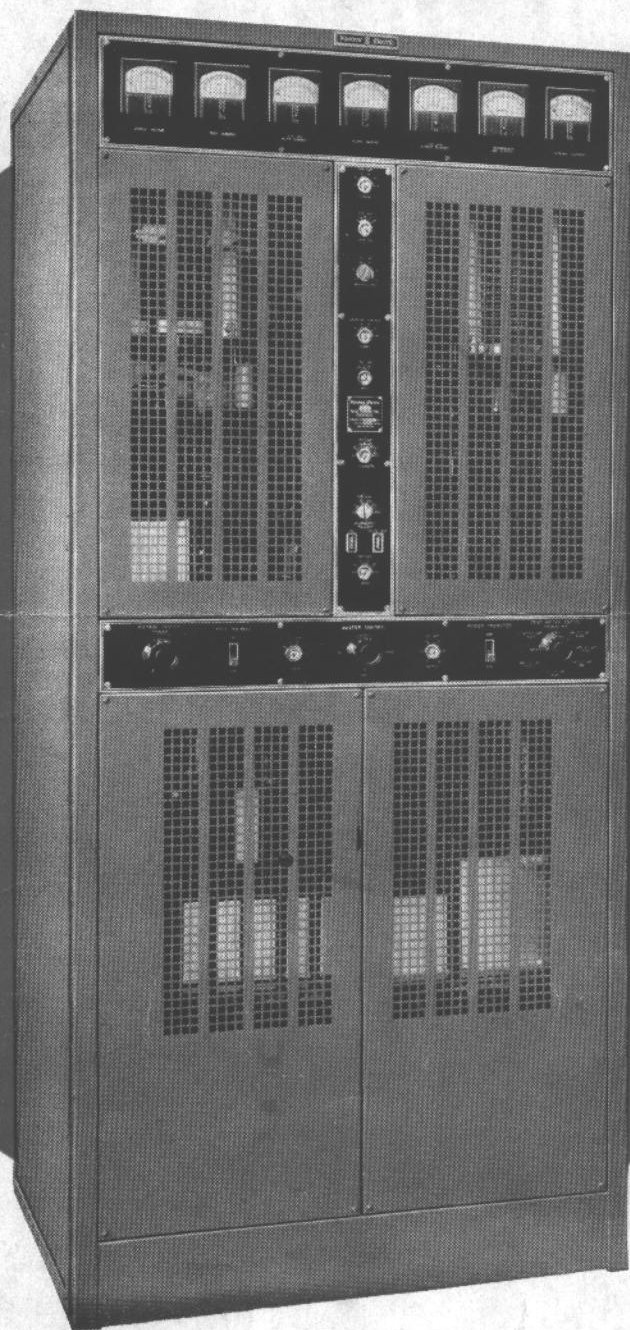
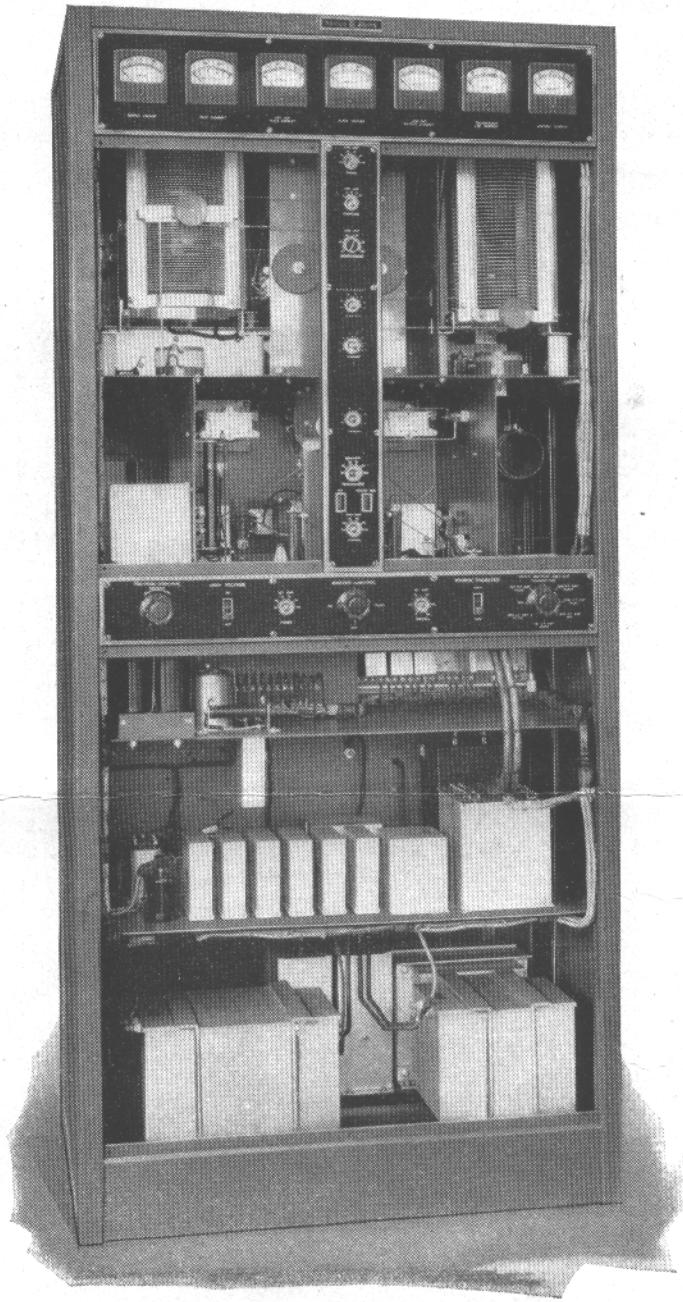


FOR THE
100-250 WATT FIELD



Western Electric



Open—Front View

Copyright 1936 Western Electric Company, Incorporated.
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Western Electric

Radio Transmitting Equipment

310A and 310B

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

The Western Electric 310A (100 watts) and 310B (100-250 watts) Radio Transmitting Equipments have been developed especially to meet the demands of the small station for equipment with a low initial cost and low maintenance expense. These equipments, designed by Bell Telephone Laboratories, are new and are not modifications of existing transmitters. They represent completely new designs. They more than meet all of the proposed high fidelity requirements of the Federal Communications Commission.

