RADIO TELEPHONE BROADCASTING EQUIPMENT

105-C

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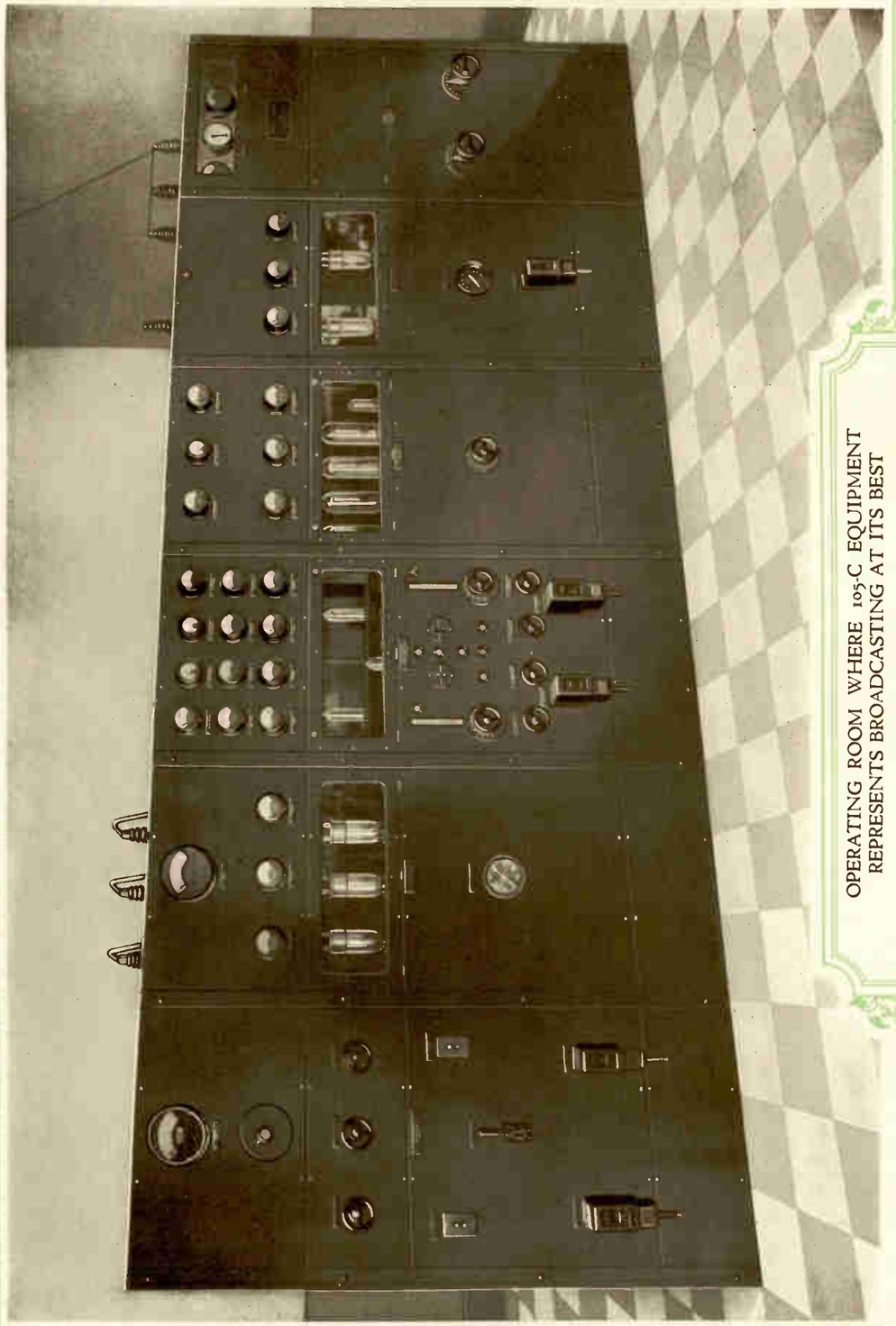


OPERATING ROOM WHERE 105-C EQUIPMENT REPRESENTS BROADCASTING AT ITS BEST

Panels from left to right: A C Power Panel Unit, Rectifier Unit, Oscillator Unit, Amplifier Unit, Power Amplifier Unit, Tuning Unit

Western Electric

No. 105-C Radio Telephone Broadcasting Equipment

(5 Kilowatt)

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

SINCE the inception of radio broadcasting, Western Electric Radio Telephone Broadcasting Equipment has maintained its leadership in the field.

More than 150 leading broadcasting stations, whose equipment is entirely that of the Western Electric Company, have given continuously dependable and highly gratifying service to operators and public alike in every part of the country under every broadcasting condition, variation and requirement.

Continuous research and development, based upon extensive field work and comprehensive laboratory experimentation provide the purchaser with the finest broadcasting equipment at the outset and then make it possible to keep that equipment constantly up-to-date by improvements which become available as completed.

Adding to this, Western Electric's reputation for quality in craftsmanship and in performance, there is now offered in the new 5 kilowatt Western Electric No. 105-C Radio Telephone Broadcasting Equipment, apparatus designed and constructed under the most exacting supervision and adhering in every detail to the requirements of modern radio engineering.

Moreover, this Broadcasting Equipment not only incorporates the desirable features of its predecessors but also improvements developed in the interim.

MODULATION IS DOUBLED

Heretofore, something less than 50% modulation has been the maximum generally attainable in broadcasting equipment. Even on that basis West-

ern Electric Radio Broadcasting Equipment always has been recognized for its wide range and high quality in transmission.

But now in the No. 5-C Transmitter, double the amount of modulation is attained, quadrupling the effectiveness of the equipment.

