Western Electric

High Fidelity
Radio Transmitting Equipment
100-1000 Watts

This bulletin describes Western Electric high fidelity transmitting equipment for radio broadcasting in the power range from 100 to 1000 watts. The equipment consists of a radio transmitter with a rated output of 100 watts, to which if greater power is desired, a radio frequency amplifier may be added at any time. For outputs in excess of 100 watts, the transmitter serves as a stable and efficient driver for the amplifier.

A demand for equipment which will meet present requirements, insure against early obsolescence and provide for future power expansion is a natural result of the higher performance standards in modern radio broadcasting. The new Western Electric radio transmitting equipment adequately fulfills these three essentials. Latest advances of the radio art, for example, stabilized feedback, a feature of the new equipment, guarantee satisfaction over a long period of use.

Tentative high fidelity standards of the Federal Communications Commission are exceeded by a wide margin and Western Electric Company's rigid requirements for quality of workmanship and materials assure dependability and lower maintenance costs.

350 C RADIO TRANSMITTING EQUIPMENT
100 Watts

The 350 C Radio Transmitting Equipment has a carrier frequency range of 550 to 1600 KC and will deliver 100 watts of completely modulated carrier power to a suitable antenna, or ample power to properly drive a 1 KW or 5 KW radio frequency amplifier.

Although completely assembled in an attractive metal cabinet, there is no sacrifice of accessibility. The component parts are so disposed as to be readily accessible for servicing and inspection.

Stabilized Feedback

A high quality of radiated signal has become one of the important requirements that modern broadcast transmitters must meet. The new transmitter is one of the first to make use of stabilized feedback, an achievement of Bell Telephone Laboratories and Western Electric pioneering. This feature effects a high fidelity of performance more than meeting present day standards in a manner which insures absolutely automatic and dependable operation at all times. Stabilized feedback involves the introduction of a portion of the output of an amplifier into the input in such a manner as to cancel the major part of the distortion and noise products introduced by the amplifier. It is a fundamental development which has made possible the outstanding results which are being obtained with Western Electric high fidelity radio transmitters.

Uniform Frequency Response

The audio frequency transmission characteristic is uniform within ½ db from 30 to 10,000 cycles per second at all percentages of modulation.

Low Distortion

The RMS value of the distortion introduced by the transmitter is shown by the curves on page 10.

Low Noise Level

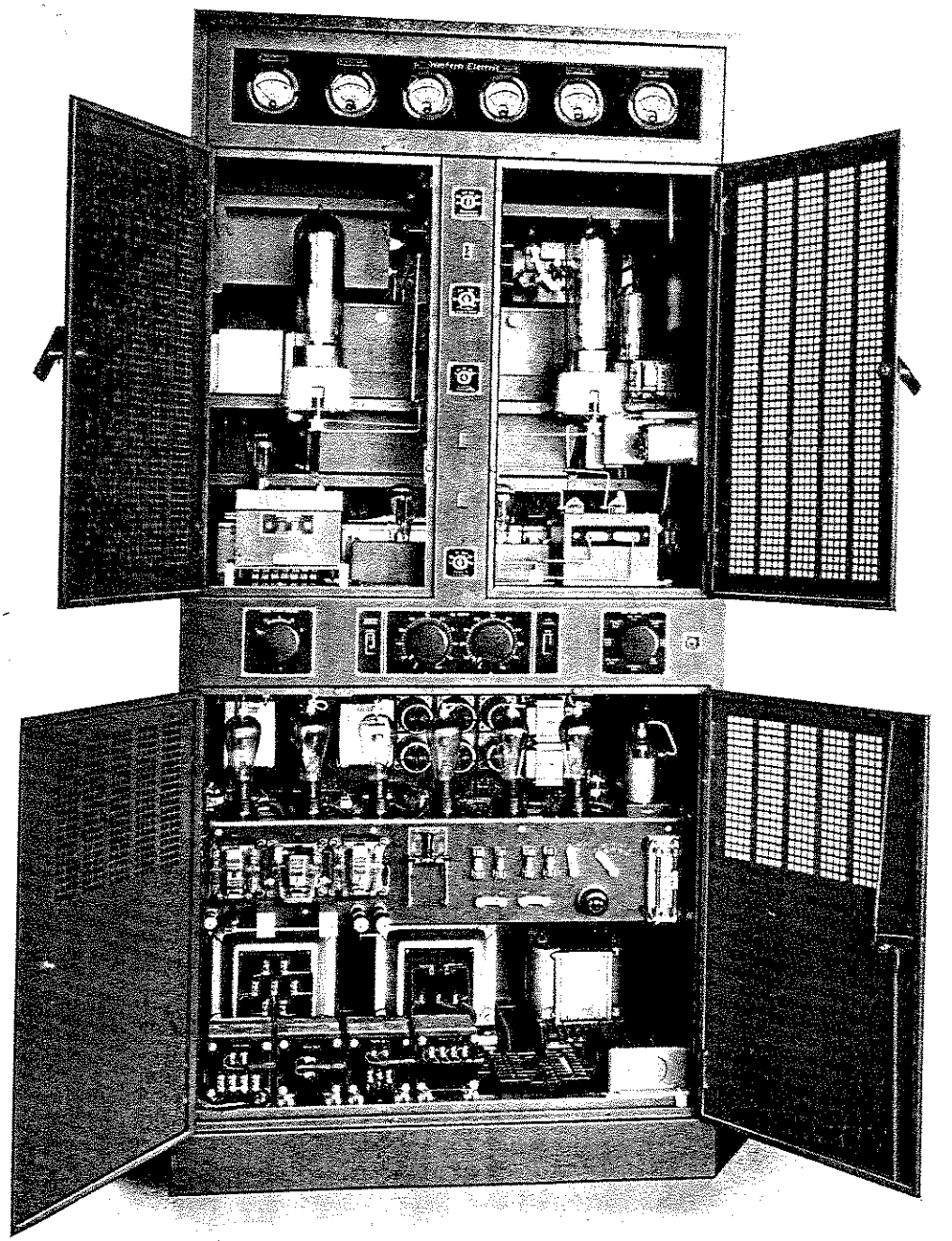
Approximately 63 db unweighted below the signal at 100% modulation and approximately 80 db weighted as measured with a program noise meter below the signal at 100% modulation.

Low Harmonic Radiation

Radio harmonics are reduced to insignificant levels by carefully designed output circuits and complete shielding.

Grid-Bias Modulation

The improved grid bias system of modulation used in this transmitter is another achievement of Bell Telephone Laboratories, exemplifying their continued leadership in the sound transmission art. Modulation is accomplished in the final amplifier which contains two vacuum tubes in push-pull arrangement. The grid-bias potential of these tubes is varied in accordance with the variations of the audio input, which results in modulation of the carrier.



Front View of the 100 Watt Radio Transmitter. Radio frequency circuits are all above the horizontal control panel and the power supply equipment is in the lower compartment.

UNIFORM FREQUENCY RESPONSE

Precision Frequency Stability

The frequency is maintained to well within the requirements of the Federal Communications Commission by means of a low temperature coefficient quartz crystal.

Provision for Power Increase

If the owner wishes to increase the carrier power output of his transmitter to 250, 500 or 1000 watts, he may do so by adding a Western Electric 71B Amplifier, especially designed for that purpose. For output powers greater than 1000 watts suitable amplifiers are available.

Low Installation and Operation Costs

The equipment is completely AC operated, without rotating machinery or batteries, and is entirely enclosed in a steel cabinet with no outside apparatus except the speech input equipment, the monitoring loud speaker and antenna connections. This single, self-contained unit reduces the cost of installation.

The small number of tubes minimizes the expense of tube replacements, which together with the feature of direct operation from the AC power supply, reduces the expense of operation. The use of rectifiers instead of motor generator sets represents distinct savings in installation and in maintenance expense.

Power Consumption

Approximately 1,670 watts at a power factor of about 0.85 are required.

Simplified Control

There are only two major radio controls and one power control for the entire transmitter. Starting is accomplished by merely throwing a toggle switch. An automatic control system applies the voltages in proper sequence by means of time delay relays.

