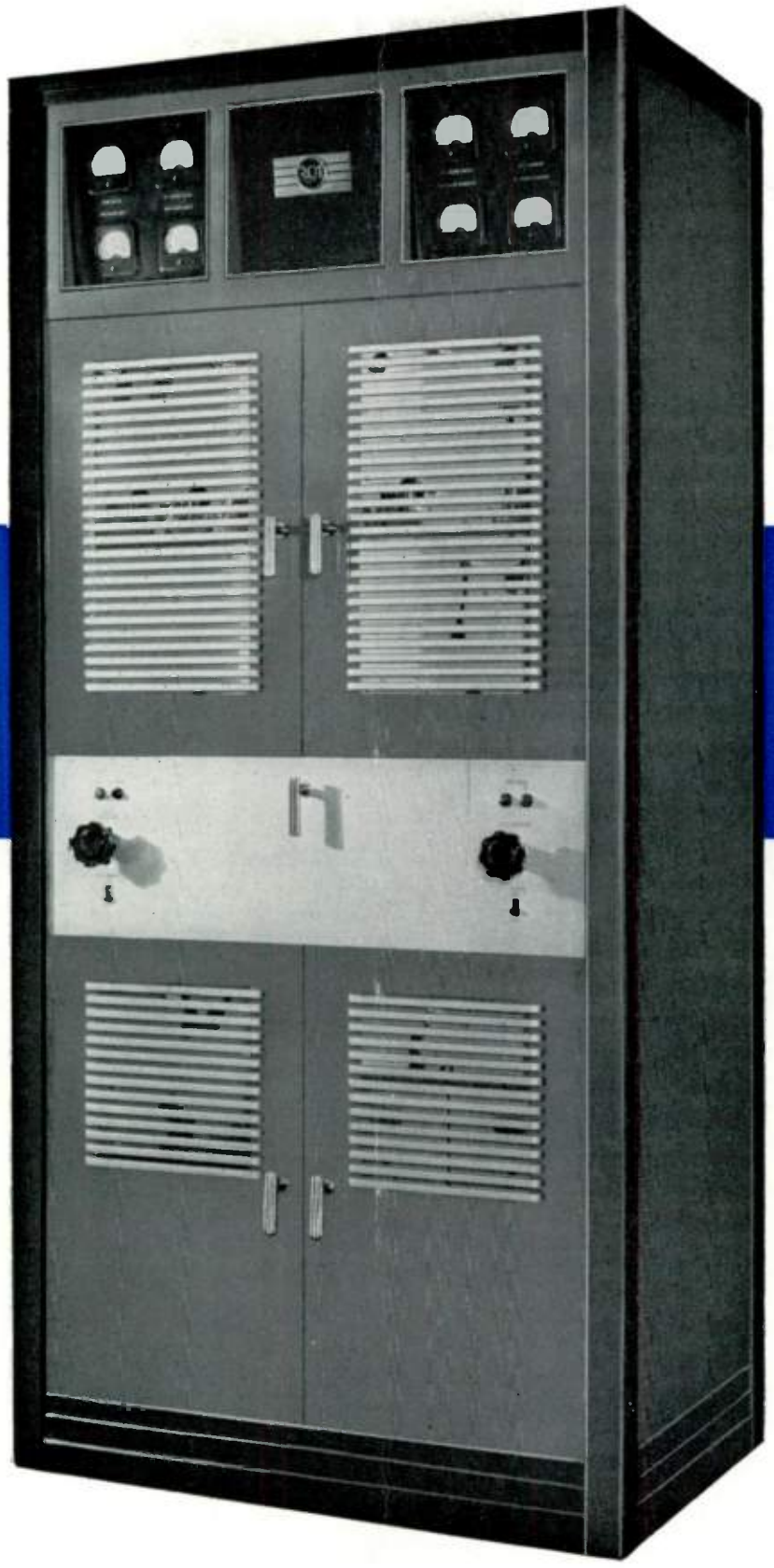
250-D

BROADCAST TRANSMITTER

WITH VERTICAL CHASSIS CONSTRUCTION



250-D TRANSMITTER

THE RCA 250-D TRANSMITTER

is offered for stations of 250-watt or 100-watt power requiring the optimum in performance, operating convenience and reliability combined with low operating expense. A standard unit in RCA's line of de luxe transmitters, the 250-D, forms the exciter for higher powered equipment from 1000 watts and up and has been constructed to the same high standards as RCA high power transmitters.... The 250-D has been provided with many new features which make for exceptional reliability and economy such as:

VERTICAL CHASSIS CONSTRUCTION WITHOUT SHELVES

(immediate accessibility of every component for inspection or adjustment).