The low level system of modulation employed in the No. 5-C Transmitter has overcome the limitation to substantially complete modulation—and this, be it remembered, without added expense for operation or equipment and without the use of an added number of modulator tubes, or the use of large modulator tubes.

When the high level modulation system is employed, a considerable number of large and expensive tubes are required to obtain comparable results. The new arrangement is therefore not only a better engineering solution but is a noteworthy contribution toward decreased cost of operation.

Complete List of Tubes Used in No. 5-C Transmitter

Oscillator Unit

*1—D-86737 Tube (50 watt)
*2—211-D Tubes (50 watt)
2—102-E Tubes

Amplifier Unit

*4—212-D Tubes (250 watt)
*1—211-D Tube (50 watt)

Power Amplifier Unit

*2—220-B Tubes (10 kilowatt)

Rectifier Unit

3—222-A Tubes (Rectifier Tubes)

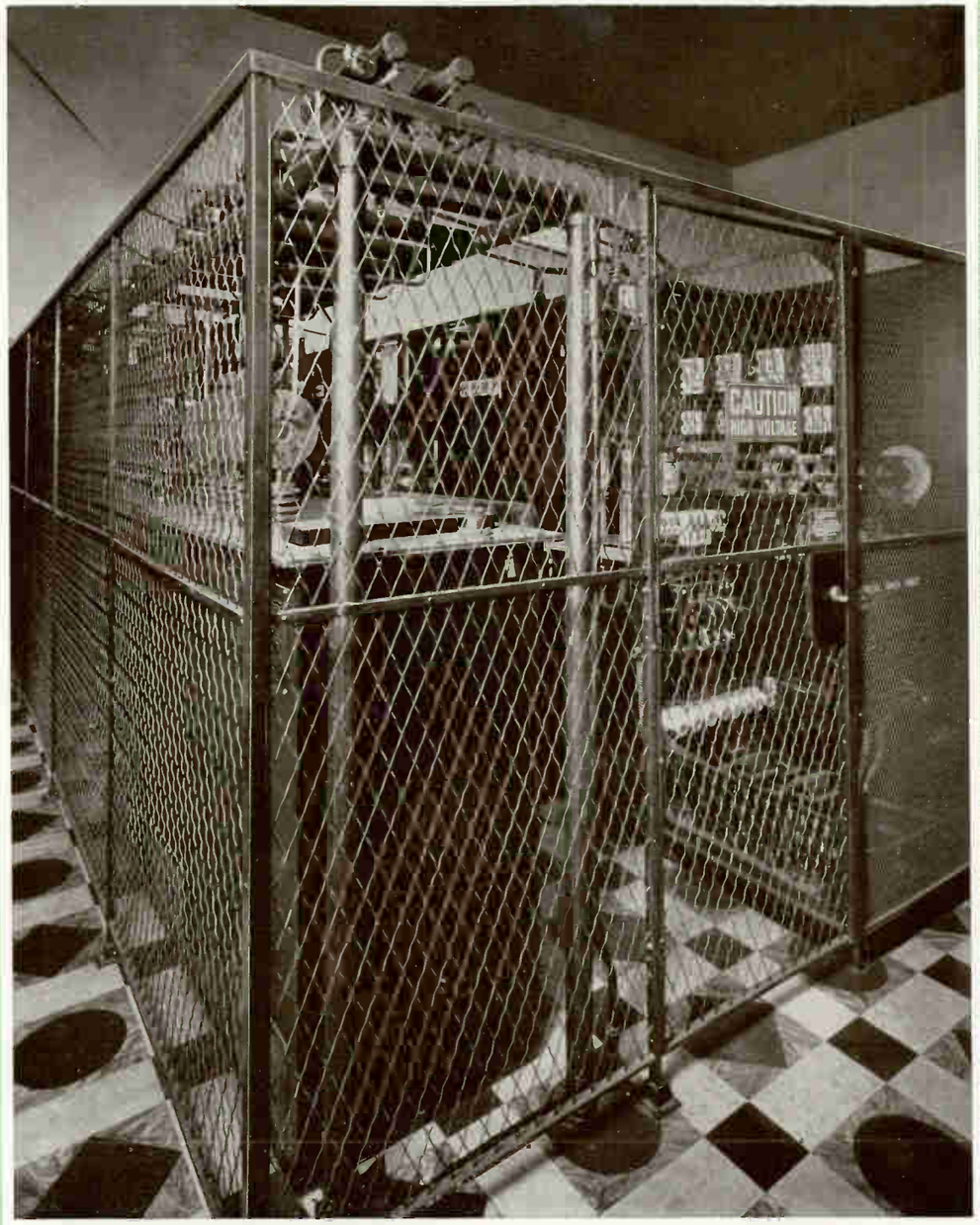
Tuning Unit

1—211-D Tube (50 watt)
(for monitoring rectifier)

Tubes have a guaranteed life of 1000 operating hours. The experience of many station operators over a period of years, however, indicates that