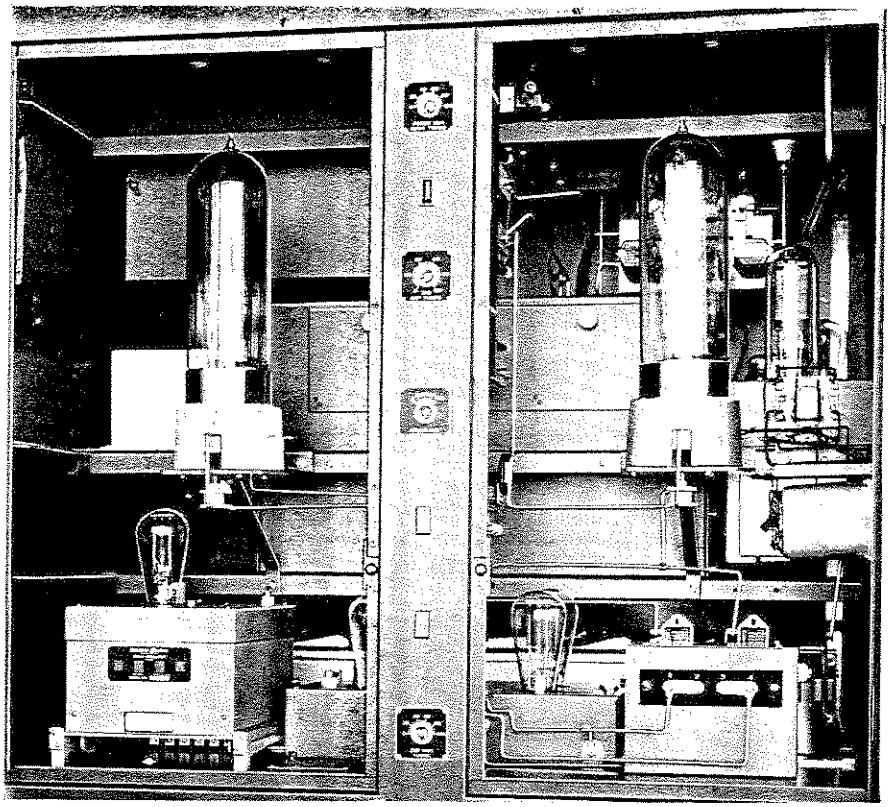
Accessibility

All meters are arranged in a row behind a flush glass plate at the top of the cabinet. Indirect illumination permits easy and accurate readings at all times. The cabinet structure has made compactness possible without sacrificing accessibility to any part of the equipment. In the front of the transmitter are four grilled metal doors which provide adequate ventilation as well as a view of the vacuum tubes.

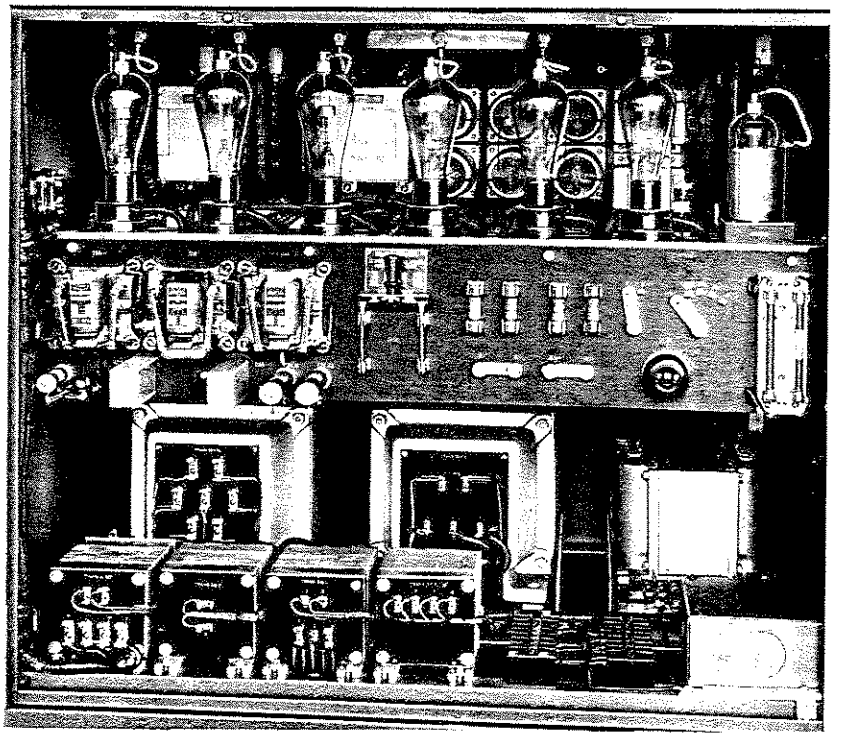
All controls are accessible from the front while the transmitter is in operation. This has been accomplished without the use of any flexible shafts, cable controls or other complicated remote tuning devices by the careful consideration given to the location of the circuit components. These controls are operated by a special spanner wrench to obviate unauthorized tampering with the adjustments.

Adaptability to Common Frequency Broadcasting

The 350 C Radio Transmitting Equipment is easily adaptable to common frequency broadcasting which is becoming an important development in the radio field. The possibility of covering considerable areas by means of a number of properly distributed and synchronized low powered transmitters makes this development of great significance to small stations.



A close-up of the Radio Frequency Compartment in the Radio Transmitter.



A close-up of the Power Compartment in the Radio Transmitter showing the Rectifier Tubes, Power Transformers, and Protective Equipment.

LOW NOISE LEVEL

Dependability

The improved circuit design of this transmitter, long life vacuum tubes, rugged mechanical construction and high standards required for Western Electric products combine to make this radio transmitter the last word in dependability.

All filter chokes, speech input coils and power transformers are of generous design to insure the utmost in reliable service.

The insulating materials used have been carefully selected to meet the requirements of their particular location in the transmitter.

In each case the most suitable insulation has been employed, utilizing in various parts of the transmitter high frequency bakelite, mycalex and isolantite. Every effort has been made in the design, materials, and construction of this equipment to provide reliable service to radio broadcast stations.

No Rotating Machinery

No rotating machinery is required. The transmitter is energized directly from the commercial AC power main and all necessary DC power is supplied by rectifiers in the transmitter cabinet. The elimination of rotating machinery has made possible a very compact installation, reducing the cost of maintenance.

MECHANICAL FEATURES

The 350 C Radio Transmitting Equipment is exceptionally quiet in operation due to careful design and to the entire absence of rotating machinery. Because of quiet operation and the complete shielding of the transmitter, speech input and control equipment may be installed in the same room. Such a compact layout should be extremely attractive to owners of lower powered stations where economy of space and operating personnel is essential.

Single Unit Mounting

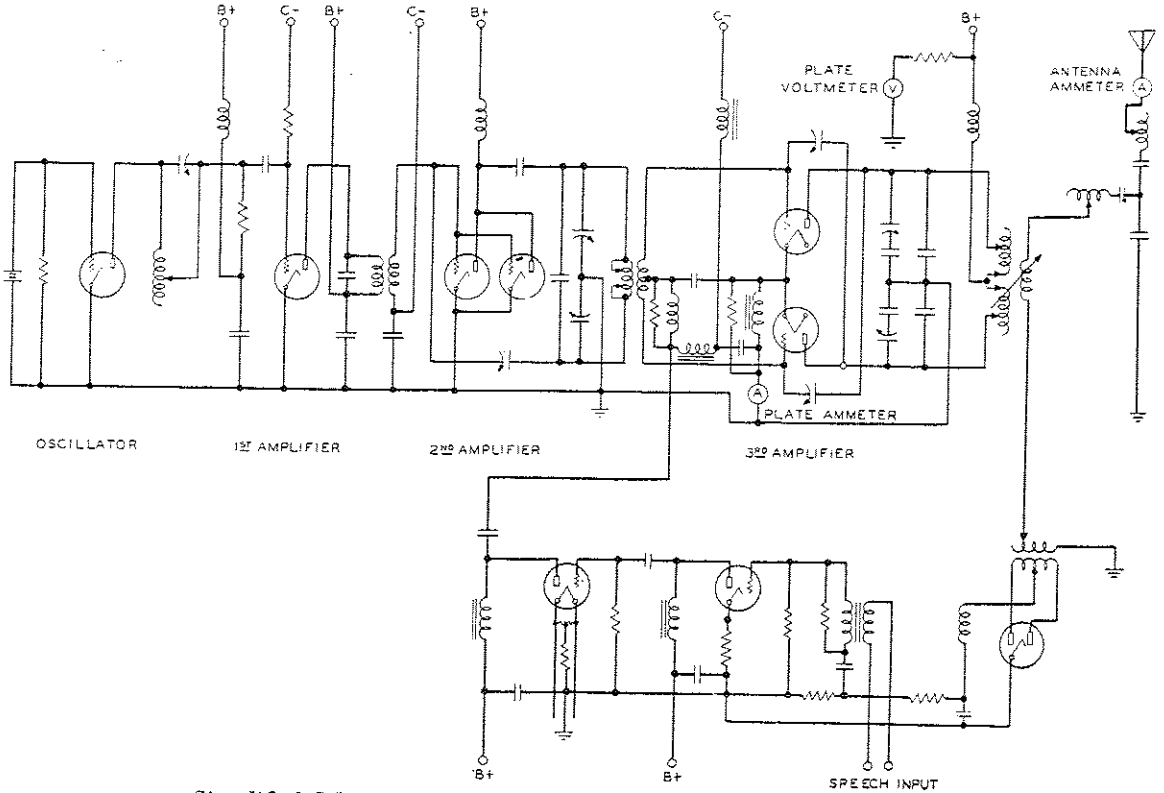
The complete transmitter, including power apparatus is mounted in a single unit 36 inches wide, 25 inches deep and 6 feet 6 inches high. It is recommended that a clear space of about 3 feet be left in the rear of the transmitter. The weight is approximately 1,500 pounds. The shipping weight, less tubes, is approximately 2,000 pounds.

