating lights for all the circuits of the transmitter are grouped on a single strip so they can be seen through the window in the door.

A single access door on the left end of the transmitter provides access to the rear of the control and r-f racks as well as the components mounted on the rear wall of the enclosure. All heavy units such as the plate transformers and large reactors are mounted on a base on the floor.

Since all operating controls and important adjustments are brought out to the front of the transmitter, it should not be necessary to enter the enclosure while power is on.

Design Features

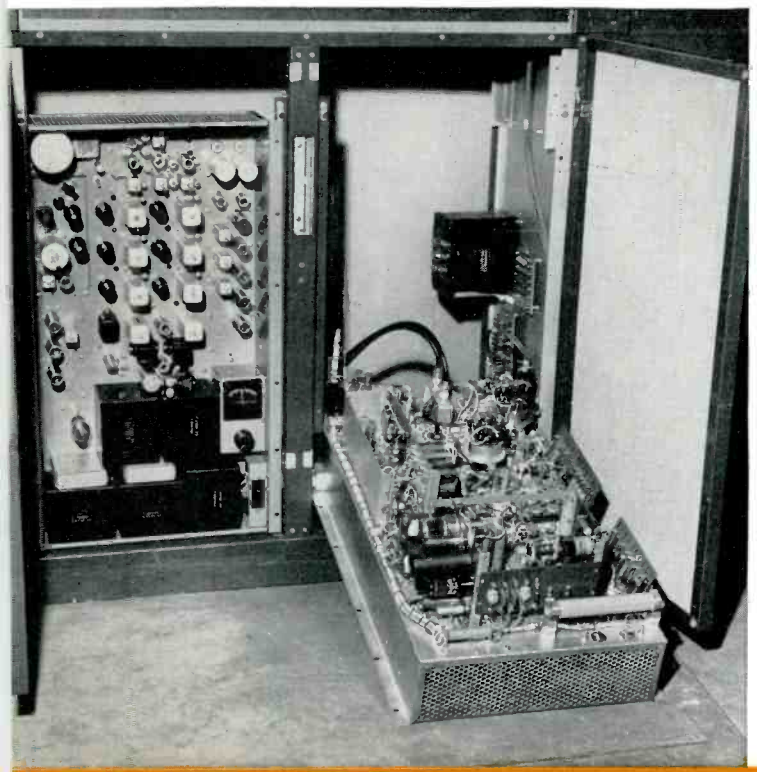
The TT-25DL was designed with reliability and ease of operation and maintenance in mind. Access to components is better because of new improved mechanical design. Space requirements have been reduced as much as 60 percent over previous designs to allow for installation in existing buildings. Reducation of required floor space is effected by the walk-in enclosure design of the TT-25DL.

This type of consrtuction eliminates the need for external access space at the rear of the enclosure. The enclosure may be placed directly against a wall or even in a corner of the room if an air intake opening is provided. Access to all components of the transmitter is possible from within the enclosure. The modulator and exciter may be serviced by tilting the chassis forward, without removal from the cabinet.

Exciter Description

The TT-25DL transmitter is driven by a common exciter containing both visual and aural chains. Accurate control of the separation of visual and aural carrier frequencies is the result of precise engineering circuit design. The visual chain is driven by either one of the two crystal controlled 6AK5 oscillator circuits as a primary source of frequency control. Oscillators may be switched by means of a d-c relay, thus making this circuit adaptable for remote control. The crystals operate at one-twelfth the visual carrier frequency and one-twelfth of the output frequency of the exciter. The aural master oscillator is a free-running 6V6 oscillator controlled by a pair of 6V6 reactance tubes which are part of the automatic-frequency control circuit used to maintain the 4.5 mc (5.5 mc CCIR) separation between carriers. An off-frequency interlock prevents uncontrolled frequency operation by cutting off plate voltage to the stages that follow the exciter. The aural master oscillator operates at one-twelfth of the carrier frequency with the output of the exciter being on the carrier frequency.

TT-25DL exciter (left) and modulator unit (right) are mounted on hinged chassis which allow units to tilt forward for utmost accessibility.



The automatic frequency control of the aural master oscillator is accomplished by feeding a small amount of energy from the aural FM oscillator and the visual 5763 amplifier following the crystal oscillator stage into a 6AS6 mixer tube. When the aural oscillator is on frequency the output of this mixer stage will be one-twelfth of the difference frequency between the aural and visual carriers or 375 kc (458.333 kc CCIR). The 375 kc (458.333 kc CCIR) signal mixes with the output of the 6J6 crystal controlled reference oscillator (1500 kc or 1833.33 kc CCIR) in the second 6AS6 mixer stage. The difference frequency is fed through a chain of three dividers with a total division of 100 to the frequency detector stage. This amount of division is necessary to reduce the swing at the frequency detector so that the carrier will not drop out under any modulation conditions of the aural transmitter. The 6J6 reference oscillator signal is fed through three divider stages with a total division of 80 to the frequency detector stage. By using the 6J6 reference oscillator output to excite both the second mixer and the divider chain for reference frequency, considerable improvement in frequency control accuracy is obtained. Signals from both the difference frequency and the reference frequency chains are fed into the frequency detector. The frequency detector is essentially a balanced modulator with a d-c component in the output which will change polarity depending upon whether the signal frequency is above or below the reference frequency. This d-c voltage is fed back to one of the reactance tubes for the master oscillator in such a way as to correct the frequency of the master oscillator.

Visual Modulator

The 4CX5000A Visual Modulated Amplifier is grid modulated by the video modulator. A modulator output signal of approximately 300 volts peak-to-peak is required for full modulation of the visual transmitter. The modulator amplifies a standard 1 volt video signal to the required level. A linearity correction circuit is included, as well as motor-driven operating controls for use when remote control is incorporated.

The first amplifier stage in the video modulator is a conventional shunt-series peaked video amplifier. This is followed by an inverter stage and a linearity corrector stage, each of which has a gain of approximately unity. The

linearity corrector is designed to predistort the signal to compensate for the non-linearity which always occurs in a grid modulated stage. Linearity correction is accomplished by the use of four biased diodes connected in the linearity corrector cathode circuit. The bias voltage on each diode is separately adjustable. Any one of the diodes can be made to start conducting at any brightness level. The grid of the linearity corrector is clamped in order to insure the same correction to the linearity characteristic regardless of the average brightness of the picture signal.

The linearity corrector is followed by a second video amplifier using a 6CL6 tube and then by a third video amplifier consisting of two 5933 tubes. The grids of the third video amplifier are also clamped and from this point on the circuit is d-c coupled. The output (modulator) stage is a shunt regulated cathode follower. It consists of three 6146 tubes connected in a circuit very similar to a conventional cathode follower, except that the cathode resistor is replaced by four 6146 tubes operating in parallel. The grids of these four tubes are fed with a signal from the plate load of the three cathode follower tubes. This makes the circuit essentially a feedback amplifier of high efficiency capable of delivering modulation at a high level to a large capacitive load.

A carefully designed clamp circuit assures reliable clamping even with greatly degraded input signal. Back porch clamping is employed.

Two power supplies are used. One supplies 250 volts to the low level stages while the other supplies 575 volts to the third video and modulator stages. The use of a negative 575 volt supply makes the use of a bucking bias supply unnecessary.

The outputs of both supplies are electronically regulated by regulators mounted on the modulator chassis. This greatly reduces the possibility of unwanted video resonances in power supply leads. The modulator rectifiers are located on the rear wall of the transmitter enclosure.

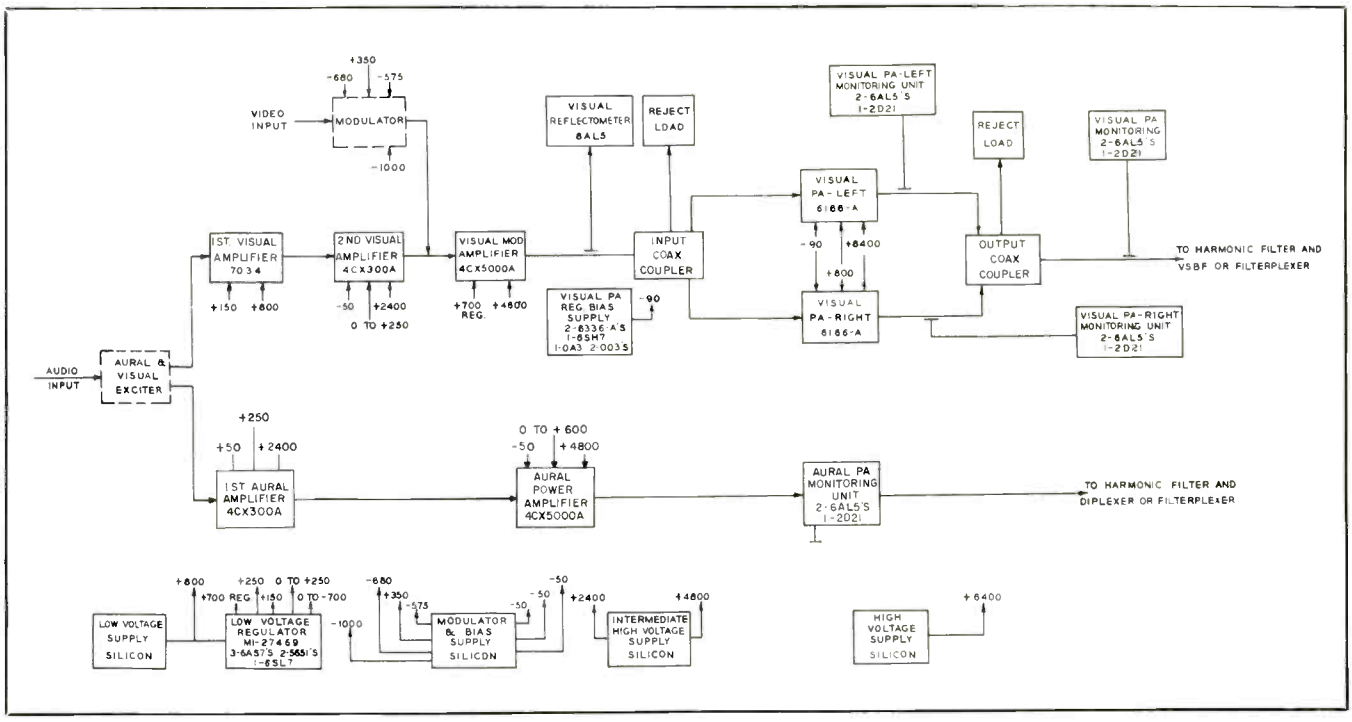
A monitor amplifier is provided for monitoring the modulator output signal. Numerous test jacks are also provided to simplify trouble-shooting and modulator alignment.

Aural Modulator

Frequency modulation is accomplished in the TT-25DL exciter by a "direct modulation" process requiring less components, fewer tubes and tube types. This process, which eliminates numerous multipliers and converter stages resulting in low noise and minimum distortion, utilizes two push-pull reactance tubes connected across the frequency determining circuit of the master oscillator. The center frequency of this oscillator is precisely maintained by the automatic frequency control circuit described in the exciter description.

Frequency modulation is obtained by feeding the audio signal into the reactance tubes which are connected across the oscillator plate tank circuit. R-F energy from the oscil-

Simplified block diagram of TT-25DL VHF TV Transmitter.



lator tank is link coupled to a transformer which has a coil in the grid circuit of each reactance tube. R-F voltages on the push-pull connected grids are 180 degrees out of phase with each other and each is 90 degrees out of phase with respect to the r-f voltage at the plates. Thus across the oscillator tank one tube appears as a capacitive reactance and the other as an inductive reactance. The magnitude of the reactive plate current in the reactance tubes varies in direct proportion to the value of audio voltage applied to the grids. Therefore, the frequency of the oscillator is varied at an audio rate to furnish the required FM signal. The mean frequency of the oscillator is controlled by varying the grid bias of one of the reactance tubes. This bias voltage is the d-c output voltage of the frequency detector stage of the exciter.

R-F Circuits

The r-f circuits employ a chain of multipliers and amplifiers. In the visual chain a 7034 tube operates as the first visual amplifier, driving a 4CX300A amplifier which in turn drives a type 4CX5000A grid modulated power amplifier. The output of the modulated amplifier is equally divided by a power-splitting coax coupler to drive two 12.5-kw linear amplifiers. The outputs of these two amplifiers are then combined in a coax coupler to provide 25-kilowatts (22.5 kw CCIR) of peak visual power. Excitation control for the visual transmitter is accomplished by varying the screen voltage on the 4CX300A stage. The aural chain consists of a 4CX300A amplifier followed by a type 4CX5000A class "C" power amplifier. Power output of the aural transmitter is adjusted by varying the screen voltage on the 4CX5000A stage. Both these controls are operated by motors and therefore can be adjusted from a remote position.

The visual linear amplifiers following the modulated stage each employ a 6166-A tetrode in a grounded-grid, grounded-screen circuit. Circuit design is simplified, since the grid and screen may be by-passed to a common ground plane. Input and output circuits are then constructed on opposite sides of the ground plane. D-c is used for filaments of the 6166-A to reduce hum modulation to a level well below the usual requirement.

RCA Type 6166-A Ceramic Power tube which serves as a long life power amplifier in the RCA TT-25DL Transmitter.

Power and Control Equipment

Wherever possible in this transmitter, the same d-c power supplies were used for both the visual and aural amplifiers. This greatly reduces the number of components in the transmitter. An exciter supply is built into the common exciter unit using stacked germanium diodes. The other supplies, all using silicon diodes, are located on the rectifier panels at the rear of the enclosure. An 800-volt supply furnishes all screen voltages as well as the 7034 plate voltage. The intermediate voltage supply has a 2400-volt output for the 4CX300A plates. The high-voltage supply uses silicon diodes. This supply provides 6400 volts for the plates of the two Type 6166-A power tubes and the two 4CX5000A. High-voltage switching allows independent operation of visual and aural final amplifiers. In addition, this feature permits removal of plate voltage from either visual amplifier in the event of tube failure which results in a minimum of lost air time. All voltages for the visual modulator are furnished by the remaining supplies. One has an output of +350 volts, and the other has several outputs, all negative with respect to ground, which supply the high-level video stages as well as bias for the modulator and r-f stages.

A single integrated control circuit is provided for both the visual and aural transmitters. The blower, filaments, and each rectifier is protected by thermal overloads which can be adjusted to reset automatically. In addition, a main line breaker and an auxiliary breaker are provided. Each incorporates magnetic trips. All rectifiers and r-f stages following the exciter are protected by instantaneous overload relays which automatically recycle twice. If the fault continues on the third try the overload circuit will remain

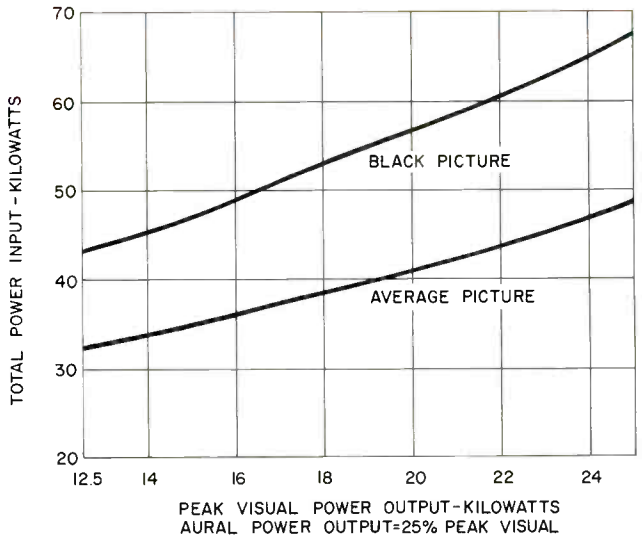
tripped until reset. Overload indicator lights are provided for each circuit. These lights have a separate reset and will remain on after the first overload thus providing a record of the circuit giving trouble even though it may be intermittent.

The equipment includes an automatic line voltage regulator which provides a stable line voltage to the filament primaries, the exciter, the modulator, and the low voltage power supply. Automatic filament line voltage regulators and automatic regulators capable of handling the complete transmitter are available as optional items.

Special Protective Circuits

Included as part of the TT-25DL is an MI-19087 Monitoring Unit for connecting in the output transmission line of the visual amplifier. This unit contains two 6AL5 diode detectors as reflectometers. The transmission line probes are installed so as to give an indication of the amount of power or reflected power. A meter on the front panel can be switched between the two diode circuits. Power output is read in percent peak power which can be calibrated to read 100 percent for rated power. The standing-wave ratio is read directly on a specially calibrated scale. In the monitoring unit a type 2D21 thyratron tube operates in conjunction with a relay to remove the high voltage plate power from the TT-25DL when the SWR exceeds a predetermined value.

A single unit reflectometer is provided for the aural amplifier. This normally is connected to read power output. Standing wave ratio can be measured by manually rotating the reflectometer head. If desired, a complete MI-19087 monitornig unit can be supplied for the aural output as optional equipment. This unit provides two reflectometer heads as well as the SWR monitor.



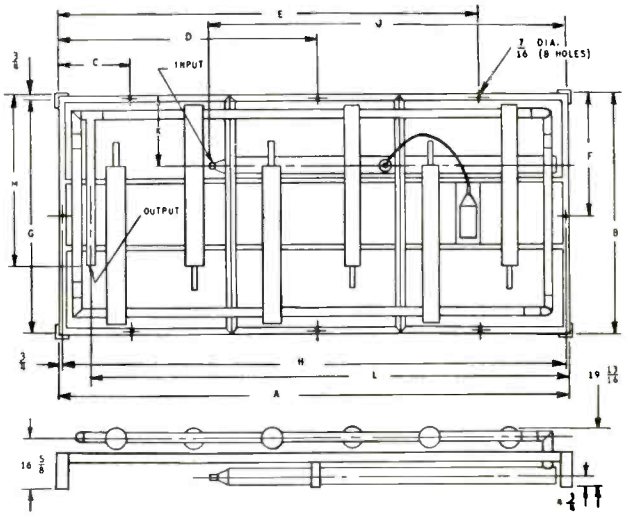
Vestigial Sideband Filter (FCC Specifications)

The MI-19085-L Vestigial Side Band Filter is furnished completely assembled and adjusted for any one of the low band VHF television channels. The filter is an integral unit designed for floor, ceiling, or wall mounting near the visual transmitter so that the input transmission line is as short as possible.

MI-19085-L Vestigial Sideband Filter.

SPECIFICATIONS

Frequency	54-88 mcs
Maximum Power (5000 ft. elevation)	25 kw
Input and Output Impedance	50/51.5 ohms, 3⅛" coaxial line
VSWR	Less than 1.1
Ambient Temperature	45°C. max.
Overall Dimensions:	
Channel 2	165"x79"x19 13/16"
Channel 3	154½"x73¾"x19 13/16"
Channel 4	146"x69½"x19 13/16"
Channel 5	143½"x63¾"x19 13/16"
Channel 6	143½"x63¾"x19 13/16"
Weight	930 lbs. max.
Mounting	Wall or ceiling
Clearance	12"



SPECIFICATIONS

Performance

	FCC Specs.	CCIR Specs.
Type of Emission:		
Visual	A5	A5
Aural	F3	F3
Frequency Range	Ch. 2-6	47-88 mc
Rated Power Output:		
Visual	25 kw[1]	22.5 kw[1]
Aural	7 kw[2]	4.4 kw[2]
R-F Output Impedance	50/51.5 ohms	50/51.5 ohms
Input Impedance:		
Visual	75 ohms	75 ohms
Aural	600/150 ohms	600/150 ohms
Input Level:		
Visual	0.7 volt peak-to-peak min.	0.7 volt peak-to-peak min. (composite video)
Aural	+10 ±2 dbm	+16 ±2 dbm for 50 kc dev. Uniform ±1 db from 50 to 50,000 cyc.
Amplitude vs. Frequency Response	Uniform ±1 db from 50 to 15,000 cyc.	——
Upper Sideband Response:[3]		
At Carrier plus 0.5 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 1.25 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 2.0 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 3.0 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 3.58 mc	+1, −1.5 db	——
At Carrier plus 4.18 mc	+1, −3.0 db	+1, −1.5 db
At Carrier plus 4.75 mc	−20 db max.	——
At Carrier plus 5.0 mc	——	+1, −4.0 db
At Carrier plus 5.75 mc	——	−20 db max.
Lower Sideband Response:[4]		
At Carrier minus 0.5 mc	+1, −1.5 db	+1, −1.5 db
At Carrier minus 1.25 mc	−20 db max.	−20 db max.
At Carrier minus 3.58 mc	−42 db max.	——
Variation in Frequency Response with Brightness[5]	±1.5 db	±1.5 db
Carrier Frequency Stability:[6]		
Visual	±1 kc	±.0005%
Aural	±500 cps[7]	±.001%
Modulation Capability:		
Visual	12.5 ±2.5% (reference white)	12.5 ±2.5% (reference white)
Aural	±50 kc	±50 kc
Audio Frequency Distortion	1.5% max. 50-100 cyc. 1.0% max. 100-7500 cyc. 1.5% max. 7500-15,000 cyc.	1.5% max. 50-100 cyc. 1.0% max. 100-7500 cyc. 1.5% max. 7500-15,000 cyc.

[1] Measured at the output of the sideband filter or filterplexer.

[2] Measured at the input to the diplexer or filterplexer.

[3] With respect to the response at 200 kc, as measured by the BW-5B Sideband Response Analyzer at transmitter mid-characteristic. 4.75 mc attenuation requires use of MI-27132 LP filter in the video input circuit.

[4] With respect to the response at 200 kc at transmitter mid-characteristic.

[5] Maximum variation with respect to the response at mid-characteristic measured with the BW-5B Sideband Response Analyzer at brightness levels of 22.5% and 67.5% of sync peak, using approximately 20% (peak-to-peak) modulation.

[6] Maximum variation for a period of 30 days without circuit adjustment.

[7] Maximum variation with respect to the standard 4.5 mc separation between aural and visual carriers.

	FCC Specs.	CCIR Specs.
FM Noise, below ±25 kc Swing	60 db	60 db
AM Noise, r.m.s.:		
Visual	45 db below 100% mod.	45 db below 100% mod. (hum and thermal)
Aural	50 db below carrier	50 db below carrier
Amplitude Variation Over One Picture Frame	Less than 5% of the peak of sync level	Less than 5% of the peak of sync level
Regulation of Output	7% max.	7% max.
Burst vs. Subcarrier Phase[8]	±5 degrees max.	——
Subcarrier Phase vs. Brightness[9]	±7 degrees max.	——
Subcarrier Amplitude[8]	±10% max.	——
Linearity (Differential Gain)[10]	1.5 db max.	1.5 db max.
Envelope Delay vs. Frequency[11]	±.08 μsec. from 0.2 to 2.1 mc ±.04 μsec. at 3.58 mc ±.08 μsec. at 4.18 mc	——
Harmonic Attenuation, ratio of any single harmonic to peak visual fundamental	At least 60 db	At least 60 db[12]

Electrical

	FCC Specs.	CCIR Specs.
Power Line Requirements:		
Transmitter:		
Line	208/240 volts, 3 phase, 50/60 cyc.	380/415 volts, 3 phase, 50 cyc.
Slow Line Variations	±5% max.	±5% max.
Rapid Line Variations	±3% max.	±3% max.
Power Consumption (25 kw Visual and 12.5 kw Aural)	See Curve	See Curve
Power Factor (approx.)	90%	90%
Crystal Heaters:		
Line	115 volts, single phase, 50/60 cyc.	115 volts, single phase, 50/60 cyc.
Power Consumption	28 watts	28 watts

[8] Maximum departure from the theoretical when reproducing saturated primary colors and their complements at 75% amplitude.

[9] Maximum phase difference with respect to burst, measured after the VSBF, for any brightness level between 75% and 15% of the sync peak using 10% (peak-to-peak) modulation. This is equivalent to 5% (peak-to-peak) modulation as indicated by a conventional diode demodulator. In addition, the total differential phase between any two levels shall not exceed 10 degrees.

[10] Maximum variation in the amplitude of a 3.58 mc sine wave modulating signal as the brightness level is varied between 75% and 15% of sync peak. The gain shall be adjusted for 10% (peak-to-peak) modulation of the 3.58 mc signal when the brightness is at pedestal level. This is equivalent to 5% (peak-to-peak) modulation as indicated by a conventional diode demodulator connected after the VSBF.

[11] Maximum departure from standard curve. The tolerances vary linearly between 2.1 and 3.58 mc and between 3.58 mc and 4.18 mc. To meet the specification a properly terminated phase correction network, ES-34034-B is required in the video input circuit of the transmitter.

[12] Measured with harmonic filters in the visual and aural transmitter outputs.

TT-25DL Tube Complement

EXCITER

Qty.	Function	Type
1	Visual Crystal Oscillator #1	6AK5
1	Visual Crystal Oscillator #2	6AK5
1	Buffer Amplifier	5763
1	1st Visual Multiplier	5763
1	2nd Visual Multiplier	5763
1	3rd Visual Multiplier	5763
1	Visual Output Amplifier	5763
2	Reactance Tube Modulator	6V6
1	FM Master Oscillator	6V6
1	1st Aural Multiplier	5763
1	2nd Aural Multiplier	5763
1	3rd Aural Multiplier	5763
1	Aural Output Amplifier	5763
1	1st Mixer	6AS6
1	2nd Mixer	6AS6
1	Difference Frequency Amplifier	6AQ5
1	1st Difference Frequency Divider	6AC7
1	2nd Difference Frequency Divider	6AC7
1	3rd Difference Frequency Divider	6AC7
1	Crystal Oscillator-Reference Frequency	6J6
1	1st Reference Frequency Divider	6AC7
1	2nd Reference Frequency Divider	6AC7
1	3rd Reference Frequency Divider	6AC7
1	Cathode Follower-Frequency Detector Drive	12AT7
1	Off-Frequency Detector	6AS6
1	Off-Frequency Interlock Control	2D21
1	Voltage Regulator	OD3

MODULATOR

1	1st Video Amplifier and Inverter	6CX8
1	Linearity Corrector	6CL6
1	2nd Video Amplifier	6CL6
2	3rd Video Amplifier	5933
7	Modulator	6146
1	Modulator Monitor	6CL6
1	Sync Cathode Follower and Amplifier	6CX8
1	Sync Separator	6EA8
1	Pulse Former and Clipper	6EA8
1	Phase Splitter #1	6CL6
1	Phase Splitter #2	6CL6
1	Clamp Diode #1	6AL5
1	Clamp Diode #2	6AL5
1	Voltage Regulator	OA2
10	Voltage Regulators (Modulator Screens)	OB2
2	Voltage Regulators	OC3
2	Voltage Regulators	OD3
2	Voltage Reference	5651
2	Low Voltage Regulators	6AS7-GA
2	High Voltage Regulators	6336-A
2	DC Amplifiers	6SL7-GT

R-F UNIT

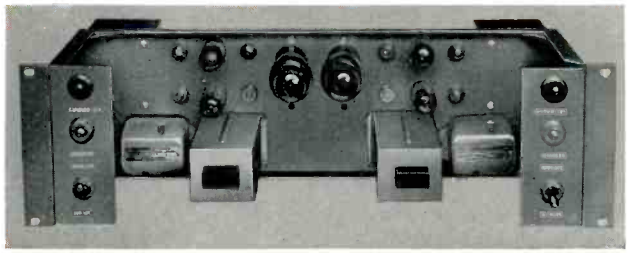
1	1st Visual Amplifier	7034
1	2nd Visual Amplifier	4CX300A
1	Visual Modulated Amplifier	4CX5000A
2	Visual Power Amplifiers	6166-A
1	1st Aural Amplifier	4CX300A
1	Aural Power Amplifier	4CX5000A
9	Reflectometer Detectors	6AL5
4	Reflectometer Thyratrons	2D21
1	Air Interlock	2D21

LOW-VOLTAGE REGULATOR

3	Regulators	6AS7G
1	D-C Amplifier	6SL7
2	Voltage Reference	5651

VISUAL BIAS SUPPLY

2	Shunt Regulators	6336-A
1	D-C Amplifier	6SH7
1	Voltage Reference	OA3
2	Voltage Reference	OD3



Carrier-Off Monitor, ES-27235, is useful accessory for remote control.

Mechanical Specifications

Weight (approx.) ..... 9000 lbs. (4082.4 kg.)

Dimensions:

- Overall Length (front line cabinets only) ..... 138" (350.5 cm)
- Overall Height (front line cabinets only) ..... 84" (213.4 cm)
- Depth (front line cabinets only) ..... 20" (50.8 cm)
- Overall Depth ..... $78\frac{13}{16}$" (200 cm)

Finish ..... Two-tone umber gray, polished stainless steel trim

Maximum Altitude[13] ..... 7500 ft.

Ambient Temperature ..... 45°C max. 0°C min.

[13] For operation at rated power and normal plate voltage.

Equipment Supplied

TT-25DL TV Transmitter, 25 kw visual, 7 kw aural with tubes, low pass, harmonic and sideband filters complete. For 208/240 volt, 3 phase, 50/60 cycle input ES-34291

TTL-25DL TV Transmitter, 25 kw visual, 7 kw aural with tubes. For 380/415 volt, 3 phase, 50 cycle input. (Output power and required filters to be determined in accordance with required operating standards.) ES-34293

Optional and Accessory Equipment

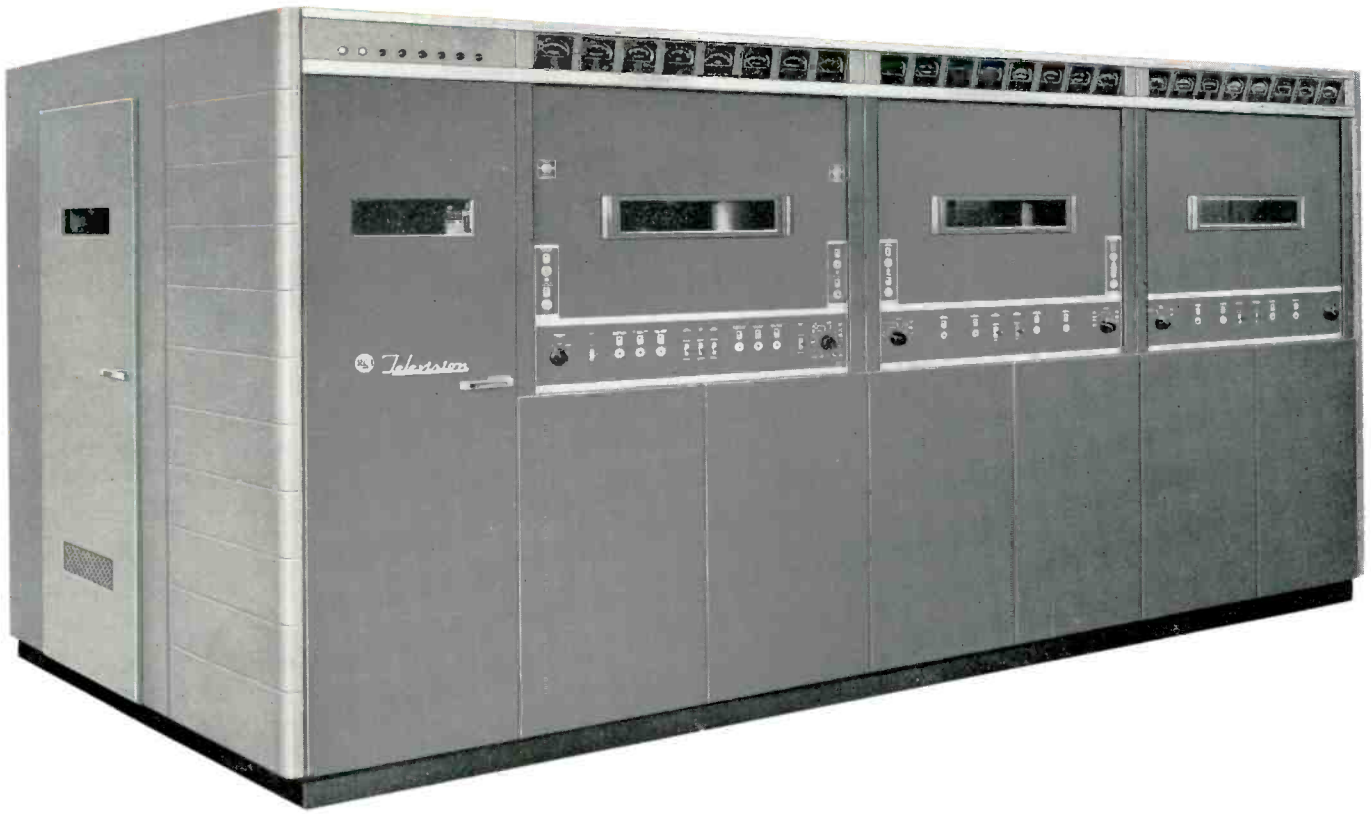
TTC-5A Control Console Equipment	ES-27274-9
Set of Minimum Spare Tubes	ES-34214
Complete Set of Spare Tubes	ES-34292
R.F. Load and Wattmeter	MI-19193
Input and Monitoring Equipment	ES-19237-E
Carrier-Off Monitor	ES-27235
Tuning Indicator for MI-27475 Exciter	MI-27487
50 Cycle Conversion Kit	MI-34439
BW-5B Sideband Response Analyzer	MI-34000-B
Plate Current Meter	MI-21200-C1
Transmission Line & Fittings ($3\frac{1}{8}$", 51.5 ohm)	MI-19113-C

NOTE: Specify items for connecting output of transmitter to VSBF or filterplexer.

WM-71A Distortion and Noise Meter	MI-30071-A
WA-28A Audio Oscillator	MI-30028-A
TO-524-AD Oscillator	MI-26500-A
BW-4B Visual Demodulator	ES-34048
Exciter Modification Kit (CCIR)	MI-34405

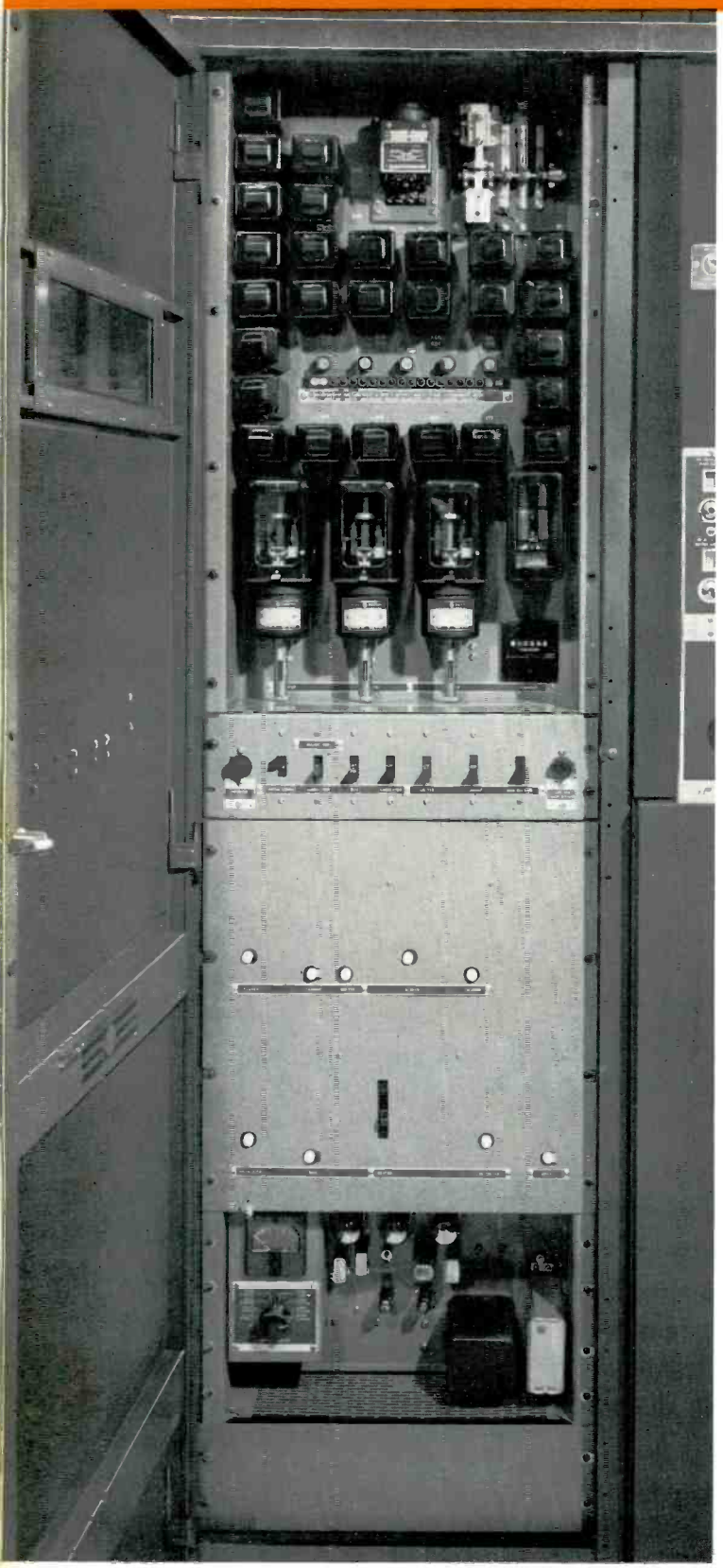
25 KW VHF TV Transmitter

TYPE TT-25DH



FEATURES

- Visual power output 25 kw peak measured at output of sideband filter or filterplexer
- Designed for color—linearity correction circuits built into modulator
- Maximum reliability through diplexed circuitry
- Completely siliconized power supply
- Economical installation
- Improved picture quality—antenna reflections absorbed in reject load
- Remote control provisions
- Complete overload protection with "localizer indicators"
- Vestigial sideband characteristics determined by fixed-tuned, trouble-free, factory adjusted sideband filter or filterplexer
- Inter-carrier frequency control accurately maintains frequency separation between aural and visual carriers
- Completely air-cooled
- Space requirements reduced 40 percent



Control cabinet with door open showing auxiliary switches, breakers, overload and auxiliary relays. Overload indicating lights for all TT-25DH circuits are grouped on strip that can be seen through window when door is closed.

DESCRIPTION

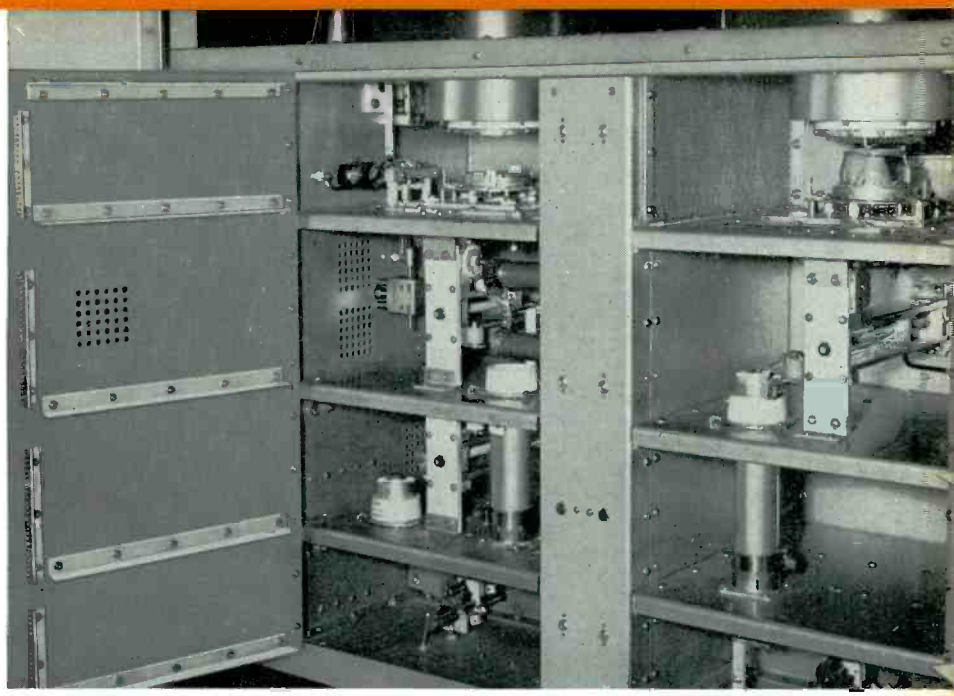
The TT-25DH Television Transmitter operates on VHF channels 7 through 13 (174 mc—216 mc), with a peak visual power output of 25 kw (22.5 kw CCIR). When used with one of the current VHF antennas, it is possible to obtain the maximum allowable 316,000 watts of effective radiated power. The TT-25DH may be purchased as a complete 25 kw high-power transmitter, or may be the result of a building-block program starting with a 5 kw transmitter (TT-5BH), then adding a 25 kw amplifier. A minimum of conversion is necessary to change from one power level to the next as the station grows.