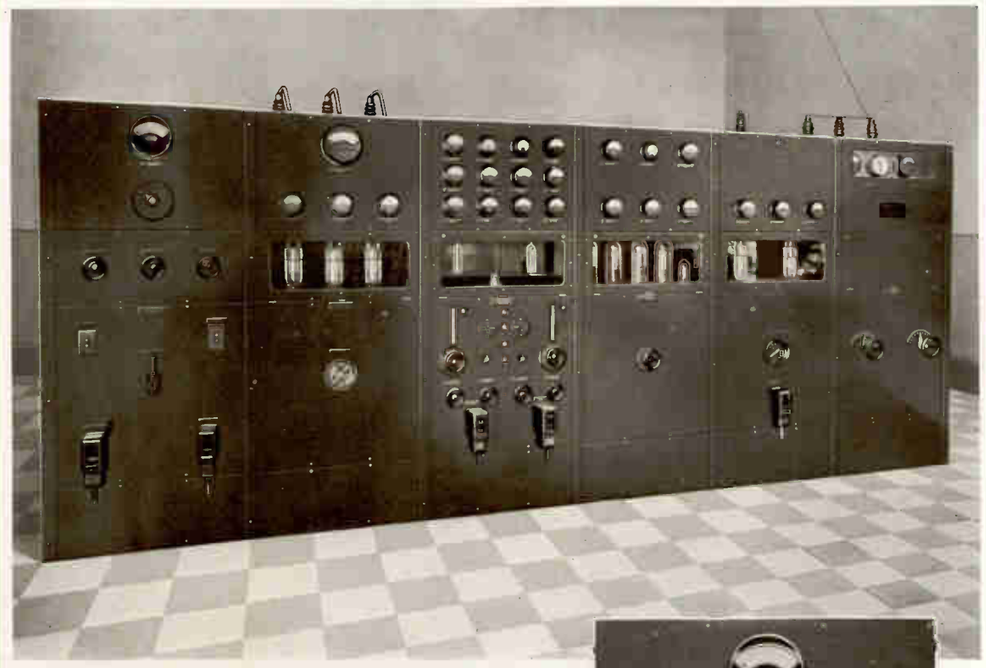
[Text continued on page 8]

** Oscillators or Amplifiers. Tubes preceded by an asterisk are so identified to show that no additional tubes are required to obtain double the amount of modulation.*



A wire mesh fence around the sides and back of the transmitter and dead front panels assure absolute protection from high voltages. Opening the face of a panel or entering the door in the mesh fence automatically shuts off all power, so that an operator may make repairs or adjustments without the slightest danger. Pulling a master switch just inside the door prevents high voltage accidents should the door inadvertently be closed

THE PERSONNEL IS PROTECTED AGAINST ACCIDENTAL CONTACT WITH HIGH VOLTAGES BY THE MOST EFFICIENT SAFETY DEVICES



A C POWER PANEL UNIT

This unit, which is served by a 220 volt, 3 phase, 60 cycle power supply, imparts energy to the motor generators, rectifier transformers, pump and blowers for the cooling system, the heater circuit for the crystal enclosing chambers and to other components requiring power from this source. Suitable overload protection and control for associated apparatus is, of course, provided in this unit

RECTIFIER UNIT

The rectifier which supplies 10,000 volts for the water-cooled tubes in the Power Amplifier Unit, is of the 3-phase type and employs three No. 222-A water-cooled Vacuum Tubes as rectifying elements. Their filaments are heated by alternating current at a potential of 21 volts which is stepped down by three single-phase transformers from the 220-volt supply. The transformers also provide suitable insulation between the filaments of the rectifier tubes and the power supply system

Rectifier Tube

The 3-phase transformer steps up the 220-volt 3-phase supply to a voltage of approximately 10,000 to neutral. The rectified 10,000 volt D C is filtered by means of the retardation coil and condenser to smooth out the ripples

2000 to 2500 hours will generally be obtained. Since the cost of tubes is one of the largest single items in the operating expenses of a broadcasting station, a prospective buyer cannot afford to overlook this feature.

The increased modulation attained in the No. 5-C Transmitter has two advantages. First, the signal content of the wave is doubled. Second, the increased modulation results in a 2 to 1 improvement in the signal-to-noise ratio.

The effectiveness of the equipment, therefore, in covering a given area through static and interference is quadrupled. In other words, results obtained are comparable with those to be had with what has been known to date as a 20 kilowatt set. Increased modulation is particularly advantageous under present day broadcasting conditions since it affords means of substantially doubling the range of a given station without a corresponding increase in beat note interference. The difference in operating expense between a 5 kilowatt and a 20 kilowatt set is obvious.

CRYSTAL CONTROL OF FREQUENCY

The insistence of the Government upon adherence to an assigned frequency is met by the crystal controlled oscillator. The inherent stability of this new oscillator insures closer adherence to the frequency for which it is adjusted than can be attained under the most favorable conditions of manual control.

The crystal control facilities in this Transmitter have been developed to an extremely high degree of efficiency.

A Piezo crystal consisting of a small quartz plate about one inch square is used. Its faces are accurately paralleled and ground to a thickness associated with the frequency of the mechanical vibration required. To assure the utmost degree of reliability a second crystal, an exact duplicate of the first, and complete with container, thermostat and control is provided. Two thoroughly insulated thermostatically controlled containers keep the crystals at a constant temperature so as to assure frequency stability.

With ordinary supervision on the part of the operating force no difficulty will be experienced in maintaining the carrier frequency well within 100 cycles of the assigned frequency. When it is recalled that the carrier frequency may be as high as one and one-half million cycles per second, control within 100 cycles is truly remarkable precision.