Personnel Fully Protected

Operating personnel have thorough protection against contact with high voltage. The cabinet is entirely "dead front" and circuit breakers cut off all high voltages when the doors are open.

CIRCUIT INFORMATION

The radio frequency circuit includes a quartz crystal controlled oscillator, two buffer stages of amplification and an output stage in which modulation is effected. Two audio amplifiers are used. The power equipment includes mercury vapor rectifiers for all plate and bias voltages, together with all necessary relays and control circuits to permit the automatic starting of the equipment. Both cathode type and overall loop type feedback are used.



Simplified Schematic of the 100 Watt Radio Broadcasting Transmitter

Oscillator Unit

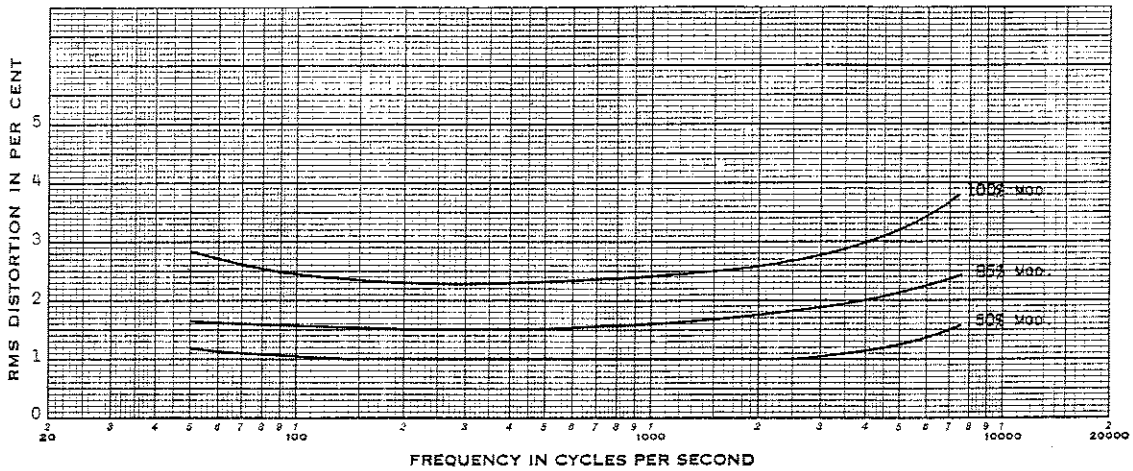
The oscillator utilizes one 271A tube and is adjusted as a unit to the operating frequency and will maintain its calibration well within the requirements of the Federal Communications Commission. A control, which is set at zero on the scale at the time of calibration, permits limited frequency adjustment.

The oscillator unit mounts conveniently in a slide rail assembly in the upper compartment of the transmitter. Power connections are made by spring contacts which engage when the oscillator unit is inserted.

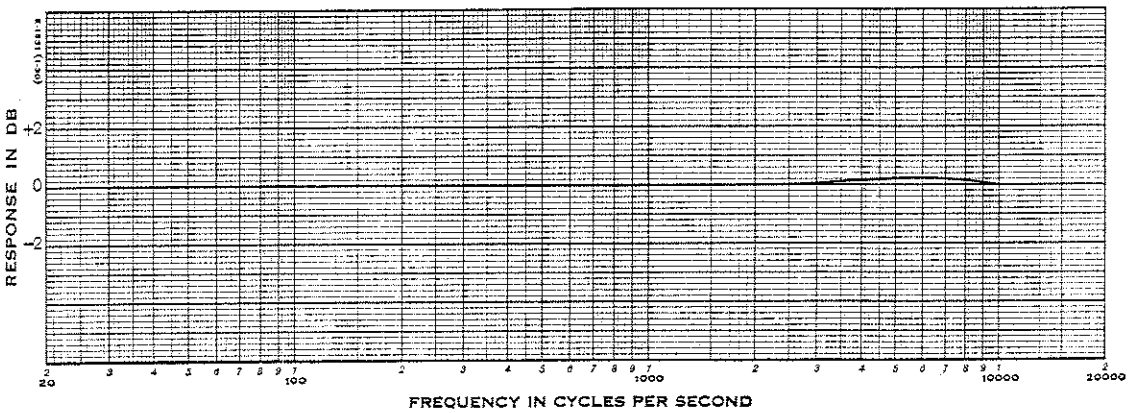
The quartz plate is maintained at a constant temperature by means of a heater, controlled by a mercury thermostat. Power for the crystal heater circuit is available at all times after the transmitter is connected to the power supply, and is independent of the operation of the transmitter. The Federal Communications Commission has approved the use of this oscillator without a thermometer.

First RF Amplifier

The first amplifier isolates the oscillator from the succeeding stages of amplification. Grid bias is obtained from a potentiometer with an "R.F. Output" adjustment. This adjustment is used to control the output of the transmitter as the output of the first amplifier may be varied smoothly by reducing the bias, from a value so far beyond cut-off that no output is obtained, to a value that gives the desired output. One 271A Vacuum Tube is used.



Typical Distortion Characteristics 350 C Radio Transmitting Equipment 100 Watts Output



Frequency Response 350 C Radio Transmitting Equipment 100 Watts Output

Second and Third RF Amplifiers

The second amplifier stage utilizing two 271A tubes is coupled to the first amplifier by an untuned radio frequency transformer and to the third amplifier by a tuned radio frequency transformer.

The third and final amplifier stage employs two 212E tubes in a push-pull circuit and it is here that modulation takes place. The grids of the tubes are biased to considerably beyond cut-off and the radio frequency voltage is applied to the two grids out-of-phase as in any push-pull amplifier. The audio frequency voltage is applied to both grids in parallel and is effectively in series with the fixed grid bias voltage. Thus the grid bias voltage is varied in accordance with the audio frequency modulating voltage which accounts for the name "grid-bias" modulation.

The already satisfactory linearity of the modulating amplifier is improved by the feedback action of a cathode resistor. The envelope of the output wave of the amplifier therefore is a true copy of the input audio frequency signal containing practically no distortion products.

Audio Amplifiers

Two audio amplifiers are used. The first employs one 271A tube, the second one 242A tube. The required audio frequency level (single frequency) to the first audio amplifier is +10 db, and +4 db for average speech and music for 100% modulation.

Antenna Coupling Circuit

The output of the third amplifier is coupled to the antenna through a coupling circuit designed to suppress radio frequency harmonics. It is adjusted so that most of the harmonic voltage is developed across an inductance which has a high reactance at the harmonic frequencies and thus very little of the harmonic voltage is transferred to the antenna.