ELECTRON-COUPLED CRYSTAL OSCILLATORS IN DUPLICATE

(which assure freedom from frequency shift and make for added reliability).

NEW TYPE HIGH EFFICIENCY TUBES...802's, 805's and 838's

(longer tube life, lower tube cost).

HIGH LEVEL, CLASS B MODULATION

(lower power costs, easy, non-critical tuning).

COMPLETE METERING WITHOUT SWITCHES . . . 16 METERS

(accurate tuning and adjustment for best performance).

CIRCUIT BREAKERS INSTEAD OF FUSES

(less lost time after temporary overloads).

ALL CERAMIC INSULATION FOR RADIO CIRCUITS

(less danger of breakdown or failure).

UNUSUAL OPERATING CONVENIENCE

(controls on front panel, automatic starting with time delay relays, line voltage adjustment, automatic switching between 100- and 250-watt carrier power, dummy antenna, variable antenna coupling.)

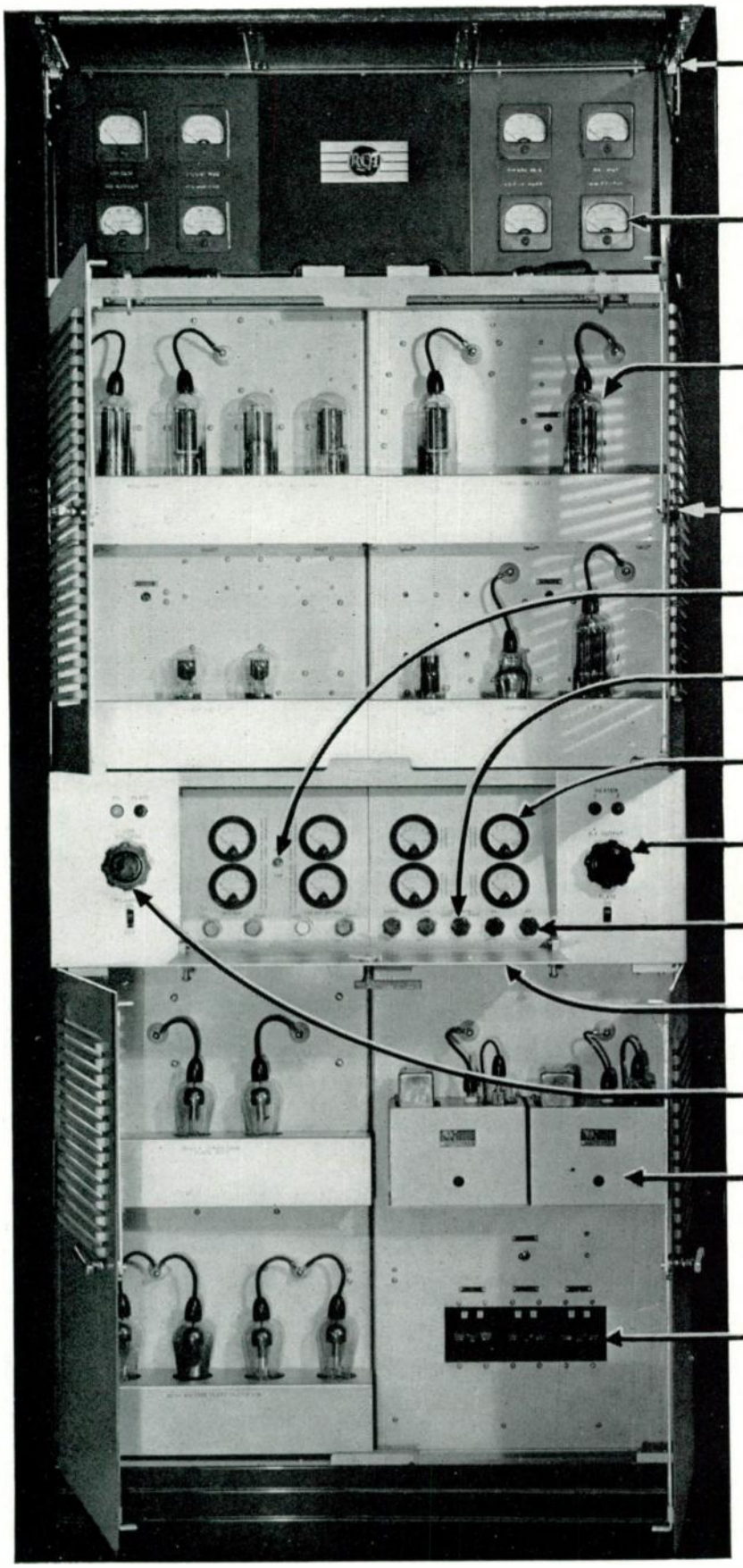
HIGH FIDELITY PERFORMANCE

(lower distortion and hum level, uniform frequency response).

A MODERN TRANSMITTER READILY ADAPTABLE FOR POWER CHANGES

The 250-D equipment has been designed from the viewpoint of the user—the broadcasting station—and in addition to reliable and economical performance it must be adaptable to changes in usage normally encountered. For stations operating with a power of 250 watts daytime, 100 watts at night, power change relays have been incorporated, operating from a panel toggle switch which alters the output and, at the same time, maintains the modulation at the proportionate value and keeps the modulation meter input at the correct level. No adjustments are necessary, throwing one switch takes care of everything.

In order to meet the requirements of the Communications Commission, the equipment has been given a separate designation when used for straight 100-watt operation (100-H) and, when used as an exciter for higher power transmitters, (250-F). However, the apparatus is identical, and the only changes made are in the tube complement for 100-watt output to conform to regulations. To increase from straight 100-watt operation to 250 watts, it is only necessary to substitute higher rating tubes in the final stages.