The 310A and 310B Equipments consist of the 23A Radio Transmitter and its associated vacuum tubes and antenna coupling equipment, and they differ only in the number of tubes used in the final radio frequency amplifier.

23A RADIO TRANSMITTER

The 23A Radio Transmitter is a 100-250 watt transmitter built to provide reliable, high fidelity performance at minimum expense. One of its outstanding features is an economy of operation not usually found in transmitters of this power. Through the achievement of a high overall efficiency accompanied by the low cost of the smaller type of vacuum tubes which are used throughout, the cost of operation has been reduced to a remarkably low figure. While this transmitter has been designed particularly to fulfill the requirements of the 100-250 watt field, it is suitable for use as a driver for the Western Electric 90A (1000 watt) Amplifier, where an increase in power under existing regulations is assigned to the station at some future time.

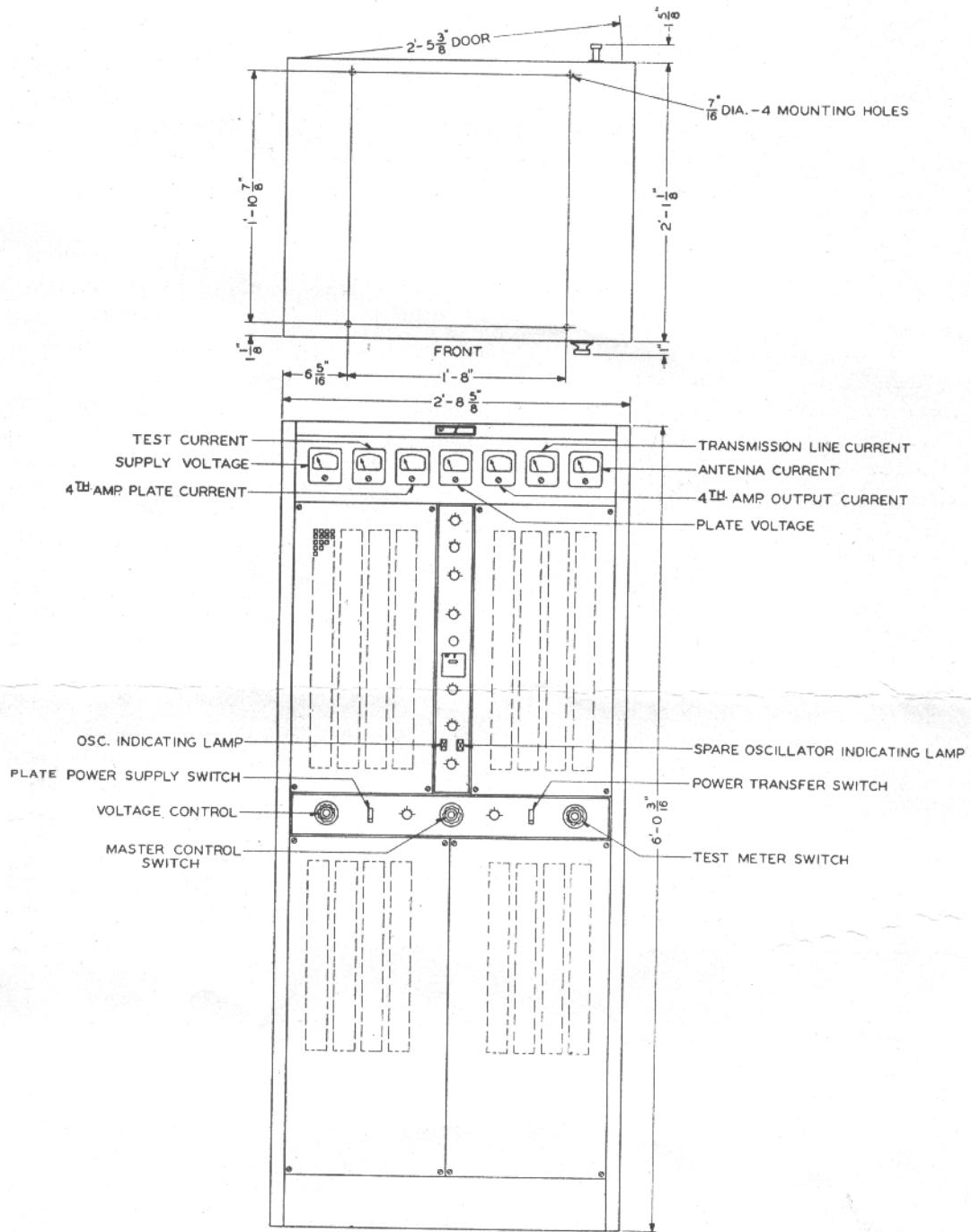
This transmitter is self-contained with the exception of the Antenna Coupling Unit which is furnished separately as a part of the 310A or 310B equipment, and is capable of delivering a maximum of 250 watts, completely modulated carrier at any frequency between 550 and 1600 kilocycles. Normally, it operates from 220 volt single phase 50-60 cycle current. A transformer can be supplied for 110 volt, 50-60 cycle operation where 220 volt current is not available.

Circuit Arrangement

Economical operation and high fidelity performance are the results of the comparatively simple and straightforward circuit arrangement which is used. The circuit consists of a crystal controlled oscillator, a buffer amplifier, a balanced modulating amplifier, followed by two stages of linear radio frequency amplification; a feedback rectifier and a plate voltage rectifier with its associated filter and control circuits. Low level modulation, featured in Western Electric radio transmitters for more than a decade, is employed in this new equipment. Provision is made for heating a spare crystal oscillator.

Western Electric

310A AND 310B RADIO TRANSMITTING EQUIPMENTS—



Outline Dimensional Diagram

DESIGNED ESPECIALLY FOR THE SMALL STATION

There are a number of interesting features in the linear amplifier stages which follow the modulation stage that will be clear from inspecting the schematics on pages 10 and 11. The series condensers between the stages provide a very accurate control of the impedance into which the tubes ahead of them operate. This feature will be appreciated as a distinct improvement over earlier devices that serve the same purpose.