Load Resistance

A load resistance is provided which may be connected in the antenna coupling circuit by means of a link switch when it is desired to operate the transmitter for test purposes or adjustments, without causing interference to other stations assigned to the same frequency.

Monitoring Circuit

Monitoring is accomplished by means of an audio output transformer connected in the high voltage return load of the third amplifier. The grids of the vacuum tubes in this stage are biased so far beyond cut-off that no audio frequency power flows in their plate circuits until the radio frequency is applied and modulation effected. The audio frequency component of the rectified carrier power then appears in this circuit and the output of the monitoring transformer is a true indication of the quality of the transmitted program.

POWER CIRCUITS

The transmitter operates from either 110 volt or 220 volt 50-60 cycle, single-phase power supply.

Bias Plate Rectifier

Grid bias voltage for all radio frequency amplifiers and the plate voltages for the oscillator and the first amplifier are supplied by a bias-plate rectifier. This rectifier employs two 258 B mercury vapor tubes in a conventional full-wave rectifier circuit.

High Voltage Rectifier

The two audio amplifiers and all radio stages obtain their plate supply voltage from the high voltage rectifier. It employs four 258 B mercury vapor tubes in a single phase, full-wave, "bridge-type" rectifier circuit.

Power Control and Protection Circuits

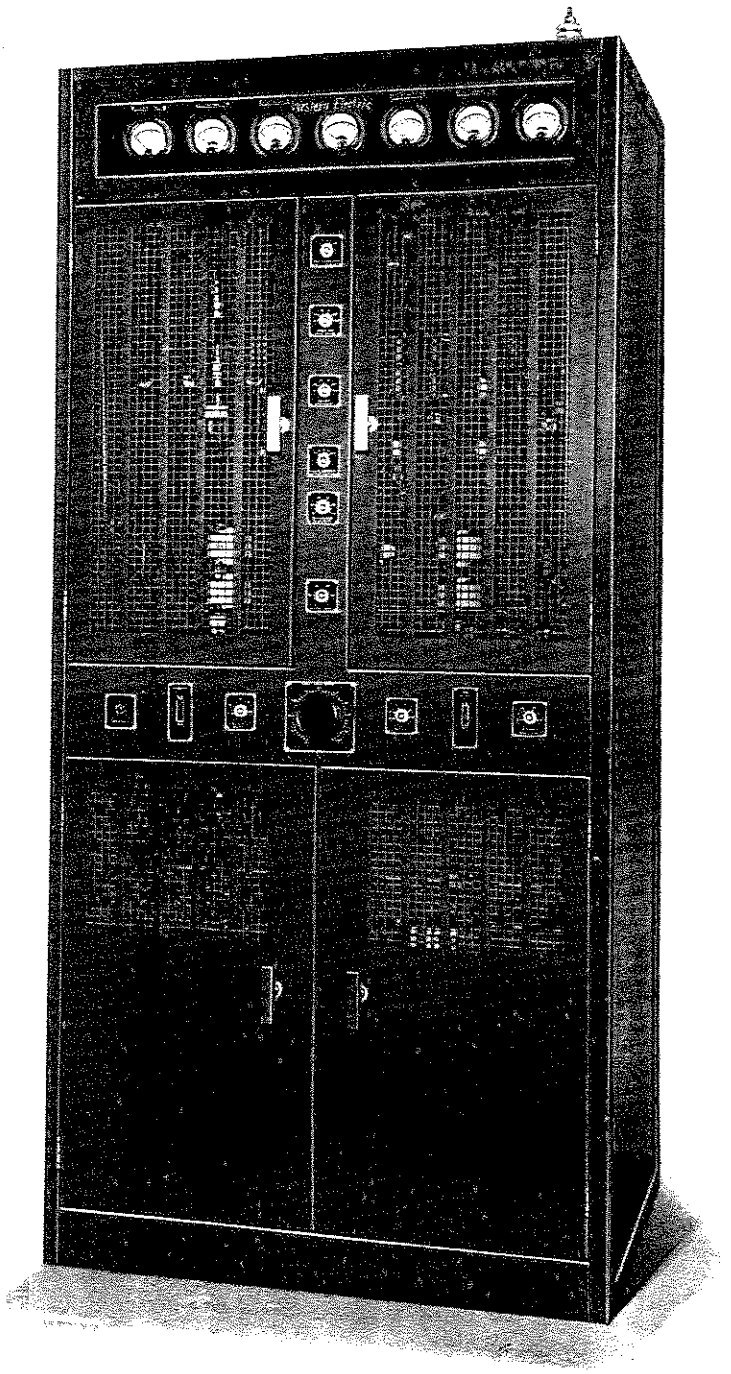
Power control and protection circuits control the sequence of power application to the various circuits of the transmitter and protect the equipment from possible damage in event of failure of any piece of apparatus.

The starting of the transmitter may be either completely automatic or semi-automatic as desired.

Antennas

The equipment can be operated with an antenna of any resistance and reactance, but with antennas of less than 10 or more than 100 ohms resistance, engineering advice should be requested from the nearest distributor.

PROVISION FOR POWER INCREASE



71 B Amplifier

LOW INSTALLATION COST

Western Electric

Radio Broadcasting Amplifier

71 B

The Western Electric 71 B Radio Broadcasting Amplifier is an efficient, high quality amplifier designed primarily to increase the power output of the Western Electric 350 C Radio Transmitting equipment to 250, 500 or 1,000 watts. The different output carrier power ratings of this amplifier depend upon the particular Western Electric vacuum tubes used in the radio stage and are in compliance with Federal Communications Commission requirements.

The 71 B Amplifier is suitable for use not only with the Western Electric 100 watt radio transmitter but also with any other radio transmitter capable of delivering 100 watts or more of radio frequency energy to the amplifier. It is designed to operate on 220 volt, 50 or 60 cycle, three phase power supply.

The amplifier does not depend on the driver or exciter for any power supply other than 100 watts or more of radio frequency energy. It will not increase or decrease the percentage of modulation furnished by the driver nor will it appreciably increase the percentage of audio distortion.

General Mechanical Design

The entire amplifying and power equipment is housed in a special metal cabinet 36″ wide, 25″ deep, and 6′6″ high. These dimensions conform exactly to those of the Western Electric 350 C 100 watt Radio Transmitting Equipment.

The surface of the amplifier cabinet is finished in gray lacquer. Four hinged doors are provided in the front. These doors afford access to all apparatus and are paneled with grilled metal to provide both visibility to the vacuum tubes and adequate ventilation.

The indicating meters are mounted across the top of the cabinet behind a glass plate. Indirect illumination of these meters permits easy, accurate reading whenever the amplifier is in operation.

The new cabinet type structure makes for compactness and accessibility of component apparatus. The unit is completely factory wired and all parts are accessible from the front. Having the entire equipment included in a single unit makes installation of the apparatus an extremely simple matter.

Moving Parts Completely Eliminated

All power for the amplifier is supplied through rectifiers directly from the AC commercial power main. The elimination of motor generator sets has not only reduced the amount of space required but also effects a material reduction in installation and maintenance cost.

All Vacuum Tubes Radiation Cooled

The vacuum tubes of the amplifier are radiation cooled and consequently do not require a water circulating or cooling system. The tubes are so placed in the amplifier that the heat resulting from radiation does not endanger other apparatus.

Circuit Arrangement

The amplifier operates from the output circuit of a 100 watt radio transmitter and consists essentially of two vacuum tubes with their associated push-pull input and output circuits, a harmonic suppression circuit, the antenna coupling and tuning circuits, radio monitoring circuit, an artificial antenna, plate and grid bias voltage rectifiers with their associated filters and the control and protective circuits.

The input to the amplifier is balanced to ground so that equal voltages are impressed upon the grids of the amplifier tubes which are operated in a push-pull circuit.

The plates of the vacuum tubes connect to a balanced output circuit. This circuit is tuned by means of a variable air condenser which is in parallel with a group of fixed condensers.

Harmonic Radiation Less Than .05%

Especially designed output and antenna coupling circuits are included in the unit to reduce harmonic radiation to a negligible value. In addition, the tuning inductances of the amplifier are thoroughly shielded to prevent any harmonic radiation from the transmitter itself. The reduction effected by these features brings the harmonic radiation well under .05% of the fundamental.

