



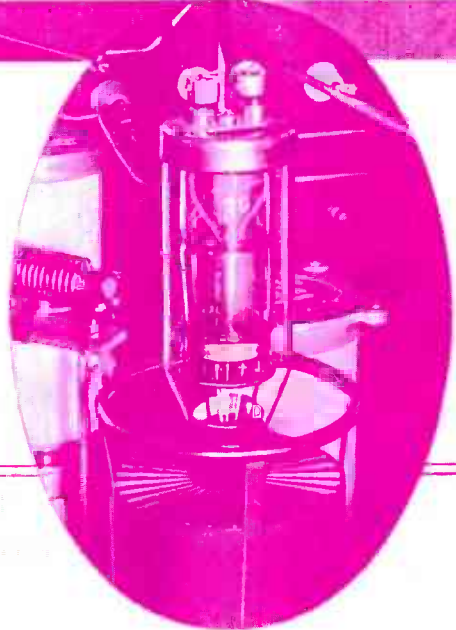
**5 KW**

**Radio Transmitting Equipment**



405 B-1

**RADIATION COOLED**



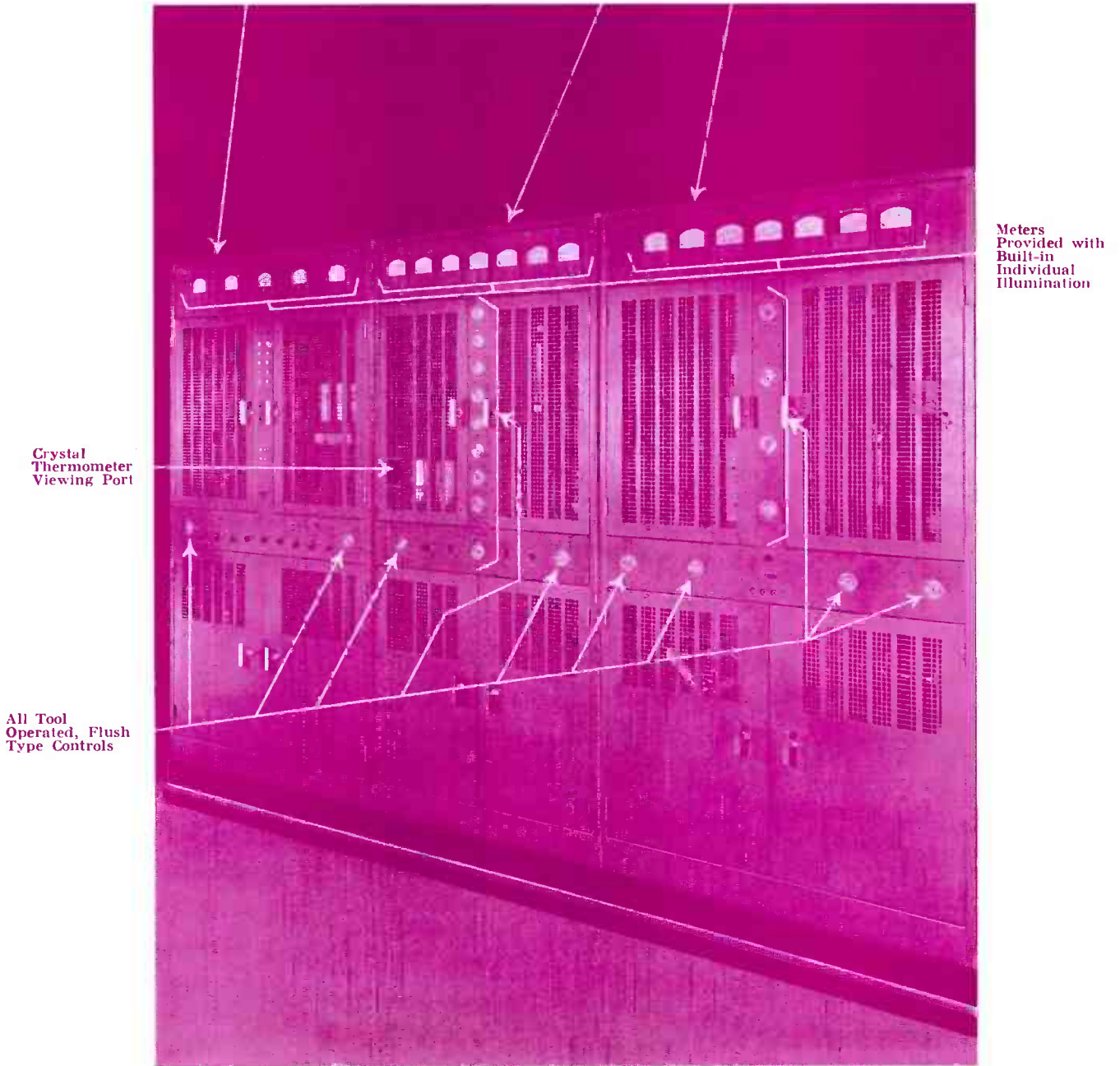
*Western Electric*

5 KW RADIO TRANSMITTING EQUIPMENT — RADIATION COOLED

D-151123  
Control  
Unit

D-99110 Oscillator-Amplifier Unit

D-151124 Power Amplifier Unit



Radio Transmitter Units Assembly  
Front View

# *Western Electric*

## Radio Transmitting Equipment

405B-1 5 KW

Radiation Cooled

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**W**ESTERN Electric's new 5 KW 405B-1 Transmitter for radio telephone broadcasting incorporates all of the advantages of the water cooled 405A-1, with the essential difference that the power amplifier tubes of the 405B-1 are radiation cooled.