Stabilized Feedback

The new system featuring stabilized feedback, developed by Bell Telephone Laboratories for the reduction of harmonic distortion and noise, enables this transmitter to provide high fidelity performance exceeding by a wide margin the tentative standards of the Federal Communications Commission. A portion of the output from the transmitter is returned to the input in such a manner as to cancel the major part of the distortion and noise products introduced by the amplifier stages.

Grid Modulation

In the 23A Radio Transmitter the modulated stage, driven by a pentode buffer, follows the usual Western Electric practice of modulation by the grid method. Advantage has been taken of the development of special suppressor grid tubes, so that the radio frequency input and the audio frequency input may be easily combined in the tubes, rather than in an external circuit as heretofore.

Control System

A manually operated switch applies the filament and plate voltages to the vacuum tubes. A separate switch may be used to remove only the plate voltage. This arrangement is of great advantage for part time operation, or for testing purposes.

Operating Adjustments

In designing the new transmitter, simplicity has been achieved in adjustments required for initial tuning to an assigned frequency and any maintenance which may be necessary for keeping it in regular operation. The necessary controls are mounted in a novel manner where they can be accurately adjusted while the corresponding meters are being read.

Audio Frequency Response

The audio frequency response characteristic of the 23A Radio Transmitter is flat within less than ± 1 db from 30 to 10,000 cycles.

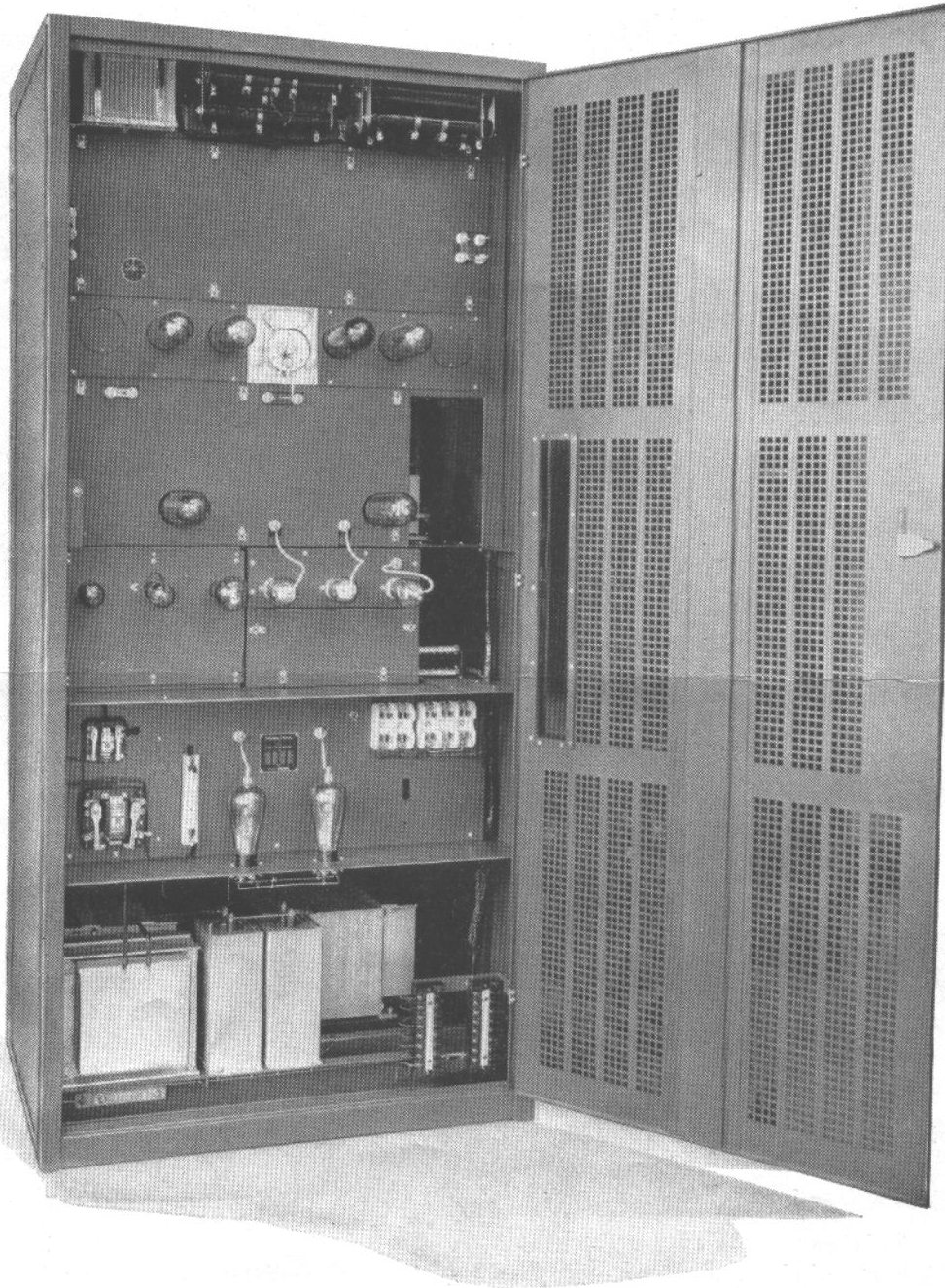
Speech Input Level

This transmitter may be fully modulated with an input level of approximately 6 milliwatts of single tone and a program level of approximately -6 db (into 500 ohms).

Audio Frequency Harmonics

The r.m.s. audio frequency harmonics in the important middle frequency range are less than $2\frac{1}{2}$ per cent at 85 per cent modulation, and less than 5 per cent at 100 per cent modulation.

310A AND 310B RADIO TRANSMITTING EQUIPMENTS—



Rear View of 23A Radio Transmitter showing the unique mechanical arrangement which provides maximum accessibility to the vacuum tubes. Note the monitor observation window in the middle panel of the open door.

Carrier Noise

Due to adequate filtering and the use of the feedback principle, the carrier noise in the case of the 23A Transmitter is approximately 80 db weighted below the signal at 100 per cent modulation and approximately 60 db unweighted below the signal at 100 per cent modulation. The character and amount of noise is independent of operating adjustments and the level is more than sufficiently low to meet the rigorous requirements of high fidelity broadcasting.