The TT-25DH circuits employ the latest design features and represent economy in operation. Highlighted features include air-cooled tubes such as the 6166-A for long life and reliability. Single ended r-f circuits greatly reduce the number of necessary tubes and circuit components. Complete overload protection with indicating lights aid in quick location of faulty circuits. Inter-carrier frequency control accurately maintains frequency separation between aural and visual carriers.

The equipment provides separate visual and aural amplifiers—with a common power supply—for use with the driver. This equipment includes air-cooled linear broadband amplifiers for the visual carrier, and air-cooled class "C" amplifiers for the aural carrier. Each amplifier consists of a single power stage utilizing a Type 6166-A Tetrode in a grounded-grid, grounded-screen circuit. The transmitter is housed in a compact cabinet having only one access door. The cabinet can be broken down for shipping into racks and panels of varying size for easy handling. All r-f circuits and control circuits are located at the front of the enclosure. The rectifiers are mounted on the rear wall and the heavy power components are mounted on the floor. The control unit is at the left front corner of the transmitter in a separate cabinet with status lights grouped on a panel above the door. The auxiliary switches, breakers, overload and auxiliary relays, etc. are in the control unit behind a non-interlocked door. Overload indicating lights for all the circuits of the transmitter are grouped on a single strip so they can be seen through the window in the door.

A single access door on the left end of the transmitter provides access to the rear of the control and r-f racks as well as the components mounted on the rear wall of the enclosure. All heavy units such as the plate transformers and large reactors are mounted on a base on the floor.

Since all operating controls and important adjustments are brought out to the front of the transmitter, it should not be necessary to enter the enclosure while power is on. Every precaution has been taken to insure the operator's



Visual r-f driver on the left and aural r-f driver on the right emphasize complete accessibility and straightforward unitized construction of the TT-25DH Transmitter.

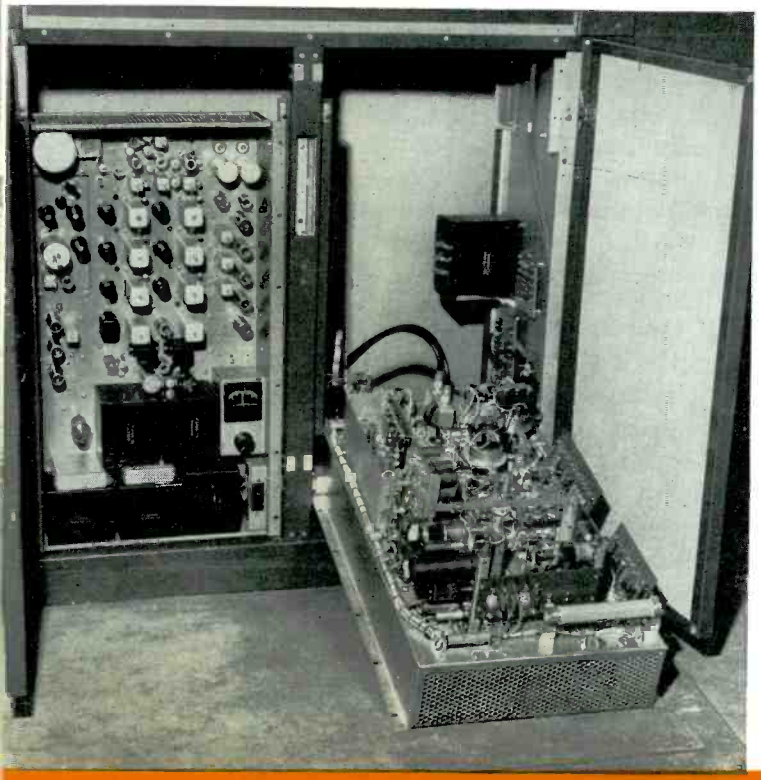
safety when it is necessary to enter the enclosure for routine maintenance and service. In addition to the conventional plate interlock and high voltage grounding contactors, the plate transformer disconnect switch is fitted with a long handle which extends across the door opening. This makes it difficult to enter the enclosure without opening the primary of the high voltage transformers. The versatility of the new transmitter cabinets may be seen in the floor plan shown.

Design Features

The TT-25DH was designed with reliability and ease of operation and maintenance in mind. Access to components is better because of new improved mechanical design. Space requirements have been reduced as much as 50 percent over previous designs to allow for installation in existing buildings. Reduction of required floor space is effected by the walk-in enclosure design of the TT-25DH.

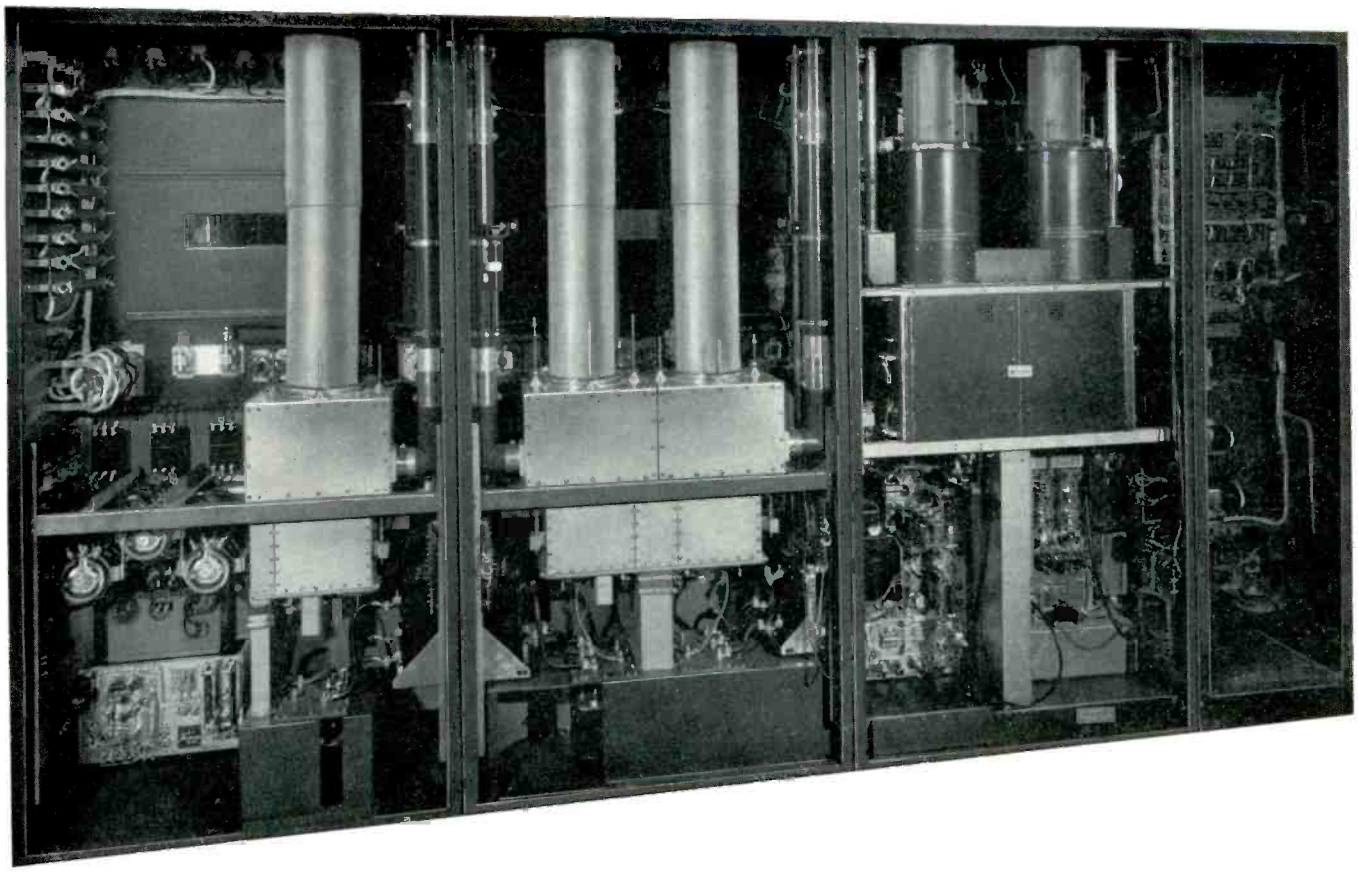
This type of construction eliminates the need for external access space at the rear of the enclosure. The enclosure may be placed directly against a wall or even in a corner of the room if an air intake opening is provided. Access to all components of the transmitter is possible from within the enclosure. The modulator and exciter may be serviced by tilting the chassis forward, without removal from the cabinet.

TT-25DH exciter (left) and modulator unit (right) are mounted on hinged chassis which allow units to tilt forward for utmost accessibility.



Exciter Circuit

The TT-25DH Transmitter is driven by a common exciter containing both visual and aural chains. Accurate control of the separation of visual and aural carrier frequencies is the result of precise engineering circuit design. The visual chain is driven by either one of the two crystal controlled 6AK5 oscillator circuits as a primary source of carrier frequency. Oscillators may be switched by means of a relay, thus making this circuit adaptable for remote control. The crystals operate at one-thirty-sixth the visual carrier frequency and one-twelfth of the output frequency of the exciter. The aural master oscillator is a free-running 6V6 oscillator controlled by a pair of 6V6 reactance tubes which are part of the automatic-frequency control circuit used to maintain the 4.5 mc (5.5 mc CCIR) separation between carriers. An off-frequency interlock prevents uncontrolled frequency operating by cutting off plate voltage to the stages that follow the exciter.



Panoramic rear view of front-line cabinets of TT-25DH Transmitter. Control panel at far right, with driver portion of transmitter including rear of exciter and modulator panels occupying next cabinet. Final amplifiers are housed in cabinets at left.

The automatic frequency control of the aural master oscillator is accomplished by feeding a small amount of energy from the aural and visual triplers into a 6AS6 mixer tube. When the aural oscillator is on frequency the output of this mixer stage will be one-twelfth of the difference frequency between the aural and visual carriers or 375 kc (458.33 kc CCIR). The 375 kc (458.33 kc CCIR) signal mixes with the output of the 6J6 crystal controlled reference oscillator (1500 kc or 1833.33 kc CCIR) in the second 6AS6 mixer stage. The sum frequency is fed through a chain of three dividers with a total division of 100 to the frequency detector stage. This amount of division is necessary to reduce the swing at the frequency detecor so that the carrier will not drop out under any modulation conditions of the aural transmitter. The 6J6 reference oscillator signal is fed through three divider stages with a total division of 80 to the frequency detector stage. By using the 6J6 reference oscillator output to excite both the second mixer and the divider chain for reference frequency, considerable improvement in frequency control accuracy is obtained. Signals from both the difference frequency and the reference frequency chains are fed into the frequency detector. The frequency detector is essentially a balanced modulator with a d-c component in the output which will change polarity depending upon whether the signal frequency is above or below the reference frequency. This d-c voltage is fed back to one of the reactance tubes for the master oscillator in such a way as to correct the frequency of the master oscillator.

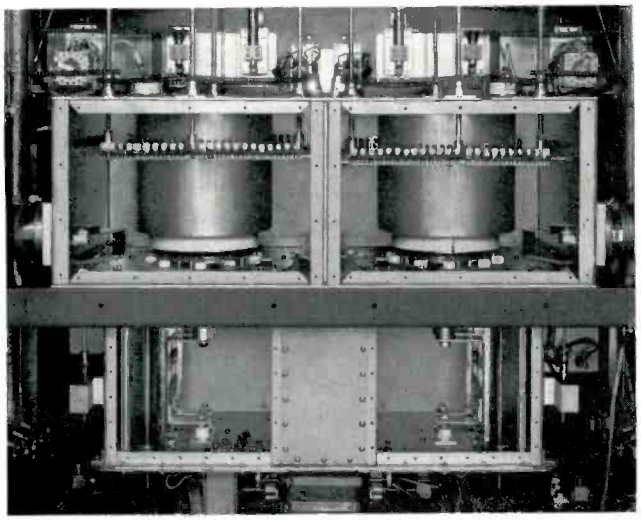
Visual Modulator

The 4CX5000A Visual Modulated Amplifier is grid modulated by the video modulator. A modulator output signal of approximately 300 volts peak-to-peak is required for full modulation of the visual transmitter. The modulator amplifies a standard 1 volt video signal to the required level. A linearity correction circuit is included, as well as motor-driven operating controls for use when remote control is incorporated.

The first amplifier stage in the video modulator is a conventional shunt-series peaked video amplifier. This is followed by an inverter stage and a linearity corrector stage,

each of which has a gain of approximately unity. The linearity corrector is designed to predistort the signal to compensate for the non-linearity which always occurs in a grid modulated stage. Linearity correction is accomplished by the use of four biased diodes connected in the linearity corrector cathode circuit. The bias voltage on each diode is separately adjustable. Any one of the diodes can be made to start conducting at any brightness level. The grid of the linearity corrector is clamped in order to insure the same correction to the linearity characteristic regardless of the average brightness of the picture signal.

The linearity corrector is followed by a second video amplifier using a 6CL6 tube and then by a third video amplifier consisting of two 5933 tubes. The grids of the third

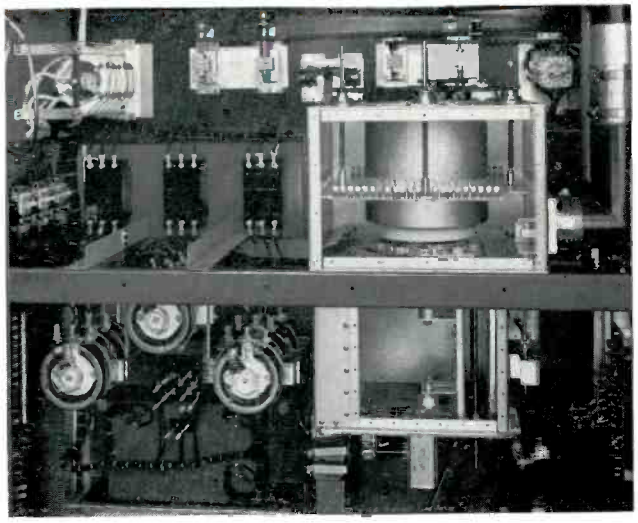


Detailed rear view of r-f amplifier showing aural high-power cavity (right) and one of diplexed visual amplifiers (left) and highlighting accessibility of the high power plate and grid cavities for routine cleaning and maintenance.

video amplifier are also clamped and from this point on the circuit is d-c coupled. The output (modulator) stage is a shunt regulated cathode follower. It consists of three 6146 tubes connected in a circuit very similar to a conventional cathode follower, except that the cathode resistor is replaced by four 6146 tubes operating in parallel. The grids of these four tubes are fed with a signal from the plate load of the three cathode follower tubes. This makes the circuit essentially a feedback amplifier of high efficiency capable of delivering modulation at a high level to a large capacitive load.

A carefully designed clamp circuit assures reliable clamping even with greatly degraded input signal. Back porch clamping is employed.

Two power supplies are used. One supplies 250 volts to the low level stages while the other supplies 575 volts to



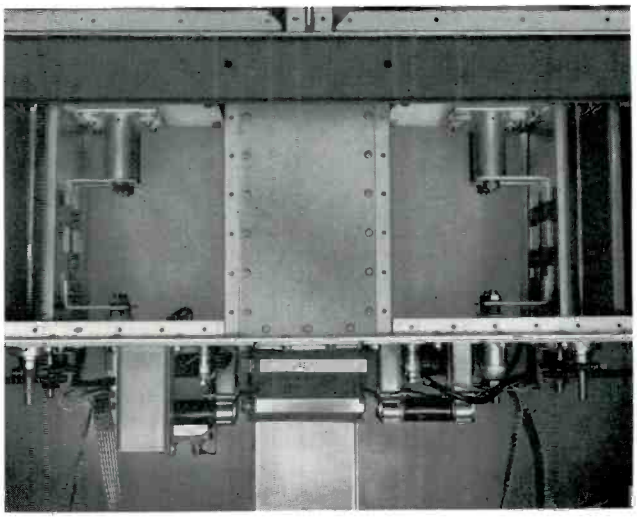
Rear view of right visual amplifier and auxiliary control equipment. Note at upper left the function switch which allows operation of either or both visual amplifiers with or without the aural transmitter. At lower left are the three individual voltage controls serving d-c, filaments and individual high power amplifiers.

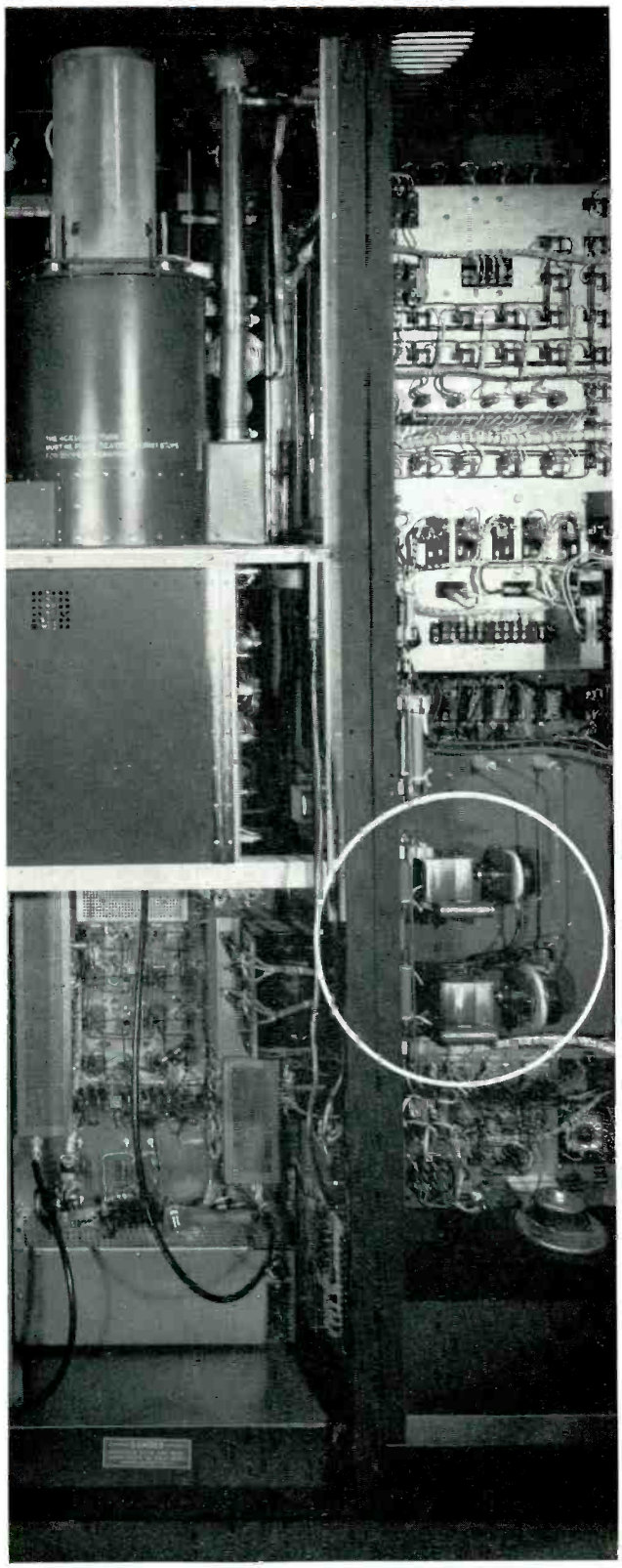
the third video and modulator stages. The use of a negative 575 volt supply makes the use of a bucking bias supply unnecessary.

The outputs of both supplies are electronically regulated by regulators mounted on the modulator chassis. This greatly reduces the possibility of unwanted video resonances in power supply leads. The modulator rectifiers are located on the rear wall of the transmitter enclosure.

A monitor amplifier is provided for monitoring the modulator output signal. Numerous test jacks are also provided to simplify trouble-shooting and modulator alignment.

Plate removed from bottom of high power amplifier, MI-27192, showing d-c filament connections to the 6166A Tubes.





Driver portion of TT-25DH (left) and control cabinet (right). Circled are the motor driven aural and visual excitation controls which are part of the built-in remote control facilities of the TT-25DH.

Aural Modulator

Frequency modulation is accomplished in the TT-25DH exciter by a "direct modulation" process requiring less components, fewer tubes and tube types. This process, which eliminates numerous multipliers and converter stages resulting in low noise and minimum distortion, utilizes two push-pull reactance tubes connected across the frequency determining circuit of the master oscillator. The center frequency of this oscillator is precisely maintained by the automatic frequency control circuit described in the exciter description.

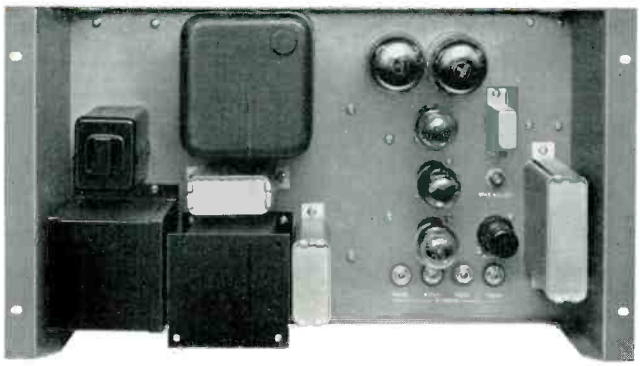
Frequency modulation is obtained by feeding the audio signal into the reactance tubes which are connected across the oscillator plate tank circuit. R-F energy from the oscillator tank is link coupled to a transformer which has a coil in the grid circuit of each reactance tube. R-F voltages on the push-pull connected grids are 180 degrees out of phase with each other and each is 90 degrees out of phase with respect to the r-f voltage at the plates. Thus across the oscillator tank one tube appears as a capacitive reactance and the other as an inductive reactance. The magnitude of the reactive plate current in the reactance tubes varies in direct proportion to the value of audio voltage applied to the grids. Therefore, the frequency of the oscillator is varied at an audio rate to furnish the required FM signal. The mean frequency of the oscillator is controlled by varying the grid bias of one of the reactance tubes. This bias voltage is the d-c output voltage of the frequency detector stage of the exciter.

R-F Circuits

The r-f circuits employ a chain of multipliers and amplifiers. In the visual chain a 7034 tube operates as a tripler driving a 4CX300A amplifier which in turn drives a type 4CX5000A grid modulated power amplifier. The output of the modulated amplifier is equally divided by a power-splitting balun to drive two 12.5-kw linear amplifiers. The outputs of these two amplifiers are then combined in the broadband diplexer to provide 25-kilowatts of peak visual power. Excitation control for the visual transmitter is accomplished by varying the screen voltage on the 4CX300A stage. The aural chain consists of a type 7034 tripler driving type 4CX300A amplifier followed by a type 4CX5000A class "C" power amplifier, which, in turn, drives a type 6166-A class "C" power amplifier. Power output of the aural transmitter is adjusted by varying the screen voltage on the 4CX5000A stage. Both these controls are operated by motors and therefore can be adjusted from a remote position.

The visual linear amplifiers following the modulated stage each employ a 6166-A tetrode in a grounded-grid, grounded-screen circuit. Circuit design is simplified, since

the grid and screen may be by-passed to a common ground plane. Input and output circuits are then constructed on opposite sides of the ground plane. The 6166-A cavity is fabricated in rectangular shape to that removal of one panel exposes the entire cavity for cleaning or other preventative maintenance. No neutralizing adjustments are required, since the 6166-A stage is effectively neutralized over the entire band. D-c is used for filaments of the 6166-A to reduce hum modulation to a level well below the usual requirement. The same cavity design is used in the aural amplifier.



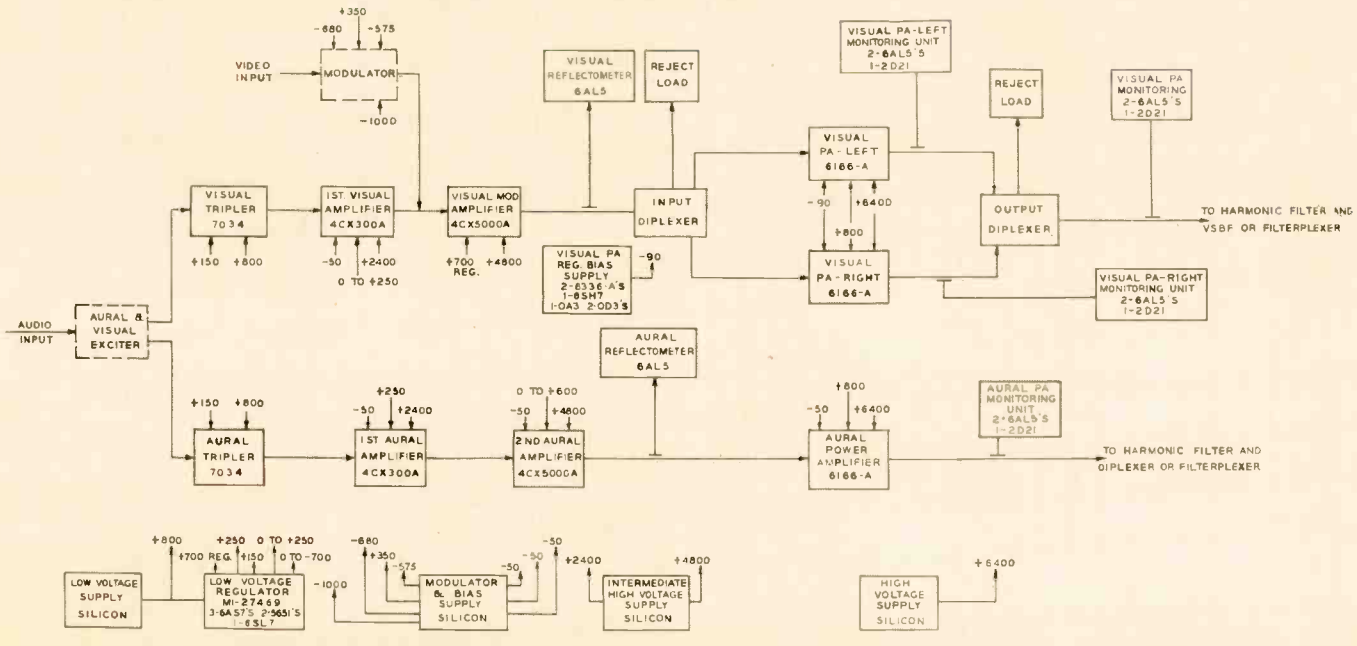
Regulated bias supply for the visual power amplifier is a chassis mounted unit located in extreme right hand cabinet of TT-25DH.

Power and Control Equipment

Wherever possible in this transmitter, the same d-c power supplies were used for both the visual and aural amplifiers. This greatly reduces the number of components in the transmitter. An exciter supply is built into the common exciter unit using stacked germanium diodes. The other supplies, all using silicon diodes, are located on the rectifier panels at the rear of the enclosure. An 800-volt supply furnishes all screen voltages as well as the 7034 plate voltage. The intermediate voltage supply has a 4800-volt output for the 4CX5000A plates and a 2400-volt output for the 4CX300A plates. The high-voltage supply uses silicon diodes which operate at one-sixth of rated current capacity. This supply provides 6400 volts for the plates of the three Type 6166-A power tubes. High-voltage switching allows independent operation of visual and aural final amplifiers. In addition, this feature permits removal of plate voltage from either visual amplifier in the event of tube failure which results in a minimum of lost air time. All voltages for the visual modulator are furnished by the remaining supplies. One has an output of +350 volts, and the other has several outputs, all negative with respect to ground, which supply the high-level video stages as well as bias for the modulator and r-f stages.

A single integrated control circuit is provided for both the visual and aural transmitters. The blower, filaments, and each rectifier is protected by thermal overloads which can be adjusted to reset automatically. In addition, a main line breaker and an auxiliary breaker are provided. Each incorporates both thermal and magnetic trips. All rectifiers and r-f stages following the exciter are protected by in-

Simplified block diagram of TT-25DH VHF TV Transmitter.



stantaneous overload relays which automatically recycle twice. If the fault continues on the third try the overload circuit will remain tripped until reset. Overload indicator lights are provided for each circuit. These lights have a separate reset and will remain on after the first overload thus providing a record of the circuit giving trouble even though it may be intermittent.

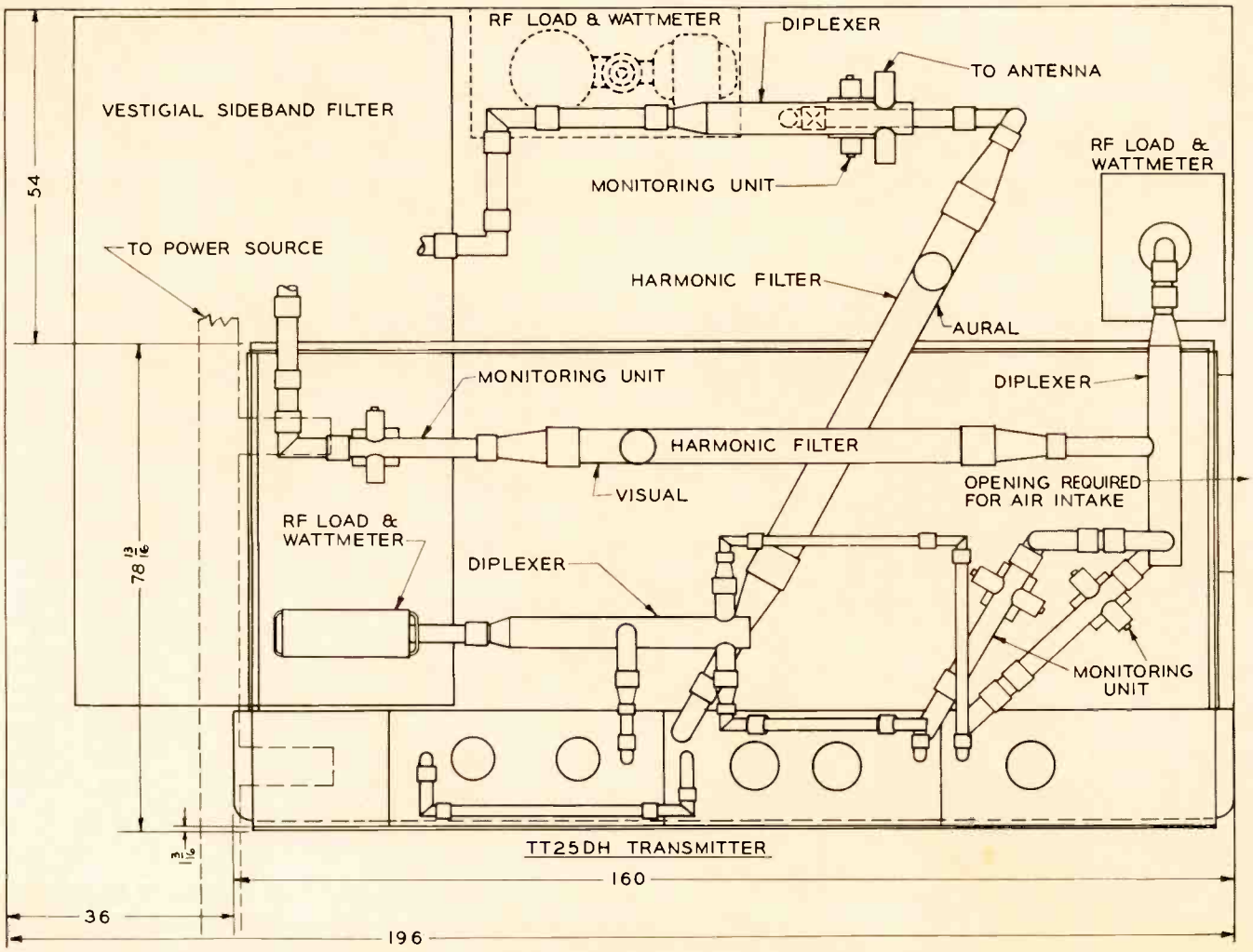
The equipment includes an automatic line voltage regulator which provides a stable line voltage to the filament primaries, the exciter, the modulator, and the low voltage power supply. Automatic filament line voltage regulators and automatic regulators capable of handling the complete transmitter are available as optional items. In localities troubled with excessive instantaneous line voltage fluctuation, an electronically controlled regulator for the low voltage supply is available as optional equipment.

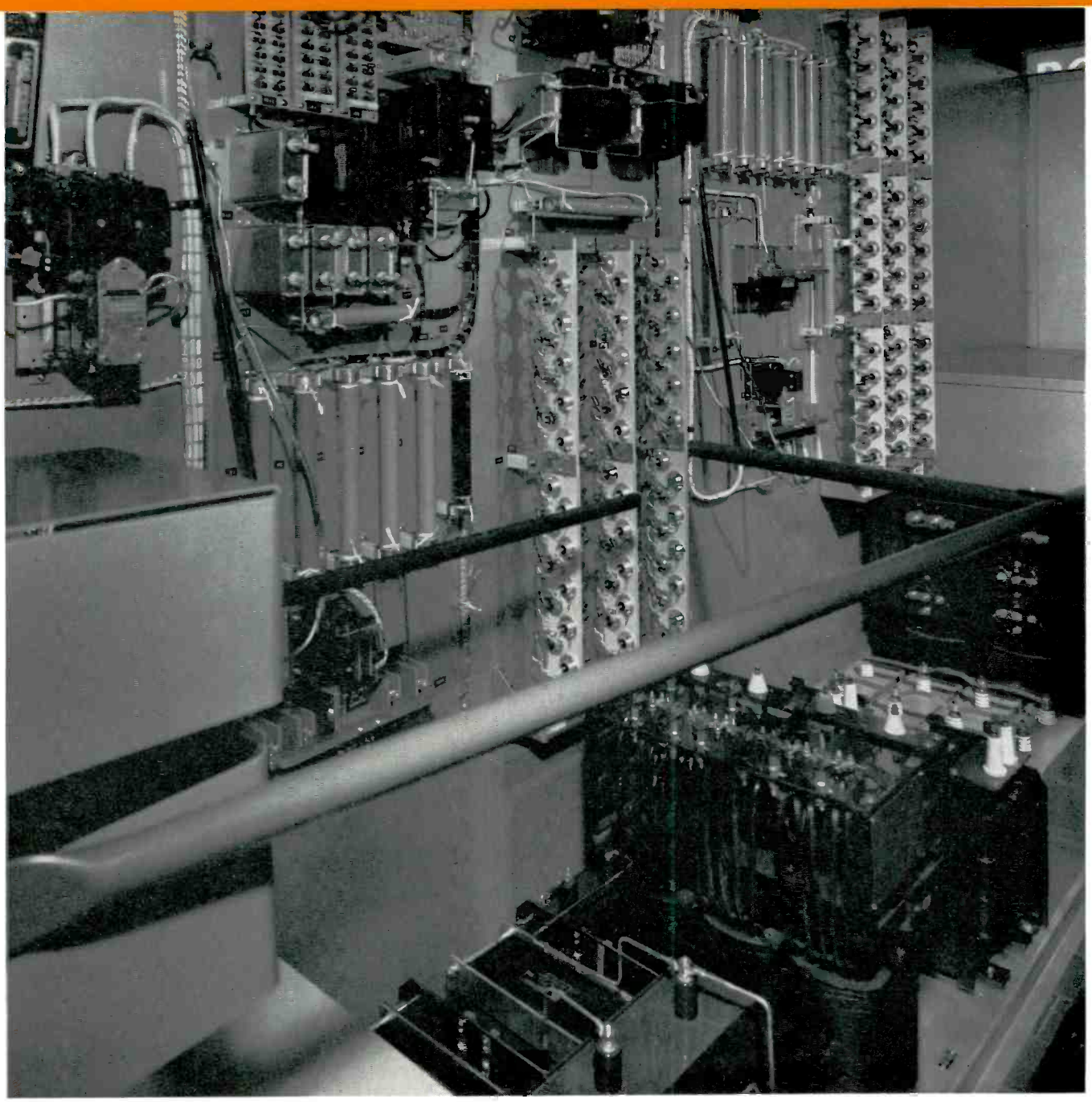
Special Protective Circuits

The TT-25DH has reflectometer units for use in the output transmission lines of both the aural and visual amplifiers. Each unit contains a 6AL5 diode detector. The transmission line probes are installed so as to give an indication of the amount of power on meters on the front panel. Reflected power can be checked by manually rotating the reflectometer heads.

A carrier-off monitor is available as optional equipment. It acts in conjunction with the reflectometer units and is particularly useful for remote control. This unit will remove the plate voltage from all the r-f stages if the output level drops below a predetermined value, such as would be the case if an r-f arc occurred in any of the r-f stages. Sometimes such an arc does not change the plate current sufficiently to trip the d-c overload relays.

Typical floor plan showing TT-25DH Transmitter, ceiling mounted sideband filter, and optional R-F Load and Wattmeter.





View showing rear wall of TT-25DH enclosure with high-voltage and intermediate voltage silicon rectifiers. Floor mounted are the intermediate and high voltage transformer and filter assemblies.

Vestigial Sideband Filter

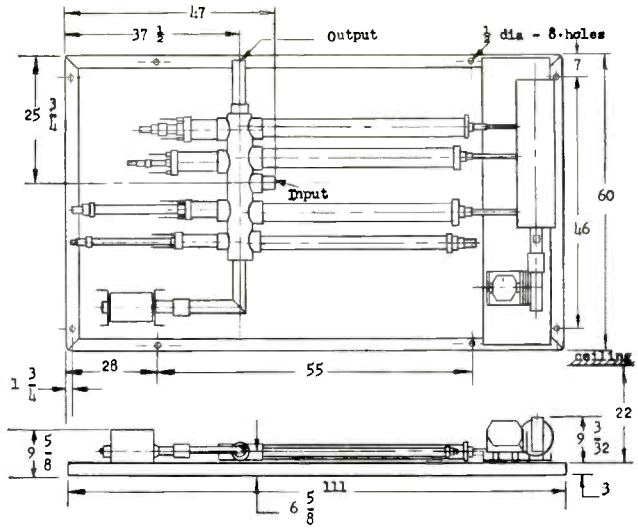
The MI-27799 Vestigial Sideband Filter is furnished completely assembled and adjusted for any one of the FCC high-band VHF television channels. The filter is an integral unit designed for floor, ceiling, or wall mounting near the visual transmitter so that the input transmission line is as short as possible.

The purpose of the filter is to attenuate the lower sideband output of a double sideband visual transmitter. It consists essentially of series and parallel lumped impedances which act as resonant circuits at their respective frequencies. The elements are so chosen that the reactance is balanced out and the input resistance is constant. The filter sections consist of lengths of coaxial line (lumped impedances), which are adjustable for tuning purposes. As the filter is pretuned at the factory to the channel stamped on the nameplate, no tuning adjustments are necessary.

Reflections are kept to a minimum when transmission line specified in the transmitter schedule of equipment is used between the transmitter and sideband filter.

SPECIFICATIONS

Frequency	174-216 mc
Maximum Power (5000 ft. elevation)	25 kw
Input and Output Impedance	50/51.5 ohms, 3⅛" coaxial line
VSWR	1.1 or better
Blower	230 volt, ¼ hp, 2850 rpm, 50/60 cycle
Air Interlock	5 amp. @ 250 volts, a-c
Ambient Temperature	45° C max.
Weight	532 lbs.
Mounting	Wall or ceiling
Clearance	12"



MI-27799 Vestigial Sideband Filter.