The inclusion of the Doherty high efficiency amplifier circuit increases the efficiency of the power amplifier stage from the 30% usually obtained to over 60%. The utilization of the Doherty circuit also results in: a considerable reduction in plate dissipation, minimizing tube cooling requirements and adapting the transmitter admirably to the use of air cooled tubes; increased stability and greater ease of adjustment; savings in space; reduced initial outlay for auxiliary equipment and marked economies in operation.

Stabilized Feedback, another Bell Telephone Laboratories achievement, is included.

These additional features also are provided: An automatic circuit breaker and reclosing contactor in the power circuit to the rectifier; an automatic voltage regulator; omission of fuses in the transmitter; meters, with concealed lighting, flush mounted in the front of the units to provide visual indications of circuit conditions throughout transmitter; provision of cathode ray oscillograph connections in all important circuits; and key operated tuning controls which permit easy control and accurate tuning.

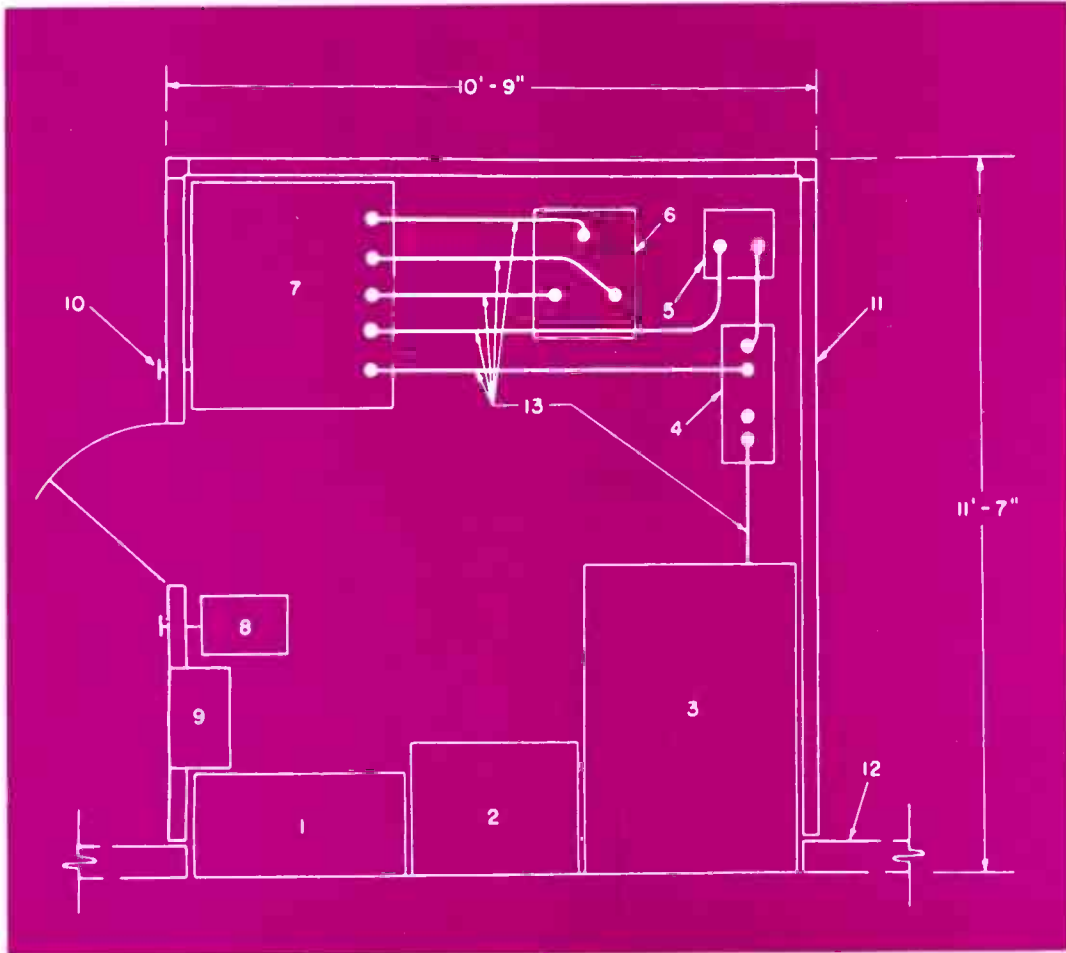
An antenna coupling unit can be supplied for either shunt excited (base grounded) or series excited (base insulated) vertical radiators.

The transmitter is entirely AC operated.

The compactness of the transmitter permits it to be economically installed in smaller space than is usually required for equipment of equivalent power, and the cabinet unit construction is styled to harmonize with any architectural treatment. This type of construction and assembly, together with Western Electric's rigid standards of material and workmanship, with high fidelity performance characteristics, result in radio transmitting equipment that is unequalled in the 5 KW field. The 405B-1 radio transmitter more than meets the requirements of the Federal Communications Commission.

And in addition, air-cooling of the power amplifier tubes eliminates all water-cooling apparatus, making the transmitter proper entirely self-contained.