Radio Frequency Harmonics

The output circuits incorporated in the 23A Transmitter are sufficiently selective so that no radio frequency harmonic greater than 0.03 per cent of the fundamentals (voltage basis) is present. This corresponds to better than 70 db below fundamental.

Carrier Power Output

If 100 watt and 250 watt operation is desired, six tubes are used in the last radio stage and the output of the transmitter may be changed from 100 to 250 watts or the reverse in a few seconds by front panel adjustments only, and without program interruption. For 100 watt output only, four tubes are employed in the last radio stage and the operating conditions are similar to those when the 250 watt transmitter is operated at 100 watts.

VACUUM TUBES

The 310A and 310B equipments have two full sets of the following vacuum tubes furnished with each equipment.

310A	310B	Used as
1-244A	1-244A	Feedback
1-262A	1-262A	First Audio Amplifier
1-271A	1-271A	Second Audio Amplifier
1-247A	1-247A	702A Oscillator
1-837	1-837	Buffer Amplifier
2-837	2-837	Modulating Amplifier
2-242C	2-242C	Third Amplifier
4-242C	6-242C	Fourth Amplifier
2-249B	2-249B	Plate Voltage Rectifier

Low Tube Cost

With the requirements of the moderate powered station in mind, a tube complement has been selected for this transmitter after extensive tests that represents a new standard of operating economy. A very definite saving has been effected by the use of a larger number of inexpensive tubes rather than a lesser number of larger, more expensive ones. Since the tubes employed are highly standardized and are manufactured in quantity, an unusually low cost for a complement of tubes results.

Crystal Control

A quartz controlled oscillator using a low temperature coefficient quartz plate supplies radio frequency to the buffer stage. This oscillator is newly developed and

includes a number of interesting features. It has a frequency stability variation with temperature of only a few parts per million per degree Centigrade. It is enclosed in an oven in which the temperature is kept constant by a simple thermostat which regulates the amount of current supplied to the heating element from the power line. The use of a low temperature coefficient quartz plate makes it possible to use a simple thermostat, rather than elaborate thermionic control apparatus. A visual thermometer is supplied for temperature observations.

One oscillator is furnished and space is provided for a second. The spare position accommodates a second oscillator and is provided with heater contacts.

Audio Frequency Monitoring

An audio frequency monitoring circuit, operating from the final stage of the transmitter, delivers a satisfactory audio level for station monitoring.

A small coupling coil in the last linear amplifier may be used to connect to a cathode ray oscillograph or other visual monitoring device which the station may wish to use for the purpose of checking the adjustment and operation of the transmitter.

Power Requirements

The transmitter operates normally from 220 volt, single phase, 50-60 cycle power supply. A transformer can be supplied for operation from 110 volt source. The use of the single phase power supply is a convenience in localities where it is sometimes difficult to obtain three phase power.

The typical power consumption for 250 watts output is approximately 2300 watts and for 100 watts output approximately 1900 watts at a power factor of about 90 per cent.

All power equipment is situated in the lower part of the transmitter cabinet.

Protective Features

The exterior of the transmitter is electrically dead and the opening of the full length door on the back of the cabinet releases a safety switch which disconnects all high voltage from the equipment, thus affording protection to the operating personnel. This transmitter fully complies with Rule 132 of the Federal Communications Commission regarding good engineering practice.

GENERAL MECHANICAL DESIGN

The equipment is compactly assembled in a sturdy metal cabinet, attractively finished in aluminum gray. Its general appearance is similar to the larger transmitters manufactured by the Western Electric Company. This cabinet is provided with a single hinged door in the rear which provides access to all apparatus and vacuum tubes. The cabinet is also provided with four removable panels on the front, two side covers and a top cover which are fastened to the frame by screws and may be readily removed for access to all parts of the transmitter. The rear door, the four front panels, and the top of the cabinet are perforated to allow inspection of the apparatus in the interior and also to permit ventilation. All of the radio frequency coils and condensers are in adequately shielded compartments and are easily accessible for adjustments, from the rear

4524
Project 2000 or
964
1230 KC
200
10%

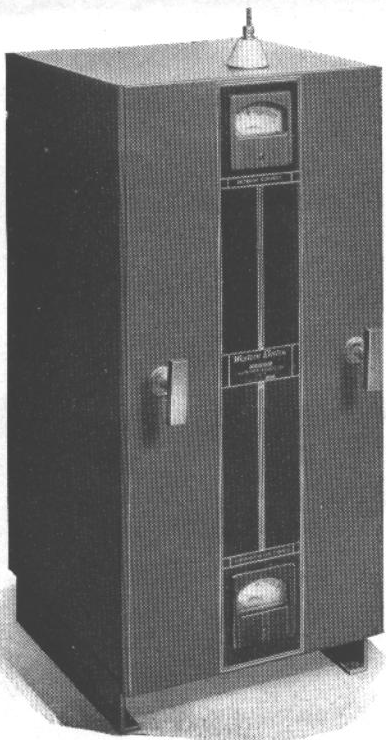
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of the transmitter. The vacuum tubes are mounted on shelves and are completely accessible from the rear of the cabinet.

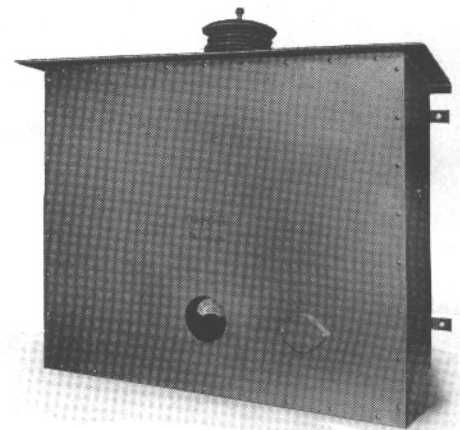
Tuning meters are conveniently grouped across the top on an etched metal designation panel, which lends a distinctly modern touch. Meters are provided so that a total of fourteen current and voltage conditions in various parts of the transmitter circuit may be continuously observed.