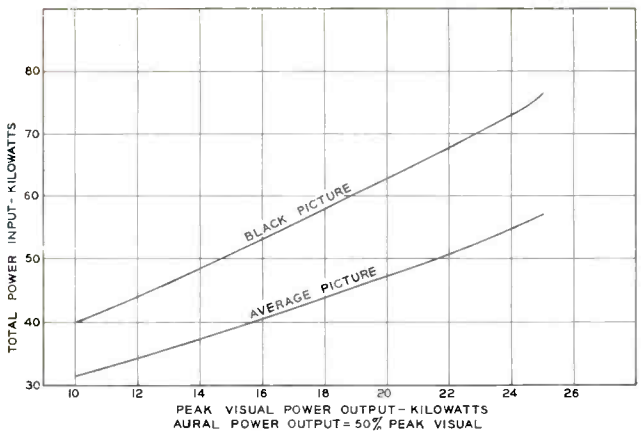
SPECIFICATIONS

Performance

	FCC Specs.	CCIR Specs.
Type of Emission:		
Visual	A5	A5
Aural	F3	F3
Frequency Range	Ch. 7-13	174-216 mc
Rated Power Output:		
Visual	25 kw[1]	22.5 kw[1]
Aural	13.6 kw[2]	12.5 kw[2]
Minimum Power Output:		
Visual	10 kw[1]	10 kw[1]
Aural	5 kw[2]	4.4 kw[2]
R-F Output Impedance:	50/51.5 ohms	50/51.5 ohms
Input Impedance:		
Visual	75 ohms	75 ohms
Aural	600/150 ohms	600/150 ohms
Input Level:		
Visual	0.7 v. peak-to-peak min.	0.7 v. peak-to-peak min. (composite video)
Aural	+10 ±2 dbm	+16 ±2 dbm for 50 kc dev. Uniform ±1 db from 50 to 15,000 cyc.
Amplitude vs. Frequency Response	Uniform ±1 db from 50 to 15,000 cyc.	——
Upper Sideband Response:[3]		
At Carrier plus 0.5 mc	+1, −1.5 db	——
At Carrier plus 1.25 mc	+1, −1.5 db	——
At Carrier plus 1.5 mc	——	+1, −1.5 db
At Carrier plus 2.0 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 3.0 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 3.58 mc	+1, −1.5 db	——
At Carrier plus 4.0 mc	——	+1, −1.5 db
At Carrier plus 4.18 mc	+1, −3.0 db	——
At Carrier plus 4.75 mc	−20 db max.	——
At Carrier plus 5.0 mc	——	+1, −1.5 db
At Carrier plus 5.75 mc	——	−20 db max.
Lower Sideband Response:[4]		
At Carrier minus 0.5 mc	+1, −1.5 db	+1, −1.5 db
At Carrier minus 1.25 mc	−20 db max.	−20 db max.
At Carrier minus 3.58 mc	−42 db max.	——
Variation in Frequency Response with Brightness[5]	±1.5 db	±1.5 db

	FCC Specs.	CCIR Specs.
Carrier Frequency Stability[6]		
Visual	±1 kc	±.0005%
Aural	±500 cps[7]	±.001%
Modulation Capability:		
Visual	12.5 ±2.5% (reference white)	12.5 ±2.5% (reference white)
Aural	±50 kc	±50 kc
Audio Frequency Distortion	1.5% max. 50-100 cyc. 1.0% max. 100-7500 cyc. 1.5% max. 7500-15,000 cyc.	1.5% max. 50-100 cyc. 1.0% max. 100-7500 cyc. 1.5% max. 7500-15,000 cyc.
FM Noise, below ±25 kc Swing	60 db	60 db
AM Noise, r.m.s.:		
Visual	45 db below 100% mod.	45 db below 100% mod. (hum and thermal)
Aural	50 db below carrier	50 db below carrier
Amplitude Variation Over One Picture Frame	Less than 5% of the peak of sync level	Less than 5% of the peak of sync level
Regulation of Output	7% max.	7% max.
Burst vs. Subcarrier Phase[8]	±5 degrees max.	——
Subcarrier Phase vs. Brightness[9]	±7 degrees max.	——
Subcarrier Amplitude[8]	±10% max.	——

[1] Measured at the output of the sideband filter or filterplexer.
[2] Measured at the input to the diplexer or filterplexer.
[3] With respect to the response at 200 kc, as measured by the BW-5B Sideband Response Analyzer at transmitter mid-characteristic. 4.75 mc attenuation requires use of MI-27132 LP filter in the video input circuit.
[4] With respect to the response at 200 kc at transmitter mid-characteristic.
[5] Maximum variation with respect to the response at mid-characteristic measured with the BW-5B Sideband Response Analyzer at brightness levels of 22.5% and 67.5% of sync peak, using approximately 20% (peak-to-peak) modulation.
[6] Maximum variation for a period of 30 days without circuit adjustment.
[7] Maximum variation with respect to the standard 4.5 mc separation between aural and visual carriers.



Input power curve for TT-25DH Transmitter.

	FCC Specs.	*CCIR Specs.*
Linearity (Differential Gain)[10]	1.5 db max.	1.5 db max.
Envelope Delay vs. Frequency[11]	±.08 μsec. from 0.2 to 2.1 mc ±.04 μsec. at 3.58 mc ±.08 μsec. at 4.18 mc	—
Harmonic Attenuation, ratio of any single harmonic to peak visual fundamental[12]	At least 60 db	At least 60 db

Electrical

	FCC Specs.	*CCIR Specs.*
Power Line Requirements:		
Transmitter:		
Line	230/208 volts, 3 phase, 50/60 cyc.	230/208 volts, 3 phase, 50/60 cyc.
Slow Line Variations	±5% max.	±5% max.
Rapid Line Variations	±3% max.	±3% max.
Power Consumption (25 kw Visual & 12.5 kw Aural)	See Curve	34 kw (black pix) 30 kw (av. pix) (Visual vs. aural output ratio 5:1)
Power Factor (approx.)	90%	90%
Crystal Heaters:		
Line	115 volts, single phase, 50/60 cyc.	115 volts, single phase, 50/60 cyc.
Power Consumption	28 watts	28 watts

[8] Maximum departure from the theoretical when reproducing saturated primary colors and their complements at 75% amplitude.

[9] Maximum phase difference with respect to burst, measured after the VSBF, for any brightness level between 75% and 15% of the sync peak using 10% (peak-to-peak) modulation. This is equivalent to 5% (peak-to-peak) modulation as indicated by a conventional diode demodulator. In addition, the total differential phase between any two levels shall not exceed 10 degrees.

[10] Maximum variation in the amplitude of a 3.58 mc sine wave modulating signal as the brightness level is varied between 75% and 15% of sync peak. The gain shall be adjusted for 10% (peak-to-peak) modulation of the 3.58 mc signal when the brightness is at pedestal level. This is equivalent to 5% (peak-to-peak) modulation as indicated by a conventional diode demodulator connected after the VSBF.

[11] Maximum departure from standard curve. The tolerances vary linearly between 2.1 and 3.58 mc and between 3.58 mc and 4.18 mc. To meet the specification a properly terminated phase correction network, ES-34034-B is required in the video input circuit of the transmitter.

[12] Measured with harmonic filters in the visual and aural transmitter outputs.

TT-25DH Tube Complement

EXCITER

Qty.	*Function*	*Type*
1	Visual Crystal Oscillator #1	6AK5
1	Visual Crystal Oscillator #2	6AK5
1	Buffer Amplifier	5763
1	1st Visual Multiplier	5763
1	2nd Visual Multiplier	5763
1	3rd Visual Multiplier	5763
1	Visual Output Amplifier	5763
2	Reactance Tube Modulator	6V6
1	FM Master Oscillator	6V6
1	1st Aural Multiplier	5763
1	2nd Aural Multiplier	5763
1	3rd Aural Multiplier	5763
1	Aural Output Amplifier	5763
1	1st Mixer	6AS6
1	2nd Mixer	6AS6
1	Difference Frequency Amplifier	6AQ5
1	1st Difference Frequency Divider	6AC7
1	2nd Difference Frequency Divider	6AC7
1	3rd Difference Frequency Divider	6AC7
1	Crystal Oscillator-Reference Frequency	6J6
1	1st Reference Frequency Divider	6AC7
1	2nd Reference Frequency Divider	6AC7
1	3rd Reference Frequency Divider	6AC7
1	Cathode Follower-Frequency Detector Drive	12AT7
1	Off-Frequency Detector	6AS6
1	Off-Frequency Interlock Control	2D21
1	Voltage Regulator	OD3

RCA Type 6166-A Ceramic Power tube which serves as a long life class "C" power amplifier in the RCA TT-25DH Transmitter.

SPECIFICATIONS (Continued)

TT-25DH Tube Complement (Continued)

MODULATOR

Qty.	Function	Type
1	1st Video Amplifier and Inverter	6CX8
1	Linearity Corrector	6CL6
1	2nd Video Amplifier	6CL6
2	3rd Video Amplifier	5933
7	Modulator	6146
1	Modulator Monitor	6CL6
1	Sync Cathode Follower and Amplifier	6CX8
1	Sync Separator	6EA8
1	Pulse Former and Clipper	6EA8
1	Phase Splitter #1	6CL6
1	Phase Splitter #2	6CL6
1	Clamp Diode #1	6AL5
1	Clamp Diode #2	6AL5
1	Voltage Regulator	OA2
10	Voltage Regulators (Modulator Screens)	OB2
2	Voltage Regulators	OC3
2	Voltage Regulators	OD3
2	Voltage Reference	5651
2	Low Voltage Regulators	6AS7-GA
2	High Voltage Regulators	6336-A
2	DC Amplifiers	6SL7-GT

R-F UNIT

1	Visual Tripler	7034
1	1st Visual Amplifier	4CX300A
1	Visual Modulated Amplifier	4CX5000A
2	Visual Power Amplifiers	6166-A
1	Aural Tripler	7034
1	1st Aural Amplifier	4CX300A
1	2nd Aural Amplifier	4CX5000A
1	Aural Power Amplifier	6166-A
10	Reflectometer Detectors	6AL5
4	Reflectometer Thyratrons	2D21
1	Air Interlock	2D21

LOW-VOLTAGE REGULATOR

3	Regulators	6AS7G
1	D-C Amplifier	6SL7-GT
2	Voltage Reference	5651

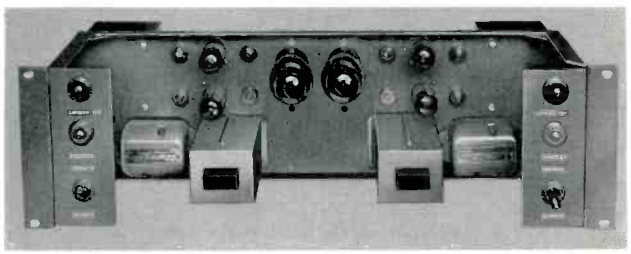
VISUAL BIAS SUPPLY

2	Shunt Regulators	6336-A
1	D-C Amplifier	6SH7
1	Voltage Reference	OA3
2	Voltage Reference	OD3

Mechanical Specifications

Weight (approx.)	9000 lbs. (4070 kg.)
Dimensions:	
Overall Length (front line cabinets only)	160" (406.4 cm)
Overall Height (front line cabinets only)	84" (213.4 cm)
Depth (front line cabinets only)	20" (50.8 cm)
Overall Depth	78 13/16" (200 cm)
Finish	Two-tone umber gray, polished stainless steel trim
Maximum Altitude[12]	7500 ft.
Ambient Temperature	45°C max. 0°C min.

[12] For operation at rated power and normal plate voltage.



Carrier-Off Monitor, ES-27235, is useful accessory for remote control.

Equipment Supplied

TT-25DH TELEVISION TRANSMITTER ES-34212

Qty.	Description	Stock No.
1	Control Unit	MI-27180-A
1	5-kw R-F Unit	MI-34460
1	Aural and Visual Amplifier Unit	MI-27192
1	Amplifier and Auxiliary Control Unit	MI-34426
1	Switchgear Panel	MI-34427
1	Plate Contactor Panel	MI-34428
1	Rectifier Panel	MI-34461
1	High Voltage Rectifier Panel	MI-34431
1	Line Regulator	MI-27473-A
1	Line Regulator Control Panel	MI-27471
1	Transformer Filter Assembly	MI-34462
1	Transformer	MI-27636-C
1	High Voltage Filter Assembly	MI-34429
1	High Voltage Transformer	MI-34430
1	Blower Enclosure and Filter Panel	MI-34432
1	Blower Unit	MI-27195
1	Installation Material	MI-34433
1	Wiring Material	MI-34434
1	Low Voltage Regulator	MI-27469
2	Crystal Unit	MI-27492
2	Side Panel	MI-30541-G84
4	Monitoring Unit	MI-19088
3	Monitoring Diodes	MI-19051-B
1	Low-pass Filter	MI-27132
2	Harmonic Filter	MI-27318-A7/A10
1	Sideband Filter	MI-27799-Channel
2	Diplexers	MI-27393
1	Input Reject Load	MI-19196-H
1	Output Reject Load	MI-27396
1	Set of Operating Tubes	ES-34213
1	Set Transmission Line	MI-34435-Channel
3	Reducer Couplings	MI-19113-C7
20	Couplings	MI-19112-8
11	90° Mitre Elbow (1 5/8")	MI-19112-18C
11	90° Mitre Elbow (3 1/8")	MI-19113-C18
26	Coupling	MI-19113-C8
1	Finish Touch-Up Kit	MI-27660-A1
1	Miscellaneous Hardware Kit	MI-7474
1	Tool Kit	MI-27088
1	Set of Installation Drawings	8530228-501
1	Socket Alignment Gauge	MI-27578-A
2	Sets of Instruction Books	IB-31507
2	Sets of Installation Books	IB-31508

Optional or Accessory Equipment

TTC-5A Control Console Equipment, with master monitor but less master monitor power supply	ES-27274-9
Set of Spare Tubes	ES-34213
Set of Min. Spare Tubes	ES-34214
Filterplexer	MI-27316-Channel
R-F Load and Watttmeter	MI-19193-H
Input and Monitoring Equipment	ES-19237-E
Carrier-Off Monitor	ES-27235
Tuning Indicator for MI-27475-H Exciter	MI-27487
50 Cycle Conversion Equipment	MI-34439
BW-5B Sideband Response Analyzer	MI-34000-B
Plate Current Meter	MI-21200-C1
WM-71A Distortion and Noise Meter	MI-30071-A
WA-28A Audio Oscillator	MI-30028-A
TO-524-AD Oscillator	MI-26500-A
BW-4B Visual Demodulator	ES-34048
Exciter Modification Kit (CCIR)	MI-34405

35 KW VHF Amplifier

TYPE TT-35BH

FEATURES

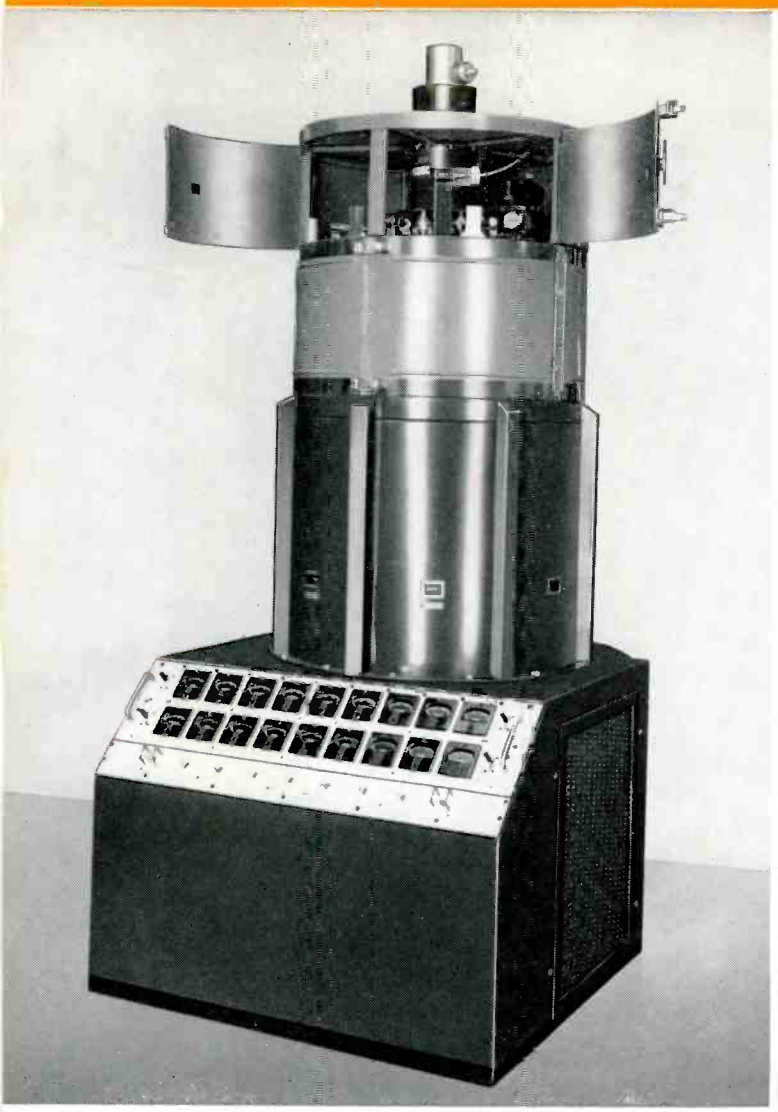
- Visual power output 35 kw peak measured at output of sideband filter or Filterplexer
- Air-cooled tubes—air-cooled transformer
- Low tube cost—easy tube change
- Utmost accessibility
- Flexible location of individual units to meet specific customer requirements
- Complete metering for all amplifier tubes
- Important amplifier meters are repeated on control unit
- High speed a-c and d-c overload protection
- Simple, single-ended r-f circuits
- Economical installation—low operating costs
- Vestigal sideband characteristics determined by fixed-tuned, trouble-free, factory adjusted sideband filter

USES

The 35 KW VHF Amplifiers are high-power equipments designed to convert RCA TT-10AH or TT-11AH television transmitters for higher power operation. The Type TT-35BH amplifier is used for channels 7 through 13.

The amplifiers are designed to provide excellent monochrome or color coverage for large urban centers. They are capable of up to 35 kilowatts peak visual power measured at the output of the sideband filter and 21 kw aural power. Maximum performance is necessarily dependent upon and governed by the performance of those portions of the transmitter preceding the amplifier. When used in conjunction with standard RCA superturnstile or travelling wave antennas, the amplifiers permit TV stations to achieve present maximum power ratings established by the FCC.

The amplifiers provide an economical method of increasing station power as required. Full power output can be achieved on all channels 7-13 at low dollar per hour operating cost. Unit construction of the add-on amplifiers allows utmost flexibility of layout and best use of existing station floor space.



External view of the high band amplifier for channels 7 to 13.

DESCRIPTION

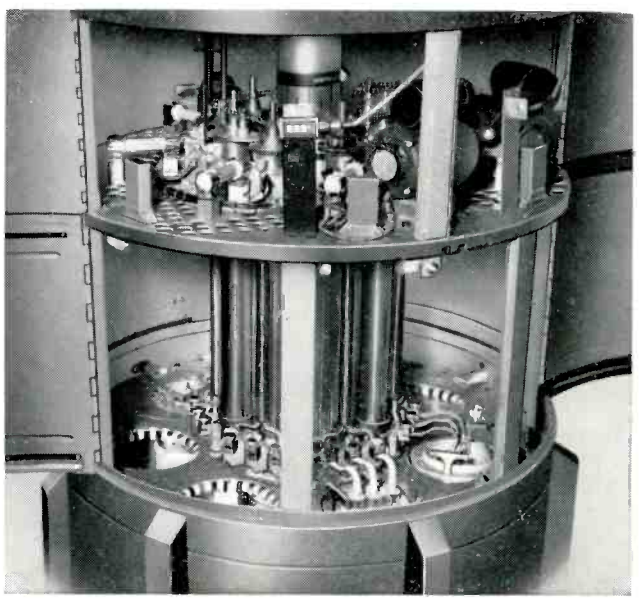
RCA VHF TV amplifier equipments include air-cooled linear broad-band amplifiers for the visual carrier, and air-cooled class "C" amplifiers for the aural carrier. Each amplifier consists of a single power stage utilizing a cluster of seven air-cooled RCA type 5762-A Triodes in a grounded-grid circuit. Fewer operating tubes can be used in the aural amplifier for reduced power operation.

The complement of equipment includes dual r-f amplifier and blower units, power supplies, control units, and plate transformers—one of each for both the aural and visual sections of the driver. The equipment is housed in cabinets which are divided so that flexibility is afforded in arranging the components.

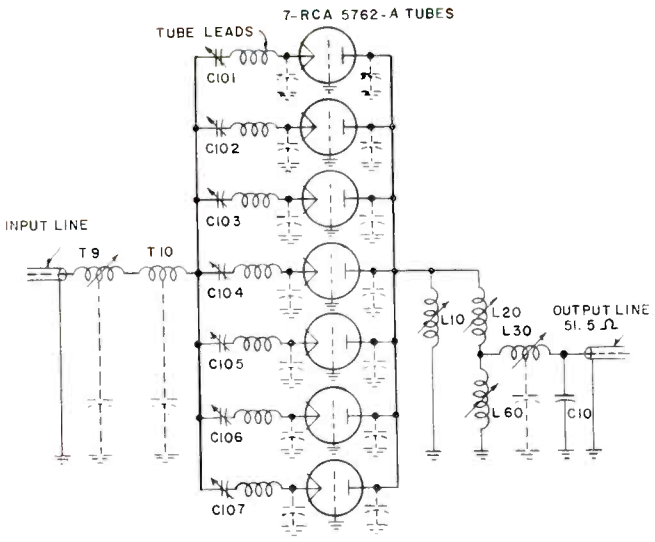
The amplifiers are housed in cylindrical cabinets which provide complete accessibility to all tubes as well as their circuit components, The amplifier base houses the blower, filament transformers, meters, and tuning controls. Air for cooling the tubes is drawn in through two filters on the sides of the bottom section and is expelled out the top of the unit.

The power supplies and control and distribution equipment for the amplifiers is housed in four cabinets. These cabinets may be placed either in line with or away from the driver transmitter. Since the two power supply cabinets do not contain any operating controls or meters, they can be mounted either with the other cabinets or in the rear of existing equipment. Two high-voltage grounding hooks are located in each power supply cabinet. Front and rear doors and removable panels are a feature of each cabinet. They allow a maximum of accessibility to maintenance and service personnel.

The equipment contains tank circuits to cover channels 7 to 13 inclusive. The video and audio signals are fed to the driver and modulation occurs in this unit. The r-f output from the visual driver is fed to the class "B" linear amplifier. The aural amplifier is similar to the visual amplifier, except that it is frequency modulated and therefore operated class "C". The visual amplifier has sufficient bandwidth so that it can easily reproduce the picture information from the driver transmitter.



Closeup showing the cluster of seven air-cooled 5762-A triodes used in the 35 kw amplifier equipment.



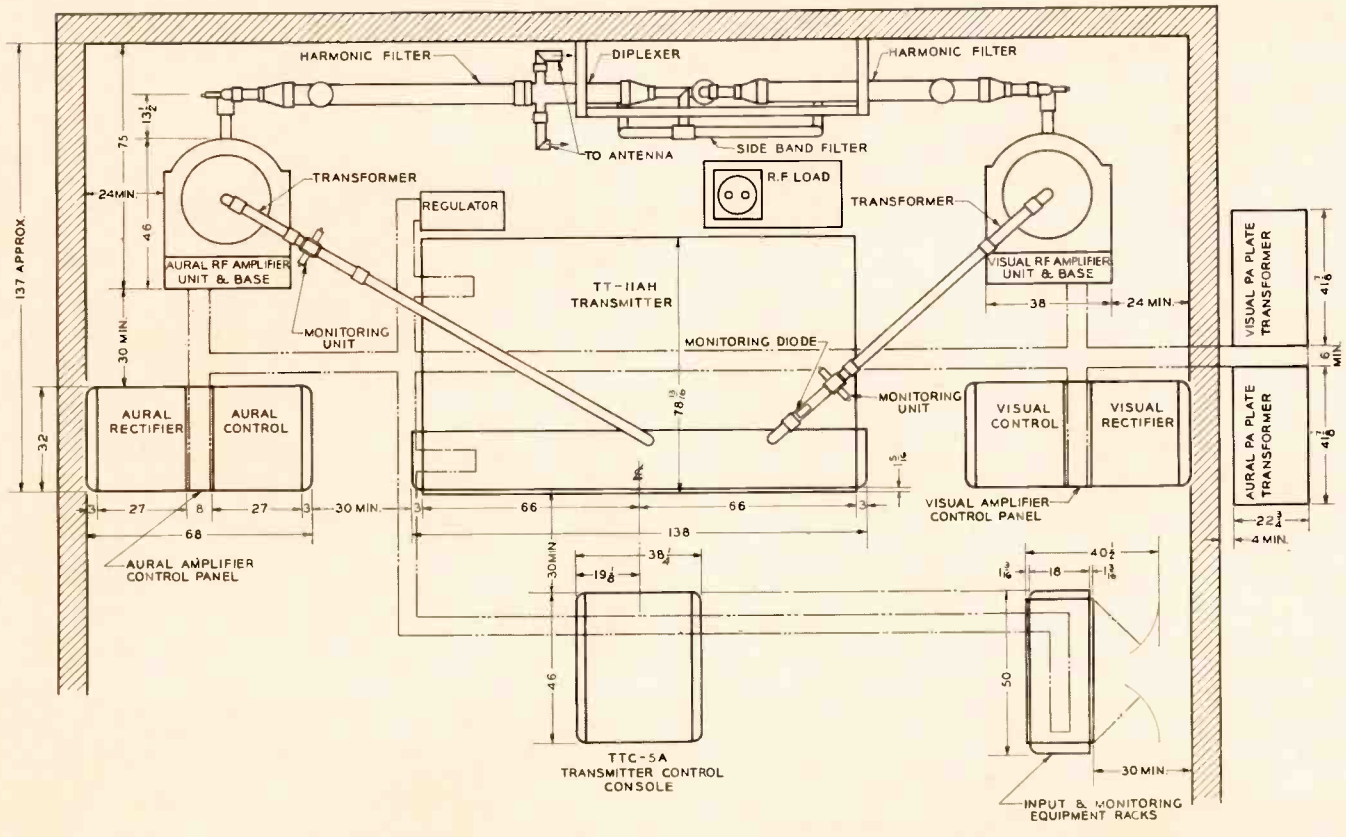
Equivalent circuit of the 35 kw high band amplifier for channels 7 to 13.

Diode monitors are included so that tuning and monitoring may be accomplished at both the input and output levels. A reflectometer is included for both the aural and the visual transmitters. This unit, which may be inserted at any convenient place in the output line, is designed to directly read percent power output, and standing wave ratio. RCA transmitters adding 35 kw amplifiers must have a vestigial sideband filter capable of handling 35 kw in the visual portion.

The control equipment is of conventional design. The overload system has an automatic reset feature. After an overload occurs the plate voltage is removed momentarily, then automatically returned twice. If the overload persists for the third time the plate voltage will remain cut off. All circuits such as the filament bus, the blower, and the bias supply are protected by breakers with thermal-magnetic trips. The control equipment for the aural and visual transmitters is identical, and is arranged so that either r-f amplifier may be turned on and off independently.

Except for the bias supply and slight differences in the high-voltage filter, the power supplies for the aural and visual amplifiers are identical. The high-voltage rectifiers employ six RCA 673 mercury vapor rectifier tubes in a double 3-phase half-wave circuit with a balance coil. The bias supply for the visual amplifier is well regulated, its output voltage remaining constant for large changes in grid current. The bias for the aural amplifier is essentially obtained from grid leak resistors with just enough fixed bias to protect the tubes when there is no drive.

Typical floor plan of TT-11AH Transmitter with TT-35BH amplifier.



SPECIFICATIONS

Performance Specifications[1]

	Visual	Aural
Type of Emission	A5	F3
Frequency Range	Channels 7-13	Channels 7-13
Rated Power Output	35 kw	21 kw
Input Power Level	8.5 kw	4.5 kw
R-F Output Impedance	50/51.5 ohms	50/51.5 ohms
R-F Input Impedance	50/51.5 ohms	50/51.5 ohms
Frequency Response:		
±1 db at carrier	+0.5 mc[2]	
±1 db at carrier	+1.25 mc	Uniform ±1 db
±1 db at carrier	+2.0 mc	from 50 to
±1 db at carrier	+3.0 mc	15,000 cycles
±1 db at carrier	+3.58 mc	
+1, −1.5 db at carrier	+4.18 mc	
Variation in Frequency Response with Brightness[3]	±1½ db	
AM Noise, rms	50 db below 100% mod.	50 db below carrier
Amplitude Variation Over One Picture Frame	Less than 2% of the peak of sync level	
Regulation of Output	4% max.	
Linearity (Differential Gain)[4]	1.5 db	

Electrical Specifications

Power Line Requirements:

Line	208/230 volts, 3 phase, 60 cycles
Slow Line Variations	±5% max.
Rapid Line Variations	±3% max.
Regulation	3% max.

Power Consumption:

	Amplifier	Complete Transmitter
Black Picture and 21 kw Aural	98 kw	136 kw
Average Picture and 21 kw Aural	81 kw	114.5 kw

Tube Complement

VISUAL SECTION AMPLIFIER

Function	Qty.	Type #
Visual Linear Amplifier	7	5762-A
High Voltage Power Supply	6	673
Bias Supply	1	5R4GY
Bias Supply	7	6336A
Bias Supply	1	6SH7
Bias Supply	2	OD3
Bias Supply	1	OA3
Monitor	2	6AL5
Monitor	1	2D21

AURAL SECTION

Function	Qty.	Type #
Aural Amplifier	7	5762-A
High Voltage Power Supply	6	673
Bias Supply	1	5R4GY
Monitor	2	6AL5
Monitor	1	2D21

Mechanical Specifications

Dimensions.....(For dimensions see floor plans)

Weight (approx.):

Aural and Visual Power Amplifier and Blower, each	1100 lbs. (499 kg.)
Aural and Visual Power Supply and Filter	1100 lbs. (499 kg.)
Aural and Visual Control Unit, each	1000 lbs. (453.6 kg.)
Aural and Visual Plate Transformer, each	1250 lbs. (567.0 kg.)

Finish.....Two tone umber gray with brushed chrome trim and fittings

Maximum Altitude[5].....5000 ft.

Ambient Temperature.....45°C max., 10°C min.

Equipment Supplied

TT-35BH 35 KW VHF AMPLIFIER ES-34266

Description	Qty.	Stock #
R-F Amplifier Units	2	MI-19066
R-F Amplifier Base Units	2	MI-19067
Blower Units	2	MI-19068
Control Units	2	MI-19367
Visual Rectifier Unit	1	MI-19368
Aural Rectifier Unit	1	MI-19369
Monitoring Units	2	MI-19088
Monitoring Diode	1	MI-19051-B
Harmonic Filters	2	MI-27318[6]
Driver Reflectometer Meters (0-20 micro-amp.)	2	MI-19181-A
Set of Installation Material	1	MI-19380
Set of Wiring Material	1	MI-19076
Transmission Line (*Supply quantity to suit installation requirements as specified on sales order)	*	MI-19113-B
Transformers	2	MI-19111-11[6]
Elbows (*Supply 2 if specified on sales order)	2	MI-19111-2
Finish Touch-Up Kit	1	MI-28153
Set of Equipment Tubes	1	ES-19229
Nameplate	1	MI-28180-1
Miscellaneous Hardware Kit	1	MI-7474
Instruction Books	2	IB-30290
Installation Instruction Books	2	IB-30289
Carrier Off Monitor	1	ES-27235

Optional and Accessory Equipment

Diplexer	MI-19394[6]
R-F Load and Wattmeter	MI-19193-H
BW-5B Sideband Response Analyzer	ES-34010-B
Set of Complete Spare Tubes	ES-34267
Set of FCC Spare Tubes	ES-34268
Set of End Shields (2 per set)	MI-28061
Set of 4-inch Channels (1 front and 1 rear)	MI-19365
Plate Current Meter	MI-21200-C1
50 kw Vestigial Sideband Filter	MI-27315-H
Low Pass Video Filter	MI-27132

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[1] The overall performance of a TV transmitter using the TT-35BH 35 kw Amplifier is necessarily dependent upon and governed by the performance of those portions of the transmitter preceding the amplifier.

[2] With respect to the response at 200 kc, as measured by the BW-5B Sideband Response Analyzer at transmitter mid-characteristic. 4.75 mc attenuation requires use of MI-27132 LP Filter in the video input circuit.

[3] Maximum variation with respect to the response at mid-characteristic measured with the BW-5B Sideband Response Analyzer at brightness levels of 22.5% and 67.5% of sync peak, using approximately 20% (peak to peak) modulation.

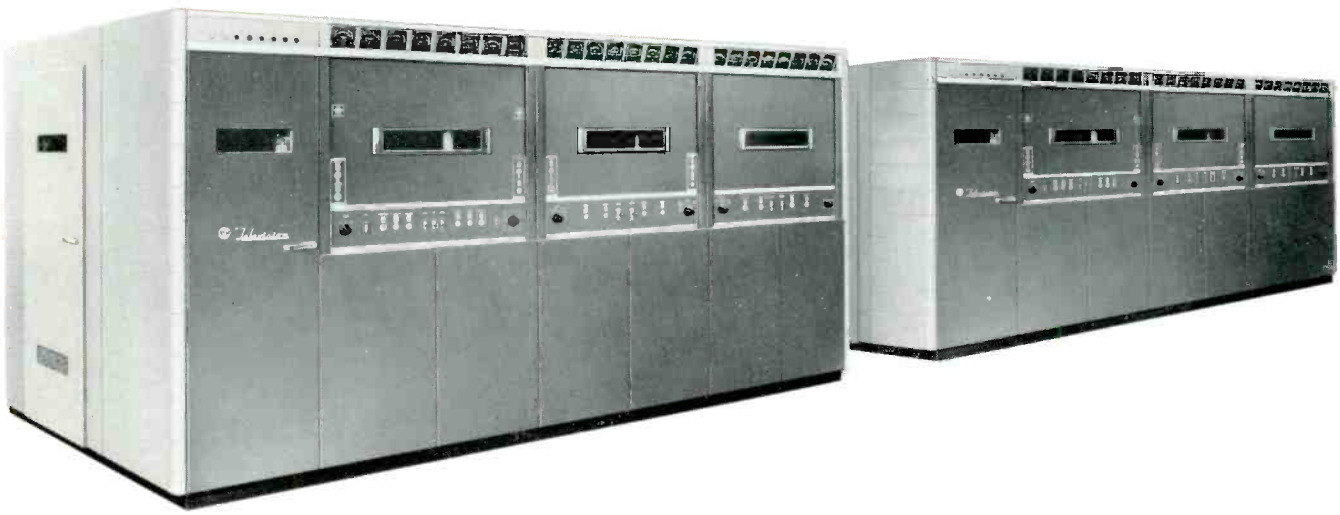
[4] Without correction. The correction circuits are normally applied in or ahead of the video modulator in the driver. Measured at 3.58 mc with increments not larger than 10% between 15% and 75% of peak of sync voltage.

[5] For operation at rated power and normal plate voltage.

[6] Order to suit customer's assigned frequency.

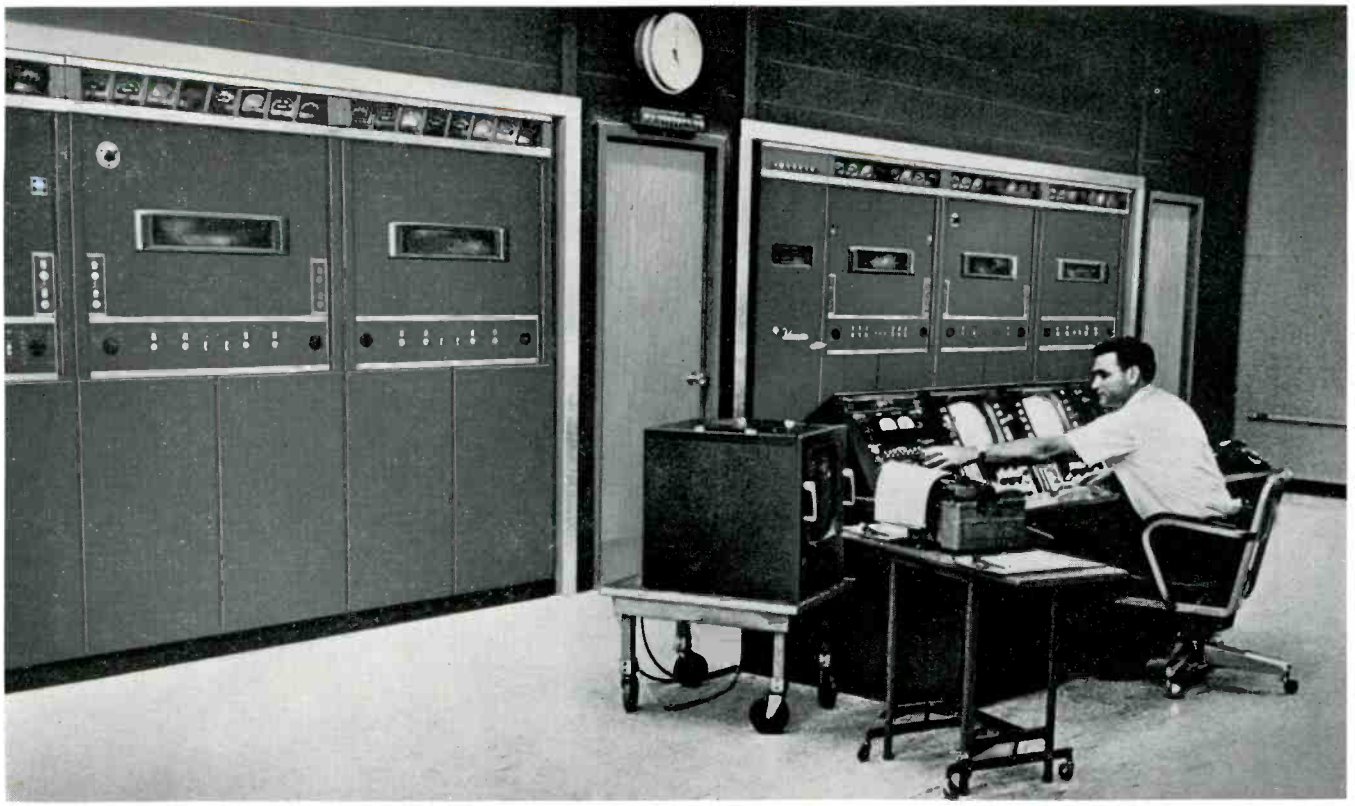
50 KW VHF TV Transmitter

TYPE TT-5ODH



FEATURES

- Visual power output 50 kw peak measured at output of sideband filter or filterplexer
- Designed for color—linearity correction circuits built into modulator
- Increased reliability and performance through paralleled transmitter concept
- Completely siliconized power supply
- Economical installation
- Improved picture quality—antenna reflections absorbed in reject load
- Remote control provisions
- Complete overload protection with "localizer indicators"
- Vestigial sideband characteristics determined by fixed-tuned, trouble-free, factory adjusted sideband filter or filterplexer
- Inter-carrier frequency control accurately maintains frequency separation between aural and visual carriers
- Completely air-cooled



TT-50DH Transmitter installation showing the two 25-kw transmitters and control console employed by Station WNAC-TV, Boston, Mass. This is the first parallel television system in the United States.

DESCRIPTION

The TT-50DH Television Transmitter operates on VHF channels 7 through 13 (174 mc—216 mc), with a peak visual power output of 50 kw (45 kw CCIR). When used with one of the current VHF antennas, it is possible to obtain the maximum allowable 316,000 watts of effective radiated power. The TT-50DH may be purchased as a complete 50 kw high-power transmitter, or may be the result of a building-block program starting with a 5 kw transmitter (TT-5BH), then adding a 25 kw amplifier and later doubling the facilities by adding a TT-25DH transmitter. A minimum of conversion is necessary to change from one power level to the next as the station grows.

The TT-50DH Transmitter consists of two RCA TT-25DH Transmitters operating in tandem and the first to employ the new concept of paralleled operation in the United States. This system has been shown to be more reliable than conventional systems for both monochrome or color transmission, while an increase in electrical performance and operating economy is also realized.

The parallel TV system uses new methods of video phase monitoring and contains a variable synthetic line for video delay. A simplified method to minimize r-f phase and amplitude errors at the combining diplexer is employed.

As in the TT-25DH, highlighted features include air-cooled tubes such as the 6166-A for long life and reliability. Single ended r-f circuits greatly reduce the number of necessary tubes and circuit components. Complete overload protection with indicating lights aid in quick location of faulty circuits. Inter-carrier frequency control accurately maintains frequency separation between aural and visual carriers.

The equipment provides separate visual and aural amplifiers—with a common power supply—for use with the driver. This equipment includes air-cooled linear broadband amplifiers for the visual carrier, and air-cooled class "C" amplifiers for the aural carrier. Each amplifier consists of a single power stage utilizing a Type 6166-A Tetrode in a grounded-grid, grounded-screen circuit.

The two 25-kw transmitters are housed in compact cabinets that can be broken down for shipping into racks and panels of varying size for easy handling. All r-f circuits and control circuits are located at the front of the enclosure. The rectifiers are mounted on the rear wall and the heavy power components are mounted on the floor. The control unit is at the left front corner of the transmitter in a separate cabinet with status lights grouped on a

panel above the door. The auxiliary switches, breakers, overload and auxiliary relays, etc. are in the control unit behind a non-interlocked door. Overload indicating lights for all the circuits of the transmitter are grouped on a single strip so they can be seen through the window in the door.