Apparatus Layout  
405B-1, 5 KW Radio Transmitting Equipment

LEGEND

- |                              |                               |
|------------------------------|-------------------------------|
| 1. Control Unit              | 7. High Voltage Rectifier     |
| 2. Oscillator Amplifier Unit | 8. Induction Regulator        |
| 3. Power Amplifier Unit      | 9. Power Distribution Panel   |
| 4. High Voltage Condensers   | 10. Grounding Switch          |
| 5. High Voltage Choke Coil   | 11. Metal and Glass Partition |
| 6. High Voltage Transformer  | 12. Building Partition        |
| 13. High Voltage Bus         |                               |

## General Information

|   |  |
|---|--|
| <i>Equipment</i>  | 405B-1 Radio Transmitting Equipment.   |
| <i>Type</i>   | Radio Broadcasting.  |
| <i>Frequency Range</i>                                    | 550 to 1600 KC. Similar equipment is also available for Police Service.  |
| <i>Carrier Power Output</i>                               | 5000 Watts (normal)—Power reduction by push-button control to 2500 or 1000 watts as adjusted.  |
| <i>Power Supply</i>                                       | 210 to 250 volt, 60 cycle, 3 phase (can also be furnished for 50 cycles).  |
| <i>Operation</i>  | All AC.  |
| <i>Typical Power Consumption Data</i>                     | 15.3 KW for Carrier only, 15.75 KW for average program, 19.5 KW for single frequency, 100 per cent modulation.   |
| <i>Assembly</i>   | Three units are arranged to form one side of an enclosure. The power apparatus consisting of distribution cabinet, regulator, transformers and filter is installed in the enclosure behind these units. The compact high voltage rectifier may be installed immediately behind the control unit or elsewhere in the enclosure as shown on page 4.        |
| <i>Protective Enclosure</i>                               | For the standard arrangement, steel and glass partitions are available for the protection of the personnel. They enclose the high voltage power apparatus behind the transmitter units and can be provided for standard layouts. When visibility, such as is afforded by these partitions is not essential, fireproof wall construction may be utilized. |
| <i>Approximate Overall Dimensions including Enclosure</i> | 10' 9" wide x 11' 7" deep x 6' 6" high.  |
| <i>Shipping Weight</i>                                    | 10,000 pounds.   |

## D-99110 Oscillator Amplifier

| <i>Vacuum Tube List</i> | Quantity | Type | Function                           |
|-------------------------|----------|------|------------------------------------|
|                         | 1        | 247A | Oscillator                         |
|                         | 2        | 837  | First and Second RF Amplifiers     |
|                         | 2        | 241B | Modulating RF Amplifier            |
|                         | 1        | 837  | First AF Amplifier                 |
|                         | 2        | 837  | Second AF Amplifier                |
|                         | 4        | 249B | Plate and Screen Supply Rectifiers |
|                         | 1        | 274A | Grid Bias Rectifier                |
|                         | 2        | 84   | Feedback and Monitoring Rectifiers |

An additional socket is provided in this unit to keep a spare 249B vacuum tube ready for instant service.

## D-151124 Power Amplifier

| Quantity | Type  | Function                        |
|----------|-------|---------------------------------|
| 2        | 343AA | Radio Frequency Power Amplifier |
| 1        | 274A  | Protective Circuit Rectifier    |

## D-151123 Control Unit

| Quantity | Type | Function           |
|----------|------|--------------------|
| 1        | 313A | Part of 246A Relay |

## D-99114 High Voltage Rectifier Tube Unit

| Quantity | Type | Function               |
|----------|------|------------------------|
| 4        | 249B | Grid Bias Rectifiers   |
| 6        | 315A | Plate Supply Rectifier |

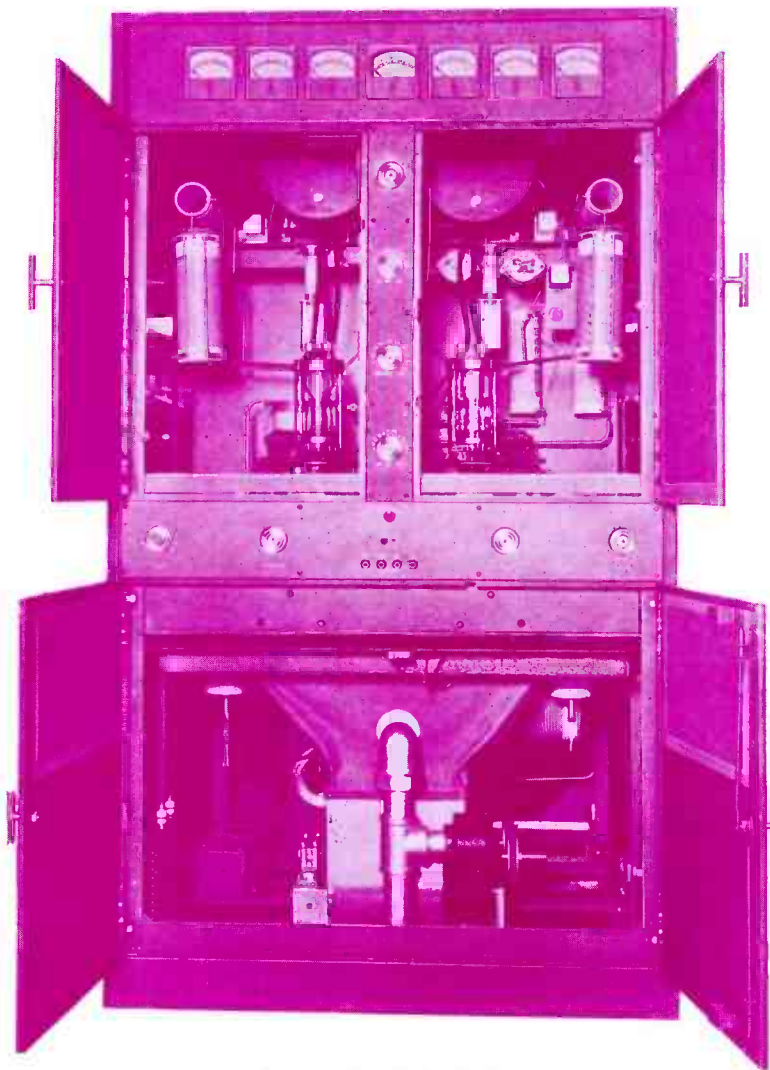
An additional socket is provided in this unit to keep a spare 315A Vacuum Tube ready for instant service.