The matter of harmonic suppression at broadcasting stations becomes increasingly important with the increased use of higher radio frequencies. The harmonics of broadcasting transmitters may cause serious interference with other services as well as broadcasting.

In minimizing harmonic radiation, the station owner recognizes not only the ethics of the art but also the possibility of more rigid regulation.

Contains Artificial Antenna

An artificial antenna for tuning and testing purposes is embodied as part of the unit. It is mounted in the top of the unit to insure ready radiation of the dissipated heat. A suitable switch is provided for transferring the output circuit of the amplifier to this antenna.

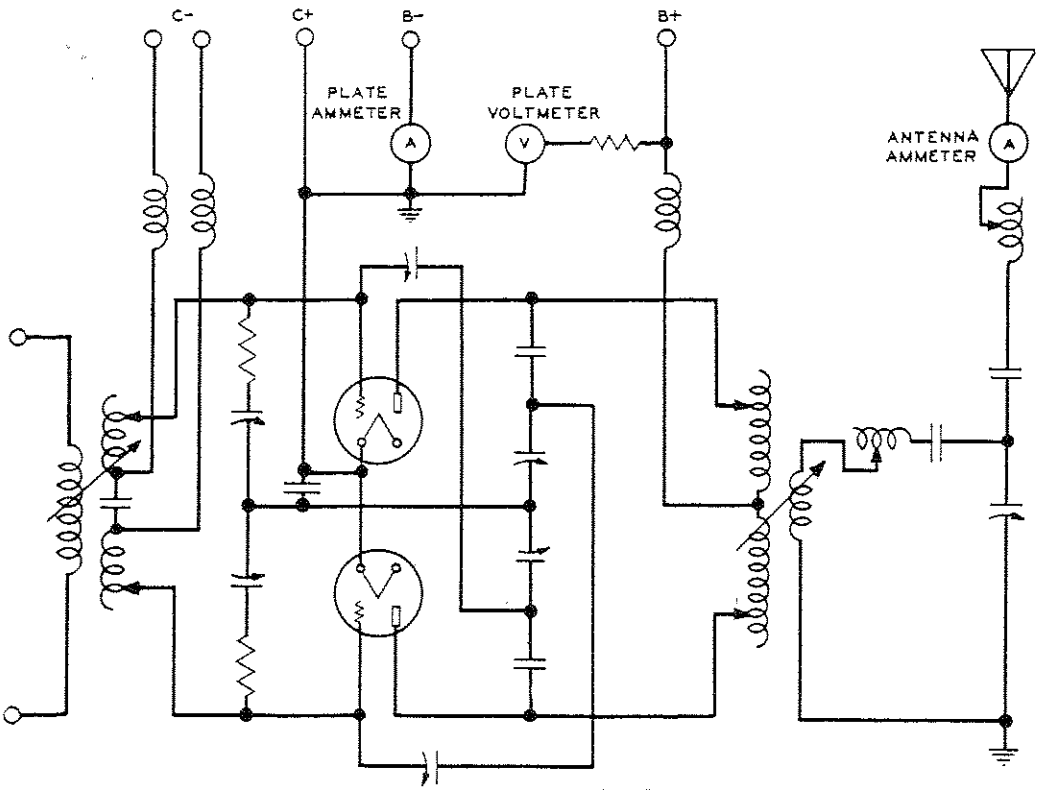
The use of an artificial antenna for tuning and testing is very desirable in that it keeps the transmitter off the air during these periods, reducing interference with other broadcasting units. It is of particular importance when stations are sharing time. The artificial antenna enables the station operator to "warm up" his transmitter and be ready for immediate transmission when it is time to go "on the air."

Automatic Control Circuits

The automatic starting circuits of the amplifier are arranged so that they will function in conjunction with the starting circuit of the Western Electric 100 watt radio transmitter. When used with radio transmitters which do not embody automatic starting systems, the control circuits of the amplifier may be arranged to act entirely as a self-contained system, furnishing full automatic protection to the amplifier.

Operating Personnel Fully Protected

The outer surface of the cabinet is kept at ground potential. Door switches remove the high voltages from the amplifier when the doors are open. These features provide thorough protection to the operating personnel.



Schematic of the 71 B Amplifier

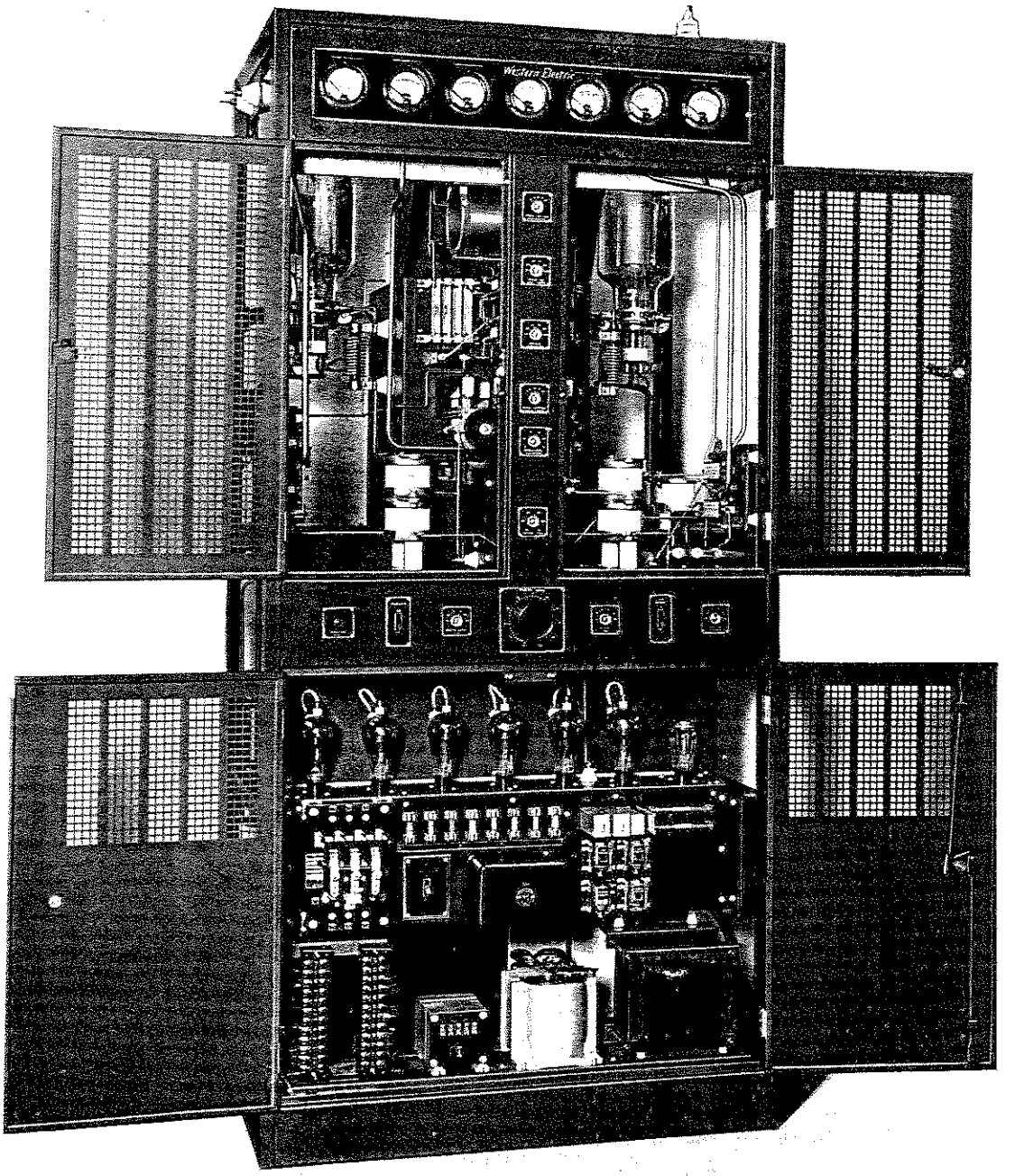
Quality Construction

The Western Electric 71 B Amplifier possesses a quality of design and construction which is a result of years of experience in the manufacture of sound transmission apparatus. It is an outstanding example of the equipment embodying all the latest improvements in its field and is built to the highest standards. It allows expansion of 100 watt stations to 250, 500 or 1,000 watts with very little additional space. It brings to the small station, equipment for increasing facilities to higher power along the most improved and up-to-date lines.

