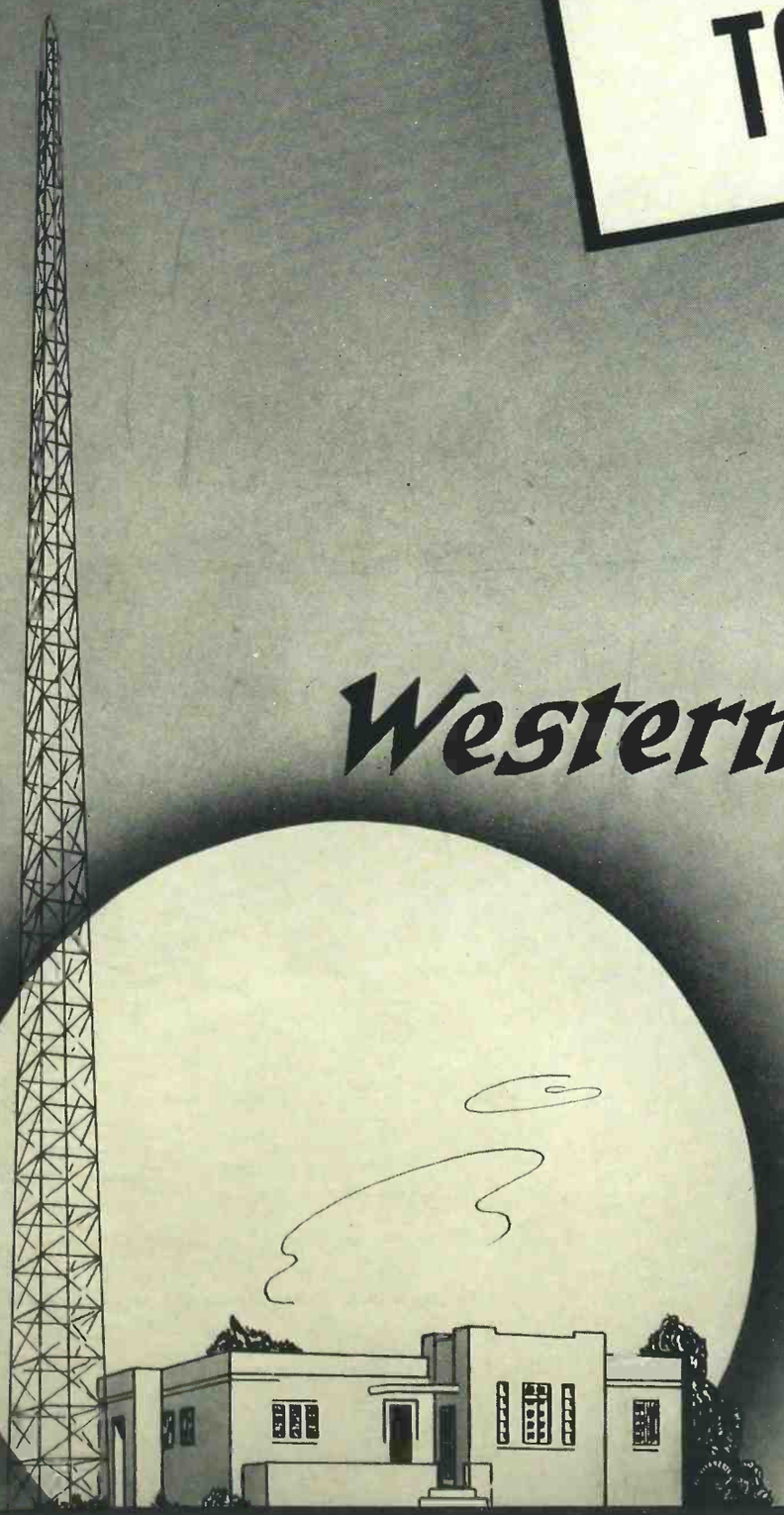
TOMORROW'S TRANSMITTER—

TODAY!



Western Electric

BROADCASTING EQUIPMENT

•

443A-1
1000 WATTS

Western Electric

Radio Transmitting Equipment

443A-1 • • • 1000 Watts

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

IN RADIO TRANSMITTING apparatus as in other types of sound transmission equipment it is recognized that Western Electric's pioneering has long been outstanding. To the credit of Western Electric are such recent outstanding examples as Single Mast Radiators — 110A Program Amplifier — 250 KW Vacuum Tube — Cardioid Directional Microphone — Stabilized Feedback — the Doherty High Efficiency Amplifier Circuit — all introduced and sponsored by the leading producer of sound transmission equipment and each recognized as an outstanding contribution to the Radio Art.