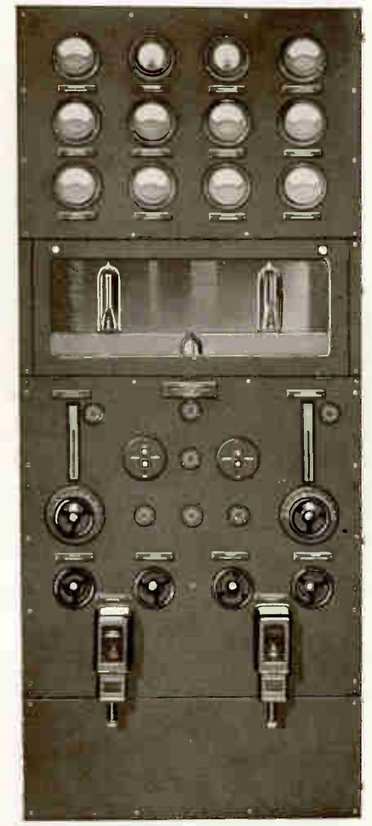
The importance of such precision is apparent because many stations are

[Text continued on page 11]

OSCILLATOR UNIT

This is the unit in which the crystals are located

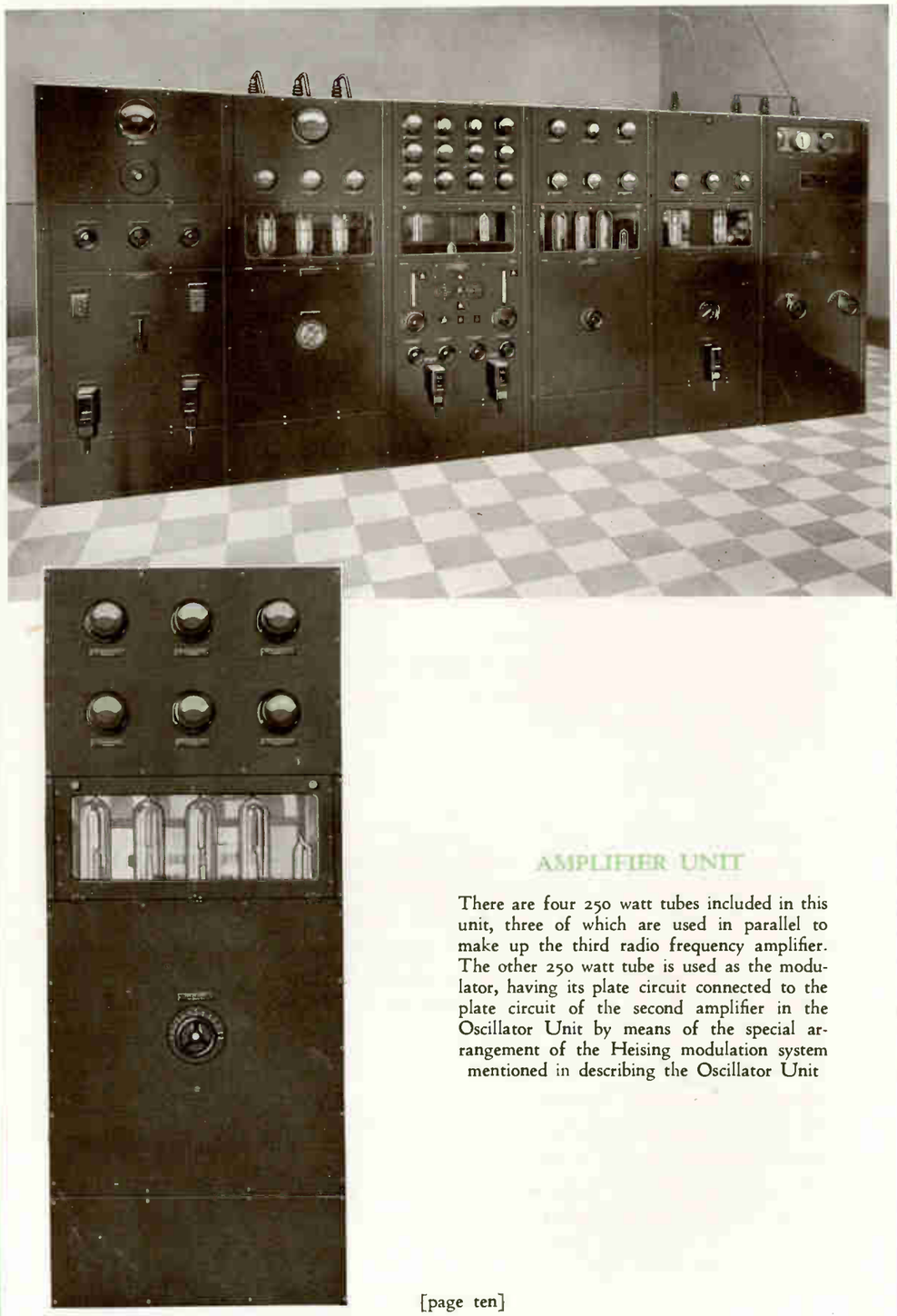
In this transmitter modulation is effected at an early stage. The first and second amplifiers, which are 50 watt vacuum tubes, are mounted in this Oscillator Unit. The first amplifier is tuned and feeds the grid of the second amplifier. The tuned plate circuit of the second amplifier is connected by a modification of the Heising modulation system to the plate circuit of the 250 watt modulator tube mounted in the



amplifier unit. Coupling between the modulating or second amplifier is made by means of a movable coupling coil operated from the panel, permitting a continuously variable adjustment of the power output

The Oscillator Unit also contains the D C power control apparatus, and the system for obtaining from a 250 volt generator the several negative grid voltages required in operating the set

Tube used in Oscillator and Modulator Circuits



AMPLIFIER UNIT

There are four 250 watt tubes included in this unit, three of which are used in parallel to make up the third radio frequency amplifier. The other 250 watt tube is used as the modulator, having its plate circuit connected to the plate circuit of the second amplifier in the Oscillator Unit by means of the special arrangement of the Heising modulation system mentioned in describing the Oscillator Unit

faced with loss of licenses unless close adherence to their assigned frequencies is maintained.