A single access door on the left end of each transmitter provides access to the rear of the control and r-f racks as well as the components mounted on the rear wall of the enclosures. All heavy units such as the plate transformers and large reactors are mounted on a base on the floor.

Since all operating controls and important adjustments are brought out to the front of the transmitter, it should not be necessary to enter the enclosure while power is on. Every precaution has been taken to insure the operator's safety when it is necessary to enter the enclosure for routine maintenance and service. In addition to the conventional plate interlock and high voltage grounding contactors, the plate transformer disconnect switch is fitted with a long handle which extends across the door opening. This makes it difficult to enter the enclosure without opening the primary of the high voltage transformers. The versatility of the new transmitter cabinets may be seen in the floor plan shown.

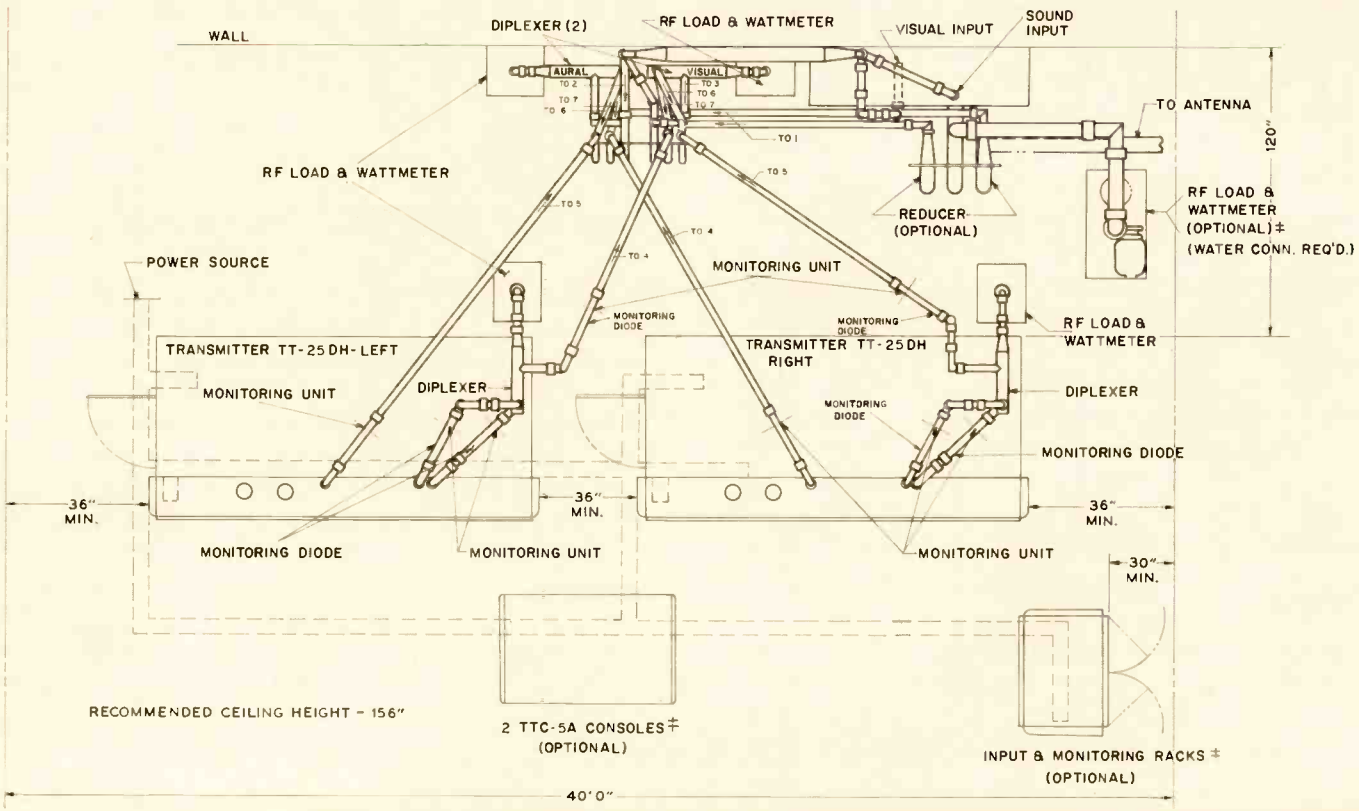
Design Features

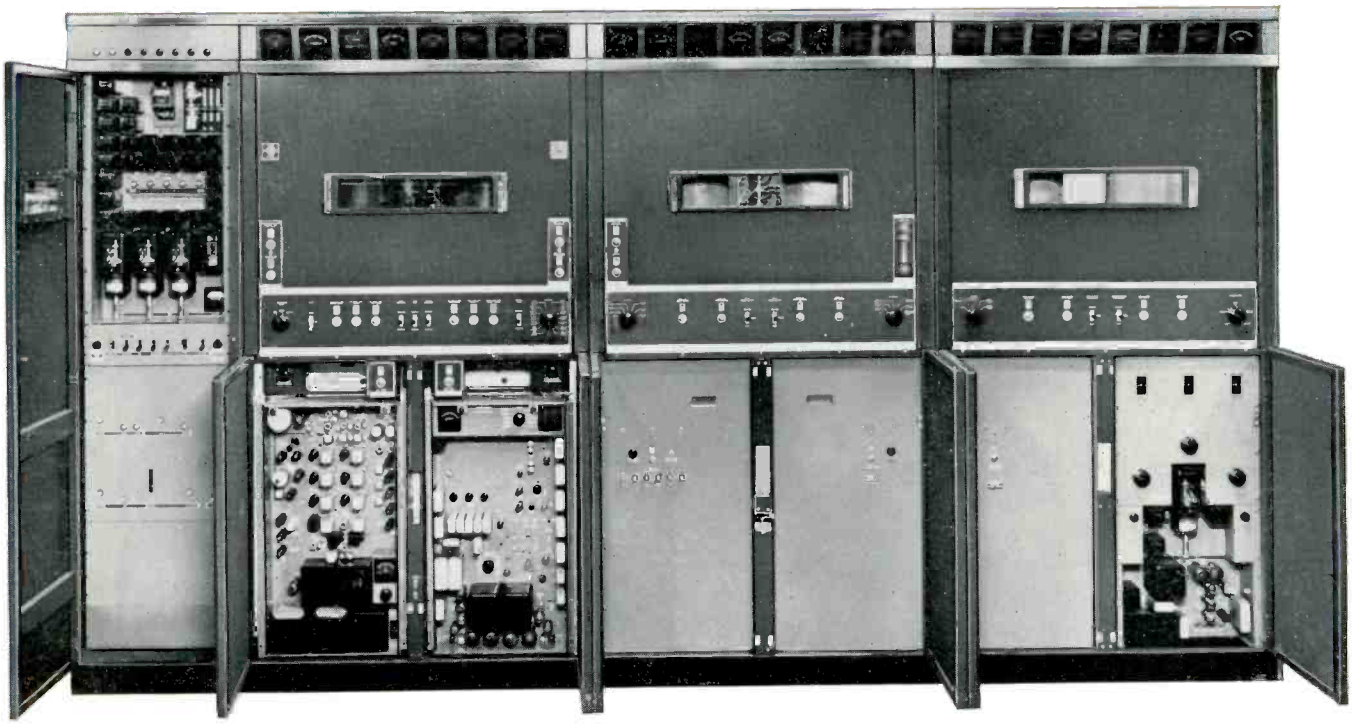
The TT-50DH was designed with reliability and ease of operation and maintenance in mind. A basic advantage of the parallel system is the fact that if either transmitter fails, the remaining transmitter is unaffected and the fall off in radiated power is approximately 6 db or one-quarter field strength. As a result the viewer will probably notice no change in the aural reception due to the AGC in the receiver. Close-in viewers will notice little if any change in picture quality, while distant viewers may lose some quality due to less contrast and resolution. Paralleling transmitters also reduces somewhat the need for a standby transmitter, or power cut-back equipment.

Another distinct advantage of paralleling is new ease in tuning and testing. Continuous video phase monitoring and correction is achieved by using a wideband differential oscilloscope as a phase detector and monitor, and a variable synthetic line-switching section as a corrective device. This method allows the video phase to be monitored, and corrected, if need be during picture program.

This method of r-f phase-detection and correction circuits employed has a second advantage. This system utilizes a constant-impedance line stretcher between exciter and transmitter in one half of each the aural and visual parallel

Typical floor plan for the TT-50DH Transmitter.





Front view of one of the tandem 25-kw transmitters with doors open. Control cabinet is seen on left, with driver portion of the transmitter including exciter and modulator panels occupying the next cabinet and final amplifiers in cabinets at right.

chains. By minimizing the combining diplexer reject load power through varying the line stretcher length, correct in-phase operation can easily be achieved. No longer is it necessary to use the trial-and-error method of inserting precut lengths of coaxial cable into one-half the parallel chain to reduce the combining diplexer reject power to a given level; nor the more expensive method of using an automatic phase control servo circuit employing a motorized line stretcher, a phase comparitor, and a feed back control network.

Operating cost is lower for the parallel system as compared to the main/stand-by system. It eliminates having an idle transmitter used only during failures or maintenance of the main transmitter, and lowers inventory costs for spare tubes and components since they are identical in both transmitters. Maintenance cost will be reduced since this type work can now take place during regular working hours by shutting down the transmitter half to be repaired. The vast majority of the viewers will notice little, if any, difference on their screens. In the case of transmitter failure a direct comparison can be made to meter readings, etc. of the work and non-working units, thus speeding the repair time.

Access to components is better because of new improved mechanical design. Reduction of required floor space is effected by the walk-in enclosure design of the transmitter. This type of construction eliminates the need for external access space at the rear of the enclosure. The enclosure may be placed directly against a wall or even in a corner of the room if an air intake opening is provided. Access to all components of the transmitter is possible from within the enclosure. The modulator and exciter may be serviced by tilting the chassis forward, without removal from the cabinet.

Exciter Circuit

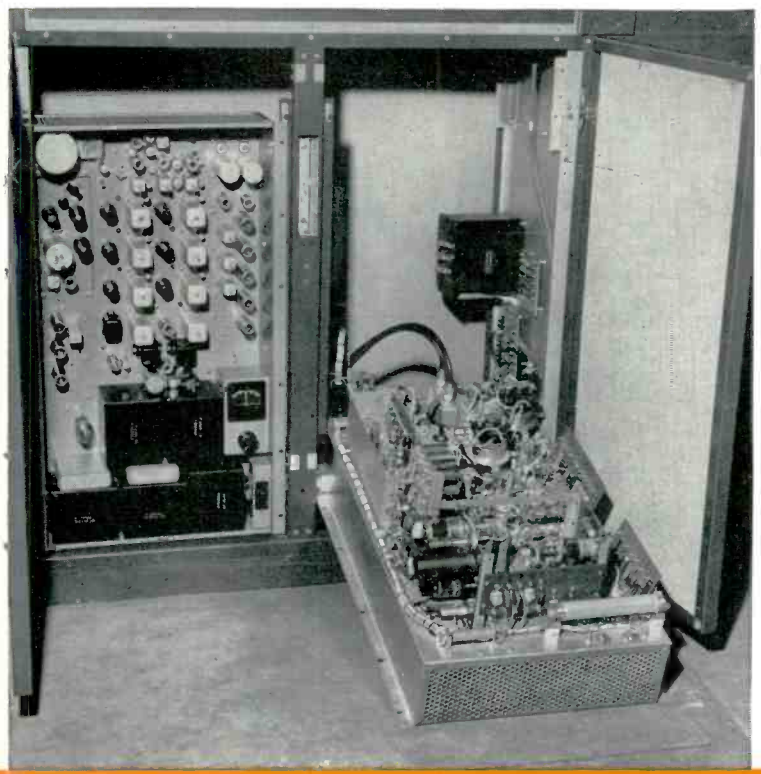
The TT-50DH Transmitter is driven by a common exciter containing both visual and aural chains. Since only the exciter of one of the two 25-kw units operating in parallel is required, the exciter in the other unit is always available in the stand-by condition. This is an excellent fail-safe feature of the TT-50DH.

Accurate control of the separation of visual and aural carrier frequencies is the result of precise engineering circuit design. The visual chain is driven by either one of the two crystal controlled 6AK5 oscillator circuits as a primary source of carrier frequency. Oscillators may be switched by means of a relay, thus making this circuit adaptable for remote control. The crystals operate at one-thirty-sixth the visual carrier frequency and one-twelfth of the output frequency of the exciter. The aural master oscillator is a free-running 6V6 oscillator controlled by a pair of 6V6 reactance tubes which are part of the automatic-frequency control circuit used to maintain the 4.5 mc (5.5 mc CCIR) separation between carriers. An off-frequency interlock prevents uncontrolled frequency operating by cutting off plate voltage to the stages that follow the exciter.

Visual r-f driver on the left and aural r-f driver on the right emphasize complete accessibility and straightforward unitized construction of the TT-50DH Transmitter.

The automatic frequency control of the aural master oscillator is accomplished by feeding a small amount of energy from the aural and visual triplers into a 6AS6 mixer tube. When the aural oscillator is on frequency the output of this mixer stage will be one-twelfth of the difference frequency between the aural and visual carriers or 375 kc (458.33 kc CCIR). The 375 kc (458.33 kc CCIR) signal mixes with the output of the 6J6 crystal controlled reference oscillator (1500 kc or 1833.33 kc CCIR) in the second 6AS6 mixer stage. The sum frequency is fed through a chain of three dividers with a total division of 100 to the frequency detector stage. This amount of division is necessary to reduce the swing at the frequency detector so that the carrier will not drop out under any modulation conditions of the aural transmitter. The 6J6 reference oscillator signal is fed through three divider stages with a total division of 80 to the frequency detector stage. By using the 6J6 reference oscillator output to excite both the second mixer and the divider chain for reference frequency, considerable improvement in frequency control accuracy is obtained. Signals from both the difference frequency and the reference frequency chains are fed into the frequency detector. The frequency detector is essentially a balanced modulator with a d-c component in the output which will change polarity depending upon whether the signal frequency is above or below the reference frequency. This d-c voltage is fed back to one of the reactance tubes for the master oscillator in such a way as to correct the frequency of the master oscillator.

Transmitter exciter (left) and modulator unit (right) are mounted on hinged chassis which allow units to tilt forward for utmost accessibility.



Visual Modulator

The 4CX5000A Visual Modulator Amplifiers are grid modulated by the two video modulators. The modulator output signal of approximately 300 volts peak-to-peak is required for full modulation of each of the visual transmitters. The modulators amplify a standard 1 volt video signal to the required level. A linearity correction circuit is included, as well as motor-driven operating controls for use when remote control is incorporated.

The first amplifier stage in each video modulator is a conventional shunt-series peaked video amplifier. This is followed by an inverter stage and a linearity corrector stage, each of which has a gain of approximately unity. The linearity corrector is designed to predistort the signal to compensate for the non-linearity which always occurs in a grid modulated stage. Linearity correction is accomplished by the use of four biased diodes connected in the linearity corrector cathode circuit. The bias voltage on each diode is separately adjustable. Any one of the diodes can

be made to start conducting at any brightness level. The grid of the linearity corrector is clamped in order to insure the same correction to the linearity characteristic regardless of the average brightness of the picture signal.

The linearity corrector is followed by a second video amplifier using a 6CL6 tube and then by a third video amplifier consisting of two 5933 tubes. The grids of the third video amplifier are also clamped and from this point on the circuit is d-c coupled. The output (modulator) stage is a shunt regulated cathode follower. It consists of three 6146 tubes connected in a circuit very similar to a conventional cathode follower, except that the cathode resistor is replaced by four 6146 tubes operating in parallel. The grids of these four tubes are fed with a signal from the plate load of the three cathode follower tubes. This makes the circuit essentially a feedback amplifier of high efficiency capable of delivering modulation at a high level to a large capacitive load.

A carefully designed clamp circuit assures reliable clamping even with greatly degraded input signal. Back porch clamping is employed.

Two power supplies are used in each modulator. One supplies 250 volts to the low level stages while the other supplies 575 volts to the third video and modulator stages. The use of a negative 575 volt supply makes the use of a bucking bias supply unnecessary.

The outputs of both supplies are electrically regulated by regulators mounted on the modulator chassis. This greatly reduces the possibility of unwanted video resonances in power supply leads. The modulator rectifiers are located on the rear wall of each of the transmitter enclosures.

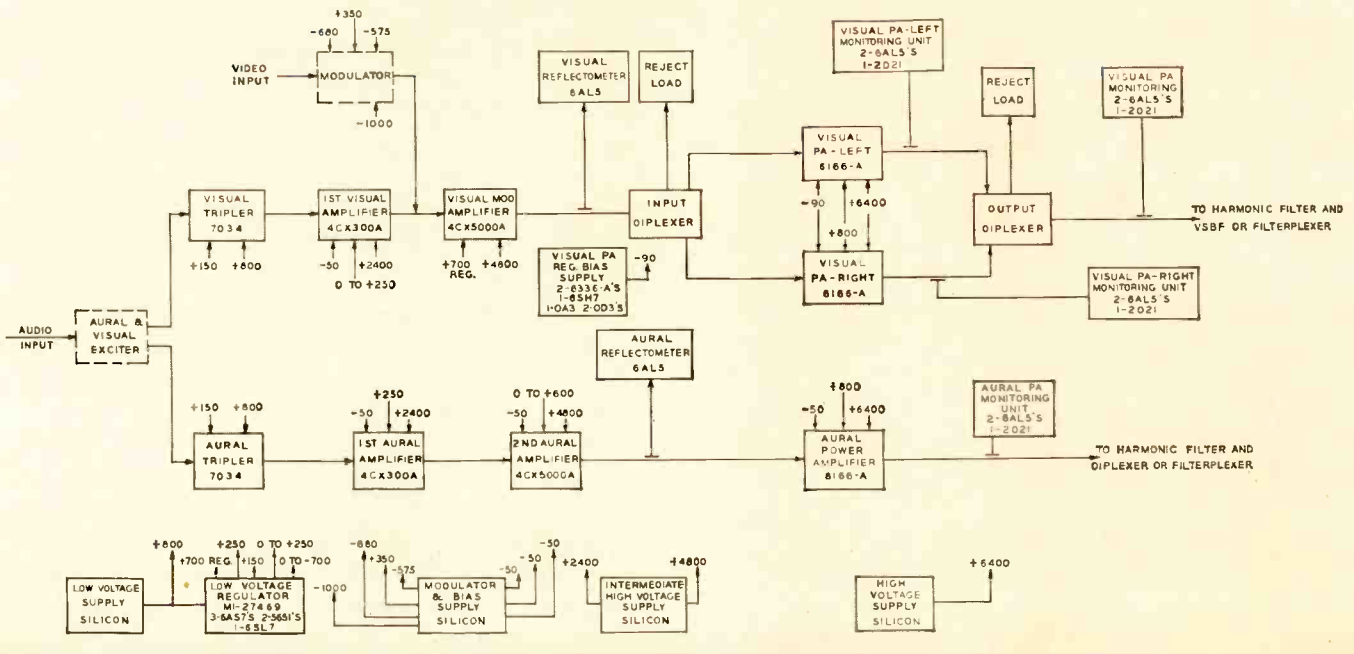
A monitor amplifier is provided for monitoring the modulator output signal. Numerous test jacks are also provided to simplify trouble-shooting and modulator alignment.

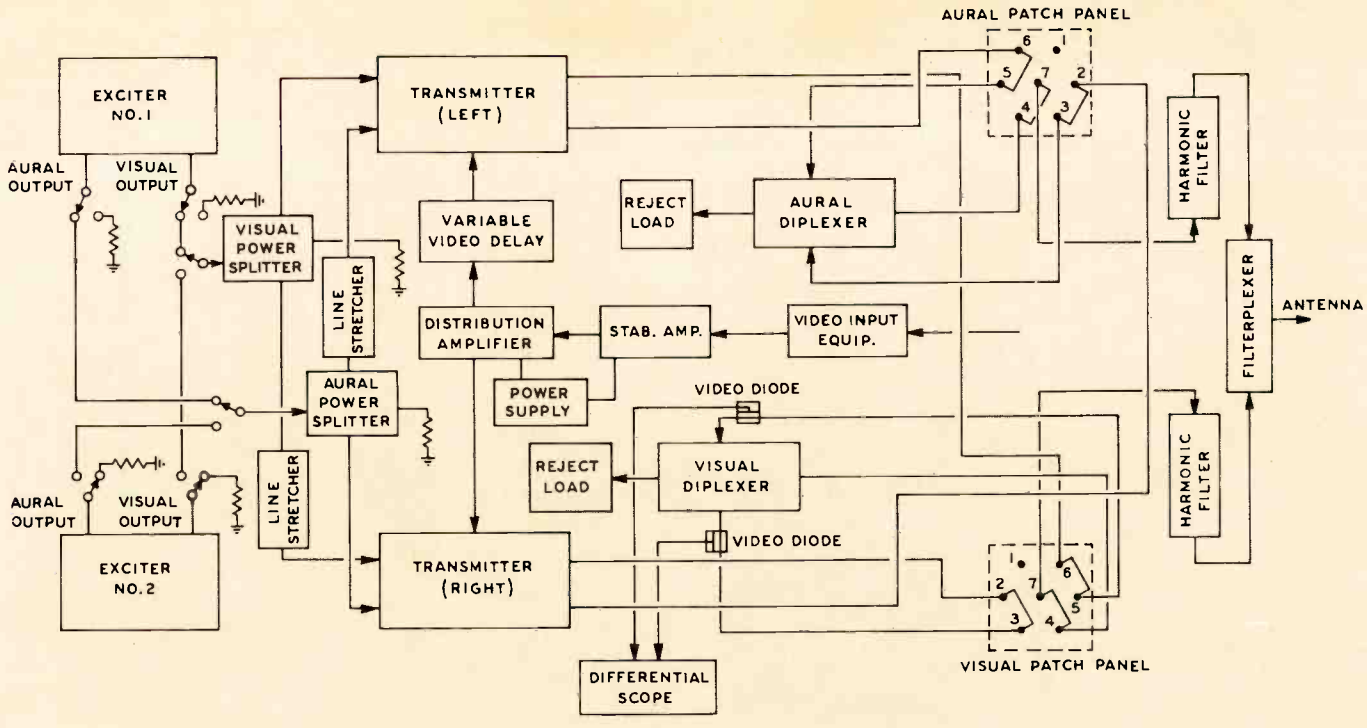
Aural Modulator

Frequency modulation is accomplished in the TT-50DH exciter by a "direct modulation" process requiring less components, fewer tubes and tube types. This process, which eliminates numerous multipliers and converter stages resulting in low noise and minimum distortion, utilizes two push-pull reactance tubes connected across the frequency determining circuit of the master oscillator. The center frequency of this oscillator is precisely maintained by the automatic frequency control circuit described in the exciter description.

Frequency modulation is obtained by feeding the audio signal into the reactance tubes which are connected across the oscillator plate tank circuit. R-F energy from the oscillator tank is link coupled to a transformer which has a coil in the grid circuit of each reactance tube. R-F voltages on the push-pull connected grids are 180 degrees out of phase with each other and each is 90 degrees out of phase with respect to the r-f voltage at the plates. Thus across the oscillator tank one tube appears as a capacitive reactance and the other as an inductive reactance. The magnitude of the reactive plate current in the reactance tubes varies in direct proportion to the value of

Block diagram of one of the two 25-kw transmitters whose visual and aural outputs to the combining network are used in the TT-50DH parallel TV system.





Simplified block diagram of TT-50DH VHF TV Transmitter.

audio voltage applied to the grids. Therefore, the frequency of the oscillator is varied at an audio rate to furnish the required FM signal. The mean frequency of the oscillator is controlled by varying the grid bias of one of the reactance tubes. This bias voltage is the d-c output voltage of the frequency detector stage of the exciter.

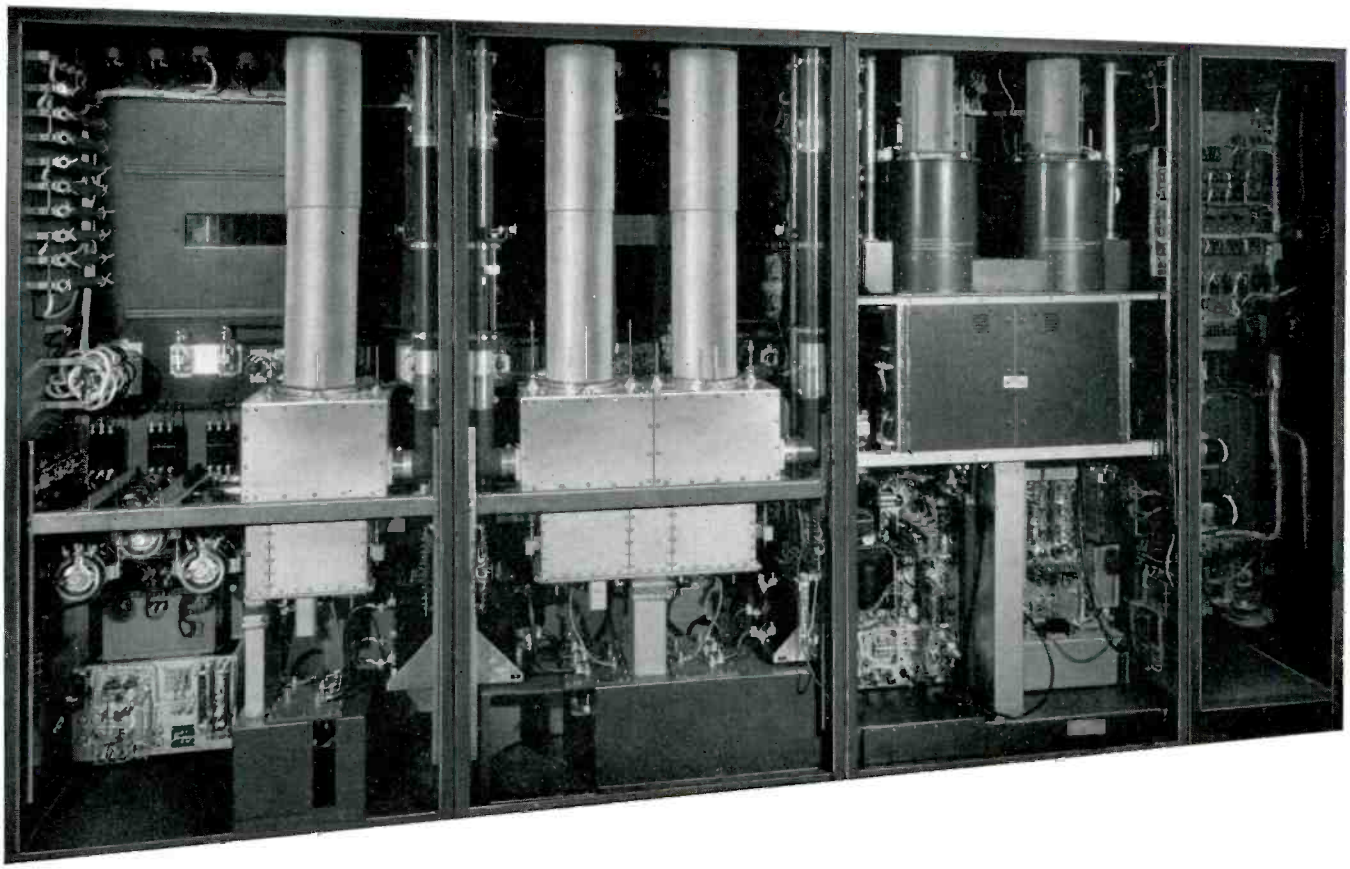
R-F Circuits

The r-f circuits of each transmitter employs a chain of multipliers and amplifiers. In the visual chain a 7034 tube operates as a tripler driving a 4CX300A amplifier which in turn drives a type 4CX5000A grid modulated power amplifier. The output of the modulated amplifier is equally divided by a power-splitting balun to drive two 12.5-kw linear amplifiers. The outputs of these two amplifiers are then combined in the broadband diplexer to provide 25-kilowatts of peak visual power. Excitation control for the visual transmitter is accomplished by varying the screen voltage on the 4CX300A stage. The aural chain consists of a type 7034 tripler driving type 4CX300A amplifier followed by a type 4CX5000A class "C" power amplifier, which, in turn, drives a type 6166-A class "C" power amplifier. Power output of the aural transmitter is adjusted by varying the screen voltage on the 4CX5000A stage. Both these controls are operated by motors and therefore can be adjusted from a remote position.

The visual linear amplifiers following the modulated stage each employ a 6166-A tetrode in a grounded-grid, grounded-screen circuit. Circuit design is simplified, since the grid and screen may be by-passed to a common ground plane. Input and output circuits are then constructed on opposite sides of the ground plane. The 6166-A cavity is fabricated in rectangular shape to that removal of one panel exposes the entire cavity for cleaning or other preventative maintenance. No neutralizing adjustments are required, since the 6166-A stage is effectively neutralized over the entire band. D-c is used for filaments of the 6166-A to reduce hum modulation to a level well below the usual requirement. The same cavity design is used in the aural amplifier.

Power and Control Equipment

Wherever possible in this transmitter, the same d-c power supplies were used for both the visual and aural amplifiers. This greatly reduces the number of components in the transmitter. An exciter supply is built into the common exciter unit using stacked germanium diodes. The other supplies, all using silicon diodes, are located on the rectifier panels at the rear of the enclosure. An 800-volt supply furnishes all screen voltages as well as the 7034 plate voltage. The intermediate voltage supply has a 4800-volt output for the 4CX5000A plates and a 2400-volt output for the 4CX300A plates. The high-voltage supply uses silicon diodes which operate at one-sixth of rated current capacity. This supply provides 6400 volts for the plates of the three Type 6166-A power tubes. High-voltage switch-



Panoramic rear view of front-line cabinets of one of the 25-kw Transmitters. Control panel at far right, with driver portion of transmitter including rear of exciter and modulator panels occupying next cabinet. Final amplifiers are housed in cabinets at left.

ing allows independent operation of visual and aural final amplifiers. In addition, this feature permits removal of plate voltage from either visual amplifier in the event of tube failure which results in a minimum of lost air time. All voltages for the visual modulator are furnished by the remaining supplies. One has an output of +350 volts, and the other has several outputs, all negative with respect to ground, which supply the high-level video stages as well as bias for the modulator and r-f stages.

A single integrated control circuit is provided for both the visual and aural transmitters. The blower, filaments, and each rectifier is protected by thermal overloads which can be adjusted to reset auomatically. In addition, a main line breaker and an auxiliary breaker are provided. Each incorporates both thermal and magnetic trips. All rectifiers and r-f stages following the exciter are protected by instantaneous overload relays which automatically recycle twice. If the fault continues on the third try the overload circuit will remain tripped until reset. Overload indicator lights are provided for each circuit. These lights have a separate reset and will remain on after the first overload thus providing a record of the circuit giving trouble even though it may be intermittent.

The equipment includes an automatic line voltage regulator which provides a stable line voltage to the filament primaries, the exciter, the modulator, and the low voltage power supply. Automatic filament line voltage regulators and automatic regulators capable of handling the complete transmitter are available as optional items. In localities troubled with excessive instantaneous line voltage fluctuation, an electronically controlled regulator for the low voltage supply is available as optional equipment.

Video Line Stretcher

The video line stretcher used in the TT-50DH is a synthetic lumped constant line designed for a 30 mc cut-off frequency. The video delay unit will produce up to 50 milli-microseconds delay at 3.58 mc in 10 milli-microsecond steps. Since for most parallel transmitter systems employing two modulators, the modulators will contain identical circuitry, they therefore should produce equal overall video phase delays. Except for such variables as component tolerances, etc., affecting phase this has been found to be true in practice. Differences are easily resolved by the line stretcher during the uncomplicated initial adjustment or when future video phase drift requires compensating.

Diplexer

A bridge diplexer has been used to combine the outputs of the two independent amplifiers of the TT-50DH. A reject load at the combining diplexer holds the key to correct operation of the parallel amplifiers, since the load receives zero power only when the two input signals are in phase and equal in amplitude.

The aural and visual power splitters consist of a coaxial ring hybrid. Since the nominal power input to this circuit is only 5 watts, the physical size of the unit is very small, measuring approximately 5 by 7 by 3 inches. It contains in total some 120 inches of 75-ohm sub-miniature coaxial cable. If port 1 is used for the input, port 3 will be the reject load, and ports 2 and 4 will be the outputs separated by ½ wave length in this simple system.

The reject loads used in conjunction with the combining diplexers absorb the amplitude and phase mismatch power. Since maximum fault power available at the load will be one-quarter of the normal diplexer output power, the visual reject load for a 50-kw peak of sync antenna input must be rated for 12.5 kw peak or 7.45 kw average power. Likewise the aural reject load is rated for 7.5 kw considering a 60 percent sound/visual ratio.

Video Phase Monitoring

The video phase monitoring incorporated in the TT-50DH comprises two video detectors, pre-measured video cable, and a Tektronix 2-channel differential oscilloscope. By reclaiming the video of each modulated visual transmitter an equal distance from the diplexer input, feeding these signals through like cables containing equal delay, and then into the differential oscilloscope, a continuous means of monitoring the video phase is available. The phase monitoring oscilloscope of the transmitter also doubles as a general purpose oscilloscope used for maintenance and repair.

Correct video phasing is readily detected using this method by feeding a standard video stair-step waveform containing 3.58 mc burst on each step to the system input, and varying the video delay line switch for minimum vertical deflection as observed on the oscilloscope. Gain control adjustments on the oscilloscope are used to maintain equal inputs to both channels from the pick up diodes thus showing a true display of modulator combining phase.

R-F Phasing and Amplitude Balance

The TT-50DH provides an r-f phasing and amplitude control panel. It is made up of two constant impedance line stretchers (one each for aural and visual r-f chains), meters to indicate the amount of reject power, and amplitude controls to adjust power output of both aural and visual chains of each transmitter. By adjusting the amplitude and phasing control panels the reject power can be easily held below 150 watts.

Special Protective Circuits

The TT-50DH has reflectometer units for use in the output transmission lines of both the aural and visual amplifiers. Each unit contains a 6AL5 diode detector. The transmission line probes are installed so as to give an indication of the amount of power on meters on the front panel. Reflected power can be checked by manually rotating the reflectometer heads.

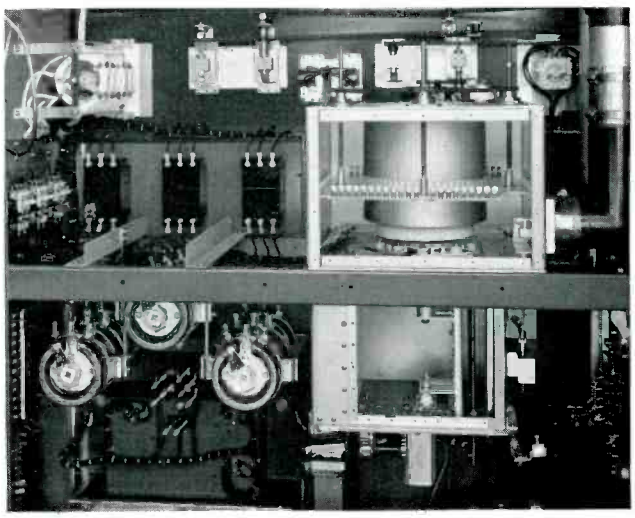
A carrier-off monitor is available as optional equipment. It acts in conjunction with the reflectometer units and is particularly useful for remote control. This unit will remove the plate voltage from all the r-f stages if the output level drops below a predetermined value, such as would be the case if an r-f arc occurred in any of the r-f stages. Sometimes such an arc does not change the plate current sufficiently to trip the d-c overload relays.

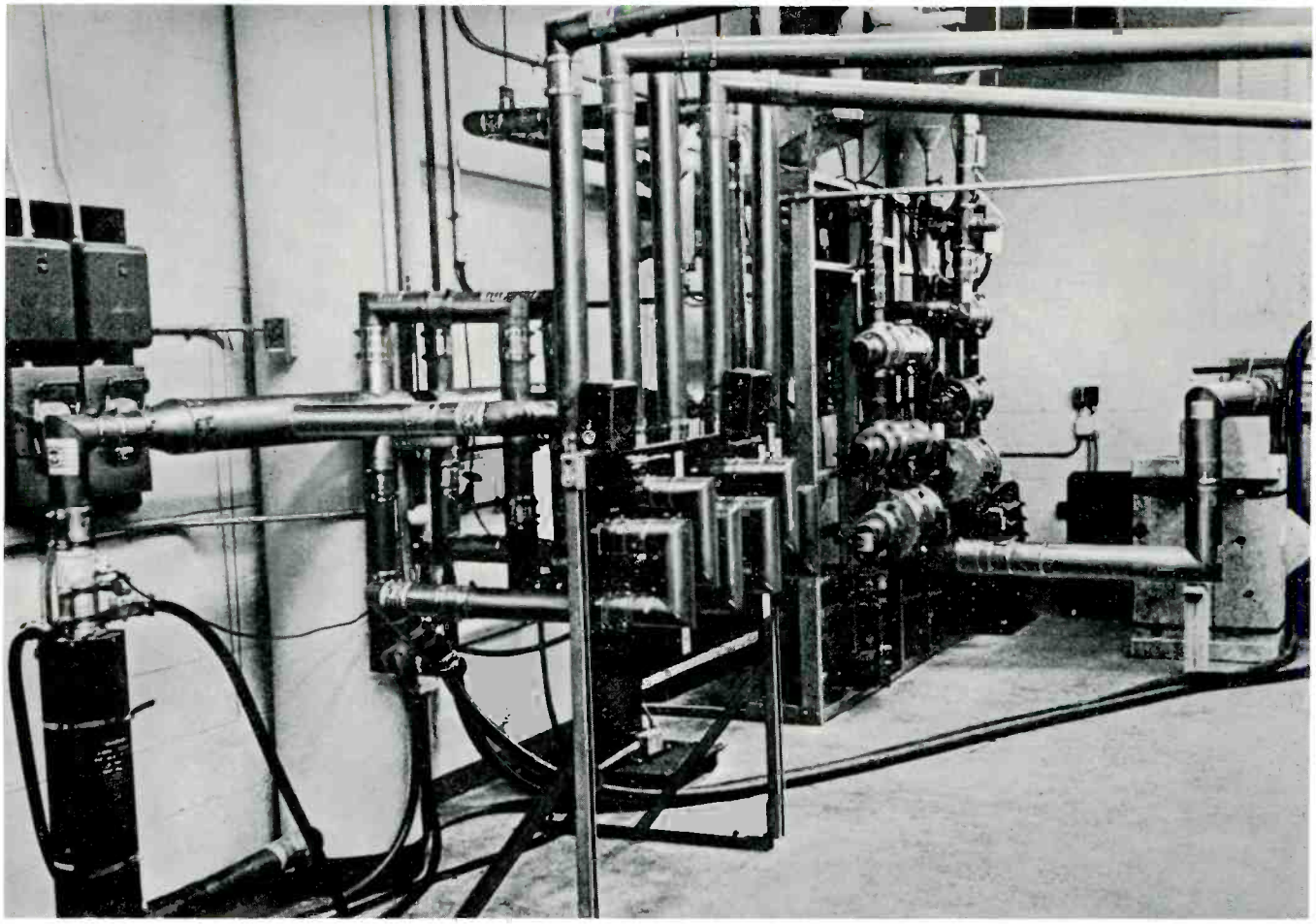
50-KW VHF Filterplexer

RCA's 50-KW VHF Filterplexer, MI-27316-H, combines the vestigial sideband filter and constant-impedance notch diplexer function in a single complete unit. It is used to properly attenuate the lower sideband of a double sideband visual transmitter and to feed the outputs from the visual transmitter and the aural transmitter simultaneously through a single coaxial line to an antenna.

The filterplexer may be used with 50-KW transmitters or with lower powered transmitters. The MI-27316-H is recom-

Rear view of right visual amplifier and auxiliary control equipment. Note at upper left the function switch which allows operation of either or both visual amplifiers with or without the aural transmitter. At lower left are the three individual voltage controls serving d-c, filaments and individual high power amplifiers.





View of transmission line complex at rear of WNAC-TV 50-kw transmitter. Patch panels with reject loads can be seen in foreground and filterplexer beyond.

mended for use with the newer antennas requiring a single line input, such as the RCA Traveling Wave type.

Appreciable savings are realized where long transmission runs are needed to reach tower or antenna, since only one line is required. The single line also greatly reduces wind load on the tower.