Hinged Door for access to Meters

8 Operating Meters

Tubes accessible from front

Interlocked Doors

Power Change Switch

Crystal Change Switch

8 Tuning Meters

R-F Output Control

Tuning Controls

Non-interlocked Door

Line Voltage Control

Two Complete Crystal Oscillators

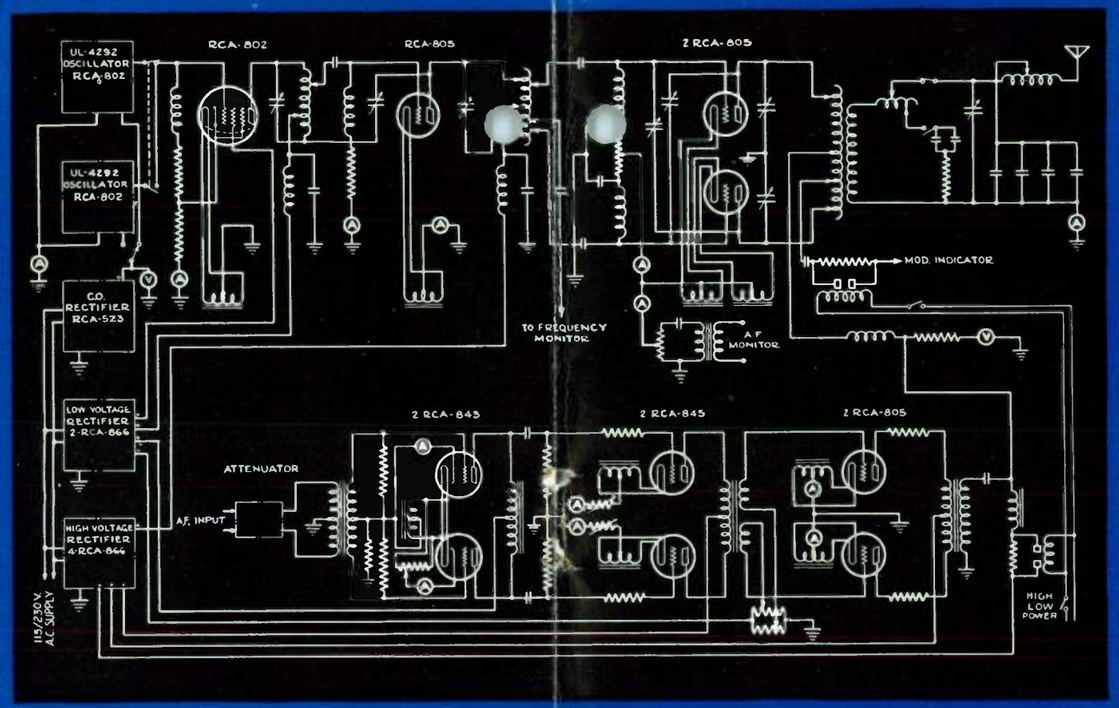
De-ion Circuit Breaker-switches

FRONT VIEW—DOORS OPEN

Exclusive New "Vertical-Chassis" Type Assembly

The method of assembling the components of the 250-D transmitter is totally different from that of any previous design. The arrangement is one which retains the advantages (of easy assembly and servicing) typical of the chassis-type of construction, and at the same time provides several additional advantages, particularly as to tube placement and accessibility. All of the circuit components, with the exception of tubes, meters and tuning controls, are mounted on two L-shaped vertical chassis mounted together to form a U. One of these contains all of the r-f circuits and (at the very bottom) the control circuits, overload relay, etc. The other contains the power supplies and the audio and modulator circuits. An easily removable shield is placed around the r-f portion of the chassis, and individual shields are used around some of the coils. This method of mounting allows all of the components to be placed in the best position from the standpoint of efficiency.

SCHEMATIC DIAGRAM 250-D



A Low Cost Transmitter

In spite of its added conveniences and advantages, this new transmitter is one of the most economical transmitters yet designed. Because the multiple-purpose design greatly increases production quantities, the first cost is surprisingly low for a transmitter of this quality. Tube costs, because of use of new-type tubes of high-efficiency and long life, are a fraction of that of comparable transmitters of other types, and power consumption, because of use of high-level Class B modulation, is much lower. Elimination of rotating machines, and other components subject to wear, has reduced replacement expense to a negligible point, while the guarantee is full protection against expense due to defective materials or workmanship. Finally, the wide field of application means highest asset value—hence, lowest write-off rate.

Thus, since the equipment is completely self-contained and easy to install, and since it is unusually economical to operate, the purchaser will save money not only at the start but throughout the life of the apparatus.

Transmitter Circuits