To these achievements Western Electric now adds the single unit, 1000 watt, 443A-1 Transmitter for radio telephone broadcasting — Tomorrow's Transmitter-Today.

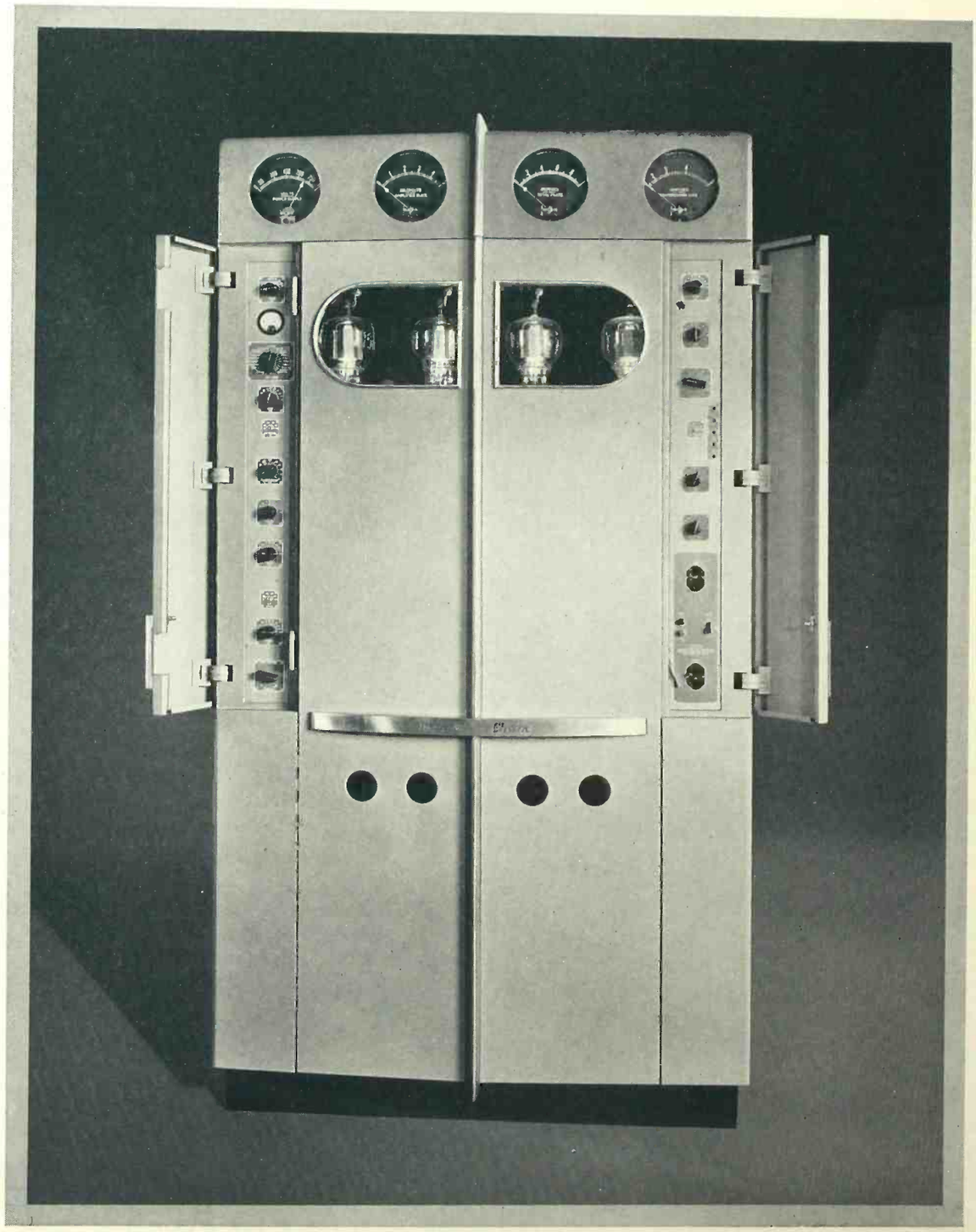
The 443A-1 was designed by engineers of Bell Telephone Laboratories and exemplifies in its mechanical and electrical design the highest skills of research and development. It marks the success of the continuous effort to develop a radio transmitter with better performance characteristics, while providing more compact assembly, easier access and improved, modernized appearance.