### *Frequency Control*

A 702A Oscillator containing a low temperature coefficient quartz plate is furnished. Provision is made for a spare oscillator with a selector switch on the front panel which permits the use of either oscillator. (A spare 702A oscillator is optional and must be ordered separately.)

### *Cooling System*

The cooling system consists of a motor-driven blower which forces filtered air through the cooling fins of the 343AA tubes. This filtered air escapes at the top of the unit. Pump troubles, water leakage and plumbing in installation are all eliminated. The cooling system cannot freeze. Two speeds of the blower are provided, the low speed for normal use and the high speed for use when there are very high ambient temperatures.



Power Amplifier Unit  
Front View with Doors Open

*Ambient Temperature*

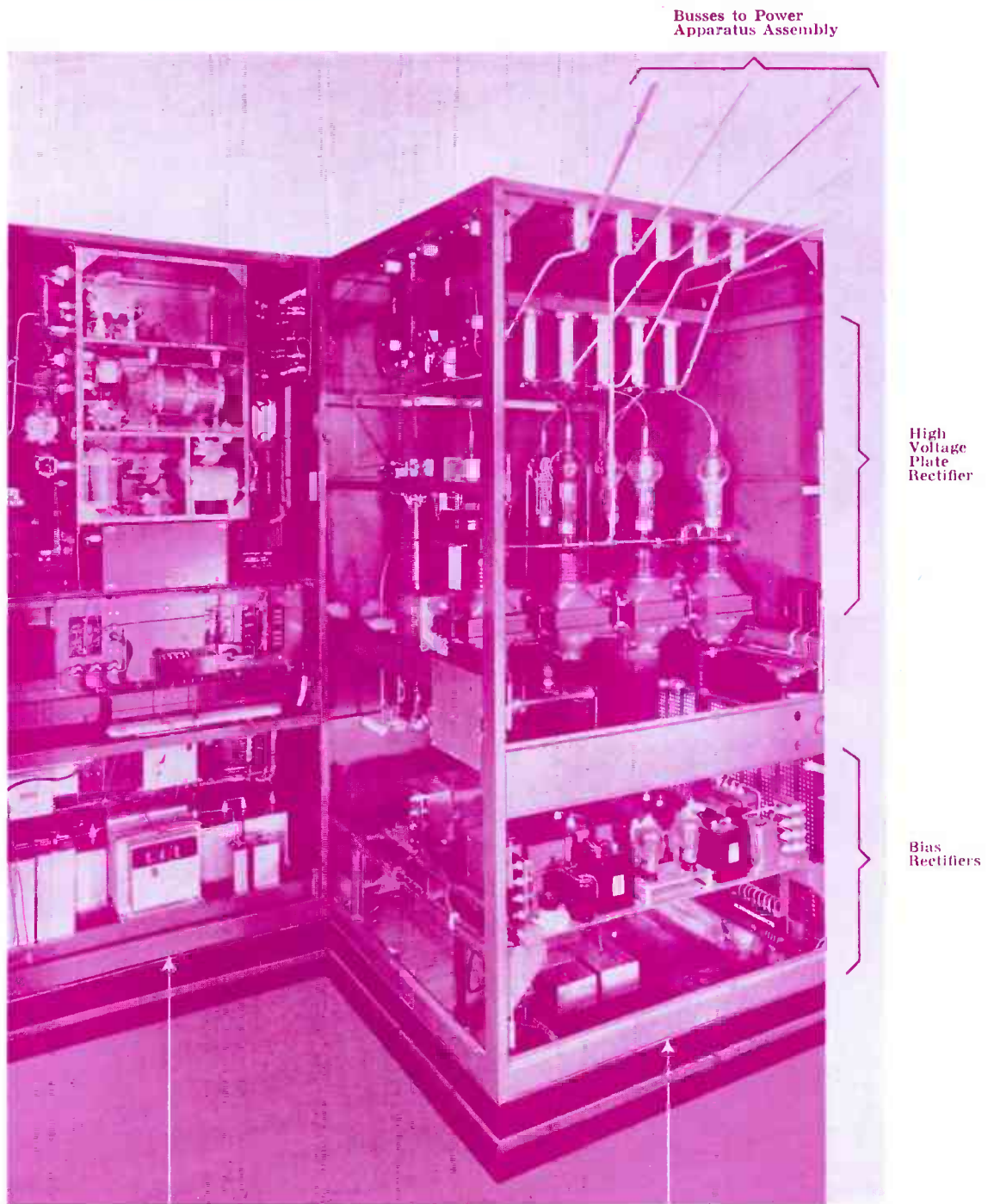
This equipment is designed to operate at locations where high ambient temperatures are encountered. Of course it will work at low ambient temperatures, and since there is no water to freeze, it may be used in locations in which the heating is not adequate to maintain temperatures above freezing during "off" periods.