ANTENNA ARRANGEMENT

The transmitter is designed to work through a concentric transmission line into either a D-97008 Antenna Coupling Unit or a D-99419 Antenna Coupling Unit. The D-97008 Unit is used with a base-insulated antenna. The D-99419 Unit is intended for use with the shunt excited (base grounded) type of antenna. Either Coupling Unit may be mounted conveniently near the antenna entrance bushing in installations where no external transmission line is required. When the antenna is remotely located, the Coupling Unit is installed out of doors near the antenna, and the transmission line extended from the transmitter to the Coupling Unit. Protection from the weather is necessary in out-door installations, and in the case of the D-97008 Antenna Coupling Unit may be provided in the form of the KS-7557 cabinet which must be ordered separately. The housing of the D-99419 Antenna Coupling Unit is designed to be weatherproof and the unit may be mounted out of doors without additional protection. No change in antenna coupling equipment is required for up to and including 1000 watt operation in the case of the D-97008, or 500 watts in the case of the D-99419, thereby affording a material saving, should it be decided to increase power later.



←
Front view of D-97008 (series) Antenna Coupling Unit. For inside use in connection with insulated antenna. For outside use this unit should be housed in a KS-7557 weatherproof cabinet which must be ordered separately.



Front view of D-99419 Antenna Coupling Unit. (Weatherproof cabinet, for inside or outside use in connection with grounded antenna.)

A switch in the transmitter enables the operator to transfer the output from the artificial antenna load (included in the transmitter) to the transmission line.

4524
input 2000 watt
2000
108
1120 KC

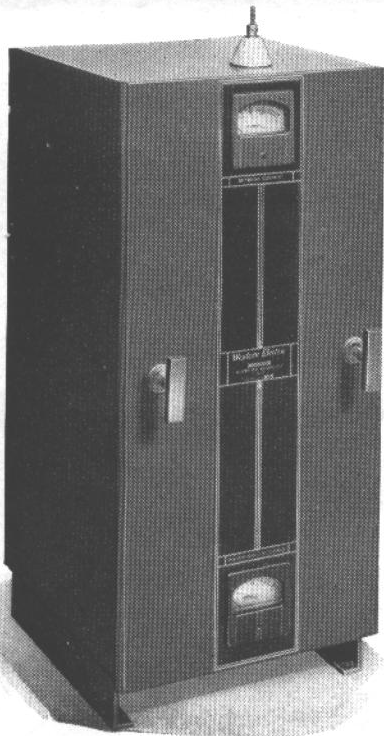
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of the transmitter. The vacuum tubes are mounted on shelves and are completely accessible from the rear of the cabinet.

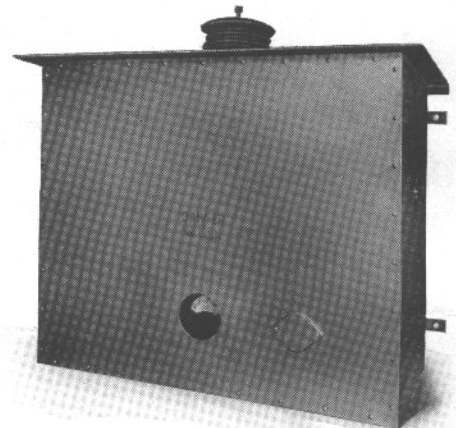
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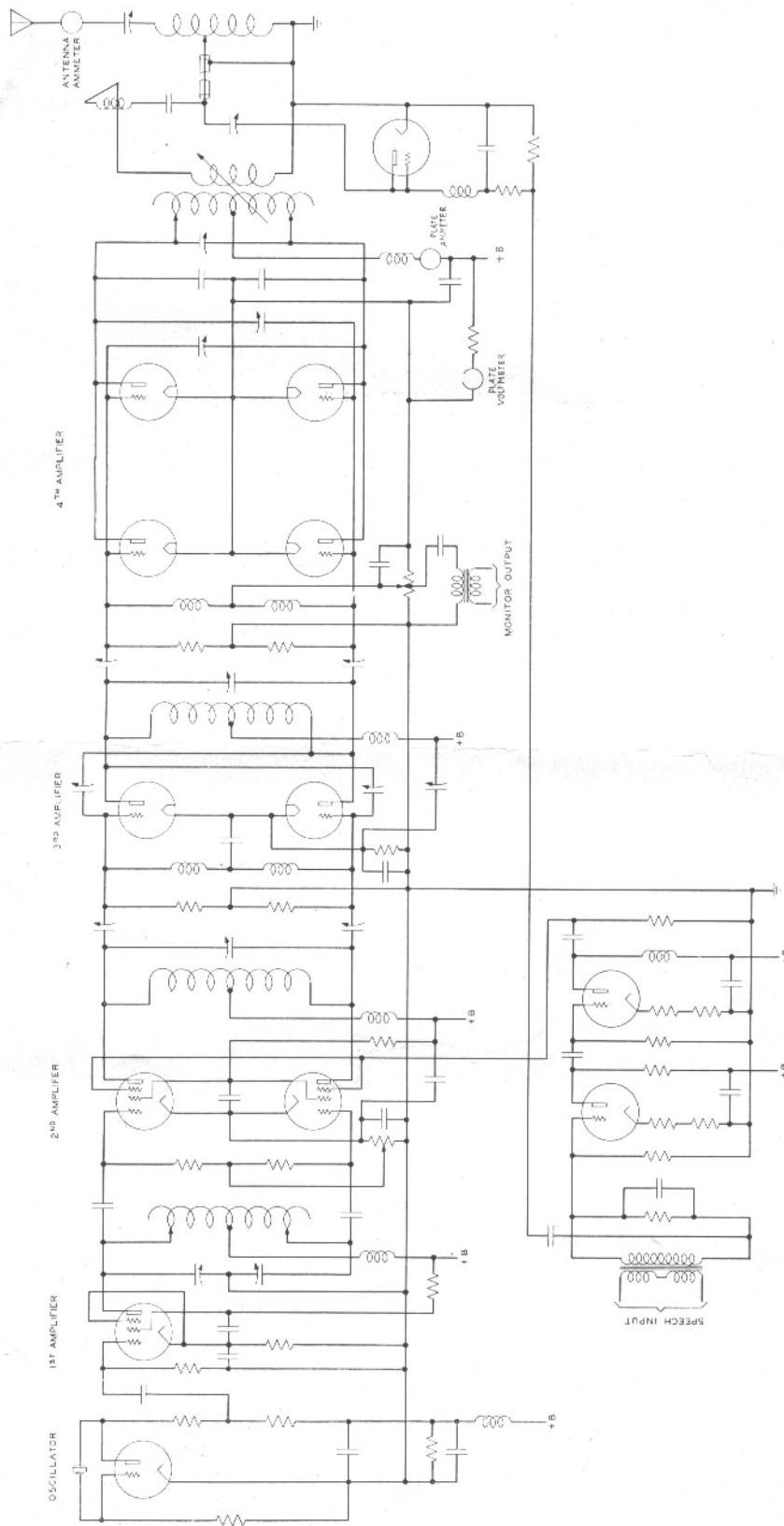
←
Front view of D-97008 (series) Antenna Coupling Unit. For inside use in connection with insulated antenna. For outside use this unit should be housed in a KS-7557 weatherproof cabinet which must be ordered separately.