DOHERTY HIGH EFFICIENCY AMPLIFIER CIRCUIT

The Doherty High Efficiency Amplifier Circuit, with its attendant increased stability, is introduced here for the first time in a medium-powered broadcasting transmitter. The three-to-one reduction in plate dissipation, effected by the use of this circuit, is largely responsible for this smaller, more compact, radio transmitter. The new transmitter can be installed in a space 44 inches wide by 39 inches deep. The height is 78 inches.

The Doherty circuit also makes possible the use of a very inexpensive complement of radiation cooled tubes, smaller circuit elements and reduced initial outlay for auxiliary equipment.

In addition, the efficiency of the power amplifier stage is increased to 60% or more; with resultant economy of operation due to low-power consumption.



On each side of the main door is a small door behind which all operating and tuning controls are located.

GRID BIAS MODULATION

And — as another Western Electric innovation — the system of grid bias modulation which was pioneered and perfected by Western Electric has been combined with the Doherty High Efficiency Amplifier Circuit without any sacrifice in efficiency. Final stage modulation at high efficiency by the grid bias method gives superlative performance with circuit simplicity and power economy.

ACCESSIBILITY

In achieving this unusual new design, neither performance nor accessibility has been sacrificed. For example, it might be expected that in designing a smaller transmitter accessibility would suffer. In reality such is not the case. The new type of mechanical construction adopted provides a degree of accessibility never before attained in a radio broadcasting transmitter.

Complete access to all apparatus, including the tubes, in the front section is gained through the main front door. On each side of the main door is a small door behind which all operating and tuning controls are located, thus preventing accidental operation of these controls by the operating personnel or by a casual visitor to the station. All normal servicing, such as changing tubes and neutralizing of the last stage, is done from the front of the unit. A minimum of time is, therefore, required to locate and replace the tube that has reached the end of its normal life.

At the back of the cabinet are two full length doors that give complete access to all apparatus in the rear.

All electrical apparatus, with the exception of three door switches which are mounted on the cabinet, is assembled on a central structure. When installing the transmitter, all electrical connections to the central structure are completed before the cabinet is placed in position.

MODERN APPEARANCE

Appearance, now such an important factor, also has been given considerable attention. In addition to attractive modernistic, well balanced mechanical design, color and finish are carefully harmonized. The meter section at the top is finished in a tone of blue that blends with the gray on the remainder of the unit. All trim is satin chrome finished. The styling is by Henry Dreyfuss, the well-known designer.

ADDITIONAL FEATURES

Additional features are: The absence of the conventional types of fuses. Overload protection is provided by the use of magnetic circuit breakers which also serve as switches and make possible a very simple and effective control circuit.