The 250-D transmitter unit may be operated as a 100-watt transmitter, as a 250- or 100/250- watt transmitter, or as the exciter for 1 kw., 5 kw. or 50 kw. transmitters. The circuits for the three modes of operation are very similar. The connections for 250-watt (or 100/250-watt) operation represent the standard, and most frequently used, arrangement. Two complete crystal oscillator units are built in. Each contains a V-cut "zero temperature coefficient" crystal in a new, unusually stable circuit which utilizes an RCA-802 as an oscillator. A selector switch on the sub-control panel connects the output of either of these oscillators to the buffer stage, which is also an RCA-802. This is a pentode-type tube and hence requires relatively low excitation. It allows the oscillator to be very lightly loaded, thereby preventing reaction from following stages. The intermediate stage, using a single RCA-805, furnishes the necessary excitation to drive the output stage, which consists of a pair of RCA-805's in push-pull. The tank circuit of this stage is inductively coupled to the output circuit. The latter consists of a T-network designed to feed into either a concentric or an open type line, or into the antenna directly. It also includes a dummy antenna for use in adjusting or warming up the transmitter before going on the air.

The audio circuit includes three stages, all connected push-pull. The input may be coupled through fixed pad attenuators (11 db. in 2 db. steps) and the input transformer, to the grids of the RCA-813's which make up the first stage. This stage is impedance-capacity coupled to the second stage, which consists of a pair of RCA-845's. These latter operate Class A and are connected through a stepdown transformer to the output stage, thereby insuring the well-regulated driving power required by the Class B modulators. The latter are RCA-805's which, operating Class B, are capable of easily providing the required audio power modulate outputs well above 250 watts. All three audio stages have separate bias adjustments and individual plate current meters, thus allowing all three stages to be balanced in a matter of seconds, and obviating the need of removing tubes, as is necessary in transmitters with fewer meters.

A toggle switch on the sub-panel provides for instantaneous changeover from 250 watts to 100 watts. The operation is accomplished through three relays actuated by this switch. The first cuts in a plate-voltage resistor which reduces the output power, the second introduces corresponding attenuation in the audio input, and the third reduces coupling to the modulation monitor. Thus the operation is completely automatic and no additional adjustments are necessary.