*Ventilation and  
Air Conditioning*

The control unit and oscillator amplifier unit are ventilated by natural convection. The units are designed, however, to permit the addition of supplementary parts for providing air conditioning by dust-free filtered air.

- Control System* Toggle switches are provided to control the power to the transmitter. Delay and sequence relays prevent the bias and plate voltages from being applied until the tube filaments are properly heated. All controls can be multiplied at any convenient operating point. Controls are provided for separately adjusting the filament voltage applied to either power amplifier tube.
- Voltage Regulator* An automatic voltage regulator is furnished with the equipment for controlling the voltage of the entire power input to the transmitter. Constant voltage is maintained which insures long life for the tubes and the equipment and relieves the operating personnel from the duty of adjusting for changes in line voltage.
- Plate Supply Transformer* For indoor use, three single phase transformers are mounted in a case filled with non-inflammable oil (Asbestol). Each transformer is brought out to individual terminals and an open delta connection can be obtained (normal connection is closed delta) of sufficient capacity to permit continuous operation, thus providing the equivalent of a spare transformer.
- Filter Retard* The filter retard is also housed in a case filled with non-inflammable oil (Asbestol). This feature allows indoor installation.
- Filter Condenser* Two 2-microfarad Dykanol condensers are mounted in a small steel angle frame structure together with a condenser charging resistor and a voltmeter multiplier. Only a slight amount of hum would be introduced by the temporary emergency disconnection of one of these condensers.
- Power Distribution Cabinet* Completely assembled and wired at the factory the power distribution cabinet may be installed with the minimum of time and effort. The incoming power is distributed to the parts of the transmitter requiring power, through "no-fuse" circuit breakers and electrically operated switches. This cabinet may be obtained knocked down for assembly and wiring by the installer, if desired.
- Cathode Ray Oscillograph Tuning* Provision is made for a portable cathode ray oscillograph with lines and plugs to assist in tuning. Jacks provided in the panel of the power amplifier unit allow insertion of the oscillograph into the circuit. The circuit action is thus made graphic insuring complete accuracy of adjustment.