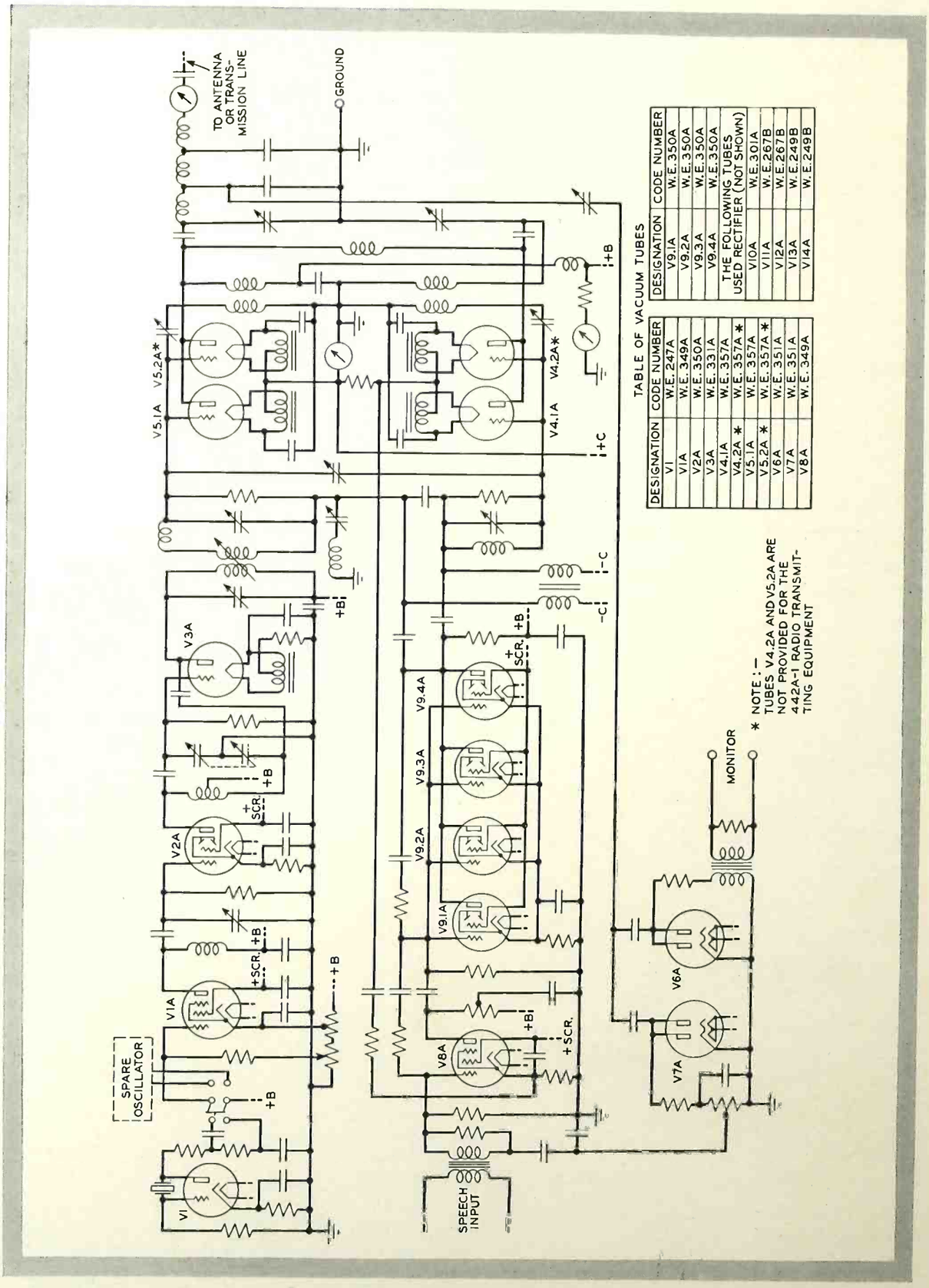


TABLE OF VACUUM TUBES

DESIGNATION	CODE NUMBER
V1	W.E. 247A
V1A	W.E. 349A
V2A	W.E. 350A
V3A	W.E. 331A
V4.1A	W.E. 357A
V4.2A *	W.E. 357A *
V5.1A	W.E. 357A
V5.2A *	W.E. 357A *
V6A	W.E. 351A
V7A	W.E. 351A
V8A	W.E. 349A

DESIGNATION	CODE NUMBER
V9.1A	W.E. 350A
V9.2A	W.E. 350A
V9.3A	W.E. 350A
V9.4A	W.E. 350A
THE FOLLOWING TUBES USED RECTIFIER (NOT SHOWN)	
V10A	W.E. 301A
V11A	W.E. 267B
V12A	W.E. 267B
V13A	W.E. 249B
V14A	W.E. 249B

Schematic — 445 A-1 Radio Transmitting Equipment

Large, black, dial meters with white numerals and calibrations provide superior legibility. Cathode ray oscillograph connections are included in all important circuits. There is a manually operated voltage regulator. Door switches protect the operating personnel from high voltage contacts by causing the primary power of the plate and grid supply rectifiers to be disconnected when the front or back doors are opened. Additional protection is provided by a switch that grounds the high voltage circuit when the front door is opened; a feature never before provided on transmitters of this power rating.

Through the use of stabilized feedback, a development of Bell Telephone Laboratories, both distortion and noise are kept very low.

Coupling equipment is included in the transmitter and permits operation either through a transmission line or directly into an antenna. However, when the location of the antenna necessitates the use of a transmission line, a coupling unit is required at the antenna location.

This new 443A-1 (1000 watts) Radio Transmitting equipment more than meets the requirements of the Federal Communications Commission and is designed for 1000, 1000-500, 1000-250, 500 or 500-250 watt service. When used solely for 500 or 500-250 watt service, the 442A-1 Radio Transmitting equipment should be specified. The 442A-1 is essentially the same as the 443A-1 except that it uses two instead of four 357A vacuum tubes in the modulating radio frequency amplifier.

DESCRIPTION

Equipment

443A-1, 1000 Watt Radio Transmitting Equipment (442A-1, 500 Watt Radio Transmitting Equipment).

Type

Radio Broadcasting and Police.