Front view of D-99419 Antenna Coupling Unit. (Weatherproof cabinet, for inside or outside use in connection with grounded antenna.)

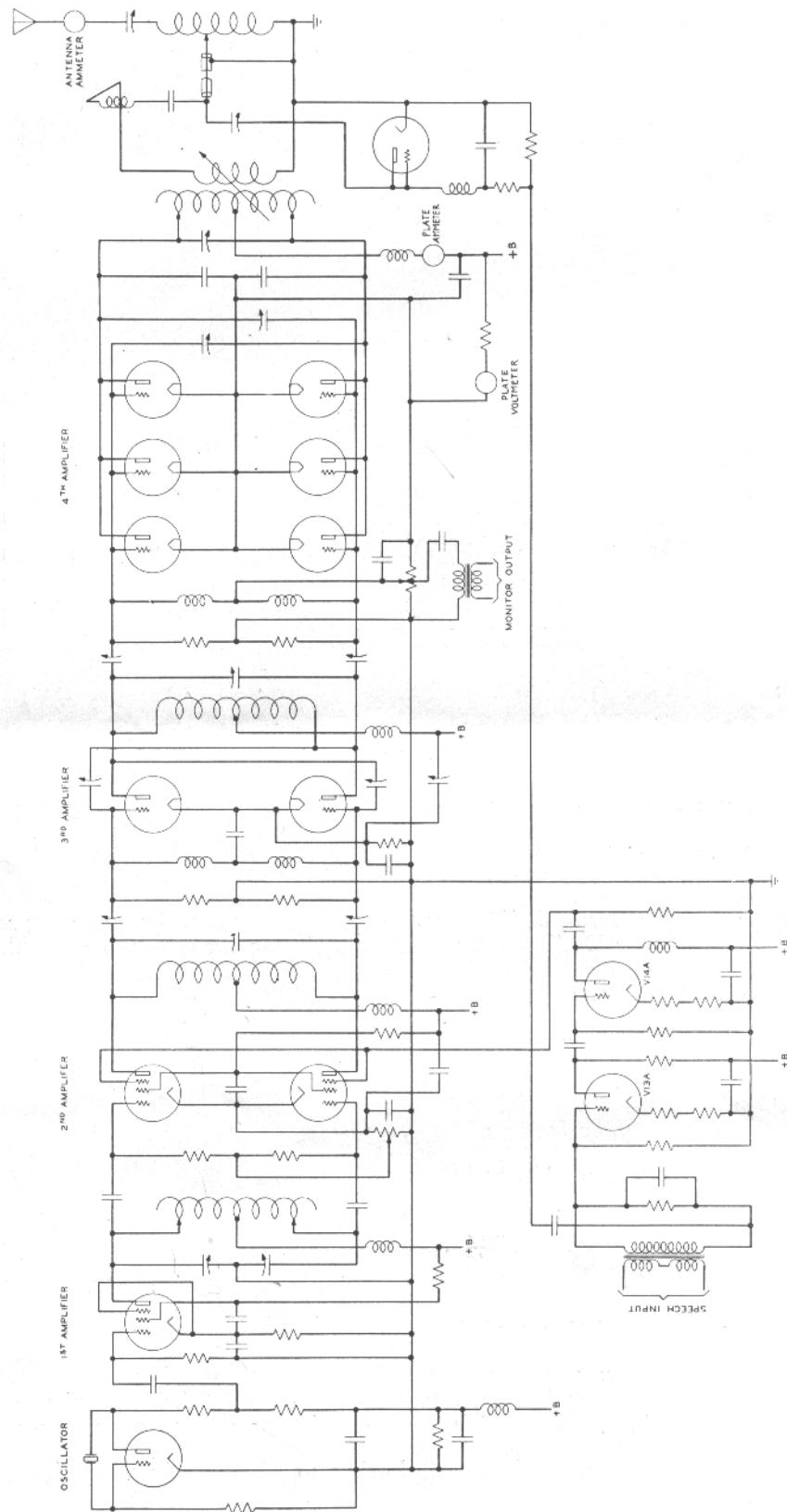
A switch in the transmitter enables the operator to transfer the output from the artificial antenna load (included in the transmitter) to the transmission line.