Furthermore, the use of crystal control and an isolating stage between the oscillator and the modulating amplifier prevents frequency modulation and distortion in transmission.

HARMONIC SUPPRESSION

The adequate suppression of harmonics becomes a problem of increasing difficulty as the output power of a transmitter is increased. In the design of the 105-C equipment great care has been taken to insure satisfactory performance in this respect.

A special double tuned circuit and capacity coupling are employed between the last power amplifier stage and the antenna which prevents the effective transfer of harmonic power to the latter.

PROTECTION AGAINST DISRUPTION OF SERVICE

Protective devices have been devised and included for the extra advantages and insurance they afford.

Adequate protection is provided against circuit overloads, partial or complete failure of the cooling system, failure of the grid bias voltage, and various other possible causes of interruption of service.

SAFETY FEATURES

Safety for the operating personnel is essential in a radio transmitter. It is especially important that the danger element in the use of relatively high voltages be eliminated. Thorough consideration has been given to precautionary measures in this equipment. The design affords assurance that injury to the operating personnel through accidental contact with high voltages is practically impossible. The panels are all "dead front." There is no danger of injury from contact with them or with the instruments mounted on them.

Several of the panels are provided with a plate glass window behind which tubes are located for visibility. Should it be necessary to open a window, the act of opening will automatically shut off the current. The windows make all parts located at these points easily accessible for repairs and replacements, while the automatic opening of the circuit eliminates all personal danger from high voltage.

[Text continued on page 14]

Amplifier Tube

POWER AMPLIFIER UNIT

This is the last step of amplification. The output of the Amplifier Unit is received by this unit and amplified to the 5 K.W. level by two tungsten filament water-cooled tubes operated in parallel. Plate potential for these tubes is supplied by the Rectifier Unit at 10,000 volts. Water for cooling these tubes is conducted to the tube jacket by means of a rubber hose

A pressure gauge shows at a glance whether the water circulating system is operating properly

TUNING UNIT

The Tuning Unit housing a closed tuned circuit and a coupling condenser of large capacity provides the means by which the output of the Power Amplifier Unit is transmitted to the antenna. The coupling circuits constitute a filter which minimizes the radiation of all radio frequency harmonics. Provision has been made for all necessary adjustments. The tuning coil is shielded. The arrangement of tuning and coupling condensers makes it possible to operate the transmitter in connection with antennae whose resistances fall within the range of 15 to 600 ohms. Three meters behind the plate glass window in this unit assure very precise adjustment of the output circuits, especially in connection with tuning high impedance antennae.

NO. 560-TYPE LOUD SPEAKING TELEPHONES

Western Electric Loud Speaking Telephones are supplied as part of the monitoring equipment so that the operators may, through the medium of monitoring rectifier in the Tuning Unit, compare the quality of the output of the transmitter with its input. These speakers operate from an amplifier in the speech input equipment. One is located in the radio room, and the other in the control room. In this way, the operating staff are constantly aware of the effectiveness of the programs as broadcast

The equipment behind the panels is entirely enclosed by wire mesh fencing. It is impossible to enter the enclosure except through a door made of the same wire mesh. When the door is opened the circuit is broken and high voltage in the whole system is automatically stopped. An additional safety factor is provided by two manual switches just inside the door which should be opened by the person entering. These switches when opened prevent the high voltages from being applied through error. The set cannot be started while either of these switches is open, nor is it possible to start the set without first closing all of the windows and the door in the fencing.

SIMPLICITY AND EASE OF CONTROL

Simplicity and ease of control are outstanding features of the new 105-C Radio Telephone Broadcasting Equipment. This statement applies particularly to the transmitter as will be verified by the following description.

Pushing a single master control button sets the transmitter in operation. As soon as the contact is made by means of this starting button, a control system is energized, which in turn, by means of time delay relays, automatically applies the voltages in their proper sequence.

This method of procedure is much more rapid and less subject to error than a manual system involving a number of switches. It also guards against damage to equipment should any failure of the cooling system develop. Neither can the operator through negligence or ignorance fail to apply the power in the proper sequence.