Power Consumption

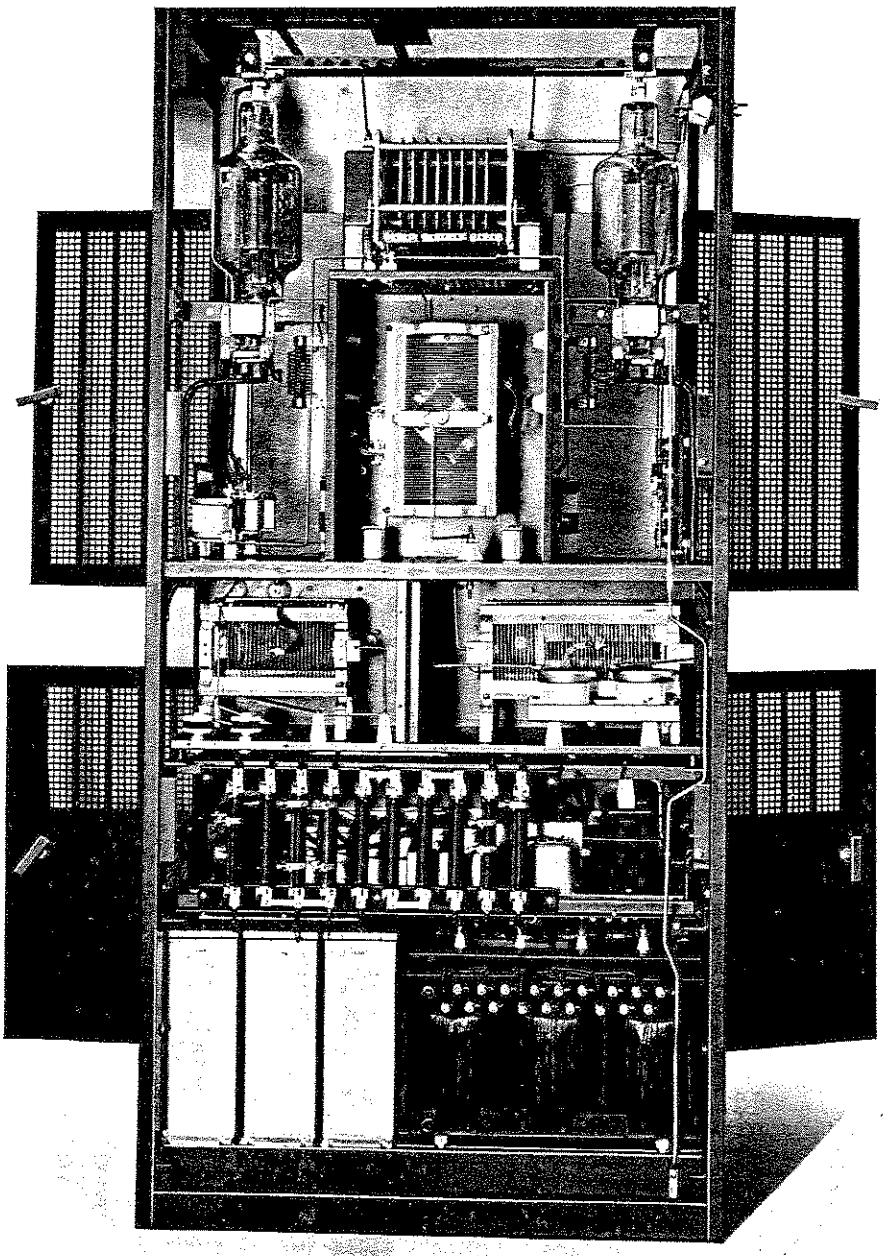
The equipment operates on 220 volts, 50 or 60 cycle, 3 phase power supply. The following table gives the total power required for operation at the three-power output ratings at a power factor of 90%.

Output Rating	*Full Operation*
1,000 watts	4,000 watts
500 watts	2,400 watts
250 watts	1,500 watts



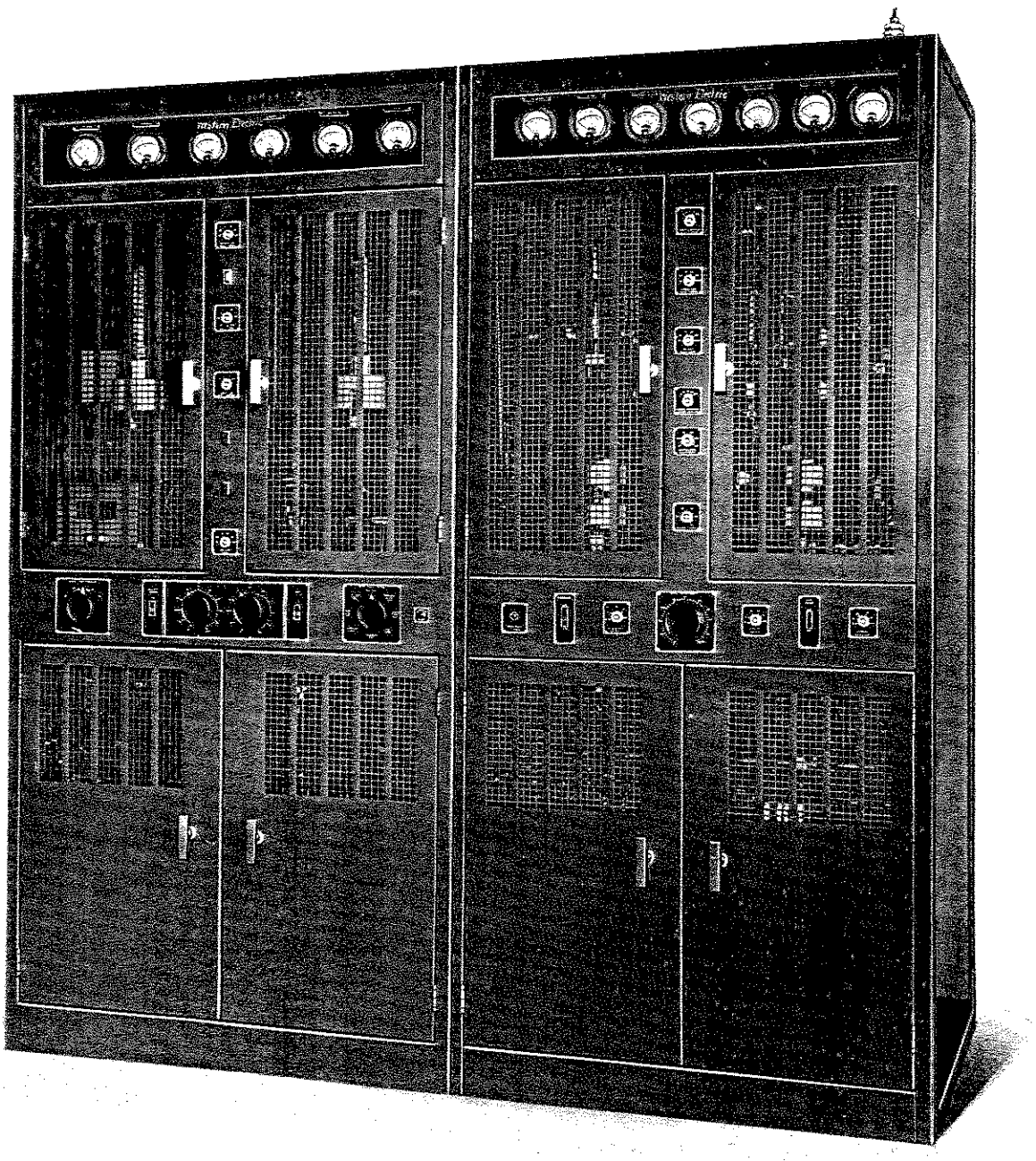
Front View of the Power Amplifier Unit showing the Radio Frequency Circuits in the upper section with the Power Equipment and Rectifier Tubes in the lower section.

ACCESSIBILITY



Rear View of the Power Amplifier Unit with the Back Panel and Shields removed to show the complete accessibility of the equipment.