Frequency Range

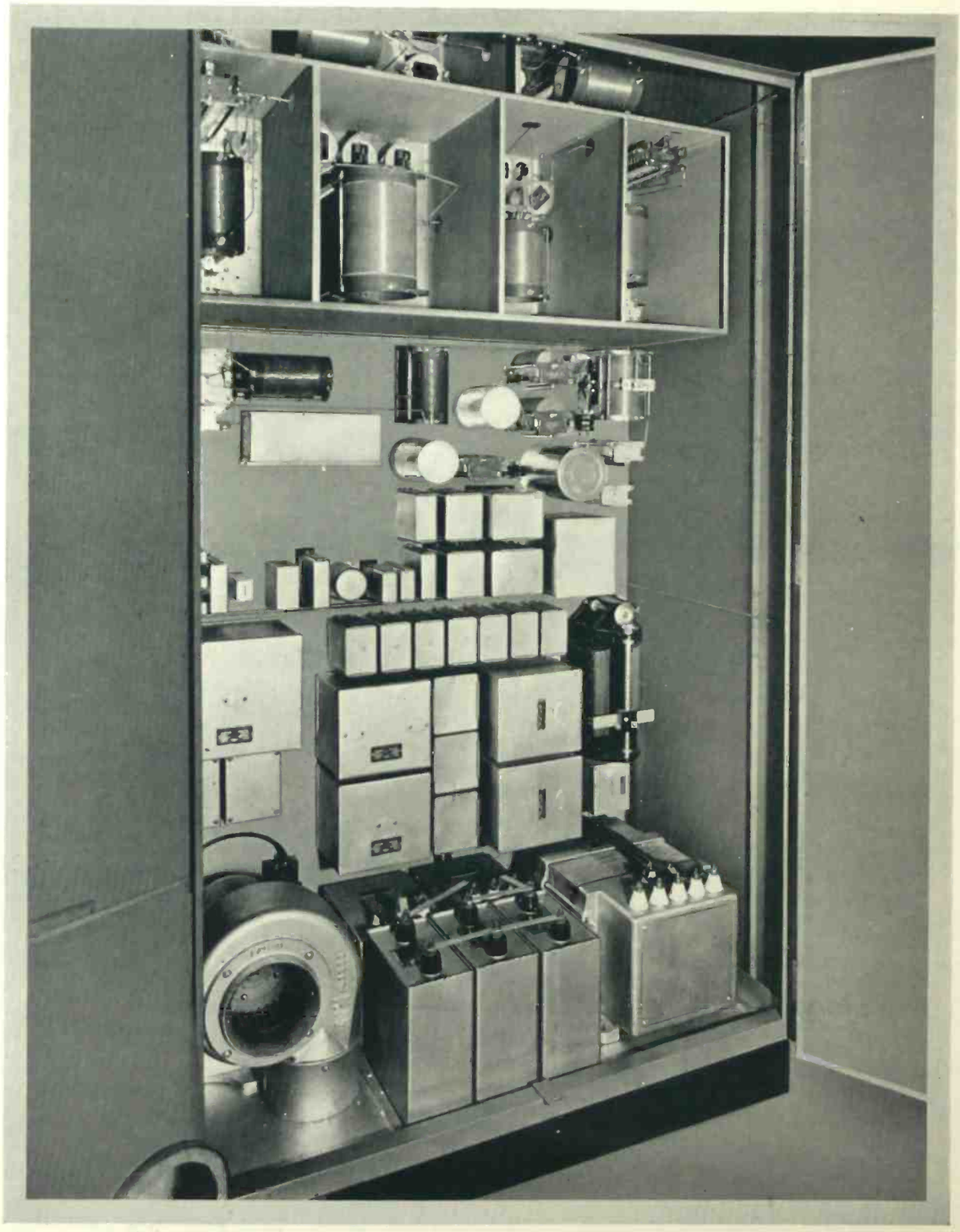
550 to 2500 KC.

Carrier Power Output

1000 or 500 watts (normal)—Power reduction by toggle switch control to 500 or 250 watts as adjusted. Power reduction equipment is optional and must be ordered separately.

Power Supply

187 to 250 volts, 60 cycle, single phase (can also be furnished for 50 cycles).



A blower in the rear of the unit provides forced air cooling for the entire Transmitter

Operation

All AC.

Typical Power Consumption Data

443A-1	4.5 KW	at 85% P.F. for carrier of 1000 watts only
	4.4 KW	for average program modulation
	5.15 KW	for single frequency, 100% modulation
442A-1	3.3 KW	at 85% P.F. for carrier of 500 watts only
	3.4 KW	for average program modulation
	3.7 KW	for single frequency, 100% modulation

Installation

All electrical connections to this single unit transmitter are made to the main central structure before placing the cabinet in position.

Approximate Overall Dimensions

44" wide by 39" deep by 78" high.

Shipping Weight

Approximately 2000 lbs.