COOLING SYSTEM

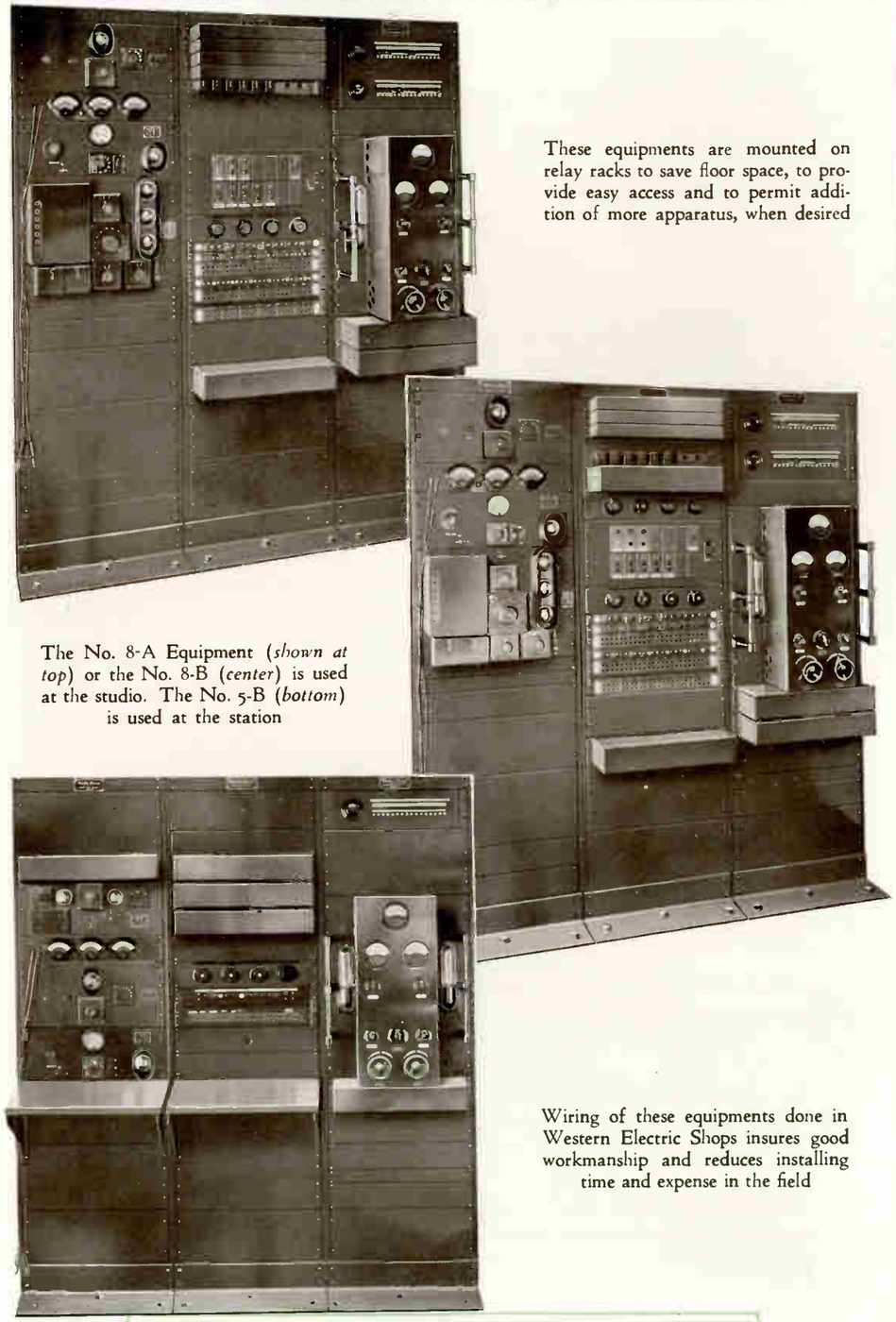
Damage to the vacuum tubes of the Power Amplifier is prevented by an advance type of control of the water cooling system. Should the water cooling system fail for any reason, a water flow operated relay will immediately shut down the set.

SPEECH INPUT EQUIPMENT

Studio Equipments

Good broadcasting practice and government regulation have caused the separation of studios and transmitting stations. Two speech input equipments are therefore required; one at the studio and another at the transmit-

[Text continued on page 17]



These equipments are mounted on relay racks to save floor space, to provide easy access and to permit addition of more apparatus, when desired

The No. 8-A Equipment (*shown at top*) or the No. 8-B (*center*) is used at the studio. The No. 5-B (*bottom*) is used at the station

Wiring of these equipments done in Western Electric Shops insures good workmanship and reduces installing time and expense in the field

SPEECH INPUT EQUIPMENTS

No. 20-A Filter

RADIO RECEIVING EQUIPMENT

To enable the station to comply with government regulations, a radio receiving set is provided with the equipment to pick up distress signals. It is finished to harmonize with the rest of the equipment, is complete with ear phones and capable of receiving signals from a great distance

No. 2-B Tuning Unit

No. 4-D Radio Receiver

No. 20-A Filter is designed to overcome any receiving difficulties arising from proximity to the transmitting antenna

A comprehensive Studio Control System is a part of the No. 8-A and No. 8-B Speech Input Equipments

ting point. The No. 8-A or the No. 8-B is used at the studio and the No. 5-B at the station.

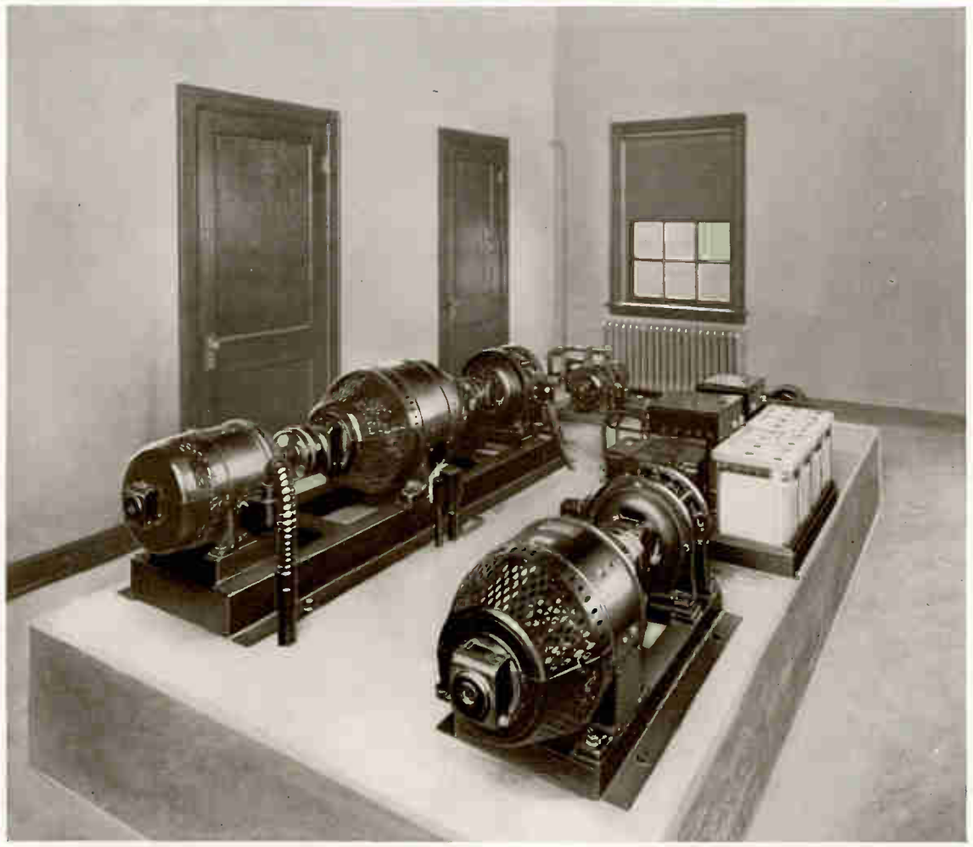
These equipments are mounted on relay racks to save floor space, to provide easy access and to permit addition of more apparatus, when desired. All wiring is done as far as possible in our shops which insures good workmanship and reduces installing time and expense in the field.