Adaptability to Common Frequency Broadcasting (Synchronization)



The complete 1,000 Watt Radio Broadcasting Transmitter with the Oscillator Modulator Unit at the left and the Power Amplifier Unit at the right.

DEPENDABILITY

Western Electric

Radio Transmitting Equipment

250 — 500 — 1000 Watts

As mentioned in the preceding pages, the Western Electric 71 B Amplifier and the 100 Watt Radio Transmitter, have a carrier power output of 250, 500 or 1,000 watts. A complete 1,000 watt broadcasting transmitter occupies a section of floor space only 25″ by 72″ or slightly more than 12 square feet.

Vacuum Tube List for 71B Amplifier

The vacuum tubes used for the 71 B Amplifier are as follows:

250 Watts	*500 Watts*	*1,000 Watts*	*Used As*
2—270A	2—251A	2—279A	Power amplifier
6—258B	6—268B	6—258B	Plate voltage rectifier
2—253A	2—253A	2—253A	Grid bias rectifier

Except for these differences in vacuum tubes, the circuit of the amplifier is the same at 250 and 500 watts as it is at 1,000 watts. Adapters are provided for the power amplifier tube sockets to adapt the amplifier unit for 250 watt service.

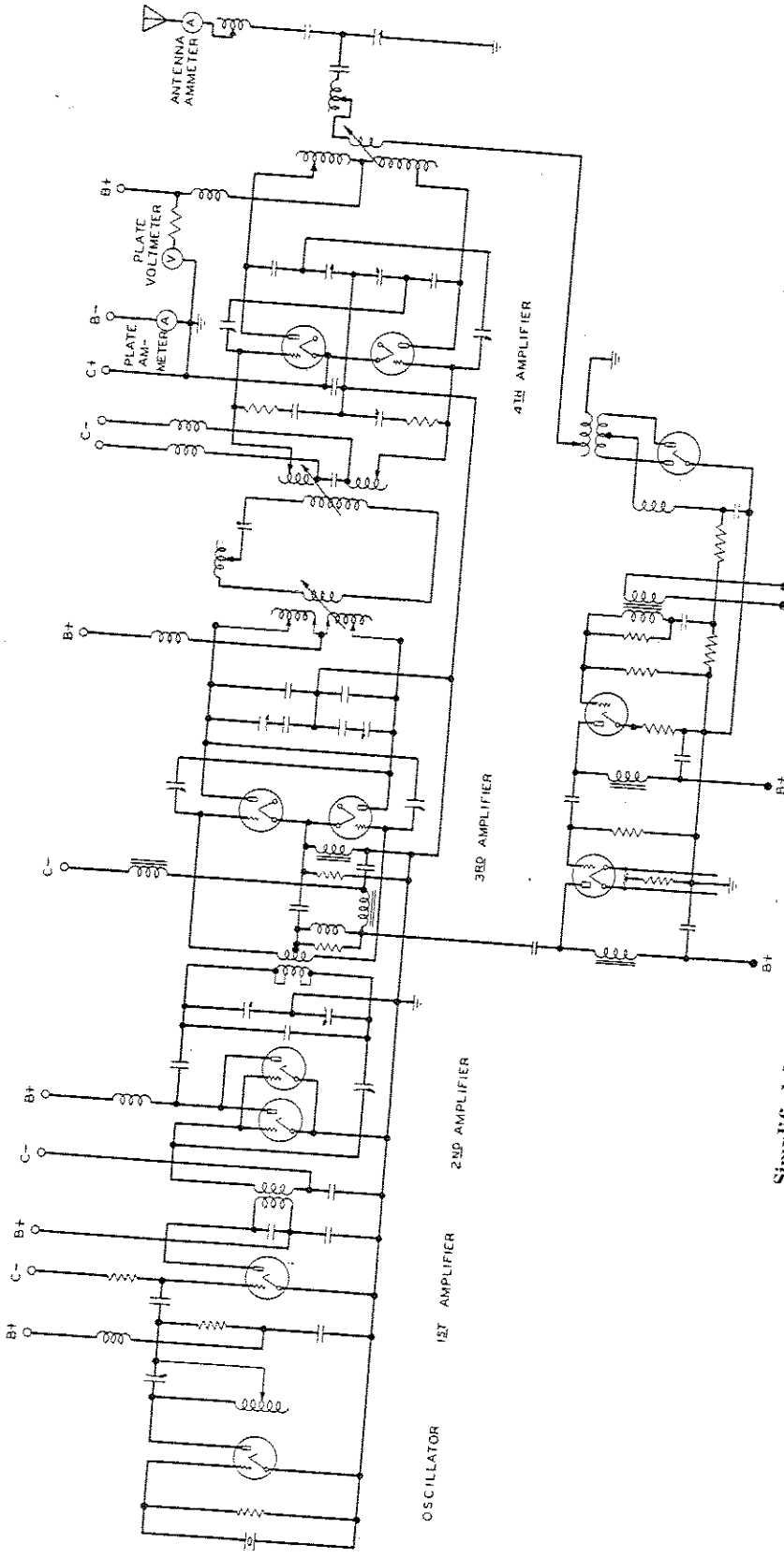
The transformers which supply the filament current are connected with the automatic starting system in the transmitter so that they are activated when the master starting switch in the transmitter is closed. By keeping the high voltage control switch, which is provided in the amplifier closed, all power can be controlled from the radio transmitter, making a full automatic starting system for the entire equipment.

The equipment operates on 220 volts, 50 or 60 cycle, 3 phase power supply. The following table gives the total power required for operation at the three-power output ratings at a power factor of 90%.

Output Rating	*Full Operation*
1,000 watts	5,670 watts
500 watts	4,070 watts
250 watts	3,170 watts

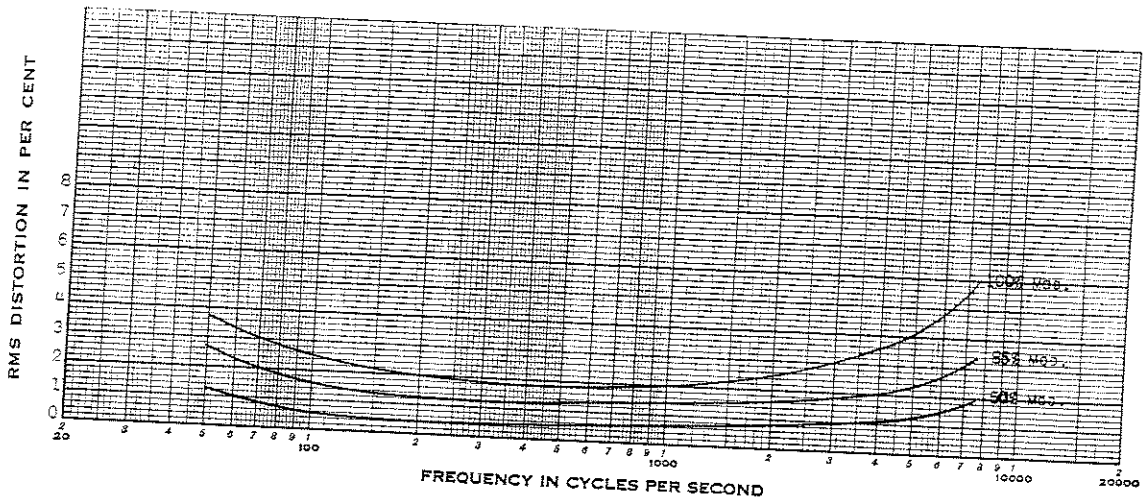
Additional Information

Requests for any information regarding this and other Western Electric radio transmitters and amplifiers should be addressed to the Distributor located nearest to you. A list will be found on the last page of this bulletin.