The radio frequency circuits for 100-watt operation remain precisely the same as those for 250-watt operation. The tube complement is, however, altered by substituting RCA-838's in place of the RCA-805's. The intermediate stage, then, uses one RCA-838, and the output stage two RCA-838's in push-pull. The output circuits also remain the same. The changes in the audio circuits are slightly more extensive. Since the audio power required is much less, the driver and modulator stages are combined, so that only two stages are used in place of the previous three. The modulator stage now consists of four RCA-845's in push-pull parallel. The same modulation transformer is used, the sockets are already in place and, as the filament voltages are the same, the only change required in connections is paralleling the grid and plate leads.

Three completely independent plate supplies are provided. The first uses an RCA-5Z3 and furnishes voltage for the oscillators only. The second uses a pair of RCA-866's and supplies higher voltage for the buffer and speech stages, as well as bias for the modulator stage. The third uses four RCA-866's and supplies 1250 volts to the plates of the power amplifier and modulator stages, and slightly lower voltage to the intermediate stage.

New Type High Efficiency Tubes

The tube line-up used in the 100-H and 250-D transmitters is one of the outstanding new features. Nearly all previous low power transmitters employed either an excessive number of small tubes, with consequent frequent failure, or one or more relatively expensive large size tubes. In the 100-H and 250-D transmitters, new-type tubes, which perform the required operations much more efficiently, are used. As a result, a much smaller number are required. Moreover, all of these are of small size and are inexpensive. The r-f stages use a total of only five tubes, and these and the modulators are sufficiently inexpensive that they may, if desired, be replaced after a specified number of hours. In addition, the number of tube types used is an absolute minimum. This markedly reduces the number of spare tubes which must be carried on hand and no handicap is encountered by so doing, due to the fact that all of these types are widely used and are carried in stock in almost every locality.

TUNING AND CONTROL PANEL

All Controls Centralized on Recessed Sub-Panel

The problem of location arises with respect to tuning controls as well as tubes. In some transmitters, tuning elements are rigidly coupled to controls on the panel. Thus, if tuning condensers and variable inductances are located with respect only to their position in the circuit, the corresponding controls are unsymmetrically arranged and scattered about the panel, while, if the latter are arranged symmetrically, the tuning components are more or less out of place in the circuit. In the 250-D transmitter, flexible cable couplings are used in order to allow grouping of all controls on a single conveniently placed panel. This makes it possible to mount all condensers, coils, etc., in the optimum position with respect to the circuit, and yet have all the controls on a single small panel. All the r-f tuning controls, the bias controls, and the crystal selector switch, as well as the eight small tuning meters, are located on a sub-panel behind a hinged door of the control panel. Thus they are out of sight and protected from inadvertent detuning but at the same time are immediately accessible.

Tubes Correctly Mounted . . . Accessible from Front

The vertical chassis type construction permits tubes to be mounted in a manner which is both convenient and efficient. Tubes are placed vertically in front of the vertical chassis with their associated apparatus directly in the rear. Tubes are easily reached through the front doors and at the same time leads from the tubes are short. Vertical mounting of tubes assures satisfactory life and freedom from sagging elements. The chimney effect of the tube compartment provides a ventilating system which carries off the developed heat rapidly.

A TRANSMITTER WITH ADVANCED STANDARDS

Designed correctly to modern standards, the 250-D transmitter is constructed in a single cabinet pleasingly finished in tones of gray and aluminum. The design is both attractive and practical, arranged to harmonize with transmitter room surroundings and to present a modern appearance, symbolic of the latest type equipment. The finish is an acetate lacquer which is waxed and hand-rubbed to preserve the new appearance and facilitate cleaning. All the apparatus is supported by a vertical chassis having a U-shaped cross section and mounted inside of a protecting cabinet. The front panel of the chassis is a few inches behind the front panel of the cabinet, and between these two panels the tubes and oscillator units are mounted. All other equipment is mounted on the inside vertical surfaces of the chassis so that upon opening the rear door, any component can be located without removing shelves or other parts. At the top of the cabinet, eight illuminated operating meters are mounted behind a hinged glass door.