Vacuum Tube List

QUANTITY	TYPE	FUNCTION
1	247A	Oscillator
1	349A	First R.F. Amplifier
1	350A	Second R.F. Amplifier
1	331A	Third R.F. Amplifier
*4	357A	Modulating R.F. Amplifier
1	349A	First A.F. Amplifier
4	350A	Second A. F. Amplifier
2	351A	Feedback and Monitoring Rectifiers
2	249B	Plate and Screen Supply Rectifiers
2	267B	Plate and Screen Supply Rectifiers
1	301A	Grid Bias Rectifier

*2——357A Tubes used with the 442A-1, 500 Watt Radio Transmitting Equipment.

Frequency Control

A 702A Oscillator containing a low temperature coefficient quartz plate is furnished. Provision is made for a spare oscillator. A selector switch permits

the use of either one. (The spare 702A Oscillator is optional and must be ordered separately.

Ventilation and Air Filtering

A blower in the rear of the unit provides forced air cooling for the entire transmitter. This cooling system is designed to provide a slight air pressure within the unit, thus preventing dust from filtering into the equipment. A spun glass filter is provided at the air intake in the lower section of the left rear door. The blower discharges toward the lower front section of the unit where the air passes upward and provides the necessary cooling for the tubes and associated apparatus. A very thin spun glass filter is provided at the outlet on the top of the cabinet directly above the final stage tubes, to prevent the accumulation of dust within the unit when it is not in operation. A thermostat with buzzer is provided to give warning of excess temperature within the unit such as could be caused either by failure of the blower motor or by clogging of the air intake filter.

Ambient Temperature

This equipment is designed to operate at locations where high ambient temperatures are encountered.

Control System

Toggle and push button switches are provided to control the power to the transmitter. All controls can be multipled at any convenient operating point. Automatic time delay equipment for filament preheating is optional.

Voltage Regulator

A manually operated voltage regulator is provided to adjust for the proper input voltage to the transmitter.

Cathode Ray Oscillograph Tuning

Provision is made for utilizing a portable cathode ray oscillograph with lines and plugs to assist in tuning. Jacks provided in the control panel allow insertion of the oscillograph into the circuit. The circuit action is thus made graphic insuring complete accuracy of adjustment.

Transient Protective Device

The radio frequency output circuit 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.

Recommended Associated Equipment

For installation at the transmitter location, we recommend the Western Electric 705A Speech Input Bay; at the studio the Western Electric 704A Speech Input Bay, 721A Control Cabinet and/or the 23 Type Speech Input Equipment. These equipments are described in Western Electric bulletins, which may be had upon request.

Construction Permit Data

Full technical information on the 445A-1 and 442A-1 radio transmitting equipments has been furnished the Federal Communications Commission 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 18 of this bulletin.

ELECTRICAL CHARACTERISTICS

Frequency Response

Flat within ± 1.5 db from 30 to 10,000 cycles per second.

Speech Input Level

Program level about + 8 vu (6 milliwatts).
Level of single frequency for 100% modulation + 14 vu.

Stabilized Feedback

The use of stabilized feedback controls harmonic distortion and noise and provides high fidelity performance which exceeds by a wide margin the acceptable standards in this respect. A small portion of the radio frequency output of the transmitter is rectified by Vacuum Tube V7A, and the audio component of the rectified wave is fed in series with the program input to the first audio stage. This stabilized feedback is automatic in operation and independent of transmitter operating adjustment.

Four tubes are used in parallel in the second audio stage, which is then resistance coupled to the grids of the modulated or final radio frequency stage. The output of this final stage is fed through a radio frequency filter and coupling circuit to a thermocouple meter where connections can be made either directly to an antenna or to a transmission line. Terminals connecting to the third and fourth stages provide the necessary radio frequency for frequency and modulation monitoring purposes. Refer to the schematic on page 6.

Complete access to all apparatus, including the tubes, in the front section is gained through the main front door

Distortion

Typical measurements of rms audio frequency harmonic distortion in the frequency range of 50 to 3,000 cycles per second show less than 3% at 100% modulation. To 7,500 cycles, the distortion is below 5%. Distortion measurements include all audio frequency harmonics up to 25,000 cycles.

Modulation Capability

The ability to take high program levels is another new feature included in this equipment. The modulated amplifier is designed to carry over-modulation peaks without a sharp increase in distortion and with absolutely no damaging effect to circuit components or tubes. This is a direct result of the continued development and research in 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 or better unweighted, 70 db weighted below signal level at 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

Grid bias modulation of the Doherty High Efficiency Circuit.