The 50-KW Filterplexer consists essentially of two bridge-baluns connected by two equal lengths of interconnecting coaxial transmission line each incorporating three filter circuits or cavities. The first and second cavities are used to obtain the vestigial response characteristics of the visual input while the third is tuned to the sound frequency.

As in the constant-impedance notch diplexer and the vestigial sideband filter, the visual signal is fed into the bridge-balun circuit and travels directly to the antenna input terminals.

The filterplexer combines the high quality performance characteristics of both a sideband filter and a diplexer. The insertion loss is less than 1 db out to a point 4 megacycles above the picture carrier frequency. The inputs are designed to have a constant input impedance over the band of frequencies produced. No operating adjustments are necessary as the unit is pretuned at the factory.

The dimensions of the channel 7 Filterplexer (which is the lowest in frequency and the largest in physical size) are: 90 inches long, 87½ inches wide and 33 inches high. This unit is designed for either ceiling or wall mounting. However, mounting requirements must be specified before factory assembly and test is completed.

Each output from the transmitter is first fed into the manual patch panel section, where the signal can either be routed in its normal manner to the combining diplexer or in case of failure patched directly into the harmonic filter or test load. The patch panel section is mounted approximately 4 feet from the floor facilitating ease in the patching operation.

The two diplexers, their reject loads and the filterplexer are all mounted near the back wall. The harmonic filters are mounted above the diplexers. At least four feet aisle space should be left between the patch panels and transmitter to allow for test equipment entry and removal.

SPECIFICATIONS

Performance

	FCC Specs.	CCIR Specs.
Type of Emission:		
Visual	A5	A5
Aural	F3	F3
Frequency Range	Ch. 7-13	174-216 mc
Rated Power Output:		
Visual	50 kw[1]	45.0 kw[1]
Aural	27.2 kw[2]	9.0 kw[2]
Minimum Power Output:		
Visual	20 kw[1]	20 kw[1]
Aural	10 kw[2]	4.0 kw[2]
R-F Output Impedance	50/51.5 ohms	50/51.5 ohms
Input Impedance:		
Visual	75 ohms	75 ohms
Aural	600/150 ohms	600/150 ohms
Input Level:		
Visual	0.7 v. peak-to-peak min.	0.7 v. peak-to-peak min. (composite video)
Aural	+10 ±2 dbm	+16 ±2 dbm for 50 kc dev. Uniform ±1 db from 50 to 15,000 cyc.
Amplitude vs. Frequency Response	Uniform ±1 db from 50 to 15,000 cyc.	——
Upper Sideband Response:		
At Carrier plus 0.5 mc	+1, −1.5 db[3]	+1, −1.5 db
At Carrier plus 1.25 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 2.0 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 3.0 mc	+1, −1.5 db	+1, −1.5 db
At Carrier plus 3.58 mc	+1, −1.5 db	——
At Carrier plus 4.18 mc	+1, −3.0 db	+1, −1.5 db
At Carrier plus 4.75 mc	−20 db max.	——
At Carrier plus 5.0 mc	——	+1, −4.0 db
At Carrier plus 5.75 mc	——	−20 db max.
Lower Sideband Response:[4]		
At Carrier minus 0.5 mc	+1, −1.5 db	+1, −1.5 db
At Carrier minus 1.25 mc	−20 db max.	−20 db max.
At Carrier minus 3.58 mc	−42 db max.	——
Variation in Frequency Response with Brightness[5]	±1.5 db	±1.5 db
Carrier Frequency Stability[6]		
Visual	±1 kc	±.0005%
Aural	±500 cps[7]	±.001%
Modulation Capability:		
Visual	12.5 ±2.5% (reference white)	12.5 ±2.5% (reference white)
Aural	±50 kc	±50 kc
Audio Frequency Distortion	1.5% max. 50-100 cyc. 1.0% max. 100-7500 cyc. 1.5% max. 7500-15,000 cyc.	1.5% max. 50-100 cyc. 1.0% max. 100-7500 cyc. 1.5% max. 7500-15,000 cyc.
FM Noise, below ±25 kc Swing	60 db	60 db
AM Noise, r.m.s.:		
Visual	45 db below 100% mod.	45 db below 100% mod. (hum and thermal)
Aural	50 db below carrier	50 db below carrier
Amplitude Variation Over One Picture Frame	Less than 5% of the peak of sync level	Less than 5% of the peak of sync level
Regulation of Output	7% max.	7% max.
Burst vs. Subcarrier Phase[8]	±5 degrees max.	——
Subcarrier Phase vs. Brightness[9]	±7 degrees max.	——
Subcarrier Amplitude[8]	±10% max.	——
Linearity (Differential Gain)	1.5 db max.[10]	1.5 db max.
Envelope Delay vs. Frequency[11]	±.08 μsec. from 0.2 to 2.1 mc ±.04 μsec. at 3.58 mc ±.08 μsec. at 4.18 mc	——
Harmonic Attenuation, ratio of any single harmonic to peak visual fundamental[12]	At least 60 db	At least 60 db

Electrical

	FCC Specs.	CCIR Specs.
Power line Requirements:		
Transmitter:		
Line	230/208 volts 3 phase, 50/60 cyc.	230/208 volts 3 phase, 50/60 cyc.
Slow Line Variations	±5% max.	±5% max.
Rapid Line Variations	±3% max.	±3% max.
Power Consumption (25 kw Visual & 12.5 kw Aural)	See Curve	68 kw (black pix) 60 kw (av. pix)
Power Factor (approx.)	90%	90%
Crystal Heaters:		
Line	115 volts, single phase, 50/60 cyc.	115 volts, single phase, 50/60 cyc.
Power Consumption	28 watts	28 watts

Mechanical Specifications

Weight (approx.)	21,000 lbs. (9525.6 kg.)
Dimensions:	
Overall Length (front line cabinets only)	352" (894 cm)
Overall Height (front line cabinets only)	84" (213.4 cm)
Depth (front line cabinets only)	20" (50.8 cm)
Overall Depth	78 13/16" (200 cm)
Finish	Two-tone umber gray, polished stainless steel trim
Maximum Altitude[13]	7500 ft.
Ambient Temperature	45°C max. 0°C min.

[1] Measured at the output of the sideband filter or filterplexer.
[2] Measured at the input to the diplexer or filterplexer.
[3] With respect to the response at 200 kc, as measured by the BW-5B Sideband Response Analyzer at transmitter mid-characteristic. 4.75 mc attenuation requires use of MI-27132 LP filter in the video input circuit.
[4] With respect to the response at 200 kc at transmitter mid-characteristic.
[5] Maximum variation with respect to the response at mid-characteristic measured with the BW-5B Sideband Response Analyzer at brightness levels of 22.5% and 67.5% of sync peak, using approximately 20% (peak-to-peak) modulation.
[6] Maximum variation for a period of 30 days without circuit adjustment.
[7] Maximum variation with respect to the standard 4.5 mc separation between aural and visual carriers.
[8] Maximum departure from the theoretical when reproducing saturated primary colors and their complements at 75% amplitude.
[9] Maximum phase difference with respect to burst, measured after the VSBF, for any brightness level between 75% and 15% of the sync peak using 10% (peak-to-peak) modulation. This is equivalent to 5% (peak-to-peak) modulation as indicated by a conventional diode demodulator. In addition, the total differential phase between any two levels shall not exceed 10 degrees.
[10] Maximum variation in the amplitude of a 3.58 mc sine wave modulating signal as the brightness level is varied between 75% and 15% of sync peak. The gain shall be adjusted for 10% (peak-to-peak) modulation of the 3.58 mc signal when the brightness is at pedestal level. This is equivalent to 5% (peak-to-peak) modulation as indicated by a conventional diode demodulator connected after the VSBF.
[11] Maximum departure from standard curve. The tolerances vary linearly between 2.1 and 3.58 mc and between 3.58 mc and 4.18 mc. To meet the specification a properly terminated phase correction network, ES-34034-B is required in the video input circuit of the transmitter.
[12] Measured with harmonic filters in the visual and aural transmitter outputs.
[13] For operation at rated power and normal plate voltage.

SPECIFICATIONS (Continued)

TT-50DH Tube Complement

EXCITER

Qty.	Function	Type
2	Visual Crystal Oscillator #1	6AK5
2	Visual Crystal Oscillator #2	6AK5
2	Buffer Amplifier	5763
2	1st Visual Multiplier	5763
2	2nd Visual Multiplier	5763
2	3rd Visual Multiplier	5763
2	Visual Output Amplifier	5763
4	Reactance Tube Modulator	6V6
2	FM Master Oscillator	6V6
2	1st Aural Multiplier	5763
2	2nd Aural Multiplier	5763
2	3rd Aural Multiplier	5763
2	Aural Output Amplifier	5763
2	1st Mixer	6AS6
2	2nd Mixer	6AS6
2	Difference Frequency Amplifier	6AQ5
2	1st Difference Frequency Divider	6AC7
2	2nd Difference Frequency Divider	6AC7
2	3rd Difference Frequency Divider	6AC7
2	Crystal Oscillator-Reference Frequency	6J6
2	1st Reference Frequency Divider	6AC7
2	2nd Reference Frequency Divider	6AC7
2	3rd Reference Frequency Divider	6AC7
2	Cathode Follower-Frequency Detector Drive	12AT7
2	Off-Frequency Detector	6AS6
2	Off-Frequency Interlock Control	2D21
2	Voltage Regulator	OD3

MODULATOR

Qty.	Function	Type
2	1st Video Amplifier and Inverter	6CX8
2	Linearity Corrector	6CL6
2	2nd Video Amplifier	6CL6
4	3rd Video Amplifier	5933
14	Modulator	6146
2	Modulator Monitor	6CL6
2	Sync Cathode Follower and Amplifier	6CX8
2	Sync Separator	6EA8
2	Pulse Former and Clipper	6EA8
2	Phase Splitter #1	6CL6
2	Phase Splitter #2	6CL6
2	Clamp Diode #1	6AL5
2	Clamp Diode #2	6AL5
2	Voltage Regulator	OA2
20	Voltage Regulators (Modulator Screens)	OB2
4	Voltage Regulator	OC3
4	Voltage Regulator	OD3
4	Voltage Reference	5651
4	Low Voltage Regulator	6AS7-GA
4	High Voltage Regulator	6336-A
4	DC Amplifier	6SL7-GT

R-F UNIT

2	Visual Tripler	7034
2	1st Visual Amplifier	4CX300A
2	Visual Modulated Amplifier	4CX5000A
4	Visual Power Amplifier	6166-A
2	Aural Tripler	7034
2	1st Aural Amplifier	4CX300A
2	2nd Aural Amplifier	4CX5000A
2	Aural Power Amplifier	6166-A
20	Reflectometer Detectors	6AL5
8	Reflectometer Thyratrons	2D21
2	Air Interlock	2D21

LOW-VOLTAGE REGULATOR

6	Regulator	6AS7G
2	D-C Amplifier	6SL7-GT
4	Voltage Reference	5651

VISUAL BIAS SUPPLY

4	Shunt Regulator	6336-A
2	D-C Amplifier	6SH7
2	Voltage Reference	OA3
4	Voltage Reference	OD3

Equipment Supplied

TT-50DH TELEVISION TRANSMITTER ES-560219

Qty.	Description	Stock No.
2	Control Unit	MI-27180-A
2	5-kw R-F Unit	MI-34460
2	Aural and Visual Amplifier Unit	MI-27192
2	Ampilfier and Auxiliary Control Unit	MI-34426
2	Switchgear Panel	MI-34427
2	Plate Contactor Panel	MI-34428
2	Rectifier Panel	MI-34461
2	High Voltage Rectifier Panel	MI-34431
2	Line Regulator	MI-27473-A
2	Line Regulator Control Panel	MI-27471
2	Transformer Filter Assembly	MI-34462
2	Transformer	MI-27636-C
2	High Voltage Filter Assembly	MI-34429
2	High Voltage Transformer	MI-34430
1	Blower Enclosure and Filter Panel (Right Transmitter)	MI-34432
1	Blower Enclosure and Filter Panel (Left Transmitter)	MI-560362
1	Mounting Rack, Type BR-84D	MI-30951-D84
1	Paralleling Equipment	MI-560361
*	Filterplexer (*Sales Order must specify customer requirements)	MI-37216-Channel
1	Type TA-3B Distribution Amplifier	MI-26157-B
1	Variable Video Line Stretcher	MI-560365
1	Video Phase Measuring Equipment	MI-560366
2	Blower Unit	MI-27195
2	Installation Material	MI-34433
2	Wiring Material	MI-34434
2	Low Voltage Regulator	MI-27469
2	Crystal Unit	MI-27492
4	Side Panel	MI-30541-G84
4	Monitoring Unit	MI-19088
6	Monitoring Unit	MI-34406
9	Monitoring Diodes	MI-19051-B
1	Low-pass Filter	MI-27132
2	Harmonic Filters	MI-27318-7/10
1	Sideband Filter	MI-27799-Channel
6	Diplexers	MI-27393-A/B
2	Input Reject Load	MI-19196-H
4	Output Reject Load	MI-27396
1	Set of Operating Tubes	ES-560220
2	Set Transmission Line	MI-34435-Channel
6	Reducer Couplings	MI-19113-C7
4	Reducer Couplings	MI-19314-C13
40	Couplings	MI-19112-8
22	90° Mitre Elbow (1⅝")	MI-19112-18C
37	90° Mitre Elbow (3⅛")	MI-19313-2-NF
44	Coupling	MI-19113-C8
32	Coupling (3⅛")	MI-19313-8
*	Transmission Line (3⅛" 51.5 ohm) and Fittings (*Specify quantity required for connecting output of transmitter to VSBF and Diplexers or Filterplexer)	MI-19313
1	Nameplate	MI-28180-1
1	Finish Tauch-Up Kit	MI-27660-A
2	Miscellaneous Hardware Kit	MI-7474
2	Tool Kit	MI-27088
1	Set of Installation Drawings	8539006
2	Instruction Books	IB-31507
2	Installation Instruction Book	IB-31508

Optional or Accessory Equipment

TTC-5 Control Console Equipment, with master monitor but less master monitor power supply	ES-27274-2
Exciter Control Panel	MI-560364
TA-9A Stabilizing Amplifier	MI-40222
Set of Spare Tubes	ES-560220
Set of Min. Spare Tubes	ES-34214
R-F Load and Wattmeter (50 kw)	MI-19191
Input and Monitoring Equipment	ES-19237-E
Carrier-Off Monitor	ES-27235
50 Cycle Conversion Equipment	MI-34439
Modification Kit (CCIR)	MI-34405

Transmitter Control Console

TYPE TTC-5A

FEATURES

- Provides centralized finger-tip control center for RCA TV broadcast transmitters
- High quality wide-band picture monitor allows independent viewing of both picture and waveform
- Optional remote control for stabilizing amplifier—color or monochrome
- Provides spare monitoring circuits for both aural and visual sections of transmitter
- Push button point to point monitoring aids in isolation and identification of trouble
- Repeats all major controls from transmitter proper, including aural and visual power output indication
- Provision for measuring depth of modulation on the visual carrier—contains chopper with long life mercury contacts
- Hinged monitor control panel provides easy accessibility for maintenance and service
- Uniform styling to harmonize with RCA transmitters and auxiliary TV equipment

DESCRIPTION

The TTC-5A Transmitter Control Console provides a complete monitoring and operating control for RCA UHF and VHF broadcast television transmitters. The console provides custom planned control exactly suited to each transmitter with no unused functions and without the compromises necessary in a "universal" console.

The console contains audio and video gain and monitoring circuits and all necessary indicating lights, switches and meters for normal transmitter operation. It also houses a Type TM-6C Master Monitor for viewing the picture, and the waveform of the video signal at various points throughout the transmitter. The TTC-5A has provisions for switching between two program channels, aural as well as visual. It permits previewing of the unused program line, or both lines when neither is in use. The audio lines can be monitored at any time.

Closeup view of indicator, monitor control and transmitter control panels mounted in 22 inch console housing.

The console is assembled at the time of installation from standard console housings and special custom built panels for the various type transmitters. The console housings have available additional panel and internal space so that special requirements for custom switching, monitoring, amplifying or indicating devices can be added. Thus the console affords utmost flexibility to suit different requirements of operation and provides for possible improvements in the art, or expansion of station facilities.

Where desired, the TTC-5A may be combined with RCA TV studio control and switching equipment. However, its main purpose is transmitter control and monitoring; and other TV functions can often be better performed at a point separate from the transmitter console.

General

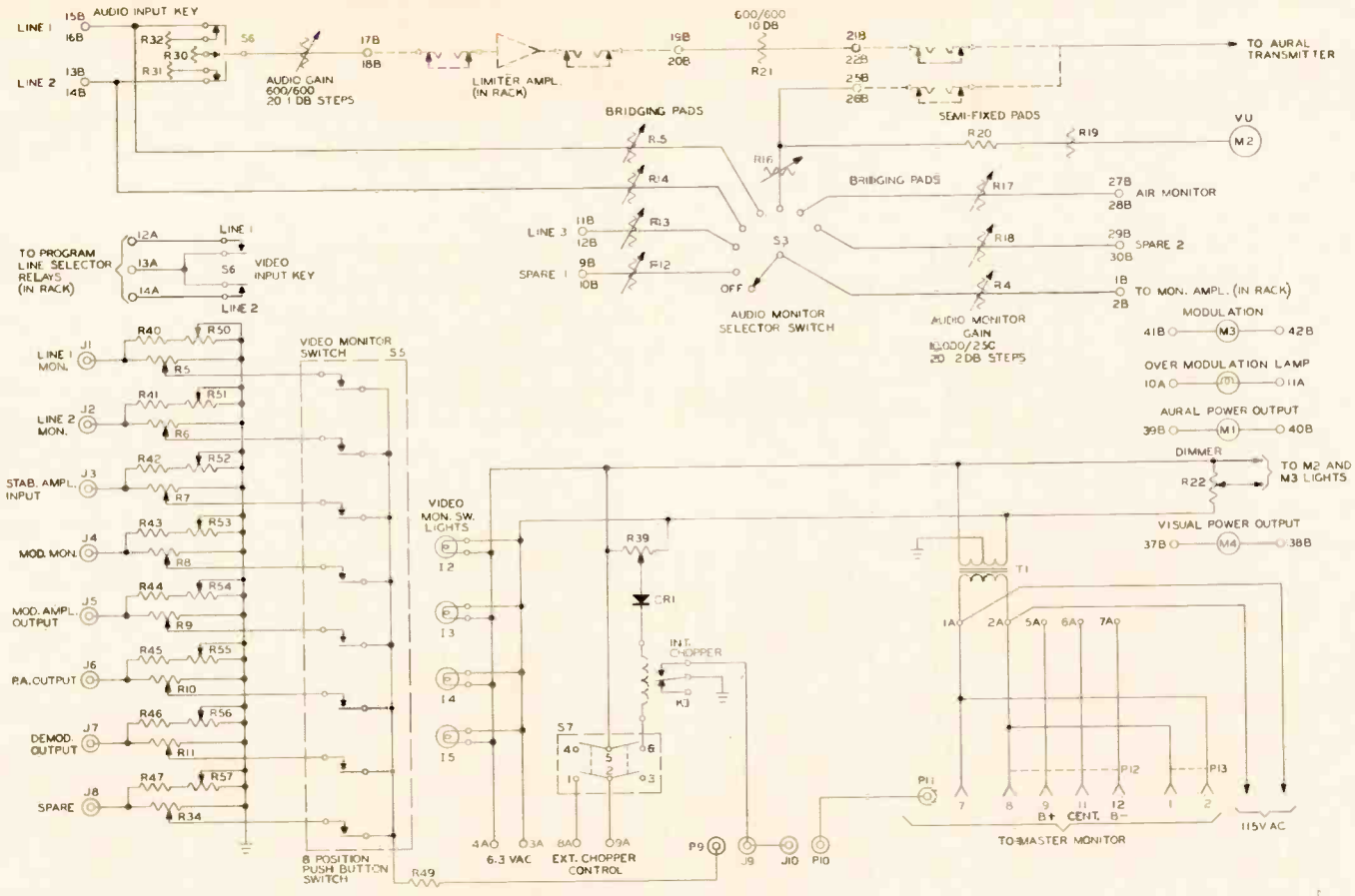
The TTC-5A Transmitter Control Console is a custom equipment made up of four major units: a Set of Panels and Accessories that must be ordered according to the type of Transmitter and consisting of a Transmitter Control Panel, Indicator Panel and Installation instructions and drawings; a Type TM-6C Master Monitor; a Monitor Control Panel; and the Console proper which is made up of a 13¼" console housing, 22-inch console housing, panels, end panels. Other items include a Program Line Selector, an Aural Modulation Monitor Meter for use with either the GR-1184-A-A General Radio TV Station Monitor or the Type 335-ER Hewlett-Packard Monitor, and set of installation hardware.

The Transmitter Control Panel contains switches and overload reset pushbuttons for transmitter supervisory control and operation. The Indicator Panel houses the supervisory indicator lamps. All panel indicating lamps operate on 115 or 230 volts a-c which is obtained from the transmitter, while a 115 volt step-down transformer supplies 6.3 volts for the meter lights and chopper. Connections to all console items are made at terminal boards and jacks when the equipment is installed. Wiring to the console may be installed in conduit, or in a duct terminating below the desk.

The TTC-5A is equipped with a TM-6C Master Monitor, mounted in the left of the console housing. It receives its power from a 280 volt d-c power supply mounted in an external rack, while its input signals come from the monitor control panel on the right. A sliding-type mount for the unit permits the monitor to be pulled forward, either partly or completely from the console proper after the four retaining screws have been loosened. This permits rapid inspection or adjustment of the unit.

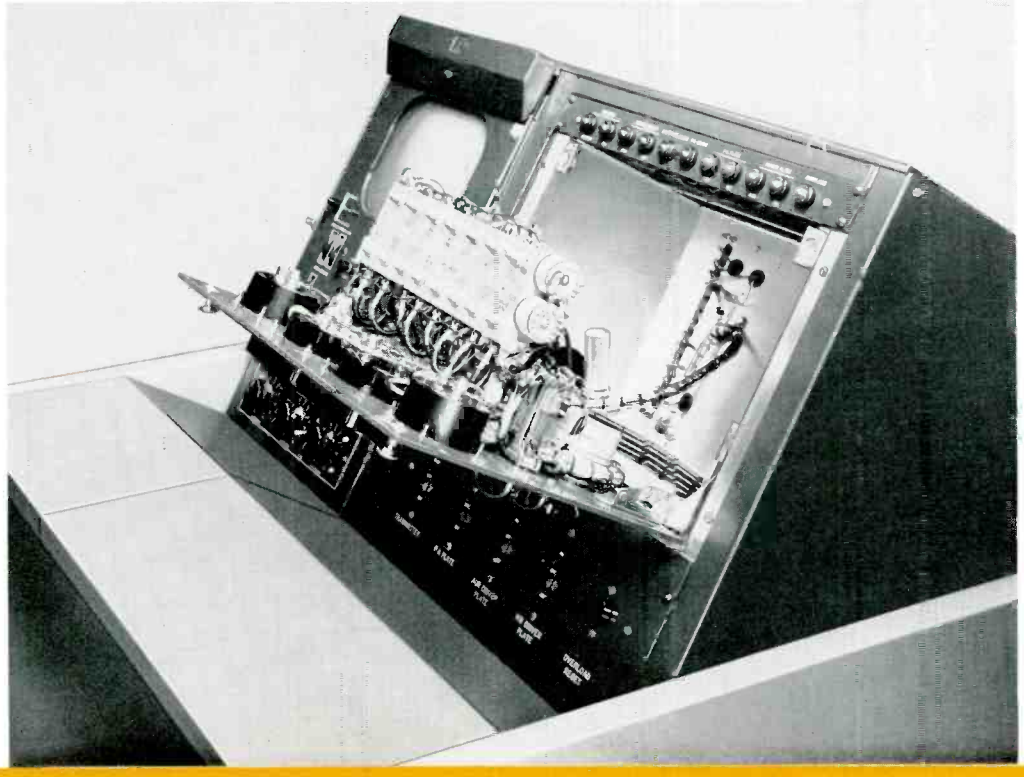
The front panel of the TM-6C monitor is arranged with an opening at the top center, fitted with a rectangular mask, for the 10-inch kinescope to present the picture screen. The screen of the 5-inch oscilloscope, immediately below the kinescope screen, contains an edge-lighted calibrated lucite scale. The lower section of the panel carries the operational switches and controls, conveniently grouped. Eight additional "set-up" controls have been brought out at the top, on a covered sub-panel, above the kinescope. The remaining controls are easily accessible from the side; and the cathode-ray oscilloscope tube is easily removed from the bottom of the unit. The unit includes three filament transformers, but d-c currents for the tube plate circuits and centering circuits are obtained from an external regulated power supply. Plug connections on the master monitor facilitate disconnecting the signal and power circuits, and an interlock opens the d-c power circuit when the monitor is withdrawn from the console.

The Monitor Control Panel is designed to work in conjunction with the RCA type ES-19237 series of input and monitoring equipment racks. It requires one set of these racks or equivalent components, for full use of its facilities. The



Functional diagram of the TTC-5A Transmitter Console.

Closeup of TTC-5A console showing "block-build" console desk construction and convenient slide and hinge arrangements for accessibility to transmitter control panels.



Monitor Control Panel includes four major circuit functions and other related ones, namely, meter circuits, audio monitor circuits, video monitor circuits, and aural input signal level indication and control.

The four meters provide for continuous indication of visual power output, aural power output, aural transmitter input level, and aural percentage modulation. The power output functions are provided by meters which duplicate the reflectometer meters on the transmitter. The aural transmitter input level is indicated by a Weston type-30 VU meter with a suitable multiplier pad connected to the input line of the aural transmitter; and the aural modulation percentage is indicated by a meter which matches the VU

meter but repeats the indication of the aural monitor in the racks. Suitable meters are available for the General Radio 1184-A-A or Hewlett Packard series of monitors. The correct meter must be specified on the order. In addition to the audio metering described above the aural monitor circuits provide means of connecting the input of an audio monitoring amplifier through adjustable bridging networks to any of seven points in the aural system from input line to off the air monitor. Two of these positions are spares which may be used for any desired auxiliary function. The video monitoring circuits provide for connecting the input to the master monitor to any of eight monitoring points in the visual transmitter system. One of these is a spare, and like the audio monitoring spares, may be used as desired. Potentiometers in every monitor termination insure proper termination and level adjustment.

In order to make the above monitoring facilities more useful, an audio gain control with 20 one db steps is provided for connection ahead of the program amplifier (usually a limiting amplifier) so that the aural input to the transmitter can be controlled. Full remote controls for a stabilizing amplifier, which is normally used ahead of the visual transmitter, are available as an optional item to control the input to the visual transmitter.

In addition to the above circuits a lamp in parallel with the overmodulation flasher of the aural monitor and a switch to control the chopper of the visual monitor are provided in the monitor control turret. Also the monitor is provided with a rheostat to dim the lights in the meters to suit the ambient light around the console to eliminate unnecessary operator annoyance and fatigue from meter lights which are brighter than necessary.

SPECIFICATIONS

Performance Specifications

Impedances:

Audio Line Input (2)	600 ohms, balanced
Audio Line Output	600 ohms, balanced
Audio Monitor Input	10,000 ohms, balanced
Audio Monitor Output	250 ohms, balanced
Master Monitor Inputs (6)	75 ohms, unbalanced
VU Meter Circuit (across transmitter input)	7500 ohms

Volume Controls:

Audio Gain	600 to 600 ohms, 20 steps, 1 db per step; initial insertion loss zero.
Audio Monitor Gain	10,000 to 250 ohms, 20 steps, 2 db per step, tapered; last step infinite; insertion loss 38 db.

Electrical Specifications

Console Power Requirements:

Indicator Lights (from transmitter)	115 or 230 volts, a-c (as required)
Meter Lights (6.3 volts from transformer)	115 volts a-c, 50/60 cycles
TM-6C Master Monitor (a-c line for tube heaters)	105-125 volts, 50/60 cycles, 90 watts
TM-6C Master Monitor (from Regulated Power Supply)	280 volts d-c, 450 ma

Tube Complement

TM-6C Master Monitor:

4 6197	1 6AL5	1 12BH7
3 6485	2 6BQ6-GT	2 12AX7
7 12AT7	1 12AU7	1 10SP4 (kinescope)
	2 6CB6	1 5ABP1(CRT)

TM-6C High-Voltage Supply:

1 6L6	1 6BQ7A	4 1X2A

Mechanical Specifications

Dimensions:

Width	69" (175.3 cm)
Depth	36" (91.4 cm)
Height	41" (104 cm)
Weight	500 lbs. (approx.) (227 kg.)

Equipment Supplied

TTC-5A Transmitter Control Console Equipment (order as follows):

For Type TT-2BL, TT-2BH, TT-6AL, TT-5BH and TT-11AH Transmitters	ES-27274-1
For Type TT-25CL or TT-25CH Transmitters	ES-27274-2
For Type TT-10AL, TT-10AH or TTU-1B Transmitter	ES-27274-3
For Type TT-25BL or TT-25BH Transmitter	ES-27274-4
For Type TT-50AH Transmitter	ES-27274-5
For Type TTU-12A or TTU-25B Transmitter	ES-27274-6
For Other Transmitters	Custom Built

Consoles include items as follows:

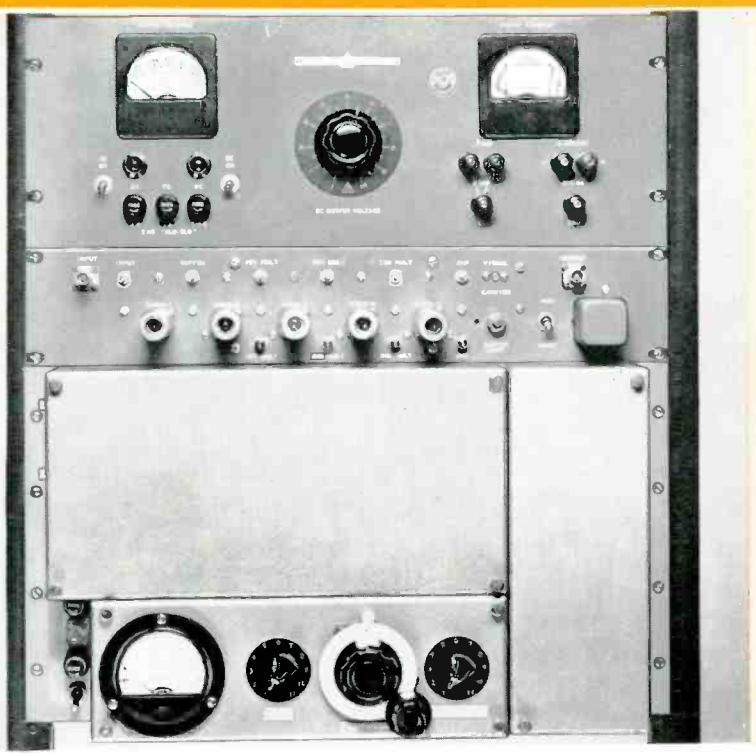
1	Transmitter Control Panel	
	For TT-2BL/BH, TT-6AL and TT-11AH	MI-27866
	For TT-25CL/CH	MI-27867
	For TT-10AL/AH and TTU-1B	MI-27868
	For TT-25BL/BH	MI-27869
	For TT-50AH	MI-27870
	For TTU-12A/25B	MI-27576
1	Indicator Panel	
	For TT-2BL/BH, TT-6AL and TT-11AH	MI-27580
	For TT-25CL/CH	MI-27581
	For TT-10AL/AH and TTU-1B	MI-27582
	For TT-25BL/BH	MI-27583
	For TT-50AH	MI-27584
	For TTU-12A/25B	MI-27577
1	Monitor Control Panel	MI-27865
1	Blank Panel 6-31/32 inch high	MI-4593-A
1	Blank Panel 1-23/32 inch high	MI-4590-A
1	Blank Panel for 22-inch console housing	MI-26846-1
1	Blank Panel for 22-inch console housing	MI-26846-2
1	Console housing 22-inches wide	MI-26787
1	Master Monitor, Type TM-6C	ES-26957-A
1	Meter, Aural Modulation Monitor:	
	For use with Type GR-1184-A-A TV Monitor	MI-19116-3
	Or, for use with Type 335-ER TV Monitor	MI-19116-6
1	Console Housing 13¼" wide	MI-26786
1	Left Hand End Panel	MI-26788-1
1	Right Hand End Panel	MI-26788-2
1	Set of Installation Hardware	MI-27579
1	Program Line Selector	MI-27407
2	Installation Drawings	644367
2	Instruction Books	IB-30259

Optional and Accessory Equipment

Television Station Input and Monitoring Equipment	ES-19237 Series
Calibration Meter	MI-21200-C1
580-D Power Supply	MI-21523-C
WP-15B Power Rectifier and Regulator	MI-26087/26088

Precise Frequency Control

TYPE TFC-1A



FEATURES

- Offers precise control of visual carrier frequency
- Extends station coverage to area now lost due to co-channel interference
- Frequency variation less than 1 cycle per 100 mc over 7-day period
- Reduction in co-channel interference of up to 15 db may be obtained
- Self-contained power supply
- Standard rack mounting
- Ease of installation—coupling head directly interchangeable with crystal holder in RCA transmitters

DESCRIPTION

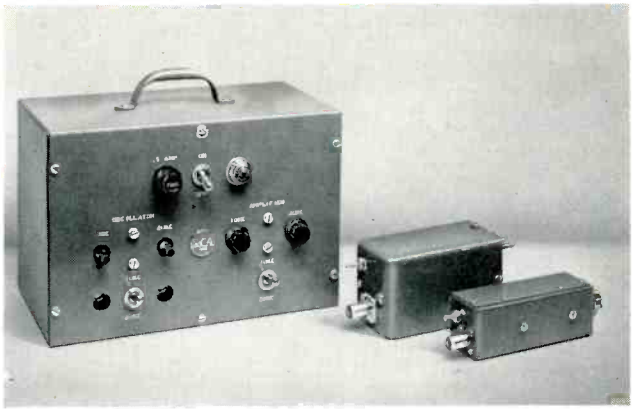
The RCA Type TFC-1A Precise Frequency Control System is designed to reduce interference between co-channel television stations and thus extend station program coverage to fringe areas now lost due to signal degeneration. Interference between two or more co-channel television stations is reduced if their picture carrier frequencies are off-set by a fixed amount, and if this difference is held constant within very small tolerances. The TFC-1A system makes use of recent developments in crystal techniques and oscillator circuits to maintain carrier frequencies at precisely their assigned off-set frequencies. It also has provisions for checking the difference frequency between co-channel stations.

Better spectrum usage through off-set carrier operation requires that one TFC-1A Precise Frequency Control System be installed at each participating station and a stable source of frame frequency be supplied. In addition, auxiliary equipment consisting of good oscilloscope, field intensity meter and frequency counter are required for determining the proper beat or offset frequency and for periodic testing of the system.

The RCA TFC-1A Precise Frequency Control System consists of four equipment units: the Crystal Oscillator, MI-34053; R-F Multiplier Unit, MI-34054 comprised of multiplier, coupling head, and two coaxial cables; a Power Supply, MI-34055; and a Selective Amplifier, MI-34056. The system is designed to fit standard racks, requiring approximately 21 inches of space, excluding the Selective Amplifier. The latter is a portable unit used only during a frequency measurement.

Co-channel stations using precise frequency control must have an offset frequency which is an even multiple of the frame frequency, (nominally 29.97 cps). Optimum improvement of co-channel interference is obtained when this condition exists. The multiplier selected is 332 to 334 for 10 kc off-set station and 664-668 for 20 kc off-set. To assure positive control of separation, an extremely stable frequency source is required. The TFC-1A supplies the equipment necessary to control offset operation with the required frequency stability. Maximum variation over a seven-day period is less than 1 part in 10^8.

To off-set the frequency of two co-channel stations, the transmitting antenna may be used to receive the picture carrier of the co-channel station. This received signal is added to the proper harmonic of the local crystal fre-



MI-34056 Selective Amplifier and MI-34060 and MI-34059 Coupling Heads.

quency. The two signals are then mixed in the field intensity meter. The beat between the two carriers, available at the ouput of the field intensity meter, is amplified through a narrow band amplifier and applied to the vertical plates of an oscilloscope. The sweep circuits of the oscilloscope are triggered by vertical drive obtained from a sync generator which is locked to a color subcarrier. With this system it is possible to set the beat or off-set frequency to an even multiple of frame frequency. To determine whether the desired even multiple has been reached it is necessary to use a frequency counter.

The TFC-1A system is easily installed in any RCA transmitter. The present crystal is removed from the transmitter and the R-F Coupling Head simply inserts in the crystal socket. It may be necessary in some cases to remove certain components in order to tune the R-F Amplifier to the proper crystal frequency. However, no soldering or wiring is necessary. For tuning, only a scope, a d-c voltmeter, and grid-dip meter are required.

The MI-34053 Crystal Oscillator Unit is so designed that its frequency is almost independent of circuit constants. Crystal oven temperature is maintained at better than .002 degrees C. per degree change in ambient. Frequency of oscillation of this super-stable unit will be between .834 mc to 1.217 mc. A self-contained power supply is provided.

The R-F Multiplier, MI-34054 is a shielded unit which multiplies and amplifies the super-stable oscillator output to the frequency of the crystal in use at present. The output is connected to the transmitter by a special coupling head which plugs directly into the crystal socket. Also available from the R-F Amplifier is the picture carrier frequency. This is provided as a convenience in measuring and adjusting the frequency of the picture carrier for optimum off-set operation. The MI-34055 Power Supply provides necessary power for the R-F Amplifier. The portable Selective Amplifier, MI-34056 is connected into the system only when making periodic frequency checks. It selects the proper low frequency beat necessary for precise frequency measurement.

The MI-34056 Selective Amplifier is a high gain, highly selective audio amplifier. Its purpose is to amplify the audio beat frequency which is produced by the picture carrier signals of two or more co-channel television transmitters being adjusted for proper off-set frequency operation. It has a self-contained power supply and its own fuse protection. The unit is contained in a portable cabinet. Output and input connectors are standard 75 ohm video con nectors. It operates from a 110 V 60 cps source.

SPECIFICATIONS

Output Frequency Range:
- Normal Operation (XMTR-Position) ..... 4.5 mc—14.0 mc
- Precise Frequency Measuring (MON-Position) ..... 54 mc—216 mc

Frequency Stability ..... Frequency variation less than one part in 10^8 over 7 day period

Output ..... Output of multiplier is sufficient to drive transmitter crystal stage to full output

	10 kc amplifier	*20 kc amplifier*
Tuning Range	9800-10200	19000-21000
6 db bandwidth at 10010 cps	60 cps	—
6 db bandwidth at 20020 cps	—	350 cps

Ambient Temperature ..... 18°-40°C.; ambient temperature not to change more rapidly than 6 degrees per hour while in operation

Ambient Humidity ..... 0-95% RH

Power Line Requirements:
- Power Supply ..... 105-125 volts, 60 cycles a-c, 250 watts max.
- Crystal Oscillator Unit ..... 115 volts, 60 cycles a-c, 75 watts
- 10-20 KC Selective Amplifier ..... 115 volts, 60 cycles a-c, 10 watts

Duty Cycle ..... Continuous

Size ..... All units are standard 19" (48.3 cm) rack mounting occupying approximately a total of 21" (53.3 cm) vertical space

Weight ..... 65 lbs. (29.5 kg.) total (approx.)