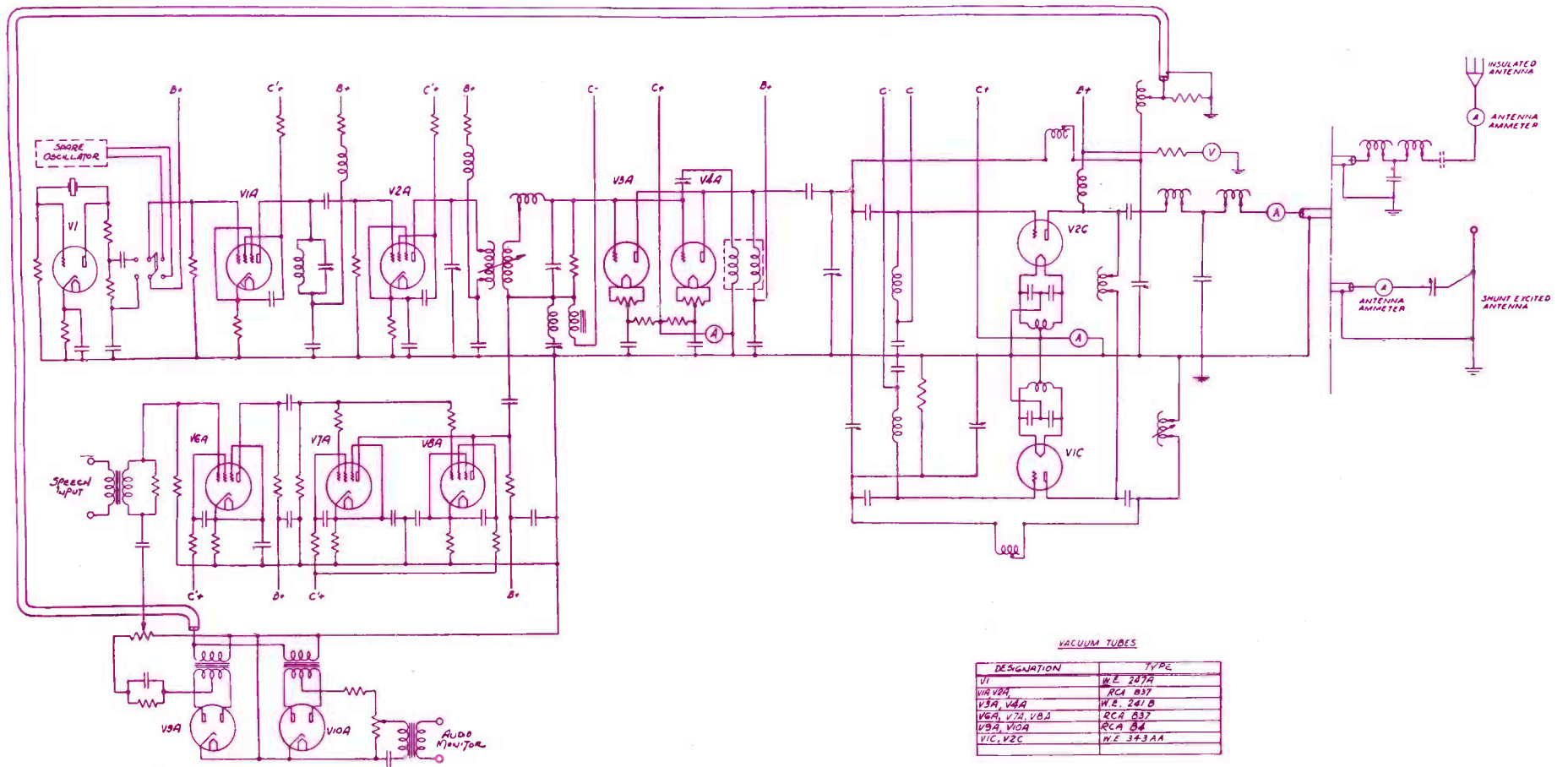




D-99110  
Oscillator-  
Amplifier Unit  
(Covers  
Removed)

D-99114  
Rectifier  
Unit

Radio Transmitter Units Assembly  
Partial Rear View Showing D-99110  
Oscillator-Amplifier and D-99114 Rectifier Units



Schematic of the 405B-1, 5 KW Radio Transmitting Equipment

- Transient Protective Device* The power amplifier is provided with a device which protects the apparatus between the amplifier tubes and the antenna, including the transmission lines, against damage due to transients set up by lightning surges or other causes. This device also indicates continuously the exact state of output and antenna-coupling circuit adjustment.
- Recommended Associated Equipment* The Western Electric 705A Speech Input Bay which includes the 110A Program Amplifier, is recommended for installation at the transmitter location. The Western Electric 704A Speech Input Bay, 721A Control Cabinet and/or the 23 Type Speech Input Equipment are recommended for installation at the studio.
- Construction Permit Data* Full technical information on the 405B-1 Type, 5 KW Radio Transmitting Equipment has been furnished the F.C.C. Paragraphs Nos. 21, 22 and 23 of the customer's application for a construction permit (F.C.C. Form No. 301) should be completed as outlined on the sample Technical Abstract listed on page 15 of this bulletin.

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## Electrical Characteristics

- Doherty High Efficiency Amplifier Circuit* This circuit increases the efficiency of the power amplifier stage more than 100 per cent—from the 30 per cent usually obtained to over 60 per cent; resulting in a reduction in plate dissipation which minimizes tube cooling requirements; the use of smaller elements, increased stability and greater ease of adjustment; savings in space; reduced initial outlay for auxiliary equipment; substantial economies in operation.
- Frequency Response* Flat within  $\pm 1$  db from 30 to 10,000 cycles.
- Speech Input Level* Program level about + 8 vu (6 milliwatts). Level of single frequency for 100 per cent modulation + 14 vu.
- Program Level Range* More than 60 db.
- Stabilized Feedback* This feature controls harmonic distortion and noise; provides high fidelity performance which exceeds by a wide margin the accepted standards in this respect; makes satisfactory AC operation practicable with resultant savings in space, operating and maintenance expense by eliminating motor generator sets. This stabilized feedback is automatic in operation and independent of transmitter operating adjustment.

- Distortion* A typical value of rms audio frequency harmonic distortion in the frequency range of 40 to 5,000 CPS is less than 2 per cent at 85 per cent modulation and less than 3 per cent at 100 per cent modulation.
- Modulation Capability* The ability to take high program levels is another new feature included in this equipment. The amplifiers are designed to carry over 100 per cent modulation peaks without a sharp increase in distortion and with absolutely no damaging effect to circuit components or tubes. This ability is a direct result of the continued development and research in low-level modulation systems and the associated overall stabilized feedback circuits.
- Efficiency of Final Stage* 60 per cent or more.
- Noise Level* The rms noise level of this equipment is 60 db unweighted, 70 db weighted below 100 per cent modulation.
- Harmonic Radiation* No radio frequency harmonic greater than 0.03 per cent (voltage) of the fundamental is radiated. This corresponds to better than 70 db below the output at the fundamental frequency.
- Method of Modulation* Low level grid bias modulation.
- Frequency Stability* Carrier frequency is maintained well within 10 cycles of the assigned frequency by means of low temperature coefficient quartz plate mounted within a temperature controlled chamber.
- Antenna Coupling* A number of antenna coupling arrangements are available:
1. Direct connection without antenna coupling unit to a single, shunt fed or series fed (50 ohms or more) radiator.
  2. Coupling through a coaxial transmission line to a shunt or a series fed radiator.
  3. Coupling through two coaxial transmission lines to a two element directive array involving shunt or series fed radiators. (Phase shifting and current ratio adjusting equipment must be provided separately.)
  4. Coupling to a line branching and phase shifting unit for multi-element antenna arrays. The external antenna coupling unit may be either a standard Western Electric 100A Antenna Coupling Equipment or a D-99418 Antenna Coupling Unit. The 100A Antenna Coupling Equipment is designed for use with a series excited (insulated) antenna and the D-99418 Antenna Coupling Unit for use with a shunt excited (base grounded) vertical radiator. The 100A An-