Frequency Stability

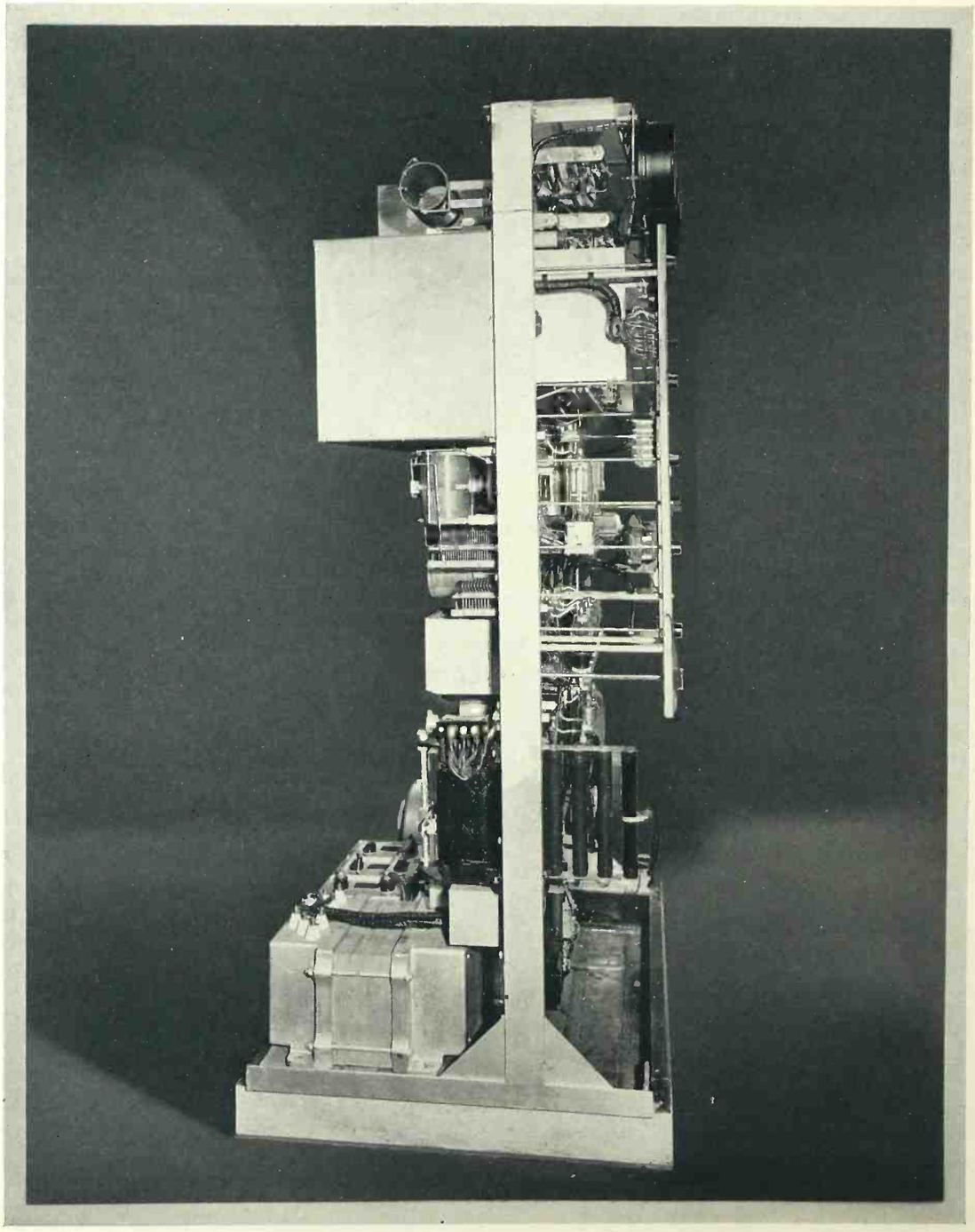
Carrier frequency is maintained well within 10 cycles of the assigned frequency by means of a low temperature coefficient quartz plate mounted within the temperature controlled chamber of the 702A Oscillator.

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 (20 ohms or more) radiator.

2. Coupling through a coaxial transmission line to a shunt or a series fed radiator.



All the electrical components, except the three door switches, are mounted on the central structure

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 following coupling units are required when using a transmission line.

	443A-1	442A-1
Shunt excited antenna	D-99418	D-99419
Series excited antenna	(550-1600 KC) D-97008	(550-1600 KC) D-97008
	(1610-2500 KC) D-97260	(1610-2500 KC) D-97260

Space is not provided on the transmitter for a remote antenna meter. This can be mounted in any convenient location.