310A AND 310B RADIO TRANSMITTING EQUIPMENTS—



Simplified Schematic of 310A Radio Transmitting Equipment

DESIGNED ESPECIALLY FOR THE SMALL STATION



Simplified Schematic of 310B Radio Transmitting Equipment

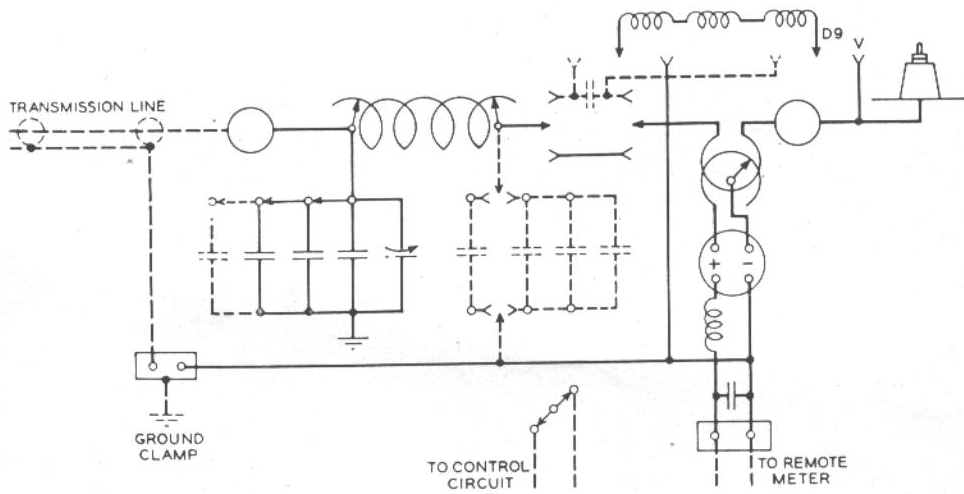


Figure 1—Schematic.
Schematic Diagram, D-97008 Antenna Coupling Unit

GENERAL FEATURES

Equipment:	310A 100 watt and 310B 250 watt Radio Transmitting Equipments (main unit 23A Radio Transmitter).
Type:	Radio broadcasting—high fidelity.
Frequency Range:	550 to 1600 kilocycles.
Carrier Power Output:	100–250 watts.
Power Supply:	220 volt 50/60 cycle, single phase. Mounting space is provided for 110/220 volt transformer if only 110 volts are available. For 110 volt operation, transformer is not furnished and is additional.
Operation:	All AC.
Typical Power Consumption Data:	2300 watts for 250 watts output. 1900 watts for 100 watts output. Power factor of 90%.
Assembly:	Single unit, self-contained cabinet.
Overall Dimension:	2'8" wide by 6'0" high by 2'3" deep. Rear door requires clearance space 2'5½".
Weight:	Approximately 1000 lbs. Shipping weight approximately 1275 lbs.
Cooling System:	Radiation cooled.
Control System:	A master control switch, manually operating, applies the filament and plate voltages to the vacuum tubes. A separate switch is provided which may be used to remove only the plate voltage.
Antenna:	Any normal antenna having a resistance above 10 ohms.

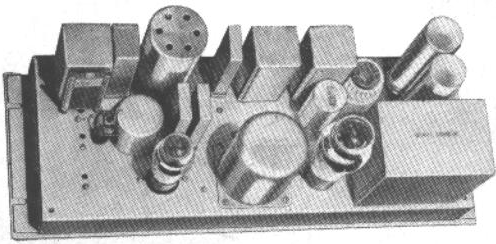
ELECTRICAL CHARACTERISTICS

Frequency Response:	Flat within ± 1 db from 30 to 10,000 cycles.
Speech Input Level:	About 6 milliwatts, single frequency. Program level is about -6 db (into 500 ohms).
Program Level Range:	More than 60 db.
Stabilized Feedback:	The Western Electric Company's new system for the reduction of harmonic distortion and noise provides high fidelity performance which exceeds by a wide margin the tentative standards of the Federal Communications Commission.
Distortion:	RMS Audio Frequency Harmonics in middle range is less than $2\frac{1}{2}\%$ at 85% modulation, and less than 5% at 100% modulation.
Efficiency in Final Stage:	$33\frac{1}{3}$ per cent.
Noise Level:	Approximately 80 db weighted below the signal at 100 per cent modulation. Approximately 60 db unweighted below the signal at 100 per cent modulation.
Harmonic Radiation:	No radio frequency harmonic greater than 0.03 per cent of the fundamental is present. This corresponds to better than 70 db below fundamental.
Method of Modulation:	Low level modulation by the grid bias method.
Modulation Capability:	100 per cent modulation.
Frequency Stability:	Carrier frequency maintained to well within 10 cycles of the assigned frequency by means of low temperature controlled coefficient quartz plates.

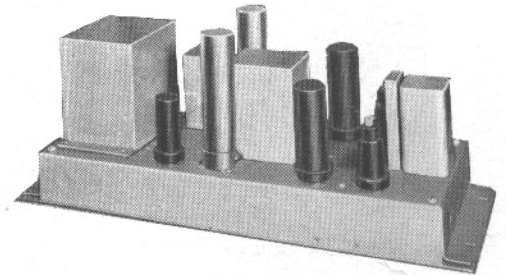
FOR FURTHER INFORMATION

Further information regarding this and other Western Electric radio telephone broadcasting equipment may be obtained from any distributor listed on the last page of this bulletin.