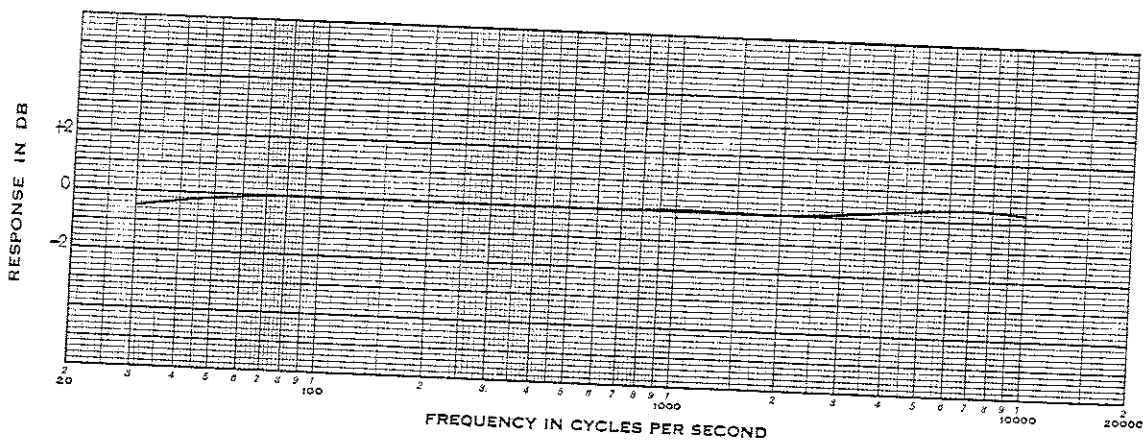


Simplified Schematic of the 1000 Watt Radio Broadcasting Transmitter

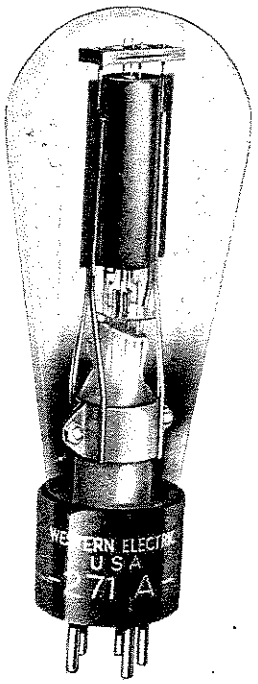
NO ROTATING MACHINERY



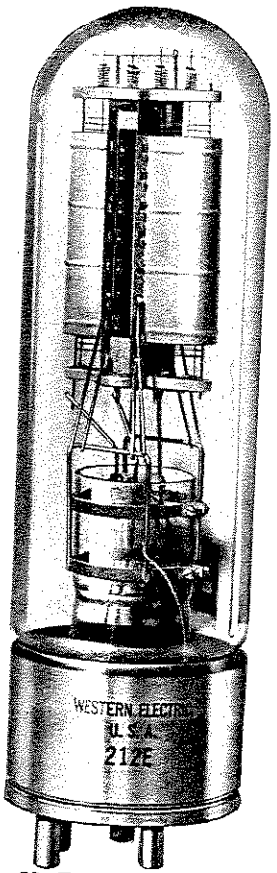
Typical Distortion Characteristics
353 E Radio Transmitting Equipment
1,000 Watts Output



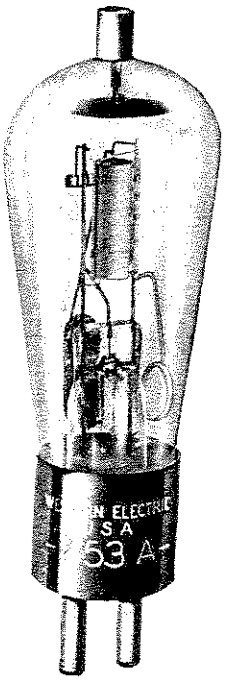
Frequency Response
353 E Radio Transmitting Equipment
1,000 Watts Output



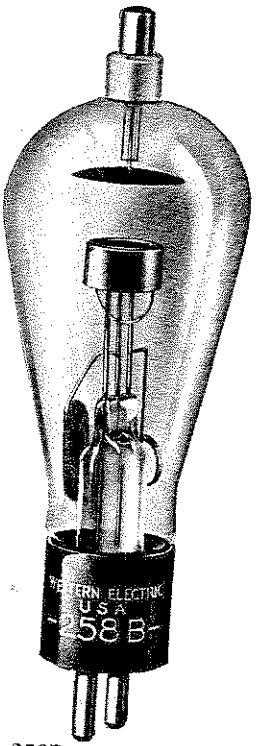
271A—Moderate-power triode with indirectly heated cathode.



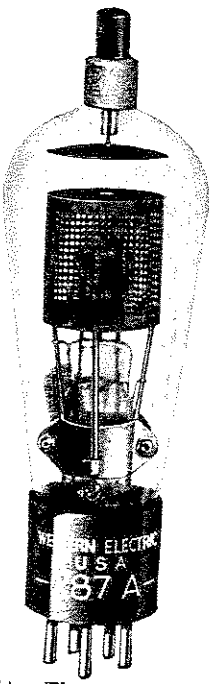
212E—Filamentary air-cooled triode.



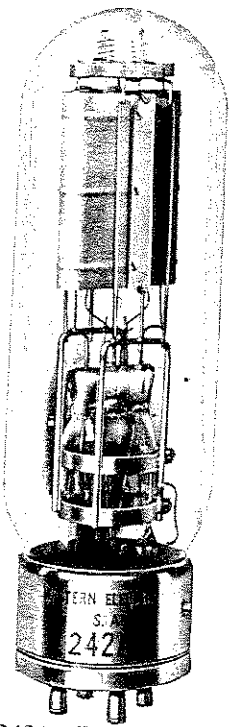
253A—Half-wave, thermionic, mercury-vapor rectifier.



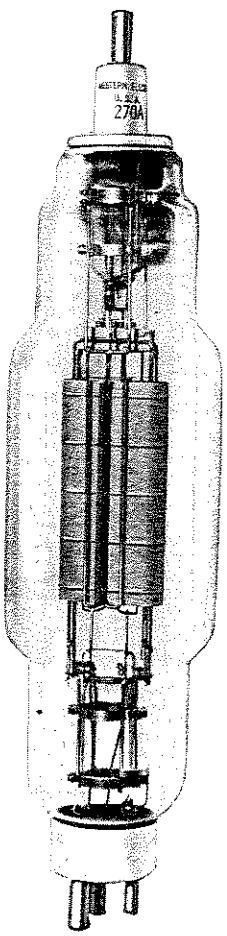
258B—Half-wave, thermionic, mercury-vapor rectifier.



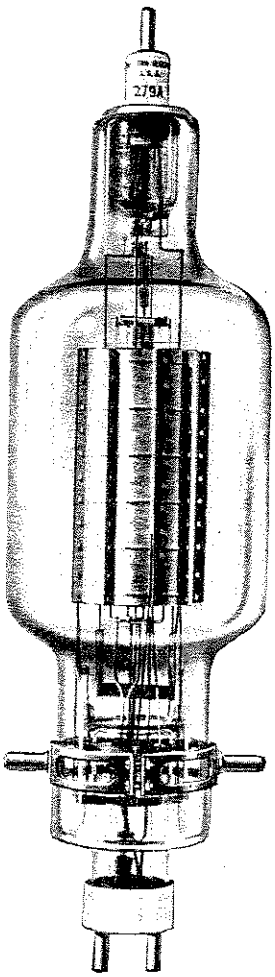
287A—Three element, mercury-vapor filled, grid-controlled rectifier with a filamentary cathode.



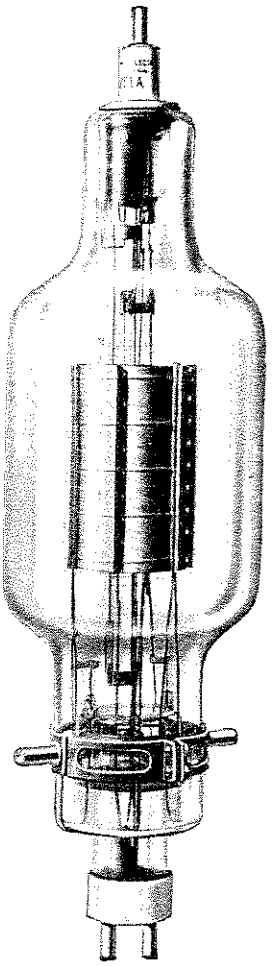
242A—Filamentary air-cooled triode.



270A—Filamentary
air-cooled triode.



279A—Filamentary
air-cooled triode.



251A—Filamentary
air-cooled triode.

Vacuum Tubes used in the 100-1000 Watt Radio
Telephone Broadcasting Equipment