Power Supply

The transmitter operates from a single phase 187 to 250 volts, 50 or 60 cycle power supply and requires 4.3 KW for a carrier output of 1,000 watts. Plate and screen potentials for all tubes are obtained from a single phase 4 tube bridge type rectifier and the associated potentiometer circuits. Surge-free starting of the transmitter is accomplished by the use of a two-step starting system for the rectifier. The bias potential for the final stage is obtained from a single phase full wave rectifier. All other radio and audio frequency stages are self biased.

MECHANICAL CHARACTERISTICS

Arrangement

The radio transmitter, modern in design and compact in construction, has been designed to give long, trouble-free life. All the electrical components, except the three door switches are mounted on a central structure as shown in the illustration on page 14. The heavy plate power equipment and blower are on the base plate while the remaining apparatus is mounted on the vertical plate structure. Most of the components are mounted on the back of this structure with the terminals extending through to the front.

Thus, practically all the wiring is on the flat front surface where it is easily accessible. Much consideration was given to the mounting of apparatus in a manner that would permit quick removal and replacement of a component, should it become necessary. The illustration, page 8, shows the way in which all filter and audio blocking condensers are mounted on the vertical structure. These condensers may be removed by simply loosening the nuts which lock the clamps holding the condensers in place.

Referring to the illustration, page 12, the lower group of five rectifier tubes supply the plate, screen and biasing potentials for the entire transmitter. Behind and below these tubes are most of the associated filters, transformers, and control circuits. The second group of tubes includes from right to left, the audio monitoring rectifier, feedback rectifier, first audio stage and the second audio stage in which four tubes are used in parallel. Two 702A radio frequency oscillators are shown on the next tier on the right with three successive stages of amplification on their left. Final stage tubes are on the top tier with the two parallel connected tubes on the right supplying the carrier power and the two on the left contributing power during modulation. The extreme right and left tubes are removed for stations operating at an output not exceeding 500 watts. All the audio and radio circuit components that demand close association with their respective tubes are located directly behind these tubes. Bleeder and potentiometer resistances from which plate, screen and grid voltages are obtained, are located above the final stage tubes. As a result the main heat generating components are near the top of the assembly where the air leaves the unit, thereby avoiding unnecessary heating of other electrical components of the transmitter.

A rear view of the central structure is shown in the illustration on page 8. All components are mounted to give the desired electrical performance and retain complete accessibility. Power equipment is confined largely to the lower section of the structure. Above this section are mounted the audio, low powered r-f, final r-f, and r-f output coupling apparatus in the order mentioned. Ceramic forms are used for all radio frequency coils.

Tuning and Operating Controls

All tuning and operating controls, a test meter with its associated transfer switch, and the phase sampling jacks are mounted on the narrow vertical side panels. In most cases the controls are directly coupled to the associated apparatus. However, where electrical requirements demand an extended drive, a rack and gear system is used. This gives a positive and smooth operating control with a minimum of backlash. Since these controls form a

part of the main central structure and the individual controls are installed and mechanically adjusted at the factory, considerable time is saved in the field installation.

The controls are divided into three groups, according to function, and a distinctive type of knob or slot is used for each group in order to eliminate confusion. Controls that are rarely used and require, in addition to their operation, the opening or closing of link switches within the cabinet, have screwdriver slots. In the second group consisting of the plate and grid circuit tuning controls, round knobs are used. The three controls used for the routine operation of the transmitter constitute the third group and have rectangular knobs. Included in this last group are the line voltage and r-f output controls and the test meter switch. This detail is just another indication of the care and thought that has been given to the design of this transmitter. The test meter and switch provided on the left panel permit reading the plate currents of all audio and radio tubes and some of the more important grid currents. It is, therefore, relatively easy to determine a defective tube.

Approximate Overall Dimensions

44″ wide by 39″ deep by 78″ high.

Protection of Personnel

The exterior of the transmitter is electrically dead. 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.

FCC. FORM NO. 301 (DEC. 1938)
ABSTRACT
5-23-39 - JCC

TECHNICAL INFORMATION REQUIRED FOR

APPLICATION FOR REGULAR BROADCAST STATION CONSTRUCTION PERMIT OR MODIFICATION THEREOF

FULL TECHNICAL INFORMATION IS CONTAINED ON THIS ONE SHEET

Western Electric

_____ RADIO TRANSMITTING EQUIPMENT

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

Normal night operation for power requested: Plate current, per tube ON FILE Plate voltage ON FILE

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) ~~If quartz crystal~~ 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 ~~XXXXXXXXXXXXXXXXXXXXXXXXXXXX~~ 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.

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