Tube Diode Complement

Precise Oscillator (Knight Unit): 1—5670, 4—6AU6, 1—12AX7, 2—OC3, 1—6BL7-GT, 1—12AU7, 1—5Y3-GT, 1—1N34, 4—1N37, 1—G12AS
Power Supply: 2—5R4-GY
Oscillator Multiplier: 2—6AU6, 2—6AN5, 1—6AQ5, 1—1N34A
10-20 kc Amplifier: 1—6U8A

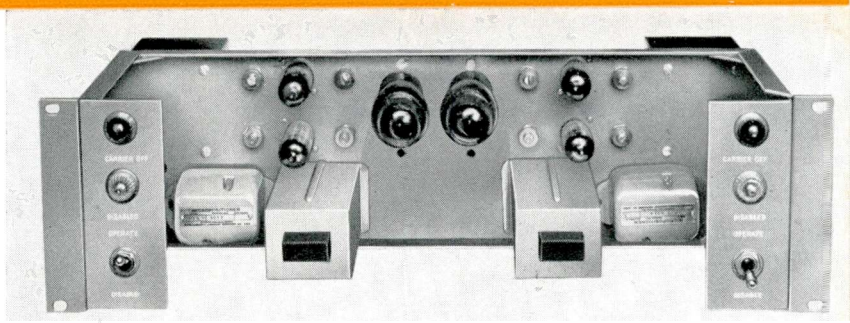
Equipment Supplied

TFC-1A Precise Frequency Control System, complete ES-34052
comprising the following equipment:
- 1 Crystal Oscillator MI-34053
- 1 R-F Multiplier Unit MI-34054
- 1 Power Supply (for MI-35054) MI-34055
- 1 10-20 kc Selective Amplifier MI-34056
- 1 Coupling Head (order as follows)
  - For use with TT-2BL, TT-2BH, TT-6AL and TT-11AH Transmitters MI-34059
  - For use with all other Transmitters MI-34060
- 1 Instruction Book IB-30261

Accessory & Optional Equipment

Oscilloscope, Type TO-524-AD MI-26500-A
R-F Test Set & Field Intensity Meter, Type BW-7B MI-19384
Field Intensity Meter, Jerrold Model 704-B
Frequency Counter HP-521-A
D-C Voltmeter
Grid-Dip Meter
TO-500 "Scope-mobile" MI-26501

Carrier Off Monitor



FEATURES

- Operates transmitter overload circuits when power output drops to preset level and protects in event of arc over
- Adjustable to any desired power level and overload level
- Separate circuits provided for aural and visual transmitter sections
- Standard 19-inch rack mounting—all front panel controls

DESCRIPTION

The ES-27235 Carrier Off Monitor and Remote Power Indicator is a convenient accessory for use with RCA Television Transmitters. It acts in conjunction with the reflectometer units to trip the transmitter overload circuit in the event of arc over in the amplifier circuit.

This unit includes a remote power indicator circuit which also uses the d-c voltage from the reflectometers. This circuit consists of cathode followers and provides a low voltage, low impedance source necessary for remote power output monitoring over telephone lines.

The Carrier Off Monitor is a protective device for television transmitters which is offered as optional equipment of particular value in high power installations. It is essentially a comparison device and functions from information supplied by the reflectometer units. When used with RCA 25-KW and 50-KW transmitters it will compare the voltages from the output reflectometer and the driver reflectometer. As long as the input and the output of the amplifiers are proportional to a preset value the monitor will not operate. Should an arc occur in the amplifier circuit the output power will be reduced, thereby upsetting the balance. The monitor will then operate and the sensitive differential relay in the cathode circuit of the comparison tube will trip the transmitter overload circuit through an auxiliary relay. The Carrier Off Monitor is designed to operate in either of two ways. In addition to the method already outlined, the Carrier Off Monitor may be connected so that it will compare the voltage from the transmitter output reflectometer to a d-c reference voltage. Two complete circuits are provided—one for the aural and one for the visual transmitter. Disabling switches are included with the equipment to disconnect the transmitter overload circuits during tune-up.

The remote power indicator also operates from the output reflectometer circuits. Two cathode follower circuits are used. One provides a voltage reference level, and the other provides a low voltage which varies with the input signal (reflectometer output). The voltage appearing at the output terminals is therefore proportional to the reflectometer voltage and has good linearity due to the cancellation of Edison effect in the tubes.

The monitor and remote indicator are mounted on a bathtub type chassis designed for standard rack mounting. All operating knobs are located on the front panel, as well as the red "Carrier-Off" lights and the amber "Disabled" lights. Screw-driver adjustments are provided for making other adjustments such as input level, sensitivity, power indicator balance.

SPECIFICATIONS

Signal Input Voltage (output from reflectometer)	50 to 150 volts (less than 50 volts at reduced sensitivity)
Differential Voltage to Trip	15% min. (depending on transmitter power)
Input Impedance:	
Driver	3.7 meg., min.
Amplifier	2.16 meg., min.
Output Relay Contacts	2 normally open
Output Impedance (Remote Power Indicator)	5000 ohms
Output Voltage (Remote Power Indicator)	1.2 volt, max.
Tube Complement	4—5814A, 2—OD3
Power Requirements:	
Filament	208-230 volts, 50/60 cycles, 10 watts
Control	115 volts, 50/60 cycles
D-C Input	350 volt (minimum), 94 ma
Dimensions (overall)	19" wide, 5-7/32" high, 9½" deep (48.26 cm wide, 15 cm high, 24 cm deep)
Weight	10 lbs., approx. (4.4 kg.)
Finish	Dark umber gray

Equipment Supplied

Carrier Off Monitor (Complete)	ES-27235
Comprising the following:	
1 Carrier Off Monitor	MI-27470
1 Set of Operating Tubes	MI-27825
1 Installation Material Kit	MI-27484*
1 Instruction Book	IB-36291

Accessories

Set of Spare Tubes	MI-27825
Set of FCC Spare Tubes	MI-27831

* Sales order must specify type of transmitter with which Monitor is to be used.

Phase Equalizer Equipment

ES - 34034 - B

FEATURES

- **Permits variable envelope delay correction at both high and low video frequencies**
- **Simple switching system permits selection of optimum delay correction**
- **Employs passive elements only—no tubes or power supplies**
- **No internal adjustments necessary—factory sealed to prevent accidental changes**

DESCRIPTION

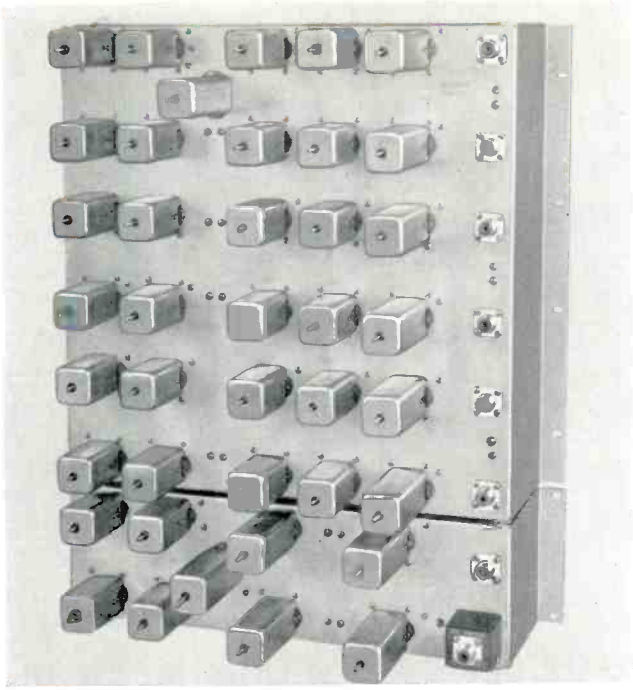
The RCA Phase Equalizer Equipment, Type ES-34034-B, is designed to compensate for various distortions introduced in video transmission systems by such components as the color receiver, transmitter, vestigial sideband filter, notch diplexer and terminal equipment. The equipment greatly improves color edges and color transitions, and provides better time correspondence between luminance and chrominance information. It is required by all RCA TV transmitters to meet FCC color specifications.

The equipment consists essentially of three elements—a High Frequency Phase Equalizer, MI-34026, a Low Frequency Phase Equalizer, MI-34025, and an Amplitude Equalizer, MI-34035. The High Frequency Equalizer is designed for insertion in the video input to a color television transmitter to compensate for envelope delay distortion due to such factors as high frequency cut-off of a color receiver, a sound notch filter, and for any additional envelope delay distortions in the high video part of the spectrum which is introduced by the transmitter or terminal equipment. The Low Frequency Phase Equalizer rectifies envelope delay distortion at low frequencies caused by the vestigial sideband filter, and improves overall transient response of the entire transmitter-to-receiver system.

Both the High and Low Frequency Phase Equalizers consist of passive, all-pass, constant resistance bridged-T networks composed entirely of reactive elements. Both are mounted on bathtub-type chassis designed for standard 19-inch rack-mounting.

The MI-34025 Low Frequency Phase Equalizer requires 5¼ inches of rack space. The front panel contains only two switches: (1) a rotary switch which enables selection of any one of four envelope delay characteristics, and (2) a toggle switch which connects the equalizer in or out of the video circuit as desired. Four degrees of delay compensation are provided for the region below 2.0 mc. A section of Type RG-11/U 75-ohm coaxial cable is supplied to connect the equalizer into the transmitter video system in series with the Receiver Equalizer section of the High Frequency Phase Equalizer. The unit has been properly adjusted at the factory and all internal adjustments have been sealed in to prevent accidental changes.

The RCA High Frequency Phase Equalizer, MI-34026, consists of three circuit networks requiring 17½ inches of rack space. The first is the receiver equalizer section which provides the envelope delay curve to meet the FCC color specification, and compensates for the high frequency



Rear view of Phase Equalizer Equipment showing one Amplitude Equalizer Unit mounted in lower right corner on the Low Frequency Chassis.

cut-off of an average color receiver. Correction is required above 3 megacycles. A toggle switch is provided for switching the receiver equalizer in or out of the circuit. The second network is the notch equalizer section which must be used if a sound notch filter (such as a Filterplexer) is used in the transmitter. There are provisions for selection of one or two basic envelope delay curves by means of a toggle switch, and another switch allows cutting the notch equalizer in or out of the circuit. Finally, there is the variable equalizer section which compensates for small system variations. A five-position rotary switch selects one of five degrees of variation in combination with the selection of an optional fixed section. Thus there are ten possible delay curves provided. A separate toggle switch allows this network to be switched in or out of the circuit. All controls, consisting of six switches, are mounted on the front panel. The unit has been carefully adjusted at the factory for correct operation, and the adjustments have been sealed to prevent accidental change.

The notch and variable equalizer networks are designed for insertion in series between distribution amplifiers, whereas, the receiver equalizer should be patched in series with the Low Frequency Phase Equalizer, between distribution amplifiers. The High and Low Frequency Phase Equalizers are supplied with precision 75 ohm ±1 percent coaxial terminations which are color coded with a red band.

SPECIFICATIONS

Performance Specifications

Type of Circuit.....Non-minimum phase reactance network (No tubes or power supply required)

Impedance.....Input and output: 75 ohms

Type of Signal.....Composite video; color or monochrome

Circuit Attenuation (total for all phase equalizers).....2.0 db

Circuit Attenuation Each Amplitude Equalizer.....2.5 db

Sweep Frequency Response to 4.2 mc.....—1 db

Delay Correction:

Low Frequency Phase Equalizer.....Constant envelope delay from 2.0 mc to 4.2 mc; four envelope delay (curves in frequency range from 0 to 2.0 mc).

High Frequency Phase Equalizer:

Receiver Equalizer.....Follows FCC specified curve

Notch Equalizer.....Constant envelope delay from 0 to 3 mc; choice of 2 curves above 3 mc

Variable Equalizer.....Constant envelope delay from 0 to 2 mc; choice of 10 curves above 2 mc

Mechanical Specifications

Low Frequency Phase Equalizer.....19" wide, 5¼" high, 10" deep; wt. 9 lbs. (48.3 cm wide, 14 cm high, 25.4 cm deep; wt. 4 kg.)

High Frequency Phase Equalizers.....19" wide, 17½" high, 10" deep; wt. 23 lbs. (45.3 cm wide, 44.5 cm high, 25.4 cm deep; wt. 10.5 kg.)

Amplitude Equalizer.....1½" wide, 1½" high, 2½" deep; wt. approx. 5 oz. (3.8 cm wide, 3.8 cm high, 6.3 cm deep; wt. 141.75 g.)

Ordering Information

Phase Equalizer Equipment, complete.....ES-34034-B

Consisting of:

1—Low Frequency Phase Equalizer on Rack-mounting Chassis, including 1 75-ohm coaxial termination, 2 connectors for RG-11/U coaxial cable, and Instruction Book (IB-36195).....MI-34025

1—High Frequency Phase Equalizer on Rack-mounting Chassis, including 1 75-ohm coaxial termination, 2 connectors for RG-11/U coaxial cable, and Instruction Book (IB-36196).....MI-34026

Amplitude Equalizer.....MI-34035

Accessory Equipment

TA-3D Distribution Amplifier (2 required).....MI-26157-D

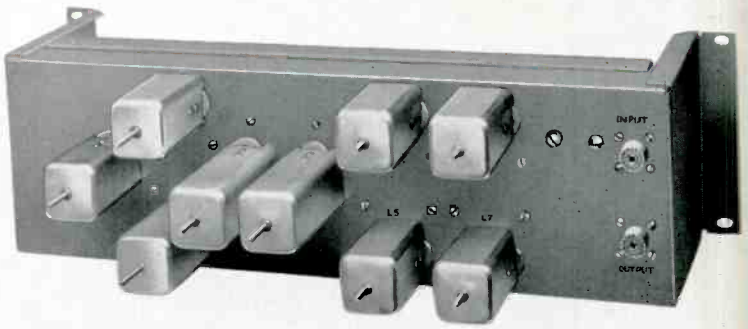
580-D Regulated Power Supply.....MI-21523-C

Low Pass Video Filter

MI-27132-A

FEATURES

- Attenuates all video frequencies above 4.75 mc by 23 db or more
- Insertion loss less than 0.5 db
- No degradation of either monochrome or color picture
- No adjustments necessary
- Mounts in standard studio equipment rack



DESCRIPTION

The Low Pass Video Filter, MI-27132-A, is used to reduce adjacent channel interference between television stations. The filter will attenuate video frequencies above 4.2 mc so that the video response is down at least 23 db at 4.75 mc. This unit when inserted in the video section of a television transmitter will permit operation of the equipment in conformance with FCC regulations. The filter will pass all frequencies from 0 to 4.2 mc with no more than 0.5 db attenuation. An all-pass phase equalizer corrects any phase distortion which is introduced as a result of the sharp cutoff.

The MI-27132-A Filter is a passive network consisting of a series of 12 coils wound on standard coil-forms and mounted on a chassis suitable for standard rack mounting. The circuit is an M-derived low-pass filter followed by a 5-section bridge T, phase equalizer. The insertion loss of the filter is never greater than 0.5 db; and the envelope delay vs. frequency characteristics remains flat to within ±.03 microseconds from 0 to 3.5 mc and ±.04 microseconds from 3.5 to 4 mc. The amplitude vs. frequency response is flat within ±0.5 db in the video frequency range from 0 to 4.2 mc, and is —23 db or more in the frequency range from 4.75 to 10 mc. The low pass video filter requires that the impedance of the signal source be 75 ohms, non-reactive. No adjustments to the circuit or equipment are necessary at any time, and no power supply is required.

The filter conforms in appearance to other RCA rack-mounted terminal equipment. It is mounted on a standard 19-inch wide chassis and finished in umber gray. One operating control, an in and out switch, is located on the front panel. The equipment is provided with input and output plugs and a load resistor assembly necessary for connecting the filter into the 75-ohm line between camera output and the input of the transmitter. The filter is usually inserted in the line following the stabilizing amplifier and can be mounted in the same rack with the stabilizing amplifier, phase equalizer and other studio equipment.

SPECIFICATIONS

Electrical:

Input:

Source Impedance	75 ohms, non-reactive
Input Impedance	75 ohms, non-reactive

Output:

Load Impedance	75 ohms, ±1%
Output Impedance	75 ohms, ±1%
Insertion Loss (from 75 ohm source to 75 ohm load)	0.5 db max.
Frequency Response	Flat within 0.5 db from 0 to 4.2 mc —23 db or more from 4.75 to 10 mc; —26 db at 6 mc

Mechanical:

Overall Dimensions	19" wide, 5¼" high, 10" deep (48.3 cm wide, 13.3 cm high, 25.4 cm deep)
Weight	5 lbs. (2.3 kg.)
Finish	Two tone umber gray

Equipment Supplied

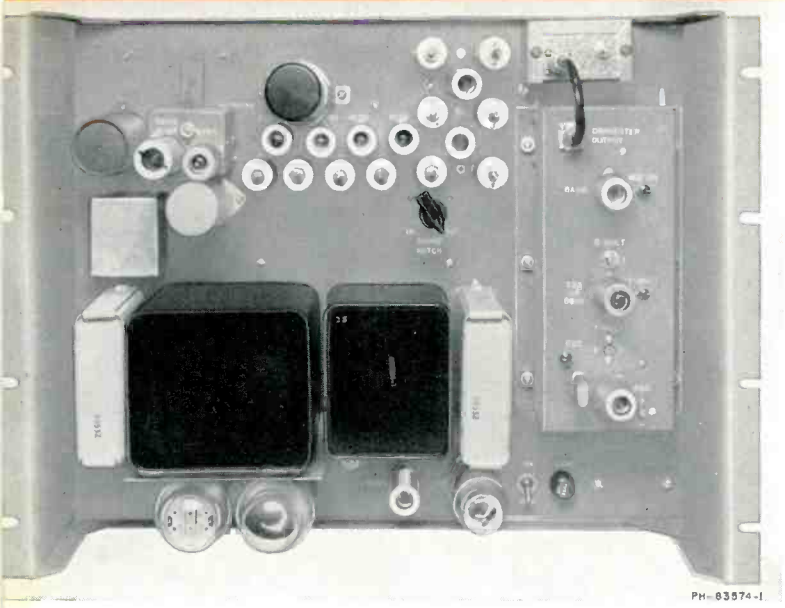
4.75 mc Low Pass Filter, complete including the following items:	MI-27132-A
1 Low Pass Video Filter	
2 Plugs, Input and Output	
1 Load Resistor Assembly (75 ohms)	
1 Instruction Book	IB-36197-1

Input and Monitoring Equipment

ES-19237 SERIES

FEATURES

- Provides full monitoring and input control for any color or monochrome VHF or UHF transmitter
- Every unit chosen to meet requirements of the FCC and good operating practice
- Custom wired racks available
- Compact, lightweight cabinets—easily installed
- Rack components arranged with regard to operating convenience
- BW-5B sideband response analyzer permits adjusting transmitter broad band response
- Provides continuous check on transmitter performance
- Plug and socket connectors for all power, video, audio, and r-f connections



View of the BW-4B Demodulator.

USES

The RCA type ES-19237 Transmitter Input and Monitoring Equipment enables stations to meet all requirements of the FCC and good operating practice for monitoring and input control of any RCA television transmitter. The equipment items are contained in two standard mounting racks which are intended to be used in conjunction with an RCA TTC-5A Transmitter Console as a central monitoring and control center.

The ES-19237 Series of monitoring equipment is supplied in four different arrangements:

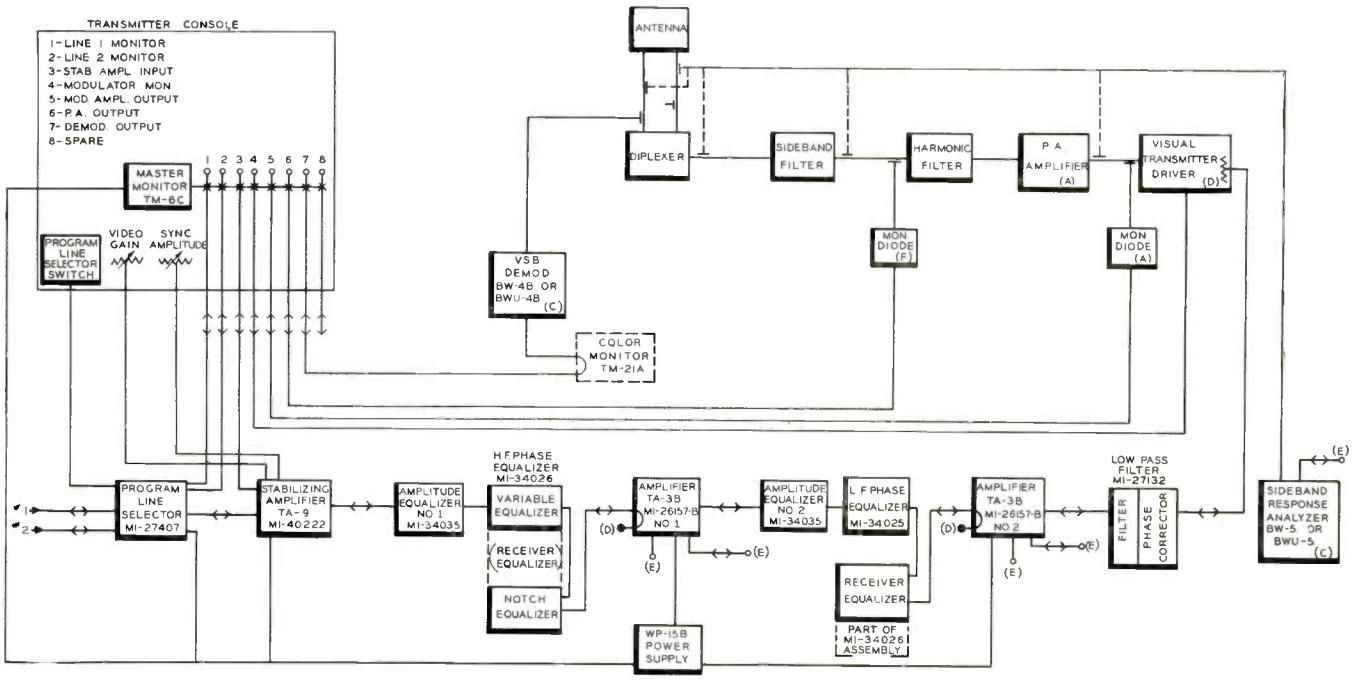
1. ES-19237-G Wired VHF monochrome and color
2. ES-19237-E Unwired VHF monochrome and color
3. ES-19237-H Wired UHF monochrome and color
4. ES-19237-F Unwired UHF monochrome and color

DESCRIPTION

The units included in RCA Input and Monitoring Equipment are enumerated in the accompanying specifications list. Units are arranged in the racks in the manner which makes them most effective and as compact as possible with due regard to convenience of operation, grouping of related units, and easy connections. The functions of each item can best be learned from a study of the block diagrams which show the interconnections of all units to a typical TV transmitter system.

When RCA monitoring equipment racks are used with a TTC-5A console, they provide everything required for routine TV station monitoring. The functions monitored are:

Visual Carrier Frequency,
Aural Carrier Frequency,
Aural Modulation. (This meter is on GR-1184-A-A or HP-335ER and is repeated on the TTC-5A console),
Visual Modulation (CRO on Console),
Aural Signals at all points where aural signals are available. Level of Transmitter input signal by VU meter;



NOTES:-

(A) ITEMS REQUIRED ONLY IF AMPLIFIER IS PRESENT

(B) 1—BOTH ANTENNA LINES MUST BE EQUIPPED WITH MONITOR PICKUPS, ONE TO SERVE DAILY, THE OTHER AS CHECK POINT

2—IF DEMODULATOR DOES NOT REJECT AURAL SIGNAL, ITS PICKUP POINT MUST PRECEDE THE DIPLEXER

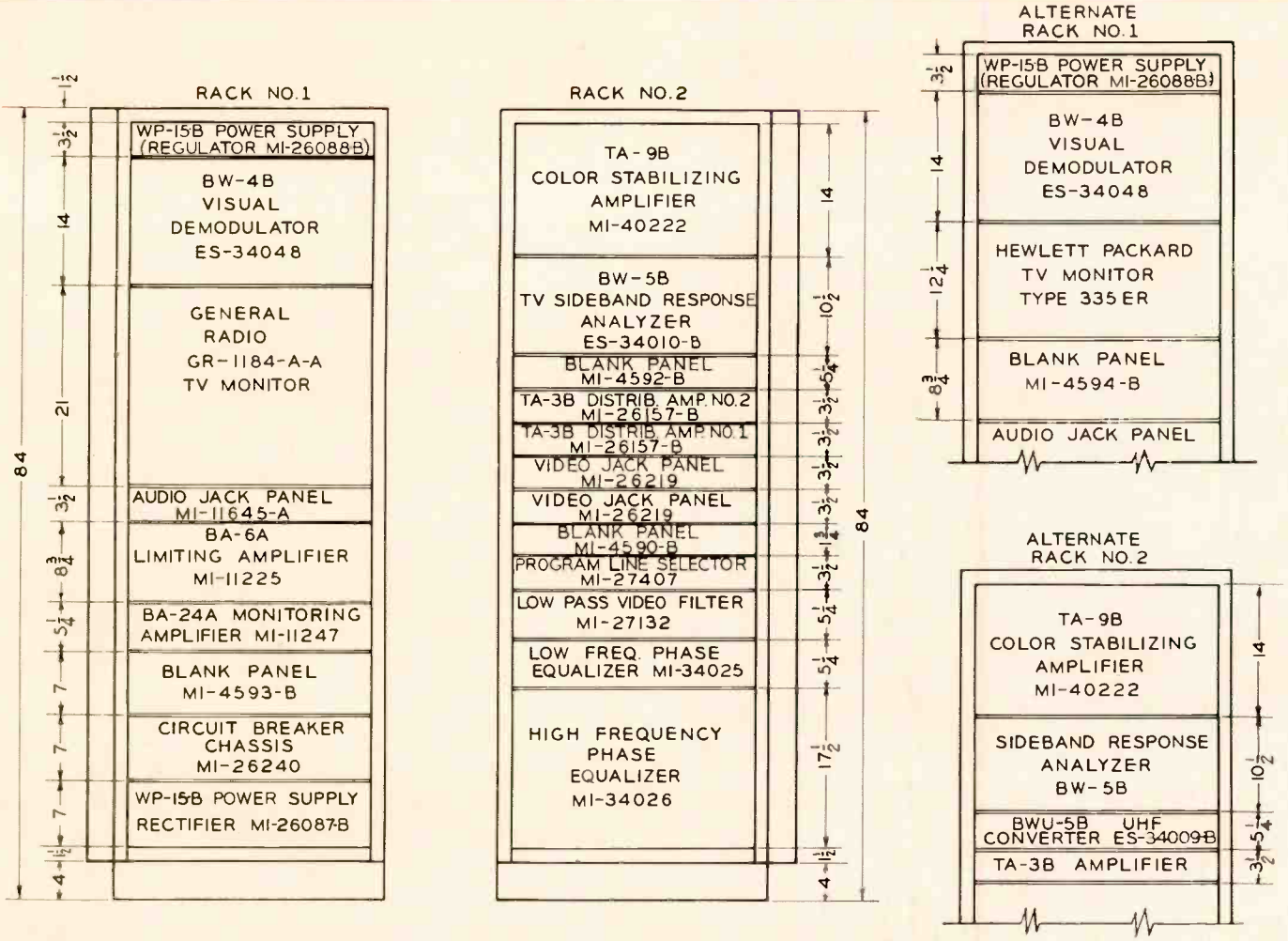
(C) USE DIRECTIONAL COUPLERS TO SUPPLY SIGNAL TO THE BW-4B AND BW-5B

(D) PRECISION TERMINATIONS REQUIRED (75Ω ±1%)

(E) TERMINATIONS REQUIRED (75Ω ±5%)

(F) NOT USED WITH SOME TRANSMITTERS

Line diagram showing video input control and monitoring functions of ES-19237 equipment.



Suggested rack arrangement for Transmitter Input and Monitoring Equipment.

and sound quality by means of the monitoring amplifier and an external loudspeaker,

Visual Signals at all points where visual signals are available. Levels are measured by the CRO in the master monitor of the console and picture quality is observed on the kinescope.

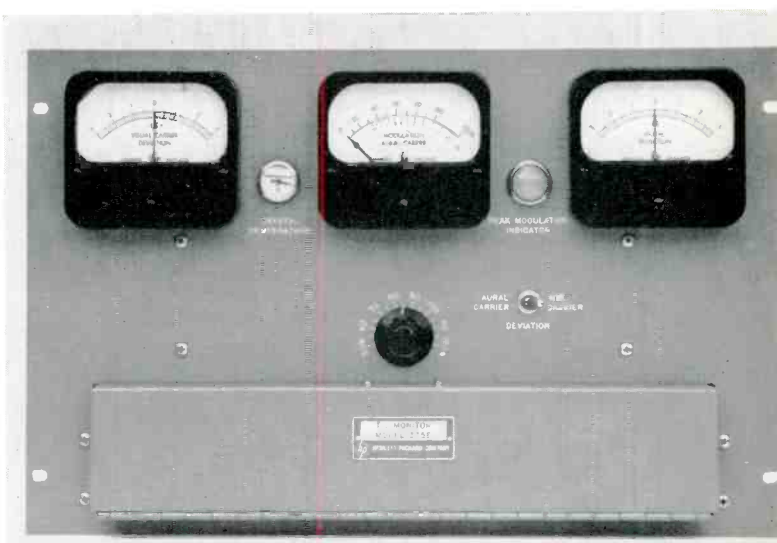
In addition to the monitoring functions listed, the racks provide:

A. Limiting amplifier BA-6A for the aural signal before application to the transmitter.

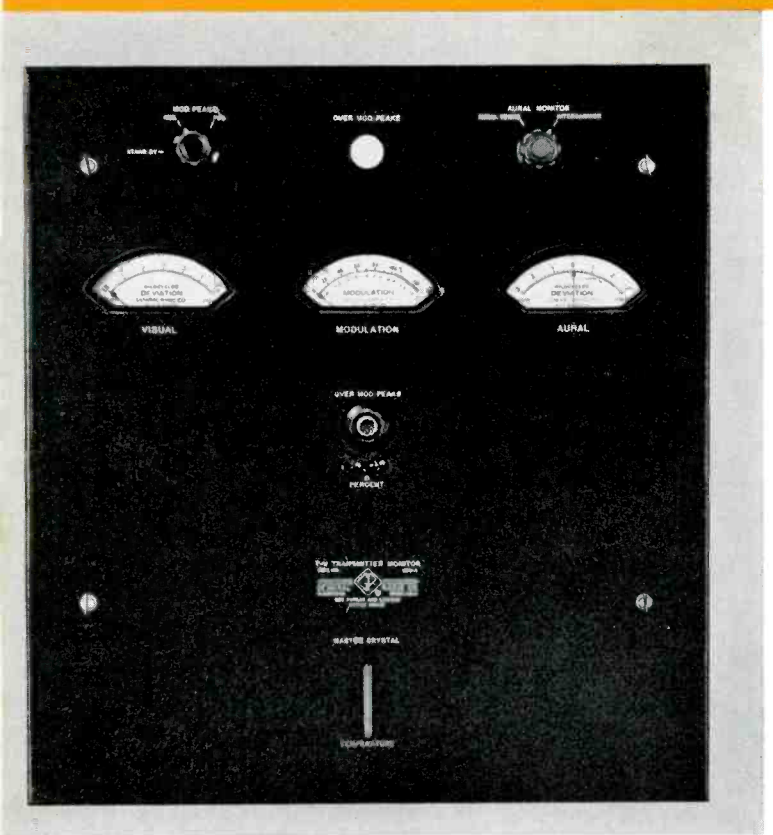
B. Stabilizing amplifier for visual signal to transmitter.

C. Sideband response analyzer BW-5B which provides a special video sweep and a synchronized selective receiver for adjusting transmitter broadband response.

The output of the sideband analyzer is fed through a cable to an external oscilloscope of standard design which may be located anywhere in the transmitter room. The resultant pattern on the CRO is a plot in which the horizontal dimensions are related to modulating frequency, and the vertical dimensions are proportional to the side-band response of the transmitter at each modulation frequency.



Television Monitor, Type 335ER. ▶

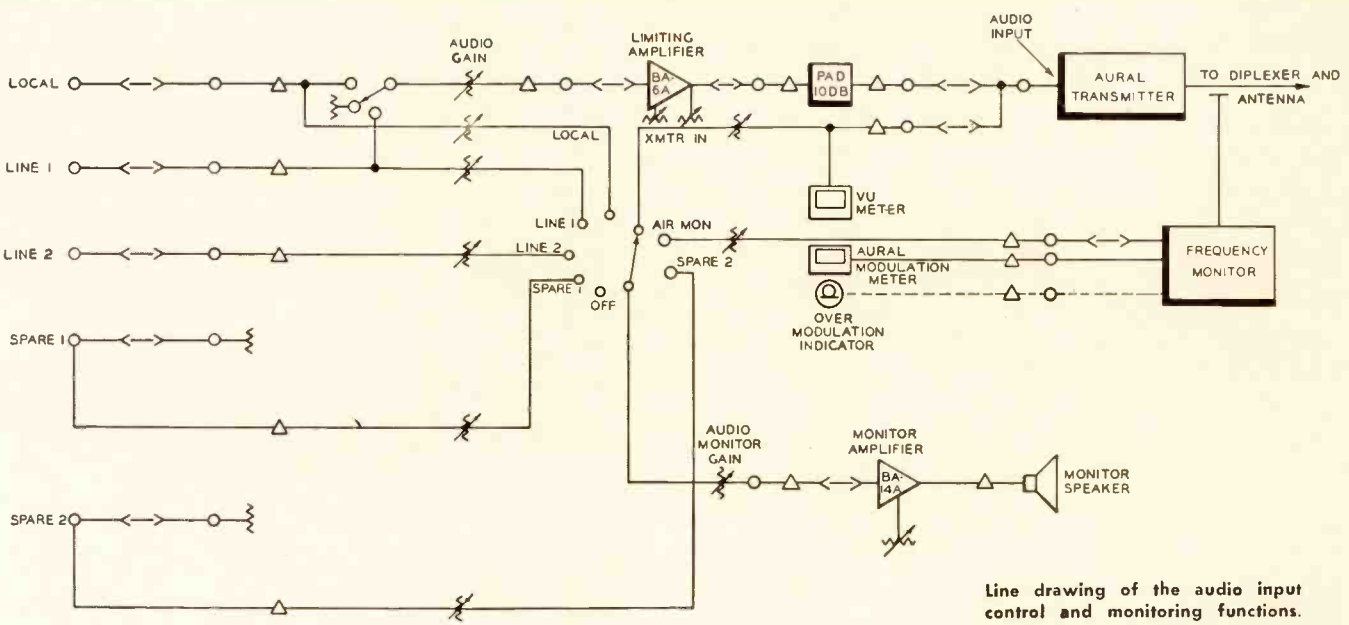


The GR-1184-A-A Monitor Equipment is removable from the front of the rack for servicing and inspection.

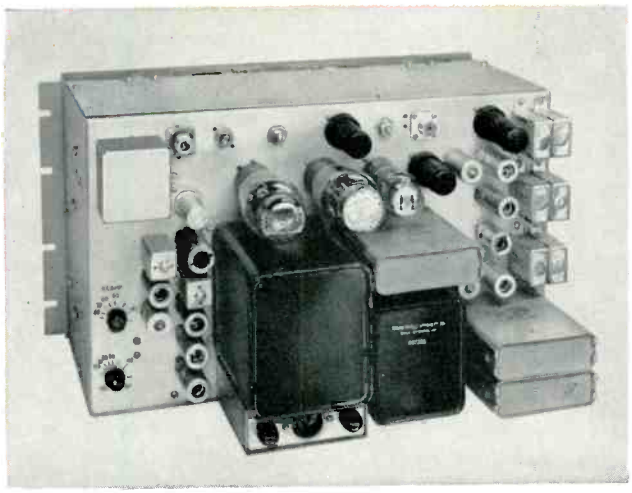
A choice of Monitoring units is available, either the GR-1184-A-A or the HP-335ER, both of which are described in the following paragraphs.

A General Radio Transmitter Monitor Unit, Type 1184-A-A provides continuous indication of center-frequency and percentage modulation (frequency deviation) from FCC assigned values of visual carrier, and aural carrier or intercarrier separation. It also furnishes a high-fidelity output for measuring distortion and noise, and a 600-ohm output for audio monitoring. The monitoring system may be used by TV stations operating on any channel and broadcasting either color or monochrome signals. The monitor also has provision for complete audio-fidelity tests and residual AM and FM noise measurements on aural and visual transmitters respectively. An external distortion and noise meter may be used to measure the audio fidelity of the aural transmitter as required for FCC proof-of-performance tests. An output signal of 10.8 volts at 100% modulation is available for this purpose. No external detector is required for measurement of the existing mixer stage. Modulation distortion can be measured at any frequency from 50 to 15,000 cycles at 100% modulation or less. By operating the station-monitoring speaker from this system, an audible warning for loss of either carrier is constantly available.

A more compact TV monitor is the Hewlett-Packard Model 335ER which may be designated in place of the General Radio Station Monitoring Unit. This VHF-UHF Television Monitor performs every important carrier monitoring function continuously, without adjustment, and with dependability and accuracy. It is equally useful in monochrome or color broadcasting. In addition to continuous, precise



Line drawing of the audio input control and monitoring functions.



Top-of-chassis view of the BW-5B Sideband Response Analyzer.

indication of visual and aural frequency deviation and percentage of aural modulation, the Model 335ER shows inter-carrier separation directly. No calculation is required.

Carefully engineered crystal reference oscillators provide accuracy in excess of FCC requirements for all channels. Because discriminator accuracy does not depend on a tuned circuit, no time-consuming adjustments are required during operation. It is never necessary to reset carrier level or realign circuits. Proper operation of the monitor can be checked conveniently by controls located behind the hinged panel cover.

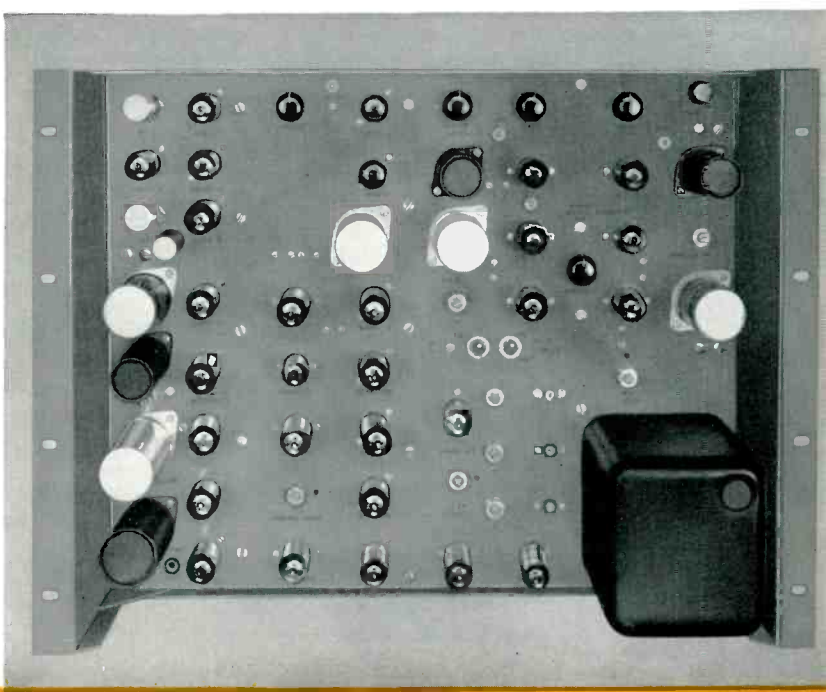
The three panel meters monitor visual and aural carrier frequency and percent modulation of the aural carrier with 100% modulation equal to 25 kc deviation. A peak modulation indicator lamp is included as standard equipment; the instrument also has provision for remote indicating meters, remote peak modulation indicating lamp, and a demodulated signal for measuring FM and AM noise levels, frequency response and distortion of the aural transmitter and for continuous program monitoring.

The master oscillator is controlled by a crystal operating in the 20-30 megacycle region. The crystal is mounted in a carefully-designed oven that controls temperature to within approximately 0.10° C. Oven temperature is indicated by a thermometer readable at the front panel. The master oscillator is provided with a vernier tuning adjustment for correcting long time drift. A cathode-coupled type oscillator circuit has been incorporated because of the exceptionally small effect varying stray capacities have on the frequency of the crystal used in this arrangement. As a further precaution, a constant-voltage transformer is provided to regulate the master-oscillator filaments.

The 335ER is particularly designed for long years of trouble-free operation. Highest quality components and construction are used throughout. A new chassis design increases accessibility of components and makes possible cool operation. The chassis is mounted on slides for easy withdrawal from the rack. The instrument includes a front panel crystal temperature indicator and illuminated meter faces.

The monitoring and control units are mounted in two sturdy metal cabinet racks the same height as RCA transmitters. The MI-19237 equipment is finished in a two-tone umber gray, blending with all RCA transmitters, and provide utmost flexibility in arrangement for future expansion. The ventilated top with slotted edges provides complete ventilation but protects the equipment from falling particles and dust. The cabinets are of metal construction, welded and bolted together in one standard height and width. Units may be placed singly or used in tandem. When placed adjacently they may be rigidly bolted together to produce a secure assembly.

Top view of chassis of the Type TA-9 Stabilizing Amplifier.