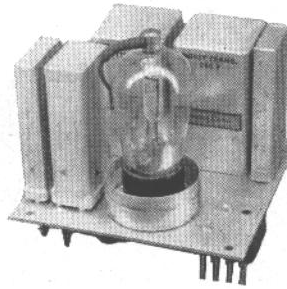
RECOMMENDED ASSOCIATED EQUIPMENT



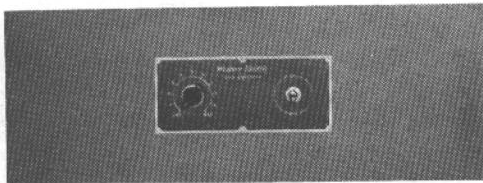
106A Amplifier



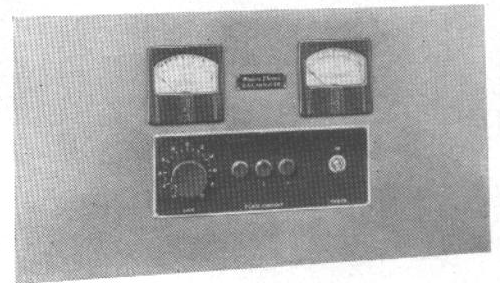
94C Amplifier



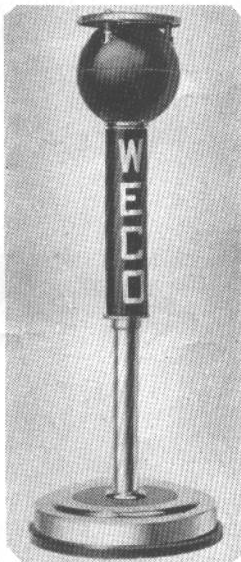
104A Amplifier



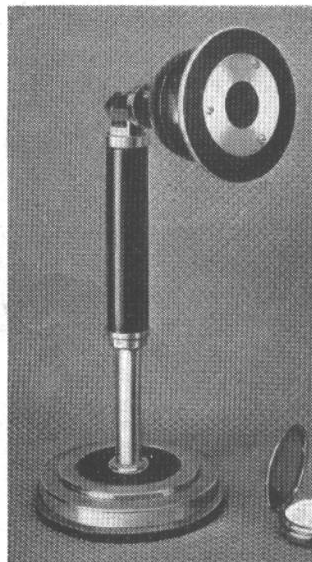
94D Amplifier



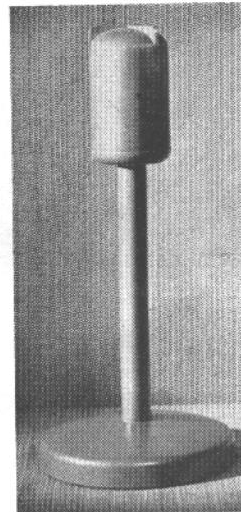
105A Amplifier



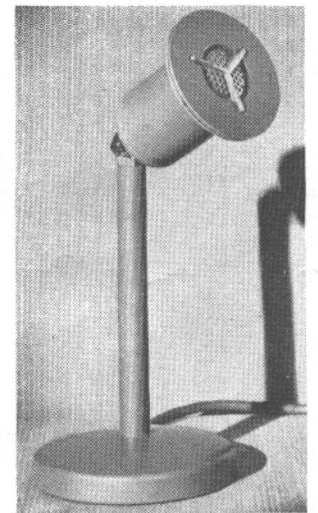
630A Microphone
Table Mounting



630A Microphone
with Acoustic
Baffle
for Directional Pickup

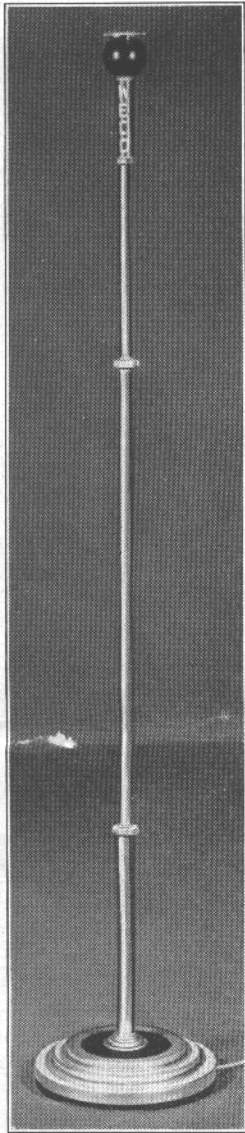


633A Microphone
with Table Mounting
Fixed Non-directional
Position

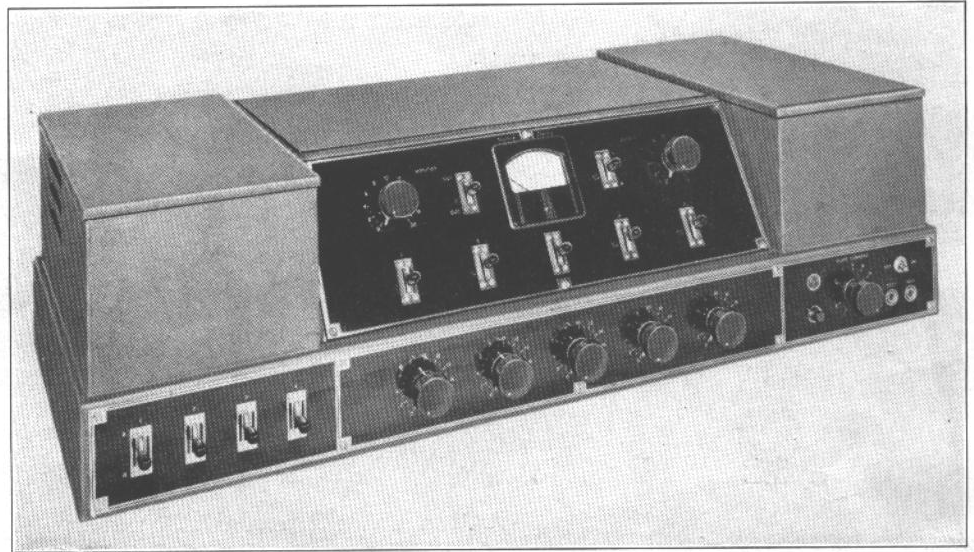


With Tilting
Attachment and Acoustic
Baffle for Directional Effect

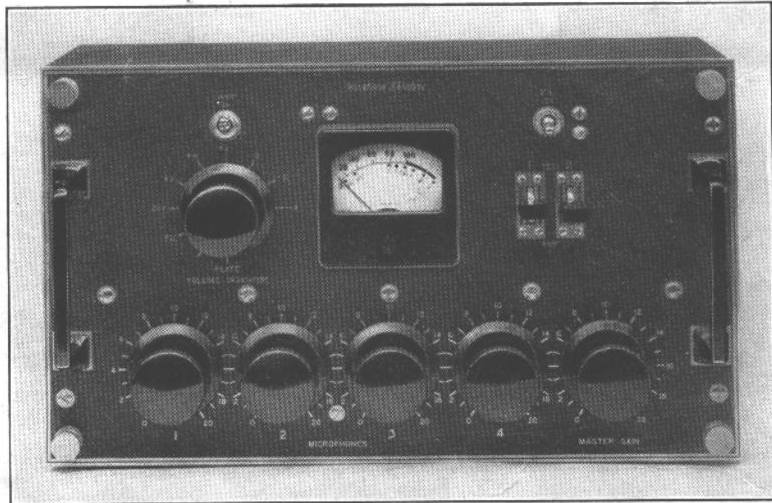
RECOMMENDED ASSOCIATED EQUIPMENT (Continued)



630A Microphone
with floor stand



23 Type Speech Input Equipment



22 Type Portable Speech Input Equipment

IMPORTANT

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 permit and license to authorize construction and operation thereof.

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