Provisions are made for connecting the input of the radio broadcasting system either to the studio transmitter or to circuits from outside pick-up points. The control of this switching is made available to the announcer and also to the control room operator. Suitable provision is made for preventing interference with the control or unauthorized changes in the connections.

Interphone signalling facilities are provided. Arrangement is made also for disconnecting the speech input equipment from the transmitter and utilizing it as a studio announcing system.

Facilities are provided for connecting by means of patching cords any one of six outside program circuits through artificial lines and relays to either one of two switching circuits. Thus either the control room operator or an

[Text continued on page 20]



POWER EQUIPMENT

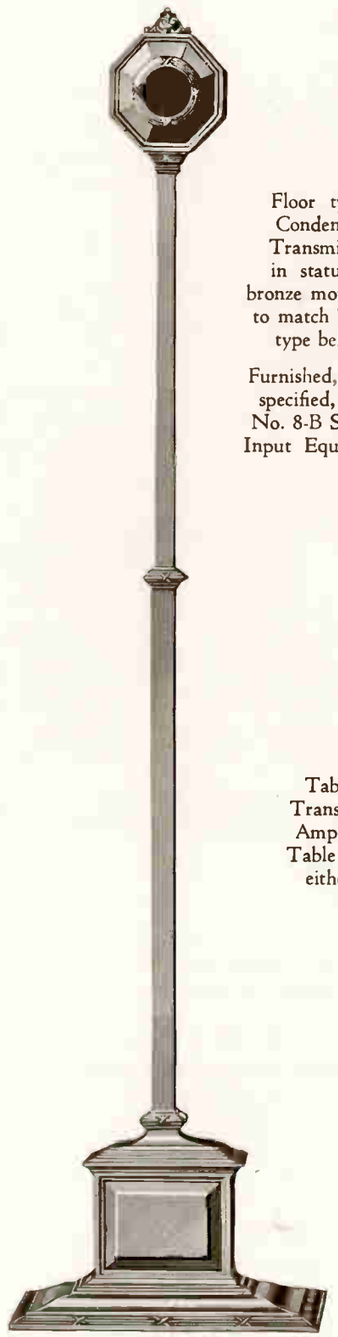
The Power Equipment requires for its operation 30 Kv-a of 3 phase 220 volt, 60 cycle power. Where this power supply is not available, the problem will be made the subject of special engineering study by the distributors of this equipment

To supply the 16 volts for the filaments, and 1600 volts for the plates of the air cooled vacuum tubes used in the Oscillator and Amplifier Units, a 3 unit motor generator set is used. For energizing the tube filaments in the Power Amplifier Unit, a 22 volt motor generator set is employed. A 250 volt motor generator set supplies all grid voltages. The transformer rectifier system mentioned in describing the Rectifier panel supplies the 10,000 volts necessary for the plates of the water cooled tubes

WATER COOLING SYSTEM

A complete water cooling system is furnished for the vacuum tubes of the Rectifier and Power Amplifier Units. It consists of a circulating pump, expansion tank, radiators, blowers, and rubber and metal conductors for the water

Water is pumped through the leads to the jackets of the tubes and then conducted back to radiators which are cooled by forced air draft from the blowers. Constant circulation through the radiators assures cool water for the tube jackets



Floor type Condenser Transmitter in statuary bronze mounting to match Table type below

Furnished, when specified, with No. 8-B Speech Input Equipment

Table model No. 394-W Transmitter with Associated Amplifier. Mountings of Table model are furnished in either bronze or in dull black finishes

TRANSMITTERS OR MICROPHONES (FLOOR AND TABLE MODELS) FURNISHED WHEN SPECIFIED WITH No. 8-B SPEECH INPUT EQUIPMENTS

announcer in the studio can control the connection of either of two outside programs. Provision is made for order lines for use with each program circuit. These order lines are interchangeable with the program circuits by means of patching cords.

Monitoring Equipment

Western Electric No. 560 type Loud Speakers are used in the 8-A and 8-B speech input equipments for monitoring. The monitoring amplifier is arranged to operate one or two loud speakers and is connected so that it can be switched from the output of the common line amplifier to the output of a radio receiver. In this way a direct comparison of the input and output of the radio transmitter can be made.

These speakers are arranged to operate in the studio which is not on the air, permitting those present there to follow the continuity of the program.

Carbon or Condenser Type Transmitter Available

Five Western Electric No. 387-W carbon type transmitters long accepted as standard are furnished with the 8-A speech input equipment. One is a spare. Four transmitter mountings are provided, two for floor and two for table use.