SPECIFICATIONS

Performance Specifications

GENERAL RADIO-TV STATION MONITOR

Frequency Range.....50-890 mc (TV channels 2-83)

RF Input:
- Impedance.....Low-impedance, loop coupling
- Level.....For use with standard EIA transmitter monitoring outputs (10 volts, 50 ohms)
- Sensitivity.....One volt for all functions except the measurement of residual AM noise on the aural transmitter, which requires a minimum of 4 volts r-f input and the visual transmitter input which requires 2 volts
- Indication.....Direct indication on front panel meter

Frequency (Crystal Stability):
- Master Reference.....±1.4 ppm/30 days or ±0.35 ppm/10 days
- Secondary reference.....±5 ppm/30 days (= 21.5 cycles)
- Interpolating reference oscillator....±5 ppm/30 days (= 22.5 cycles)

Accuracy (overall):
- Aural and Visual.....500c/30 days VHF or 500c/10 days UHF
- Intercarrier.....250c/30 days at all frequencies

Aural Modulation (FM):
- Meter Scale.....0 to 100% + 3 db, full scale
- Meter Ballistics.....As required by FCC specifications
- Meter Calibration.....100% = 25 kc deviation; selection switch for 100% = 50 kc to permit wide-deviation type tests.
- Polarity Response.....Panel switch for positive or negative peaks, for both meter and flashing lamp

Peak Indicator.....Flashing lamp indicates peaks in excess of dial setting
- Dial.....Calibrated from 0 to 100% and to +3 db above 100%
- Meter Frequency Response.....±0.25 db from 50 to 15,000 cycles; ±0.5 db from 30 to 20,000
- Peak Indicator Freq. Response.....0.5 db from 100 to 15,000 cycles

Aural FM Transmitter Fidelity Measurements:
- Audio Outputs (at low frequencies with 100% modulataion)....10.8 volts into 100 ohms or 0 db into 600 ohms
- Residual Distortion (50 to 15,000 cycles).....0.15% for 25 kc modulation deviation and 0.25% for 50 kc deviation
- Residual FM Noise.....—70 db below 25 kc modulation deviation
- Audio Response.....follows 75-μsec de-emphasis curve within ±0.5 db from 50 to 15,000 cycles, ±3 db from 15 to 30 kc
- AM Noise Reference Level (at low Frequencies).....4 volts into 100 ohms
- Residual Noise AM.....—70 db below carrier level

Visual AM Transmitter Fidelity Measurements:
- Noise (FM) Measuring Output (at low frequencies and 25 kc deviation).....1.5 volts into 100 ohm load, 75-μsec de-emphasis circuit included
- Residual (FM) Noise.....—65 db below 25 kc deviation with normal video modulation on transmitter (—70 db without video modulation)

Intercarrier Fidelity Measurements:
- Same as for aural transmitter except Residual (FM) noise is —63 db below 25 kc deviation of aural transmitter with video modulation applied to visual transmitters.

Power Supply:
- Standby Operation.....15 watts, with master crystal oven operating 115/230 volts; 50/60 cycles
- Normal Operation.....Max. demand 265 watts, with all thermostats on. Min. demand 240 watts, with all thermostats off. 115/230 volts; 50/60 cycles.

335ER TV MONITOR

Aural Frequency Monitor:
- Deviation Range.....+3 kc to —3 kc mean frequency deviation
- Accuracy.....Channel 2-6 ±500 cps for 90 days; Channel 7-13 ±500 cps for 45 days; Channel 14-83 ±500 cps for 14 days

Aural Modulation Meter:
- Modulation Range.....Meter reads full scale on modulation swing of 33.3 kc. Scale calibrated to 100% at 25 kc swing; 133% at 33.3 kc. Also includes db scale where 0 db = 100%.
- Accuracy.....±5% over entire scale from 50 to 15,000 cps

Modulation Peak Indicator (peak flash range).....50% to 120% modulation (25 kc = 100%,

Visual Frequency Monitor.....Same as Aural Frequency Monitor above

Inter-Carrier Spacing.....Directly measured, accuracy ±500 cps for six months

Audio Output:
- Frequency Range....500 to 15,000 cps. Response flat within ±.5 db. Equipped with standard 75 microsecond de-emphasis circuit.
- High Impedance Output.....10 volts into 100,000 ohms at 100% modulation at low frequencies. Distortion less than 0.25% at 100% modulation. Residual noise at least 65 db below output level corresponding to 100% modulation at low frequencies.
- Monitoring Output.....1 milliwatt into 600 ohms, balanced, at 100% modulation at low frequencies

General:
- Frequency Range.....Channels 2 to 83 inclusive, including offset channels
- R-F Power Required.....Less than 1 watt. Separate type N connectors provided for aural and visual inputs
- Ambient Operating Temperature.....113° F. maximum
- External Meter Indication.....External meter indication available for aural carrier deviation, visual carrier deviation, aural modulation percentage and peak indication. Use of external meters does not affect operation of panel meters.

LIMITING AMPLIFIER

Source Impedance.....600/150 ohms

Input Impedance.....600/150 ohms, balanced or unbalanced

Frequency Response.....30 to 15,000 cps reference below verge of limiting up to 20 db gain reduction +1 db to —2 db

Input Level:
- Minimum.....—24 dbm at limiting verge
- Maximum.....±14 dbm

Output Level:
- Maximum (limiting off) at 1000 cps.....38.5 dbm
- At verge of limiting with output controls in minimum attenuation position.....29.5 dbm ±1 db

Gain.....54 db +1 db at 1000 cps, 600-ohm source to 600-ohm load

Signal to Noise Ratio.....83 db at verge of limiting

Gain Controls:
- Input.....20 steps, 2 db per step
- Output.....20 steps, 1 db per step and fine adjustment

Harmonic Distortion (total RMS).....12 db gain reduction (100-15,000 cycles) less than 1%

MONITORING AMPLIFIER

Source Impedance.....37.5/150/600 ohms

Input Impedance.....Unloaded transformer, high in comparison with source impedance

Load Impedance.....4/8/16/150/600 ohms

Output Impedance (approx.).....1.3/1.8/3/21/78 ohms

Maximum Input Level.....—30 dbm

Maximum Gain.....104 db ±2 db

Frequency Response.....±2 db 30-15,000 cps

Maximum Output Level.....10 watts (40 dbm)

Harmonic Distartion.....Less than 1% 100-7,500 cps
At 8 W (39 dbm output).....Less than 2% 50-15,000 cps

Noise Level.....—122 dbm referred to input (—18 dbm at output at 104 db gain)

VISUAL SIDEBAND DEMODULATOR

Frequency Range:
- BW-4B.....Channels 2-13
- BWU-4B.....Channels 14-83

Output Impedance.....75 ohms, unbalanced

Input Impedance.....50 ohms, unbalanced

Polarity of Sync Pulses.....Negative

Output Voltage.....2.0 volts, peak-to-peak (max.)

SPECIFICATIONS (Cont'd)

BW-5B/BWU-5B SIDEBAND RESPONSE ANALYZER

Frequency Range: 10-0-10 mc cont. variable by panel control
Output: 0-2 volt (peak-to-peak) cont. variable by panel control
Output Impedance: 72 ohms
Rep. Rate: 120 cycles (for 60 cycle power supply)
Hum Level: —50 db below 2.0 volt (peak-to-peak)
Sweep Frequency Response: ±0.5 db 0.2 to 4.0 mc
±1.0 db 0.2 to 7.0 mc
Marker Accuracy: 200 kc throughout range
Marker Width: 50 kc approximately
Marker Amplitude: Chassis control (min. 5% of demodulated response)
Ambient Temperature Range: ±5°C. to +45°C.

BWU-5B R-F INPUT UNIT

Input and Output Impedances: 50 ohms
Frequency Range: Channels 14 to 60 ±1 db within 10 mc of center frequency
Response: ±½ db within 5 mc of center frequency
Linearity: Within ±1 db for input signals to the attenuator ranging from 0.1 to 3.0 volts rms
Output: 0.3 volt rms across 50 ohm load with 2.0 volt rms input to attenuator (Channel 7)
Overall Bandwidth: 20 megacycles

STABILIZING AMPLIFIER

Input Impedance:		
Picture	75 ohms (±1%)	1 meg, 35 mmf
Sync	Bridging	1 meg, 35 mmf
Blanking	Bridging	1 meg, 35 mmf

Output Impedance:	(Source)	(Load)
Line Picture	75 ohms	75 ohms
Monitor Picture	75 ohms	75 ohms
Sync	2100 ohms	75 ohms

Input Signal Requirements:
Composite Video (Black Negative): 0.25 v. min.; 2.0 v. max.
Sync-to-Picture Ratio (min.): 15% of input picture signal
Local Sync: 3.5—5.0 volts, negative
Local Blanking: 3.5—5.0 volts, negative

Output Signal Range:
Picture Component: 0-1.0 volt, peak-to-peak
Sync Component (output video signal): 0—.8 volt, peak-to-peak
Sync Output: .4 volts, peak-to-peak
Frequency Response: Flat ±0.5 db to 7.0 mc
Tilt (60 cycle square wave): 2% max.
Differential Gain: 0.25 db
Differential Phase: Less than 1°
Isolation Between Outputs: Better than 40 db @ 3.58 mc

Power Rquirements:
Heater Supply: 117 volts, 50/60 cycles, 120 watts
Plate Supply: 280 volts, regulated 400 ma with white stretch
280 volts, regulated 375 mc without white stretch

VIDEO DISTRIBUTION AMPLIFIER

Input Impedance: 2.7 megohms shunted by 27mmf
Input Signal Levels:
Blanked Video Only: 1.5 volts peak-to-peak, max.
Composite Video: 2.0 volts peak-to-peak, max.
Sync: 3.5 to 8.0 volts peak-to-peak
Gain: 0.5 to 2.0 adjustable
Number of Outputs: 3
Output Impedance: 75 ohms, internally terminated
Output Signal Levels:
Blanked Video Only: 1.5 volts peak-to-peak, max.
Composite Video: 2.0 volts peak-to-peak, max.
Sync: Zero to 0.4 volt peak-to-peak
Sine-Wave Frequency Response:
1.0 Cycle to 8 mc: Flat ±0.3 db
0.5 Cycle to 10 mc: Flat ±1.0 db
Low-Frequency Square-Wave Tilt: 1.5% max. at 60 cycles

PHASE EQUALIZER EQUIPMENT

Type of Circuit: Non-minimum phase reactance network (no tubes or power supply required)
Impedance (input and output): 75 ohms
Circuit Attenuation: 0.5 db
Sweep Frequency Response: ±0.5 db to 4.2 mc
Phase Response:
Low Frequency Phase Equalizer: Constant envelope delay from 2.0 mc to 4.2 mc. Four envelope delay ranges; frequency range of envelope delay adjustment 0 to 2.0 mc.
High Frequency Phase Equalizer:
Receiver Equalizer: Follows FCC specified curve
Notch Equalizer: Zero delay from 0 to 3 mc; choice of 2 curves above 3 mc
Variable Equalizer: Zero delay from 0 to 2 mc; choice of 10 curves above 2 mc

Electrical Specifications

Overall Power Requirements: 105-125/210-250 volts, 50/60 cycles, 2 kw (includes power requirements for the transmitter control console).

Unit Power Requirements:
Frequency and Modulation Monitor: 105 to 130 volts, 50/60 cycles, 265 watts
Limiting Amplifier: 105, 115, 125 volts, transformer taps provided for, 50/60 cycles, 125 watts
Monitoring Amplifier: 105-125 volts, 50/60 cycles, 70 watts
Visual Sideband Demodulator: 105-125 volts, 50/60 cycles, 250 watts
Sideband Response Analyzer: 105-125 volts, 50/60 cycles, 200 watts (with internal power supply 260 volts d-c regulated)
Stabilizing Amplifier: A-c 110-125 volts, 50/60 cycles, 120 watts
D-c 280 volts, 400 ma
WP-15-B Power Supply: 105-129 volts, 50/60 cycles, 850 watts
Video Distribution Amplifier: 105-125 volts, 50/60 cycles, 55 watts

Tube Complement

1184-A-A TV Transmitter Monitor
13—6AU6, 3—6AL6, 4—6BE6, 4—6CL6, 3—6J6, 2—6U8, 6—12AT7, 2—12AX7, 2—12BH7, 2—5651, 6—5727, 2—9005 (UHF only)

BA-6A Limiting Amplifier
2—6SK7, 2—6J7, 2—6V6-GT, 1—6H6, 1—OD3, 1—5R4GY

BA-24A Monitoring Amplifiers
1—12AX7, 2—6V6-GT/G, 1—MI-11299 (Selected 12AY7), 1—5Y3-GT/G

Rack #2:
BW-4B/BWU-4B Visual Demodulator
2—6C4, 4—6CB6, 1—6J6, 1—6AG7, 1—6AK6, 1—5V4, 1—6AS6/6CB6, 1—6AS7, 1—OC3, 1—6BC6/6BQ7 (Ch 7-84 only)

BW-5B VHF Sideband Response Analyzer*
2—6J6, 3—12AU7, 1—6SQ6, 2—6BA6, 3—6AS6, 2—6AH6, 1—6AK6, 1—5R4G, 1—6C4, 1—6AS7G, 1—6SJ7, 1—OD3

TA-9 Stabilizing Amplifier
8—6CL6, 3—6AH6, 3—6AL5, 3—6AU6, 1—12B4, 2—12AT7, 1—12AU7, 1—12AX7, 1—6AS6

(2) WP-33B Regulated Power Supplies
8—5R4GY, 2—6SL7-GT, 6—6AS7-G, 4—OD3, 2—NE-32

(2) TA-3B Video Distribution Amplifiers
2—6BQ7-A, 4—6BX7, 2—5687, 4—OB2, 2—6X4, 4—6U8

WP-15-B Regulated Power Supply
3—6336, 1—12AX7, 1—12AT7, 1—5651

(* The BWU-5B utilizes all the tubes listed above under the BW-5B VHF Sideband Response Analyzer as well as those tubes specified here: 1—6AF4, 1—6J4, 1—6X4, 1—OA2, and 1—6J6.)

SPECIFICATIONS (Cont'd)

Mechanical Specifications

Unit	Overall Dimensions Height	Width	Depth	Weight
BA-6A Limiting Amplifier	7⅝"	16 3/16"	14"	37 lbs.
BA-24A Monitoring Amplifier	42 1/32"	8⅜"	10⅜"	16¼ lbs.
BWU-4B Visual Demodulator	14"	19"	9"	35 lbs.
BW-4B Visual Demodulator	14½"	19"	10½"	58 lbs.
BW-5B VHF Sideband Response Analyzer	10½"	19"	14½"	58 lbs.
BWU-5B UHF Sideband Response Analyzer R-F Input Unit	5¼"	19"	7¾"	11 lbs.
TA-9 Stabilizing Amplifier	12¼"	19"	5"	20 lbs.
TA-3B Video Distribution Ampli.	3½"	19"	10⅜"	12½ lbs.
High Frequency Equalizer	17½"	19"	10"	23 lbs.
Low Frequency Equalizer	5¼"	19"	10"	9 lbs.
WP-15-B Rectifier	7"	19"	11"	59 lbs.
WP-15-B Regulator	3½"	19"	10⅜"	12 lbs.
BR-84 Standard Cabinet Racks	84"	22"	18"	225 lbs.
Overall Equipment (Tandem Cabinets)	84"	50"	18"	525 lbs. (approx.)

Equipment Supplied

INPUT AND MONITORING EQUIPMENT

For VHF Transmitters ES-19237-G (wired)	ES-19237-E (unwired)		For UHF Transmitters MI-19237-H (wired)	MI-19237-F (unwired)
1	—	MI-30951-B84 Monitoring Equipment Rack #1, wired	1	—
—	1	MI-30951-B84 Monitoring Equipment Rack #1	—	1
1	—	MI-30951-D84 Monitoring Equipment Rack #2, wired	1	—
—	1	MI-30951-D84 Monitoring Equipment Rack #2	—	1
2	2	MI-30546-G28 Electrical Shield	2	2
1	1	MI-30546-G21 Electrical Shield	1	1
2	2	MI-30566-G84 Single Trim Strips	2	2
1	1	MI-30568-G84 Double Trim Strip	1	1
1	1	MI-4593-B Blank Panel 7"	1	1
1	1	MI-4590-B Blank Panel, 1¾"	1	1
1	1	MI-4592-B Blank Panel, 5¼" high	—	—
1	1	MI-11225 Type BA-6A Limiting Amplifier, including panel, but less shelf and tubes	1	1
1	1	MI-11289 Tube Kit for BA-6A	1	1
1	1	MI-11599 Type BR-2A Shelf for BA-6A	1	1
1	1	MI-11247 Type BA-24A Monitoring Amplifier (less tubes)	1	1
1	1	MI-11481 Tube Kit for BA-24A Amplifier	1	1
1	1	MI-11597 Type BR-22A Shelf for BA-24A Amplifier	1	1
1	1	MI-40222 Type TA-9 Stabilizing Amplifier (with one set of tubes)	1	1

Equipment Supplied (Cont'd)

INPUT AND MONITORING EQUIPMENT

For VHF Transmitters ES-19237-G (wired)	ES-19237-E (unwired)		For UHF Transmitters MI-19237-H (wired)	MI-19237-F (unwired)
1	1	MI-26087-B WP-15-B Power Supply Rectifier	1	1
1	1	MI-26088-B WP-15-B Power Supply Regulator (with one set of tubes)	1	1
2	2	MI-26219 Video Jack Panel	2	2
1	1	ES-34048 Type BW-4B Visual Demodulator with 1 set tubes		
—	—	ES-34049-B Type BWU-4B Visual Demodulator with 1 set tubes	1	1
1†	1†	General Radio Type 1184-A-A TV Station Monitoring Equipment, complete with 1 set of tubes	1†	1†
1	1	ES-34010-B Type BW-5B Sideband Response Analyzer	—	—
—	—	ES-34009-B Type BWU-5B Sideband Response Analyzer	1	1
3	3	MI-4652-2B Audio Patch Cords	3	3
6	6	MI-26771 Video Patch Cords	6	6
23	23	MI-26784 Video Dual Connector Plugs	23	23
2	2	MI-30526-G84 Pair of Panel Mounting Angles	2	2
3	3	MI-4570-A Terminal Board Brackets	3	3
1	1	MI-4569 Audio Terminal Blocks	1	1
6	6	MI-4568 Power Terminal Blocks	6	6
1	1	MI-11645-A Type BJ-24 Double Jack Panels	1	1
1	1	MI-11647-2 Jack Mat for BJ-24	1	1
2	2	MI-30590-2 Interlock Switch	2	2
1	1	MI-27407 Program Line Selector	1	1
1	1	MI-26240 Circuit Breaker Chassis	1	1
2	2	MI-26764-1 Circuit Breaker	2	2
1	1	MI-26764-2 Circuit Breaker	1	1
1	1	ES-34034-B High and Low Frequency Phase Correction Network	1	1
2	2	MI-26157-B Type TA-3B Distribution Amplifier (with one set of tubes)	2	2
*	*	MI-4594-B Blank Panel 8¼" high (* Note: Supply one only if Hewlett-Packard Monitor is specified)	*	*
1	1	MI-27862 Mounting Hardware	1	1
1	1	Set Installation Drawings and Instruction Book IB-30252	1	1

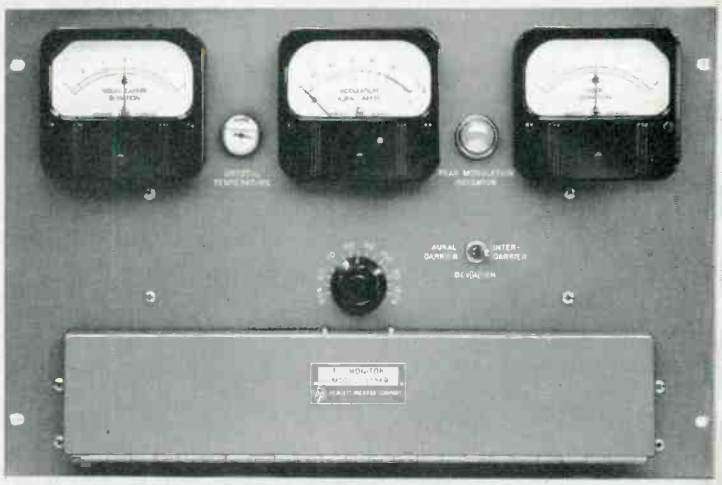
† The Hewlett-Packard Type 335-ER Station Monitoring Equipment for rack mounting may be specified instead of General Radio equipment.

Frequency and Modulation Monitor

MODEL 335-ER

FEATURES

- Provides accurate check that TV transmitter is operating within FCC specifications
- Operates reliably over long periods of time
- Covers all TV channels
- Compact size, requires minimum rack space
- External meters may be remotely located
- Simplified operation, all adjustments made from front panel of the monitor
- Forced air cooling system



DESCRIPTION

The Model 335-ER Hewlett Packard Frequency Monitor and Modulation Meter monitors the carrier frequencies of both the aural and visual TV transmitters, and measures the degree of aural modulation. Through the use of the pulse counter-type frequency meter circuit, it provides reliable, accurate operation over long periods of time and requires no adjustment during use. Because of the unit's compact size, a minimum amount of relay rack space is required for its installation.

Three panel meters on the equipment monitor the frequencies of the visual and aural carriers and the percent modulation on the aural carrier with 100 percent modulation equal to 25 kc deviation. All indications are presented simultaneously. The monitor can be used with any one of the TV channels for either color or monochrome applications. The circuit arrangement also accommodates stations that may have off-set carriers. Full provision is made for the use of a remote peak modulation lamp as well as remote indicating meters. All operating adjustments can be made on the front panel of the monitor.

In addition to its primary function of indicating the percentage modulation of the aural carrier and monitoring the frequencies of both carriers, the 355-ER is also arranged so that it provides the necessary output voltages for measuring the FM and AM noise levels and for determining the frequency response and distortion characteristics of the aural transmitter.

The Model 335-ER Frequency Monitor and Modulation Meter features a master oscillator, controlled by a crystal operating in the 20-30 megacycle region. The crystal is mounted in a carefully-designed oven that controls temperature to within approximately 0.10 degree C. Oven temperature is indicated by a thermometer readable at the front panel. The master oscillator is provided with a vernier knob adjustment for correcting long time drift.

Highest quality components are used throughout. All filter capacitors are oil-filled. A forced air cooling system assures low operating temperature for long-life and stable performance.

A cathode-coupled type oscillator circuit has been selected because of the exceptionally small effect varying stray capacities have on the frequency of the crystal used in this arrangement. As a further precaution, a constant-voltage type transformer is provided to regulate the master-oscillator filaments.

The master oscillator drives a tuned multiplier which feeds into the separate multipliers for the visual and aural channels of the monitor. In the visual channel the output of the first multiplier is multiplied until it is 4.35 mc above the assigned visual carrier frequency of the station. The output of the visual mixer is then a frequency of 4.35 mc when the visual carrier is exactly at its assigned frequency. The 4.35 mc output of the first visual mixer is then mixed

with the output of a 4.3535-megacycle crystal controlled oscillator to obtain a difference frequency of 3.5 kc.

The output of the second visual channel mixer is passed through a filter that removes the 15,750 cps line frequency component in order to avoid the possibility of interaction of this frequency with the visual deviation meter circuit. The output waveform from the filter is squared and applied to the pulse counter circuit which operates the visual carrier deviation meter. This meter is calibrated in deviation from —3 to +3 kc.

The aural channel of the monitor is similar to but necessarily more elaborate than the visual channel. The master crystal oscillator frequency is so selected that when multiplied by the first multiplier and by the aural multiplier a frequency 150 kc below the assigned aural carrier frequency is supplied to the aural mixer. The output of the aural mixer is then a frequency of 150 kc when the aural carrier is exactly at its assigned frequency.

The difference frequency voltage is squared and applied to the pulse-counter type discriminator. This counter is similar to the counter in the visual channel except that it contains circuitry that acts as a discriminator for the FM modulation on the aural carrier. The discriminator is highly linear as indicated by the fact that the distortion in the entire monitor from all sources is less than 0.25 percent at 100 percent modulation at frequencies below the knee of the standard 75 microsecond de-emphasis curve.

The discriminator operates the aural carrier deviation meter which is calibrated from —3 to +3 kc. The wider deviation range of this meter when compared with the video carrier deviation meter allows for the greater FCC tolerance on aural channel frequency than on visual channel frequency. The audio voltage obtained from the discriminator is amplified and applied to the percent modulation meter circuit and to the peak-modulation lamp circuit. The point at which the peak-modulation lamp flashes is adjustable from 50 to 120 percent modulation.

The percent modulation meter is operated from a peak-reading type voltmeter circuit whose time constant is adjusted so that the ballistic characteristics of the meter are in conformance with those of a standard VU meter. A panel switch is provided so that either positive or negative modulation swings can be measured. Two separate audio outputs are provided by the output audio amplifier. One is a high-level output which provides approximately 10 volts at low audio frequencies at 100 percent modulation. This output is primarily intended for use in making measurements of distortion and frequency response characteristics of the aural modulation. The output is provided from a high-quality system which has a response flat within 0.5 db from 50 to 15,000 cps. Distortion in the system is less than 0.25 percent at full output and noise is at least 65 db below full output. The second audio output is provided from a balanced underground source. At low frequencies a maximum of 1 milliwatt is delivered to a 600-ohm load. This output is useful for aural monitoring of the program. A 150 kc local oscillator is provided in the aural carrier channel to make possible an occasional check of the accuracy of the pulse-counting discriminator.

The 335-ER is housed in a small unit, designed for standard rack mounting. It may be provided in a number of finishes to match the station's transmitter color scheme. It operates from a regular power line. External meters are available as accessories. When ordering, power line requirements, visual and aural frequencies and offset carrier operation, if any, must be specified.

SPECIFICATIONS

Frequency Range.....41.25 mc to 940 mc, including off-set channels*
R-F Power Required.....Less than 1 watt
Ambient Operating Temperature (max.).....45° C
Aural and Visual Frequency Monitor:
- Deviation Range.....+3 kc to —3 kc mean frequency deviation
- Accuracy.....Channels 2-6 is ±500 cps for 90 days
  Channels 7-13 is ±500 cps for 45 days
  Channels 14-83 is ±500 cps for 14 days

Aural Modulation Meter:
- Modulation Range.....Meter reads full scale on modulation swing of 33.3 kc. Scale calibrated to 100% at 25 kc swing; 133% at 33.3 kc swing also includes db scale (0 db = 100%)
- Accuracy.....Within 5% of indicated modulation percentage over entire scale
- Meter Characteristics.....Meter damped in accordance FCC requirements. Reads peak value of modulaton peak of duration between 40 and 90 milliseconds. Meter returns from full reading to 10% of full value within 500 to 800 milliseconds.
- Frequency Response.....Flat within ±0.5 db from 50 to 15,000 cps

Modulation Peak Indicator:
- Peak Flash Range....From 50% to 120% modulation (25 kc = 100%)

Audio Output:
- Frequency Range.....50 to 15,000 cps. Response flat with ±0.5 db Equipped with standard 75 microsecond de-emphasis circuit.
- High Impedance Output.....10 volts into 100,000 ohms at 100% modulation at low frequencies. Distortion less than 0.25% at 100% modulation. Residual noise at least 65 db below output level corresponding to 100% modulation at low frequencies.
- Monitoring Output.....1 milliwatt into 600 ohms, balanced, at 100% modulation, at low frequencies.
- Inter-carrier Spacing Accuracy....±5 cps for 6 months on all channels

Power Line Requirements.....115 volts 60 cycles, single phase, 180 watts
230 volts, 50 cycles, single phase, 180 watts

Tube Complement:
10—12AT7, 1—6U8, 3—6AH6, 1—OB2, 4—5687, 1—2D21, 1—6SJ7, 1—6AS7

Dimensions.....19" wide, 12½" high, 13" deep (48.26 cm wide, 30.5 cm high, 33 cm deep)
Weight.....67 lbs. (30.4 kg.)
Finish.....Umber gray, or special color as designated

Ordering Information

Hewlett Packard Frequency and Modulation Monitor, complete with tubes in place, power cord, 2 coaxial connectors for r-f inputs, and instruction book.
- Monitor for 115 Volts, 60 cycles.....Model 335-ER
- Monitor for 115 Volts, 50 cycles.....Model HO2-335-ER
- Monitor for 230 Volts, 50 cycles.....Model HO3-335-ER

* Specify visual and aural frequencies when ordering and offset carrier operation, if any.

TV Sideband Response Analyzers

VHF TYPE BW-5B, and UHF TYPE BWU-5B

FEATURES

- Accurately measures overall transmitter frequency response without necessity for internal connections and with transmitter at normal power output
- Separates and visually presents upper and lower sideband response
- Provides immediate evaluation of transmitter tuning adjustments and their effect upon sidebands under normal operating conditions
- New high quality video sweep oscillator
- Includes blanking which provides base line for measuring relative amplitudes
- Marker with a dial calibrated in ¼ mc intervals for frequencies above and below carrier frequency

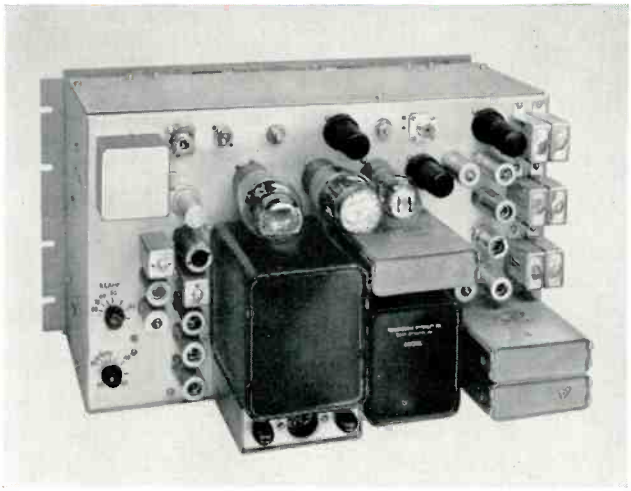
DESCRIPTION

The sideband response analyzer is a device for measuring the overall "amplitude versus frequency" characteristic of a VHF television transmitter. In conjunction with an oscilloscope it separates and visually presents the upper and lower sideband response. Its primary use is for tuning the over-coupled broadband r-f circuits of television transmitters and measuring their amplitude response characteristic. Since it includes a video sweep oscillator, it can also be used in adjusting video amplifiers, modulators, etc.

The Type BW-5B analyzer is required for a VHF TV station and Type BWU-5B analyzer for a UHF station.

The BW-5B and BWU-5B Sideband Response Analyzers provide for the display, on a suitable oscilloscope, of the entire sideband frequency response capabilities of any TV transmitter including its sideband filter. Such visual presentation permits immediate evaluation of transmitter adjustment without laborious point-to-point curve plotting, and facilitates the adjustments by indicating the effectiveness of the adjustments as they are made.

The BW-5B analyzer consists of video sweep generating circuits to provide transmitter modulation; calibrated marker circuits to develop a continuously variable frequency marker; synchronized receiver circuits to develop



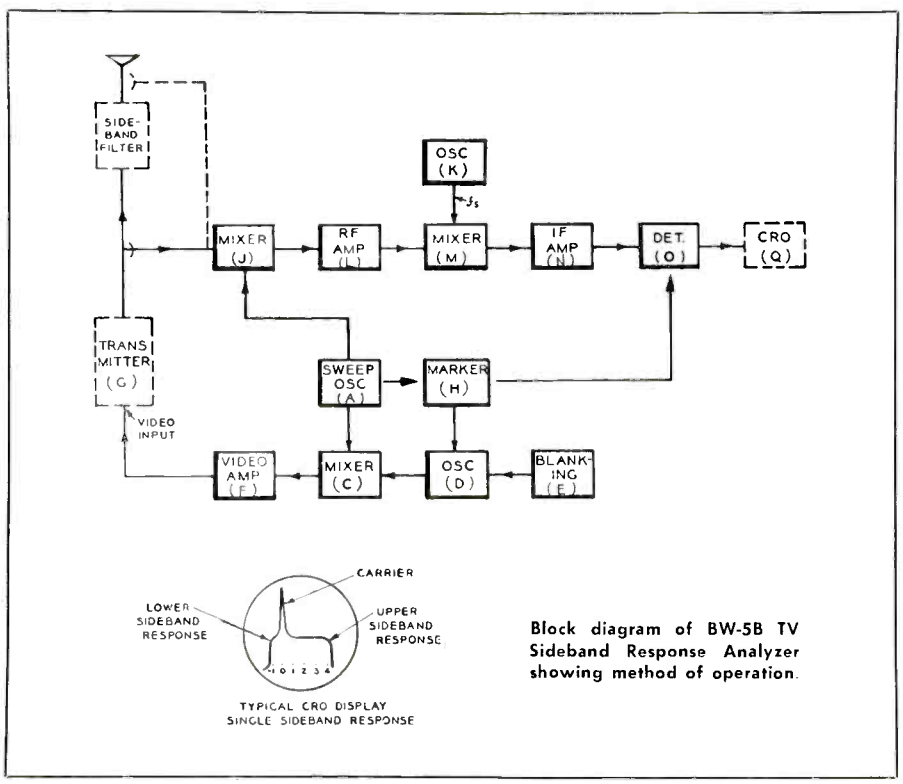
Top-of-chassis view of the Sideband Response Analyzer, BW-5B.

vertical deflection for the oscilloscope and to insure a narrow passband for a high definition sideband response presentation; sweep generating circuits, which include retrace, blanking, and phasing facilities, to develop horizontal deflection for the oscilloscope; and power supply circuits all assembled on a recessed box chassis suitable for assembly in a relay rack. Operating controls for the unit are all mounted on the front panel which is held in position by two captive knurled screws at the top edge.

The panel can be swung down to give access to the interior for ease of maintenance. A three-contact connector on the panel provides connection to an oscilloscope. Other connections to the unit are made at the rear of the chassis. The necessary output cables, power cord, and connectors are all supplied with the equipment.

The BWU-5B includes all the equipment furnished by the BW-5B and in addition has an r-f input section, MI-34005-B, built on a 5¼-inch panel and chassis designed to mount in a standard 19-inch rack. The r-f unit with tubes in place, power cord, and output cable, are required to modify the BW-5B for operation on UHF television channel. Except for the frequency ranges covered, the BW-5B and the BWU-5B equipments function similarly.

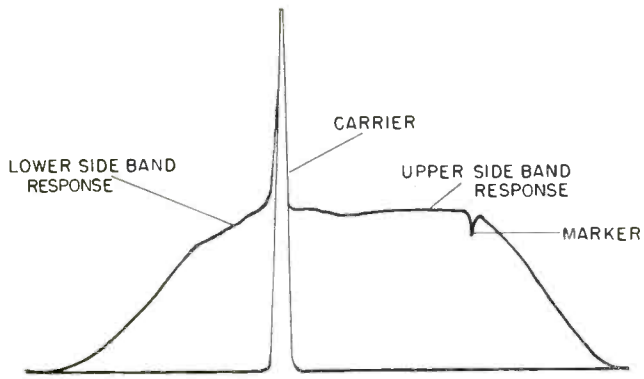
Basically the analyzer, both BW-5B and BWU-5B, provides modulation for the transmitter by mixing the output of a 130-mc fixed oscillator with the output of a sweep oscillator, which varies in frequency above and below 130 mc to the amount required (see block diagram). The mixer provides a video signal swept at twice power line frequency which is amplified and applied as modulation to the transmitter. The output voltage of this circuit is indicated on a push-to-read meter.



Block diagram of BW-5B TV Sideband Response Analyzer showing method of operation.

The transmitter modulated output is sampled and mixed with the sweep oscillator output. Among the many sum and difference frequencies that occur in the output of the R-F Mixer, a constant frequency component will exist due to the combination of the instantaneous sweep frequency with one of the transmitter sideband frequencies. This component is selected by the fixed-tuned receiver and the output of the receiver is fed to an oscilloscope, the sweep of which is properly phased to agree with the sweep frequency variations. The resultant pattern displays the transmitter sideband response over the range of modulation frequencies employed.

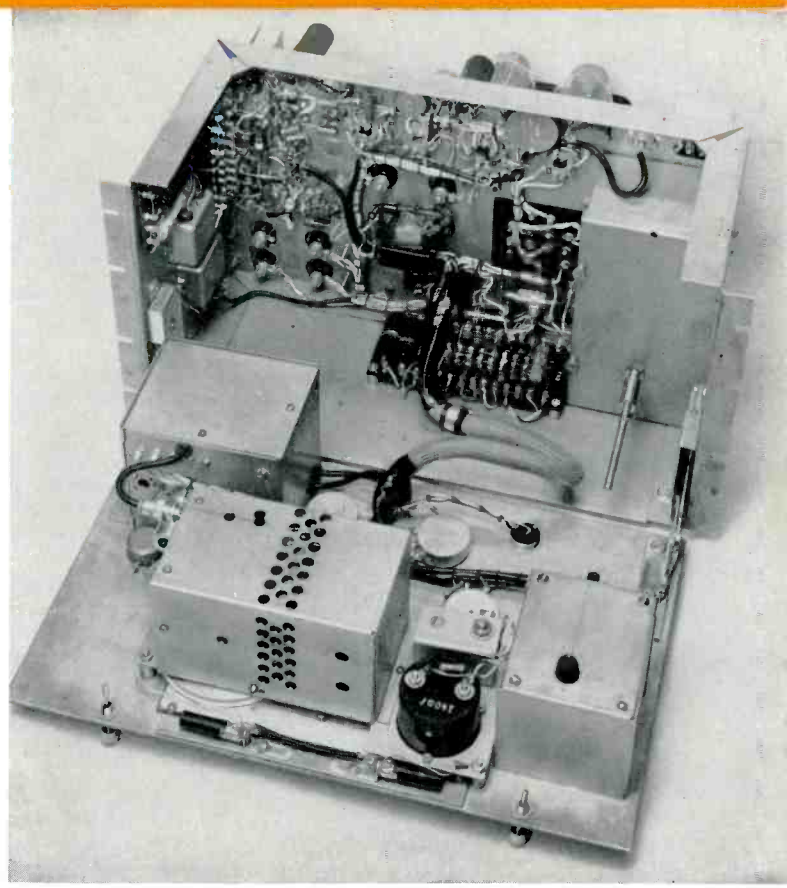
Circuits are included that develop a marker pulse which can be adjusted to indicate the frequency at any point on the pattern by means of a calibrated dial and knob. Blanking is provided to eliminate pattern retrace but can be cut off by means of a panel mounted switch. Power supply circuits in the chassis provide heater and regulated plate voltages for the equipment.



Typical response pattern of a TV transmitter using BW-5B Sideband Analyzer, illustrating the wave shape of lower and upper sidebands.

To provide maximum utility, a portable type oscilloscope is recommended for use with the analyzer. A 35-foot cable is supplied which allows the indicator to be readily moved to any vantage point within the limit of cable length. Other additional equipment necessary to make a complete installation, but not supplied except by separate order include, RG-11U coaxial cable, MI-83, and RG-8/U coaxial cable, MI-74 as required. In some installations a directional coupler and section of 3⅛-inch, 51.5-ohm or 3⅛-inch 50-ohm coaxial transmission line housing for the directional coupler should be provided.

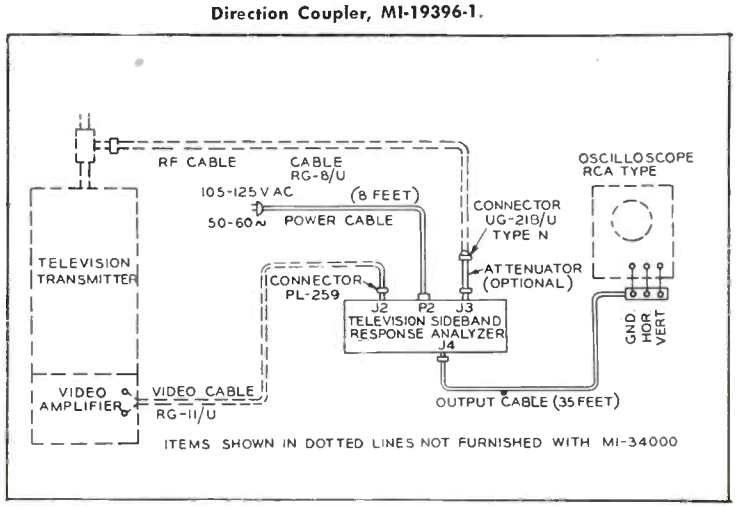
Operation on the UHF channels is made possible through the use of a wide-band frequency converter which changes



BW-5B with door open and cover removed.

the sampled output frequency of a UHF television transmitter to a channel 2 frequency, within the normal range of the BW-5B analyzer. The r-f input section which functions as a conventional superheterodyne converter has a power switch, indicator lamp, and fuses mounted on the power supply chassis. All the tuning controls are located on the top of the converter chassis.