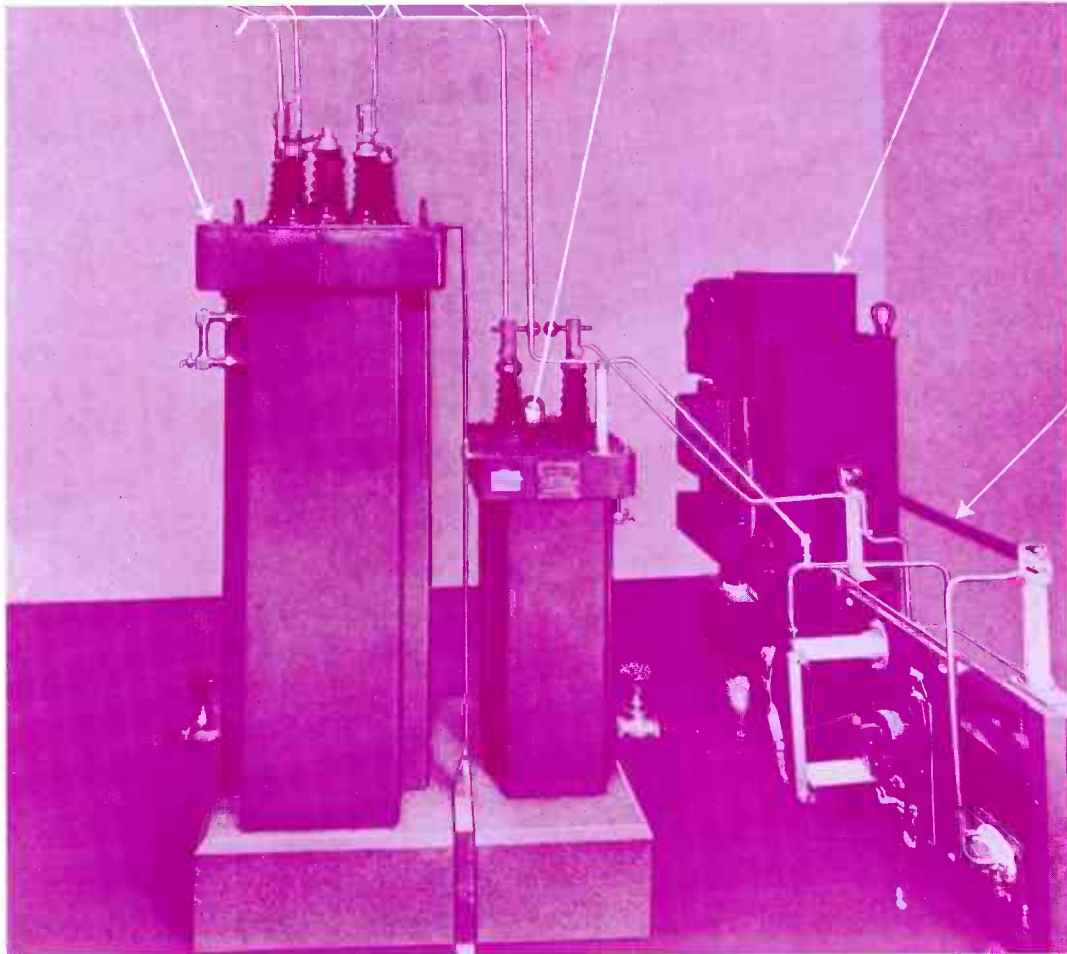
5 KW RADIO TRANSMITTING EQUIPMENT — RADIATION COOLED

High Voltage  
Plate Transformer  
(3 Single Phase  
Transformers in one  
Case—Asbestol Filled)

Busses to High Voltage  
Rectifier and  
Power Amplifier

High Voltage Filter  
Retard Coil (Non-  
Inflammable  
Oil-Filled)

Automatic Voltage  
Regulator  
(Air Cooled)



Tubular  
Plate  
Volt-  
meter  
Multi-  
plier

High  
Voltage  
Filter  
Con-  
densor  
and  
Charging  
Switch  
Assembly

Power Apparatus Assembly adjacent to rear of Radio Transmitter Units Assembly

Antenna Coupling Equipment contains a shielded transformer and thermocouple provided for connecting a remote meter, which is located in the transmitter, to indicate the antenna current. The D-99418 Antenna Coupling Unit is enclosed in a weather-proof housing and must be located at a specific distance from the shunt excited vertical radiator. This distance is determined for each installation depending upon the antenna height, frequency, etc. Detailed information is available. For a single antenna where the D-99418 Coupling Unit is employed, no remote meter is required and therefore no provisions are made in the unit for its use. Where additional meters, thermocouples and transformers are required for array purposes, they can be furnished at moderate additional cost.

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## Mechanical Characteristics

### *Arrangement*

The audio and radio circuits are assembled in three sturdy metal units of the cabinet type. These units, the control unit, the oscillator-amplifier unit, and the power amplifier unit, are attractively finished in aluminum gray, and are intended to be arranged together in a line-up. Meters, operating, tuning and power controls are flush mounted on the front of these units. The high voltage rectifier unit and associated power apparatus are installed in the protective enclosure behind the transmitter. The use of air cooling eliminates all of the external equipment associated with water cooling and makes the transmitter proper entirely self-contained.

### *Accessibility*

Front doors provide ready access to the vacuum tubes and to all parts of the transmitter units. There is no sacrifice of accessibility to achieve compactness. Access to the rear of the units and the power apparatus is obtained through a door in the protective enclosure.

### *Protection of Personnel*

The exterior of the transmitter is electrically dead, and safety switches, which operate before any part of the high voltage circuits can be touched, remove all high voltages thus protecting the operating personnel. This transmitter fully complies with all the Federal Communications Commission's requirements of good engineering practice.

A development of Bell Telephone Laboratories, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company.