The 8-B speech input equipment is offered as an alternative when the condenser type transmitter is desired. With 8-B equipment four No. 394-W transmitters with their associated amplifiers are furnished. These are single stage which amplify the small voltages developed by the condenser transmitter and at the same time act as an impedance translating device between the high impedance condenser transmitter and the low impedance input circuit to the common amplifier circuit.

Two table mountings and two floor mountings are furnished. Each type of mounting is designed to contain both the condenser transmitter and its associated amplifier to make an integral unit.

All plate potentials and polarizing voltages for the condenser transmitter are supplied by a full-wave rectifier with filter circuits. The advantages of this method of operation are evident.

Filament Current Supply

Filament current is provided by improved heavy duty, long life batteries of the glass jar type, supplied in duplicate, together with charging equip-

[Text concluded on page 22]

Table model mounting for Carbon type Transmitter. Floor model is same in design. Furnished with No. 8-A Speech Input Equipment

Floor type Condenser Transmitter in dull black finish furnished with No. 8-B Speech Input Equipment

Condenser Transmitter with closely Associated Amplifier is latest development in microphone design

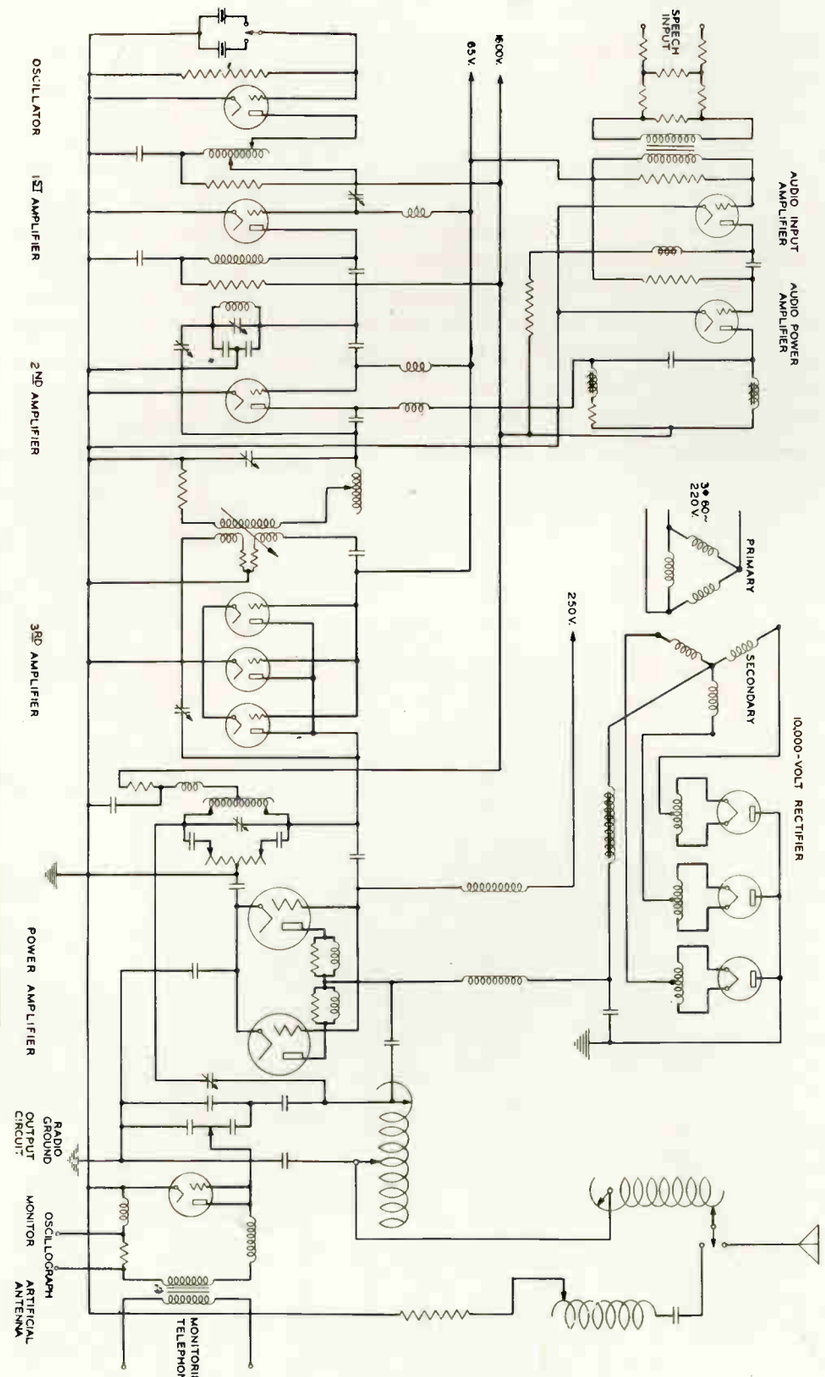
TRANSMITTERS FURNISHED WITH No. 8-A AND No. 8-B SPEECH INPUT EQUIPMENTS

ment. These facilities provide for eighteen hours continuous service out of each twenty-four. If greater capacity is required only a new set of plates is needed.

5-B Speech Input Equipment for Stations

The same advanced principles of radio engineering have been followed in the design and construction of the 5-B (station) speech input equipment as in the 8-A and 8-B (studio) equipments. All practical wiring is done in Western Electric shops. This equipment includes the necessary program and order wire terminal apparatus, line amplifier, monitoring features and emergency announcing microphone. A rectifier for plate voltages and a storage battery of adequate capacity for filament voltages form the power supply.

SIMPLIFIED SCHEMATIC OF NO. 5-C TRANSMITTER



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