Direction Coupler, MI-19396-1.



SPECIFICATIONS

Electrical Specifications (BW-5B)

R-F Input
- Frequency: 55.25-83.25 mc (channels 2 to 6); 175.25-211.25 mc (channels 7 to 13)
- Voltage: .5 to 1.0V
- Impedance: 50/51.5 ohms

Outputs
- Receiver Signal
  - Output Termination: high impedance oscilloscope input
  - Linearity: error referred to 14V carrier pip

Indicated	*Actual Response*
—25 db	—24 db
—30 db	—28 db
—35 db	—33 db

  - Noise Level: greater than 50 db below 14V
  - Receiver Gain Control Range: 10 db
- Video Sweep
  - Voltage: 0 to 2V peak-to-peak
  - Frequency: 10-0-10 mc sweep width continuously adjustable
  - Center Frequency: adjustable ±2 mc
  - Sweep Rate: Power line frequency
  - Repetition Rate: 2 times power line frequency
  - Frequency Response: ±.5 db 70 KC to 5 mc; ±1.0 db 50 KC to 7 mc
  - Distortion: less than 3% at 2V pp
- Oscilloscope Sweep
  - Open circuit voltage: 4.5V pp
  - Frequency: same as power line
  - Wave Form: same as power line
  - Internal Impedance: 12,000 ohms
  - Phase Adjustment: ±70°

Operating Conditions: 5°C to 45°C ambient temperature; 0-95% relative humidity

Supply Voltage: 105-125 volts a-c

Supply Frequency: 50-60 cycles

Power Consumption: 200 watts

Power Receptacle: 1" male motor-plug (power cord supplied)

Power Supply: Internal (260 volts d-c regulated)

Tube Complement for BW-5B

2—6J6	3—6AS6	1—6C4
2—12AU7	2—6485	1—6AS7-G
1—6SQ7	1—6AG7	1—6SJ7
1—6BA6	1—5R4-GY	1—OD3/VR150
	2—6AU6	1—12AT7

Additional Specifications for BWU-5B

R-F INPUT UNIT, MI-34005-B

Input and Output Impedances: 50 ohms

Frequency Range: 450 to 750 mc (channels 14 to 60)

Overall Bandwidth: 20 megacycles

Response: ±1 db within 10 mc of center frequency; ±½ db within 5 mc of center frequency

Linearity: Within ±1 db for input signals to the attenuator ranging from 0.1 to 3.0 volts (Normal converter input is 1 volt with input of 2.0 volts to the attenuator).

Output: 0.3 volt across 50 ohm load with 2.0 volt rms input to attenuator (channel 2)

Power Supply: 105-125 volts, 50/60 cycles, single phase, 35 watts

Tube Complement for BWU-5B

1—6J6	1—5Z4
1—6BQ7	1—OA2
1—6485	1—OB2
1—1N82A	

Mechanical Specifications

Mounting—Relay Rack: 10½" high x 19" wide x 14½" deep (26.7 cm high x 48.26 cm wide x 36.8 cm deep)

Color: Dark umber gray (smooth)

Weight: 58 lbs. (26.3 kg.)

UHF Converter
- Dimensions: 19" wide, 5¼" high, 7¾" deep (48.26 cm wide, 13.3 cm high, 19.7 cm deep)
- Weight: 14 lbs. (6.4 kg.)

Equipment Supplied

BW-5B VHF TV Sideband Response Analyzer Equipment: ES-34010-B
Including:
- 1 MI-34000-B Analyzer (tubes in place)
- 1 MI-27390 Directional Coupler
- 1 MI-34011 Type "N" Connector
- 1 Instruction Book, IB-36140-1

BWU-5B UHF TV Sideband Response Analyzer Equipment: ES-34009-B
- 1 MI-34000-B Type BW-5B Sideband Response Analyzer
- 1 MI-34005-B R-F Input Section of the BWU-5B
- 1 MI-27379 Directional Coupler
- 1 MI-34065-* Channel Frequency Crystal (* Sales order to specify frequency required)
- 2 Instruction Books, IB-30271

Optional or Accessory Equipment

Set of Spare Tubes (BW-5B): MI-34012-B

Set of Spare Tubes (BWU-5B): MI-34012-B/34067

BW-5B Coupling Unit: MI-19057-A

Transmission Line Section for Mounting BW-5B Directional Coupler (Specify one):
- 3⅛" 51.5-ohm Flanged Transmission Line: MI-19313-48
- 3⅛" 51.5-ohm Unflanged Transmission Line: MI-19313-49
- 3⅛" 50-ohm Transmission Line: MI-27912-12

RG-8/U Coaxial Cable: MI-74A

BWU-5B Directional Coupler for use with:
- MI-19089 Transmission Line: ES-34231-1, 2
- MI-27791 Transmission Line: ES-34231-1, 8
- MI-19387 Transmission Line: ES-34232-1, 2
- MI-27792 Transmission Line: ES-34232-1, 5

VoltOhmyst: WV-98C

Isolating Resistor for VoltOhmyst Probe: 270K ohm, ½ watt, non inductive with lead on test end not longer than ⅜-inch

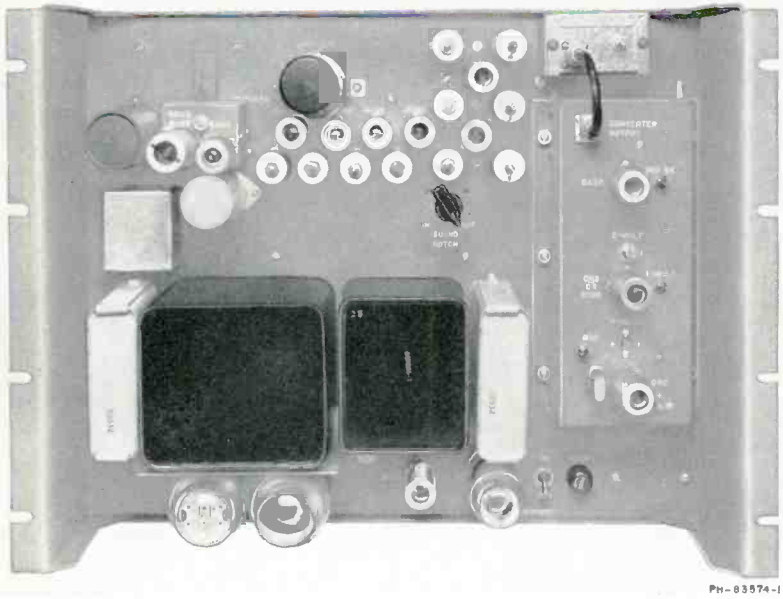
R-f Sweep Signal Generator for 175 mc (BWU-5B): WR-69B

UHF Signal Generator (for BWU-5B): WR-86A

Oscilloscope: TO-524-AD or WO-91A

Visual Sideband Demodulator

Type BW-4B/BWU-4B



PH-83574-1

FEATURES

- Monitor transmitter output any channel 2 to 60
- Directional coupler may be mounted anywhere in transmission line
- Complete sound rejection at any monitoring point
- Remote ON-OFF control of zero reference line
- Insensitive to r-f fields
- Affords appropriate demodulation for envelope delay measurements
- Transient response typical of ideal receiver

DESCRIPTION

The BW-4B/BWU-4B Visual Sideband Demodulator is designed for use with a station Master Monitor unit to permit a visual quality observation of either monochrome or color signals delivered to the antenna of a VHF or UHF television transmitter. The BW-4B equipment is used for Channels 2 to 13; the BWU-4B for UHF Channels 14 to 60.

The picture information supplied by the instrument is equivalent to that which would be obtained from an ideal television receiver located remotely from the station, but less propogation and receiving antenna defects. Picture monitoring is accomplished in the presence of sound modulation since the aural carrier is rejected.

The Demodulator is designed for two major uses. First, it provides the broadcaster with a kinescope and CRO presentation, limited by the presence of the aural carrier and hence by channel width, which will be typical of the best home receiver, and as such subject to the basic limitations of bandwidth and vestigial reception inherent in the standard TV system. This is the function of the Demodulator during programming time. Secondly, it provides a demodulator without the restrictions of bandwidth or phase, which will be useful to the broadcaster for measuring certain performance characteristics of the TV transmitter. This type of measurement is made during non-programming periods with aural carrier off.

In the first use, a 50 db trap rejects the sound carrier and as a result reduces the video response to normal bandwidth. Under these conditions, the BW-4B provides a typical composite kinescope and CRO picture, showing resolution, vertical wave form, horizontal waveform, per cent sync and depth of modulation. In the second usage, with the sound notch switched out so that the Demodulator is not limiting in phase or amplitude response at the high end, transmitter characteristics, such as amplitude response, transient response, and envelope delay may be observed. The transmitter may thus be adjusted to meet EIA and FCC standards.

The BW-4B/BWU-4B Demodulator is basically a superheterodyne TV receiver designed for vestigial reception and includes a crystal-controlled heterodyne oscillator, mixer, IF system, sound rejection circuits, a wing trap, a video detector, a video amplifier and a delay equalizer. The latter makes the low frequency envelope delay response flat, and tailors the high end so that the two sets of phase specifications with notch in and notch out may be met. Thus the unit is an ideal demodulator for color transmissions.

For VHF Channels, a "VHF" Converter is mounted in place on the chassis. For UHF Channels 14 to 60 a "UHF" Converter is substituted.

A directional coupler, MI-19396-1B or ES-34231, designed to mount in the transmission line, is included as a part of the Demodulator equipment. This coupler samples the transmitter output and supplies a controlled level of r-f

voltage to the converter input. This coupler may be inserted into the transmission line at any of several points between the vestigial sideband filter and the antenna. Normally, it is installed at a point following the VSBF or Filterplexer where the transmitter vestigial characteristics have been established. The video output of the Demodulator is dependent upon a proper setting of the pick-up level of the coupler, and should be adjusted to provide a peak of sync level of video of 2 volts across the normal BW-4B/BWU-4B output.

For measuring depth of picture modulation, a zero power reference line must be established on the CRO. This function is performed by a mechanical chopper working in the grid of the last IF stage. The action of the chopper is to reduce the second detector input to zero at a 60 cycle repetition rate on approximately a 50/50 time basis. The circuit is arranged so that a remote switch, for instance in the transmitter console, may be utilized to control the operation of the chopper. An optional 6 db pad is available in the output circuit to reduce the output from 2 volts to 1 volt peak of sync.

The demodulator is phase compensated for "notch in" conditions, and for "notch out" conditions. For both these conditions the low frequency envelope delay curve is equalized to flatness. For "notch in" conditions, the high frequency envelope delay has a rising characteristic and is tailored to be that of the accepted "average" NTSC TV receiver, i.e., complementary to the FCC standard transmitter curve. For "notch out" conditions the high frequency delay curve is substantially flat.

SPECIFICATIONS

Electrical Specifications

Frequency Range:
- BW-4B ..... Channels 2 to 13
- BWU-4B ..... Channels 14 to 60

Input Required ..... 1—2 volts r-f

Video Output ..... Max. of 2 volts peak-to-peak across 75 ohms from chopper zero reference to sync peak (sync negative). Attenuation provided to reduce level to 1 volt peak-to-peak.

Amplitude vs. Frequency Response:
- With Sound Notch Out ..... +0.6, —1.0 db from 0.20 mc to 4.0 mc compared to 0.20 mc reference
- With Sound Notch In ..... +0.6, —1.5 db from 0.20 mc to 4.0 mc compared to 0.20 mc reference

Differential Gain ..... 10% between reference white, (12.5%) and peak of sync, (100%)

Phase vs. Amplitude ..... Six (6) degrees or less for modulating signals having luminance levels from 12.5% to 75% of sync peak

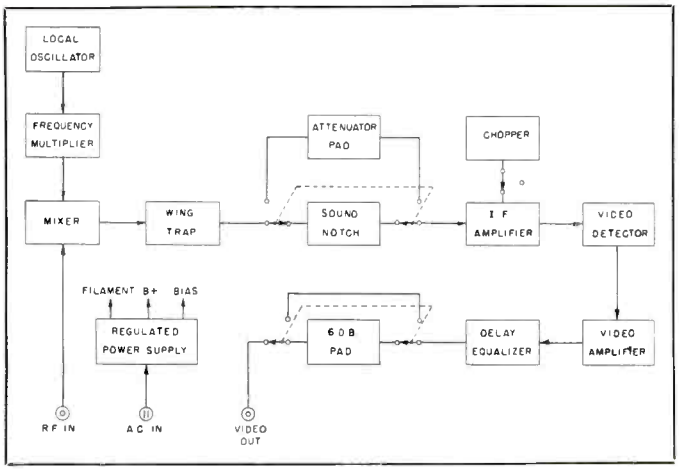
Low Frequency Response ..... Less than 2% tilt on 60 cps square wave

Envelope Delay:
- With Sound Notch Out ..... Flat within ±0.03 microsecond up to 4.18 mc compared to the average delay between 0.05 mc and 0.20 mc
- With Sound Notch In ..... Flat within ±0.03 microsecond of standard receiver curve up to 3.58 mc compared to the average delay between 0.05 mc and 0.20 mc. The tolerance increases linearly with respect to frequency to ±0.1 microsecond at 4.0 mc

Output Hum and Noise ..... 40 db below 2 volts peak-to-peak output

Sound Rejection ..... More than 50 db aural signal rejection at ±25 kc deviation from carrier frequency

Block diagram of BW-4B/BWU-4B Demodulator.



Power Source Required ..... 105 to 125 volts ac, 50/60 cycles, 250 watts (3 amp slo-blo fuse)

D-C Power Supply Voltages ..... 250 volts (regulated) —10 volts (unregulated), —3 volts (unregulated)

Tube Complement

I-F, Video and Power Supply Unit:

2—6C4	1—1N64
4—6CB6	1—6AS7
1—5R4-GY	1—OC3
1—6AK6	1—6197
1—6485	

VHF Converter Unit (BW-4B Only):

1—6J6	1—6AS6
1—6CB6 (Chan. 7-13)	

UHF Converter Unit (BWU-4B Only):

1—6J6	1—6485
1—6BQ7A	1—1N82A

Mechanical Specifications

I-F, Video and Power Supply Chassis:
- Height ..... 14" (35.56 cm)
- Width ..... 19" (48.26 cm)
- Depth ..... 14" (35.56 cm)
- Weight ..... 41 lbs. (23 kg.)

VHF or UHF R-F Converter (mounts on I-F, Video, and Power Supply Chassis):
- Length ..... 9½" (24.1 cm)
- Width ..... 4½" (11.4 cm)
- Depth ..... 4½" (11.4 cm)
- Weight ..... 2 lbs. (0.9 kg.)

Ambient Temperature ..... —15°C to 45°C

Relative Humidity ..... 0 to 95%

Ordering Information

VHF Type BW-4B Visual Sideband Demodulator and IB-32693-1 ..... ES-34048

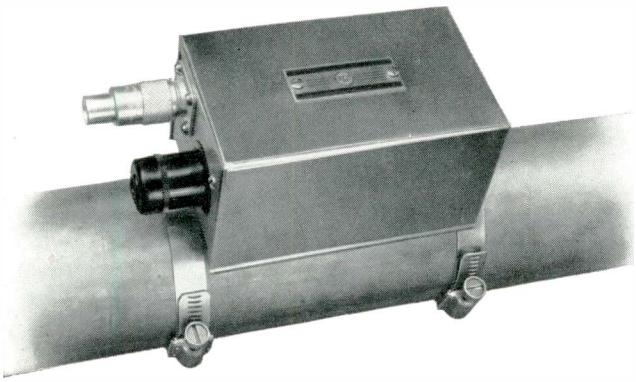
UHF Type BWU-4B Visual Sideband Demodulator and IB-36293-1 ..... ES-34049-B

Optional and Accessory Equipment

Senior VoltOhmyst	WV-98C
Plate Current Meter	MI-21200-C1
Wideband Oscilloscope, Type TO-524AD	MI-26500-A
Marker Generator	WR-99A
Television Sweep Oscillator	WR-69A
Chopper Relay	#211711
Complete Spare Tube Kit for BW-4B	MI-34014-A
Complete Spare Tube Kit for BWU-4B	MI-34069/34015
VHF Monitoring Diode	MI-19051-B
UHF Monitoring Diode	MI-19364
WA-7C Linearity Checker	MI-34017-B
BW-5B Sideband Response Analyzer	ES-34010-B

Monitoring Diodes

VHF-MI-19051-B, UHF-MI-19364



FEATURES

- Requires no external power supply
- No maintenance or periodic adjustment
- Will fit either 3⅛ or 1⅝-inch line without changes in unit
- Input circuit compensated for uniform r-f pickup over the 12 VHF channels

DESCRIPTION

The Monitoring Diode, Type MI-19051-B, is a completely self-contained unit designed for mounting on the r-f transmission line between the output of the visual TV transmitter and the sideband filter. The video output of the Monitoring Diode when fed to a master monitor, or equivalent unit, will permit observation of the picture delivered by the TV transmitter. The diode unit has excellent frequency and linearity response and is designed for use on TV channels 2 to 13.

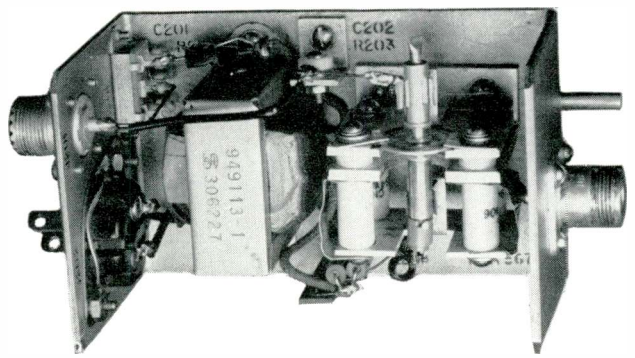
MI-19051-B consists of a double section diode whose cathodes are capacity coupled by a probe to the transmission line inner conductor. The plates are connected through a load resistor network to the 75-ohm output circuit. The output network provides a 75-ohm output impedance to match coaxial cable impedance and provides optimum performance in color TV systems. Filament voltage for the diode is supplied by a self-contained transformer which requires 115 volts a-c supply. The unit is designed for 3⅛- and 1⅝-inch transmission line.

SPECIFICATIONS

Frequency Range	Channels 2-13 inclusive
Output Impedance	75 ohms
Output Voltage	.75 volt—1.0 volt (adjustable by varying pickup)
Dimensions (overall)	7 5/16" long, 3⅛" wide, 3 3/16" high (18.5 cm long, 7.9 cm wide, 8.1 cm high)
Weight	3 lbs. (1.4 kg.) approximate
Tube Complement, 1 RCA 6AL5	Diode Rectifier

Ordering Information

VHF Diode Demodulator and IB-36114-2	MI-19051-B



FEATURES

- Permits CRO display of Modulation envelope in conjunction with video sweep input to the transmitter in L position
- Input circuit compensated for uniform r-f pickup over all UHF channels
- Automatically energized whenever monitoring equipment is in operation

DESCRIPTION

The UHF Monitoring Diode, MI-19364, is designed for mounting at any point on the visual transmission line between the transmitter and the filterplexer. The video output of the unit when fed to the master monitor or equivalent unit will permit observation of the picture delivered by the TV transmitter. It is designed for use on UHF channels 14-83.

The diode consists of a triode serving as a diode whose cathodes are capacity coupled by a probe to the transmission line inner conductor. The plates are connected through a load resistor to the 75-ohm output circuit. Filament voltage for the triode is supplied from a 115-volt a-c supply. A directional coupler is required for use with the diode. The unit, together with its coupler, mounts on 3⅛-inch or 6⅛-inch coaxial transmission line.

SPECIFICATIONS

Frequency Range	Channels 14-83
Output Impedance	75 ohms
Output Voltage	1 volt peak-to-peak
Tube Complement, 1—5675	Pencil triode
Dimensions (overall)	6¼" long, 3" wide, 2½" high (15.8 cm long, 7.6 cm wide, 6.3 cm high)
Weight	3 lbs. (1.4 kg.) approximate

Ordering Information

UHF Diode Demodulator	MI-19364

ACCESSORY EQUIPMENT

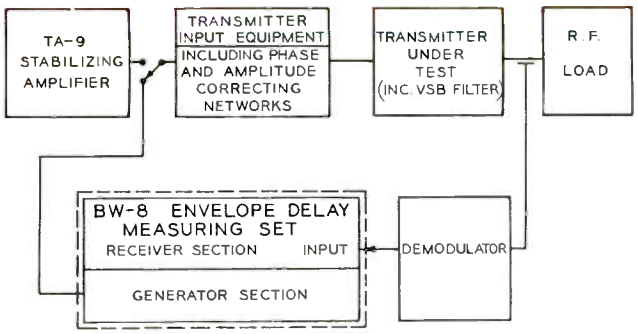
Directional Coupler for 3⅛" Transmission Line 51.5 ohm	MI-27379
Directional Coupler for 6⅛" Transmission Line 75 ohm	MI-27382
Directional Coupler for 3⅛" Universal Line, 50 ohm	MI-27385
Directional Coupler for 6⅛" Universal Line, 75 ohm	MI-27387

Envelope Delay Measuring Equipment

TYPE BW-8A/8A1

FEATURES

- Practical equipment for measurement of envelope delay of transmitter systems
- Also measures absolute delay of video equipment
- Convenient and simple to operate
- Direct reading dial
- Single frequency method of measurement
- All operating controls located on front panel
- Single unit — Built in power supply
- Choice of rack or portable mountings
- Excellent performance — Envelope delay 0 to 0.67 microseconds; accuracy ±3 percent, ±0.01 microseconds



Test set-up to measure envelope delay

DESCRIPTION

The BW-8A/8A1 Envelope Delay Measuring Equipment is designed for field measurement of the incremental slope of the phase-versus-frequency characteristic (usually referred to as envelope delay) of television transmitter systems. It can also be used to measure the absolute delay of video equipment. By maintaining proper phase relationship between the various frequencies in the television system such effects as leading white, trailing smear, ringing and misregistration can be corrected.

The BW-8 equipment is a small chassis mounted unit, easy to use. It provides a low frequency phase reference in order to measure the relative envelope delay in the region from 1.3 mc to 4.3 mc or 1.3 to 6.0 mc as referred to the average delay between 0 and 189 kc or 187.5 kc (F_A). The instrument is direct reading. All operating controls are located on the front panel for ease of operation. The unit may be housed in a standard rack mounting where it occupies only 10½ inches of rack space.

When measuring a video amplifier or any other equipment having input and output at video frequencies, no auxiliary equipment is required. When a complete transmitter is being measured the only auxiliary unit required is an r-f demodulator to feed the video signal to the receiver portion of the BW-8. The RCA BW-4 Series of Visual Sideband Demodulators or MI-19051-B/19364 Diode Demodulator can be used for this purpose. When sync and blanking are desired, they may be obtained from a studio sync generator, fed to the BW-8 generator section and combined with the BW-8 generator signal components to supply a composite test signal.

The BW-8 Envelope Delay Measuring consists of a generator that feeds the system to be measured, and a receiver section which evaluates the envelope delay of the signals after they have passed through the system under test. The generator section provides two signal sources. One is a reference frequency (F_A) derived from an internal crystal oscillator or from the twelfth harmonic of the horizontal sync frequency supplied from an external source. The second is a carrier signal (F_C) which may be varied. The receiver section contains two amplifier-limiter chains to detect and amplify video from the unit under test. A phase shifter consisting of an RLC network may be switched into either amplifier chain to permit compensation of either positive or negative time delay. It is calibrated to read delay in microseconds. The generator section occupies the left section of the chassis, the receiver chains are on the right. An electronically regulated power supply is built on the rear of the chassis.

To measure envelope delay, the output of the BW-8 generator section consists of the F_A reference signal, and a video carrier frequency modulated by the F_A reference. These signals are fed to the transmitter under test. The transmitter output is demodulated and the two components fed to the receiver section of the BW-8, where the F_A component is amplified through one section of the receiver and fed to a phase detector. The second component, which is a video carrier frequency, modulated by the F_A reference, is detected and the F_A component recovered. This signal is also fed to the phase detector. The calibrated phase shifter is then switched into the appropriate circuit and adjusted for zero phase difference between the two signals. Envelope delay in microseconds may then be read directly from the phase shifter dial. Absolute delay may be measured in much the same manner, except that the F_A reference component does not pass through the unit under test.

The circuitry of the BW-8 is shown in the block diagram. An operating switch selects the F_A reference signal and also controls addition of sync and blanking to the output test signal. Position 1 corresponds to crystal-controlled internal F_A signal and does not incorporate sync and blanking in the test signal. Position 2 adds sync and blanking while maintaining crystal oscillator for the reference frequency. Position 3 derives the reference frequency from external sync and incorporates sync and blanking in the test signal.

The variable frequency carrier oscillator (6U8) covers the F_C band in a single range. It is tuned by means of a variable inductance and gang coupled with tuned circuits of the mixer-amplifier and first amplifier in the receiver section. The plate load of the mixer amplifier (6BA7) is composed of a series of two tuned circuits resonating at the fixed frequency and the carrier oscillator frequency, the second one being permeability tuned and shunted with a constant load resistor. The electronic switch and adder (2N585) incorporates sync and blanking in the test signal whenever the switch is in position 2 or 3.

The output amplifier (5687) of the generator section is a cathode follower that can deliver more than 2 volts peak-to-peak of test signal. The output impedance is 75 ohms. An operation switch controls the path of the test signal from the generator to the receiver. When in position 2, the signal is fed directly to the receiver. In position 3, the signal passes through the network under test before reaching the receiver. Position 1 is similar to position 3, except that the F_A signal for the fifth amplifier is fed directly from the output of the generator, so it appears undelayed regardless of characteristics of the network under test. The input connector is internally loaded with a 75 ohm terminating resistor.

The receiver section is composed of two chains. Amplifier #1 (6U8) is tuned to the reference frequency, its plated-tuned circuit is mechanically coupled to the carrier oscillator and mixer circuits in the generator section. A diode envelope detector (1N90) following the first amplifier recovers the modulating signal. This signal differs from the reference frequency in phase angle to be determined. This chain is completed with two 6U8 amplifiers and a limiter amplifier (6AW8) tuned to F_A. The limiter amplifier feeds a constant amplitude signal to the phase detector.

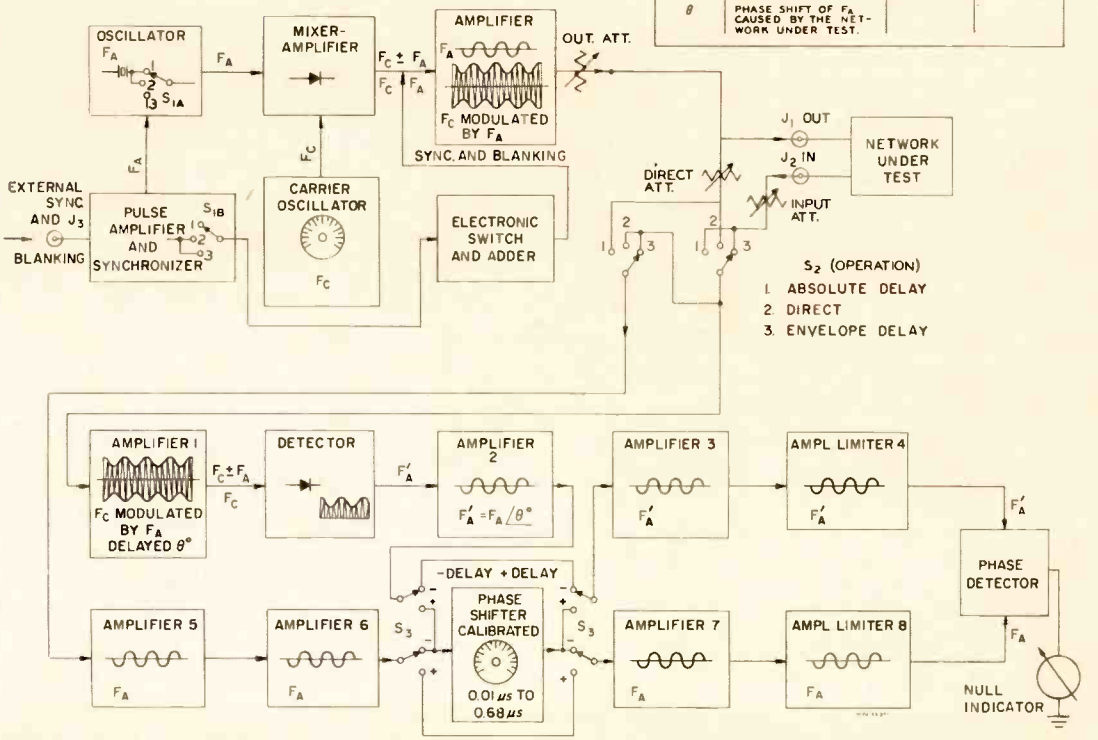
The second chain is composed of three 6U8 amplifiers and the limiter amplifier 6AW8 tuned to the reference frequency. The phase detector (two 1N100 diodes) operate similar to an FM discriminator. The output consists of a d-c voltage proportional to the phase difference of signals fed from the two limiter amplifiers. The output of the phase detector is indicated by a VTVM. A calibrated phase shifter is switched into the appropriate channel and adjusted for zero output of the phase detector. Envelope delay in microseconds may then be read directly from the phase shifter dial.

All controls of the BW-8 Envelope Delay Measuring Set are located on the front panel, those of the generator being on the left side and those of the receiver on the right. The output and input connectors, as well as the external sync input, the power connector and the fuse holder, are located on the rear of the chassis. The dial on the left controls the carrier frequency F_C and is directly calibrated. The right-hand dial drives a precision 3-turn potentiometer that controls the phase shifter. The dial is calibrated in delay, from 0.01 to 0.68 microseconds and may be measured with an accuracy of ±3 percent ±0.01 microseconds.

The VTVM (null indicator) is connected to a 5-position switch. Position 1 measures peak amplitude of the output test

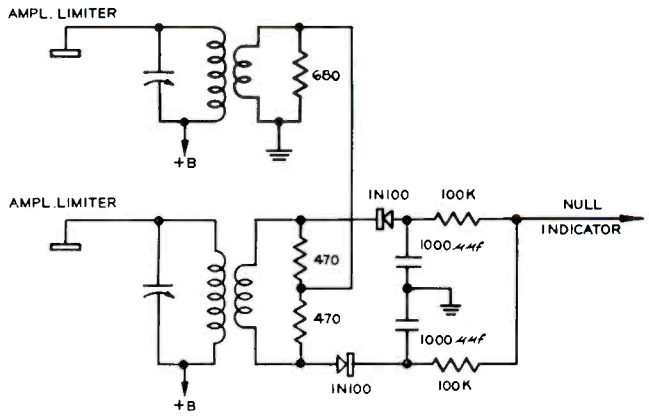
Schematic Block Diagram of BW-8 Envelope Delay Measuring Set.

SYMBOL	DESCRIPTION	BW-8A	BW-8A1
F_A	REFERENCE FREQUENCY	189 KC	187.5 KC
F'_A	REFERENCE FREQUENCY AFTER SHIFT IN PHASE	189 $\angle\theta$	187.5 $\angle\theta$
F_C	VIDEO CARRIER	1.3-4.3 MC	1.3-6.0 MC
θ	PHASE SHIFT OF F_A CAUSED BY THE NETWORK UNDER TEST.		



signal fed to the transmitter. Position 2 measures the amplitude of the signal at the input of the receiver. Position 3 is for balancing the VTVM and positions 4 and 5 are for use as a null indicator for the phase detector. Position 4 is of lower sensitivity for initial balancing of the phase detector. By means of another switch, the phase shifter network can be introduced into either one of the two receiver chains, allowing compensation of positive or negative phase delay.

Other controls located on the front panel include an a-c line switch; "Sync Amplitude" which regulates the amount of sync incorporated in the test signal; a "Zero Set" used to balance the VTVM when its switch is in position 3; and a "Delay Set", used to balance the delay of the measuring set when the operation switch is in the "direct" position.



Phase detector circuit of the BW-8.

SPECIFICATIONS

Performance Specifications

Envelope Delay ..... 0 to ±0.67 microseconds

Frequency Range:

BW-8A ..... 1.3 to 4.3 mc

BW-8A1 ..... 1.3 to 6.0 mc

Reference Frequency:

BW-8A ..... Average Envelope Delay between 0 and 0.189 kc

BW-8A1 ..... Average Envelope Delay between 0 and 187.5 kc

Delay Accuracy ..... ±3% ±0.01 microseconds

Carrier Frequency Accuracy ..... ±2% ±0.05 mc

Output Test Signal ..... 0 to 2 volt, peak-to-peak

Output Impedance ..... 75 ohms

Input Test Signal ..... 0.1 volt, peak-to-peak min.

Input Impedance ..... 75 ohms ±2%

Horizontal Sync and Blanking ..... 1 volt peak-to-peak, min.

Input Impedance (Sync) ..... 75 ohms ±1%

Electrical Specifications

Power Requirements:

BW-8A ..... 105-125 volts A-c, 50/60 cps, 180 watts

BW-8A1 ..... 115/230 volts, 50/60 cps, 180 watts

Tube Complement

6U8 Oscillator-Amplifier
6BA7 Mixer
5687 Output Amplifier
6AN8 Sync and 189-kc Amplifier
6AN8 Sync Amplifier
6U8 Input Amplifier
6U8 Amplifier
6AW8 Limiter and VTVM
6U8 Amplifier
6AW8 Limiter and VTVM
5R4-GY Rectifier
6AS7-G Voltage Regulator
6AG5 D.C. Amplifier
OC3 Voltage Reference
2N585 Electronic Switch (Transistor)
IN100 Phase Detector (Diode)
IN100 Phase Detector (Diode)
IN90 Signal Indicator (Diode)
IN90 Bias Supply (Diode)
1N90 Detector (Diode)

Mechanical Specifications

Mounting ..... Standard 19-inch rack

Finish ..... Light umber gray, smooth

Operating Conditions ..... 5°C to 45°C (41°F to 113°F), 0-95% relative humidity

Dimensions (Overall) ..... 19" wide, 10½" high, 14½" deep (48.26 cm wide, 26.7 cm high, 36.8 cm deep)

Weight ..... 35 lbs. (24 kg.) (approx.)

Ordering Information

Type BW-8A Envelope Delay Measuring Set and IB-30268 (1.3 to 4.3 mc) MI-34063

Type BW-8A1 Envelope Delay Measuring Set and IB-30268 (1.3 to 6.0 mc) MI-34068

Accessory Equipment

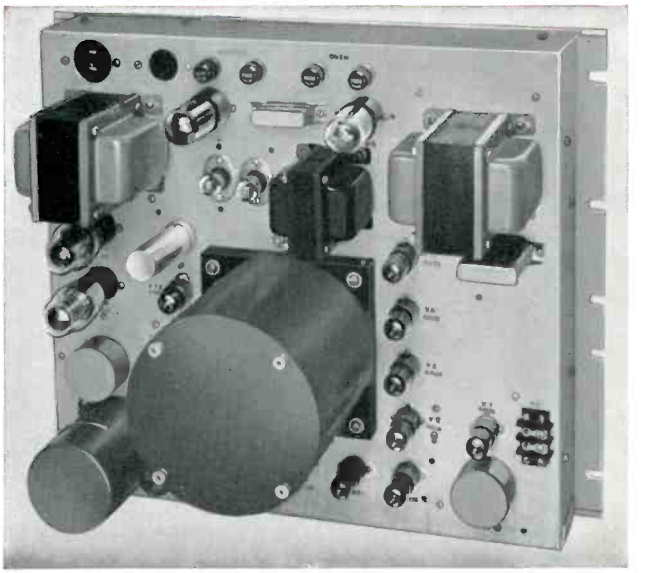
Domestic			*International*	
Type No.	*MI Number*	*Description*	*Type No.*	*MI Number*
BW-4B	ES-34048	VHF Visual Sideband Demodulator	BW-4BI	826557
BWU-4B	ES-34049-B	UHF Visual Sideband Demodulator	BWU-4BI	826559
	19051-B	VHF Monitoring Diode		19051-B
	19364	UHF Monitoring Diode		19364

Frequency Monitors

TYPE BW-11A AND BW-11AT

FEATURES

- Continuous reading deviation meter
- Wide input range
- Minimum accuracy at subcarrier frequency ±5 cycles for 1 year
- Protected trimmer adjustments for frequency calibration
- Warning lamp indicates failure of transmitter carrier or monitor crystal oscillator
- Provision for simultaneous operation of remote indicating or recording meter



Rear view of BW-11A Frequency Monitor.

DESCRIPTION

The RCA Frequency Deviation Monitors BW-11A and BW-11AT indicate continuously, and directly in cycles-per-second the magnitude and direction of any departure of the carrier signal from its proper frequency. The two models are used as follows:

1. Type BW-11A for AM broadcast stations to measure departure of the carrier from its assigned channel frequency.

2. Type BW-11AT for TV broadcast stations to measure departure of the color subcarrier from 3.579545 mc standard frequency.

The BW-11A monitor bears FCC approval for use in standard broadcast stations. The BW-11AT more than meets FCC requirement for subcarrier accuracy of ±10 cycles maximum and will provide an accurate and convenient method of calibrating and monitoring the color frequency standard now used by stations originating color programs.

The monitor is a-c operated and is mounted on a single relay rack panel. Coupling of the BW-11A Monitor to the transmitter is obtained from a short length of wire attached to the input terminals to act as an antenna. The BW-11AT Monitor's input voltage is obtained by "looping through" a coaxial cable circuit carrying a subcarrier signal.

SPECIFICATIONS

	Model BW-11A	Model BW-11AT
Frequency Range	500 to 2000 kc	3.579545
Frequency Deviation Range (readable to 1 cycle)	±30 cycles	±30 cycles
Accuracy	±10 parts per million	±1 cy. for 30 days ±5 cy. for 1 year
R-F Input Voltage	Approx. 10 mv to 25 volts	Approx. 0.15 to 25 volts
Power Supply	105-130 volts, 50/60 cycles, single phase	
Power Input	120 watts	
Dimensions	19" wide, 15¾" high, 9⅝" deep (48.26 cm wide, 40 cm high, 25 cm deep)	
Weight	60 lbs. (27.2 kg.)	
Finish	Umber gray	
FCC Approval Number for BW-11A	1471	

Tube Complement

5—6AU6	2—2D21
1—6BE6	1—5Y3-GT
1—6V6-GT	2—OC3/VR105
3—6AL5	

Ordering Information

BW-11A AM Broadcast Frequency Monitor, including Frequency Monitor (MI-30011-B), complete with tubes in place, 8-foot power cord with plugs, fuses, tuning tool, thermometer, thermostat, Crystal Unit (MI-34070), and instruction Book 30238 ..... ES-34042

BW-11AT Color TV Sub-Carrier Frequency Monitor, including Frequency Monitor (MI-30011-B), complete with tubes in place, 8-foot power cord with plugs, fuses, tuning tool, thermometer, thermostat, Crystal Unit (MI-34075), and Instruction Book 24961 ..... ES-34040-A

Accessories

Remote Meter MI-93688
Tube Kit for BW-11A/11AT MI-8295

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VHF TELEVISION TRANSMITTERS

VHF TELEVISION TRANSMITTERS (Continued)

TRANSMITTER CONTROL CONSOLE

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TEST AND MEASURING EQUIPMENT (Continued)

Page	*Type Number*	*Description*	*MI Number*
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114	WV-98C	Senior Voltohmyst	——
114	.....	Plate Current Meter	21200-C1
114	WR-99A	Marker Generator	——
114	.....	Chopper Relay	#211711
114	.....	Set of Spare Tubes for BW-4B	34014-A
114	.....	Set of Spare Tubes for BWU-4B	34069/34015
114	WA-7C	Linearity Checker	34017-B
115	.....	VHF Monitoring Diode	19051-B
115	.....	UHF Monitoring Diode	19364
115	.....	Directional Coupler for 3⅛-inch Transmission Line, 51.5 ohm	27379
115	.....	Directional Coupler for 6⅛-inch Transmission Line, 75 ohm	27382
115	.....	Directional Coupler for 3⅛-inch Universal Line, 50 ohm	27385
115	.....	Directional Coupler for 6⅛-inch Universal Line, 75 ohms	27387
116-119	BW-8A	Envelope Delay Measuring Equipment (1.3 to 4.3 mc)	34063
116-119	BW-8A1	Envelope Delay Measuring Equipment (1.3 to 6.0 mc)	34068
120	BW-11AT	Color TV Sub-Carrier Frequency Monitor	ES-34040-A
120	.....	Extension Meter for BW-11A/11AT	93688
120	.....	Tube Kit for BW-11A/11AT	8295
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