TECHNICAL INFORMATION REQUIRED FOR

*Western Electric*

FCC. FORM NO. 301 (DEC. 1938)

APPLICATION FOR REGULAR BROADCAST STATION CONSTRUCTION PERMIT  
OR MODIFICATION THEREOF

RADIO TRANSMITTING EQUIPMENT

ABSTRACT

5-23-39 - JGC

FULL TECHNICAL INFORMATION IS CONTAINED ON THIS ONE SHEET

21. Description of transmitting apparatus proposed to be installed—

- (a) Make WESTERN ELECTRIC Type no. \_\_\_\_\_
- (b) Oscillator: Type of circuit ON FILE Number, manufacturer's name, and type of tubes ON FILE
- Normal plate current, per tube ON FILE Plate voltage ON FILE
- (c) List buffer and intermediate power amplifier stages, by number and type of tubes in each stage ON FILE
- (d) Last radio stage: Number, manufacturer's name, and type of tubes ON FILE  
for power requested: Plate current, per tube ON FILE Plate voltage ON FILE  
Normal night operation  
If greater day power than night power is requested, specify the following:  
Normal day operation: Plate current, per tube ON FILE Plate voltage ON FILE  
Describe fully the proposed method and procedure of reducing power at sunset ON FILE
- (e) Modulator or last audio stage: Number, manufacturer's name, and type of tubes and how operated (Class "A", "A Prime", or "B") ON FILE  
Normal plate current, per tube ON FILE Plate voltage ON FILE
- (f) Which radio stage is modulated? ON FILE
- (g) What system of modulation is employed (high level, low level, grid bias in last radio stage, etc.)? ON FILE
- (h) If low-level modulation is employed, give for modulated radio stage: Number and type of tubes ON FILE Plate current, per tube ON FILE Plate voltage ON FILE
- (i) The transmitter is designed for what maximum percentage of satisfactory modulation? \_\_\_\_\_
- (j) State name and type number of modulation monitor \_\_\_\_\_
- (k) Give Federal Communications Commission approval number \_\_\_\_\_
- (l) Specify manufacturer's name, type, number, and full scale reading of the following meters:
- (1) In last radio stage:  
Plate voltmeter ON FILE  
Plate ammeter ON FILE
- (2) Antenna ammeter ON FILE
- (m) Describe the plate power supply for last stage ON FILE  
Rating: Current ON FILE Voltage ON FILE
- (n) Maximum carrier power output of transmitter for satisfactory operation is \_\_\_\_\_ watts.
- (o) Maximum rated carrier power of transmitter as determined by orders of the Federal Communications Commission is ON FILE watts.
22. Description of automatic frequency control equipment:
- (a) Make WESTERN ELECTRIC Type No. ON FILE
- (b) ~~Give~~ Give manufacturer's name, type of cut, and temperature coefficient in cycles per degree centigrade of the quartz crystal WESTERN ELECTRIC CO.; ON FILE
- (c) By whom will unit be calibrated? ON FILE  
Calibrated frequency: \_\_\_\_\_ kilocycles at ON FILE degrees centigrade.  
Proposed operating frequency: \_\_\_\_\_ kilocycles. (Give exact figure, correct to third decimal place at ON FILE degrees centigrade.)
- (d) State guaranteed accuracy of the calibration: ON FILE cycles.

NOTE: POWER REQUESTED FOR NIGHT OPERATION AND FOR DAY OPERATION MUST BE SHOWN ON APPLICATION FORM.

- (e) State number of frequency control oscillators which will be maintained constantly at correct operating temperature and frequency in heat-controlled chambers ON FILE
- (f) Is provision made for instantaneous connection of spare frequency control units? ON FILE
- (g) Manufacturer's name and type of automatic temperature control: ON FILE
- (h) State within what limit automatic temperature control will hold the temperature: \_\_\_\_\_ degrees centigrade. ON FILE
- (i) State temperature coefficient of the frequency control units: \_\_\_\_\_ cycles per degree centigrade. ON FILE
- (j) Is temperature coefficient positive or negative? ON FILE
- (k) State manufacturer's name and rated accuracy of: Thermostat ON FILE  
Thermometer ON FILE
- (l) Attach the circuit diagram of automatic temperature control system if not already on file with the Commission. ON FILE
- (m) Attach a sketch or drawing of the automatic temperature control chamber, if not already on file with the Commission. ON FILE
- (n) Describe checking means used for determining if transmitter retains assigned frequency \_\_\_\_\_
- (o) State name and type number of separate frequency monitor \_\_\_\_\_
- (p) Give Federal Communications Commission approval number \_\_\_\_\_

23. Applicant represents ~~that there has been heretofore filed with the Commission, an accurate schematic diagram of the fundamental radio and audio circuits of the transmitter proposed, including antenna and ground or counterpoise connections, antenna feed system, and that it indicates the type of tubes.~~ ON FILE  
(This should be a blueprint or ink drawing, and, if possible, the size of this application, and attached hereto.)

NOTE: The applicant should fill in Form 301 as indicated above, and in addition, the following items.

- 21(a) Fill in type number.  
(j) As required.  
(k) As required.
- 22(c) Fill in frequencies requested.  
(n) As required.  
(o) As required.  
(p) As required.

[15]

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In accordance with the Communications Act of 1934, Sections 2 (a) and 301, all persons who are engaged in the operation of apparatus which is used for the transmission of energy, communications or signals by radio, regardless of location, frequency or power used, are required to obtain from the Federal Communications Commission a license for the operation thereof.