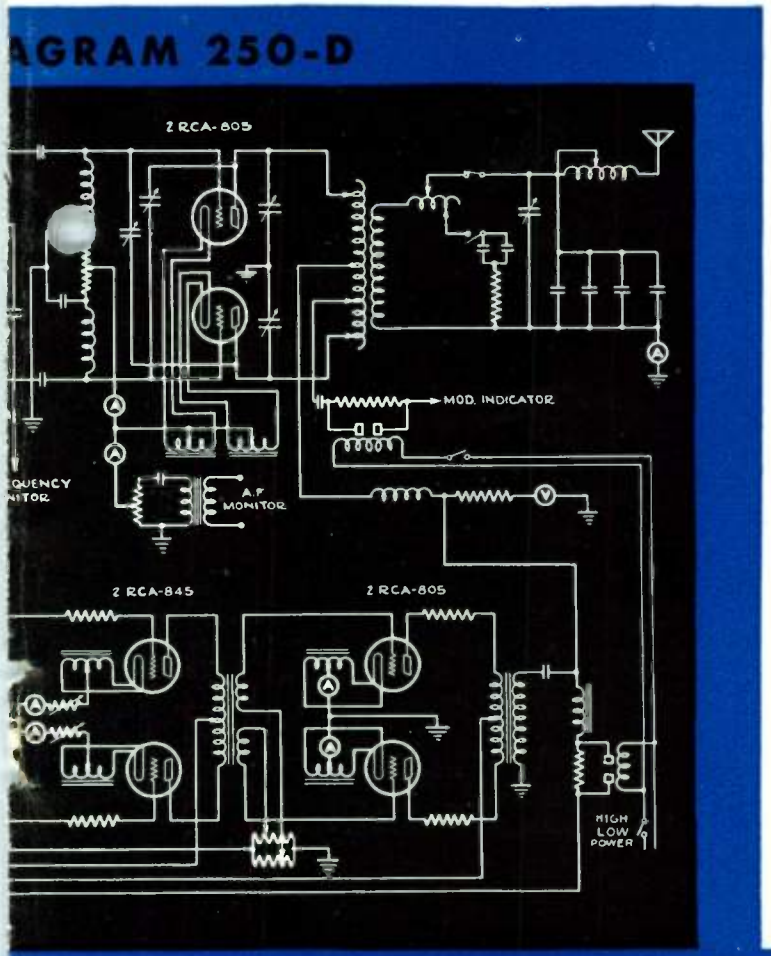
A non-interlocked door in the center of the front panel covers all tuning controls and eight additional tuning meters which are required only when adjusting the preliminary stages of the transmitter. On this panel also are mounted the power change switch, the selector switch for the two crystal oscillators and bias adjustments.

Access to the rear of the transmitter is furnished by means of doors, and any component of the entire transmitter (except tubes and crystal oscillators) is within easy reach. The absence of shelves permits every piece of apparatus to be inspected or adjusted without removing any other piece of equipment. This new type of construction has been used for the first time in the RCA 250-D transmitter.

From an electrical standpoint the circuit is straightforward and depends for its high standard of performance upon fundamentally sound design rather than upon correctional methods. The transmitter uses the high efficiency, Class B, high level modulation system which assures full carrier output with indirect power measurement. Because of the high efficiency operation, power costs are reduced to the minimum. An important operating feature is the ease of adjustment and the absence of critical settings. The latest type tubes are used in the transmitter but a minimum number of different types is employed. This means that the number of spare tubes which must be kept on hand is smaller than in previous transmitters. The output stage is push-pull to reduce harmonics and to make for easy neutralization. Push-pull audio is used throughout. Two complete crystal oscillators are included, either of which may be connected for controlling the transmitter by merely throwing a switch. These oscillators use an exceptionally stable electron-coupled circuit without tuned elements. Separate rectifiers are used for high and low power tubes as well as a separate supply for the oscillator in order to prevent reaction. Coupling to the antenna is accomplished by means of a filter circuit for reducing harmonic radiation and providing for antenna or line impedances normally used.

The control circuit is complete and includes automatic starting with time delay relays. Circuit breakers are used together with overload relays in many of the circuits instead of fuses. Adequate protection to personnel is furnished by interlocked doors. Controls for line voltage and antenna coupling are located on the front panel.

Thus the 250-D equipment offers advanced apparatus standards together with highest fidelity to assure a long and satisfactory life.



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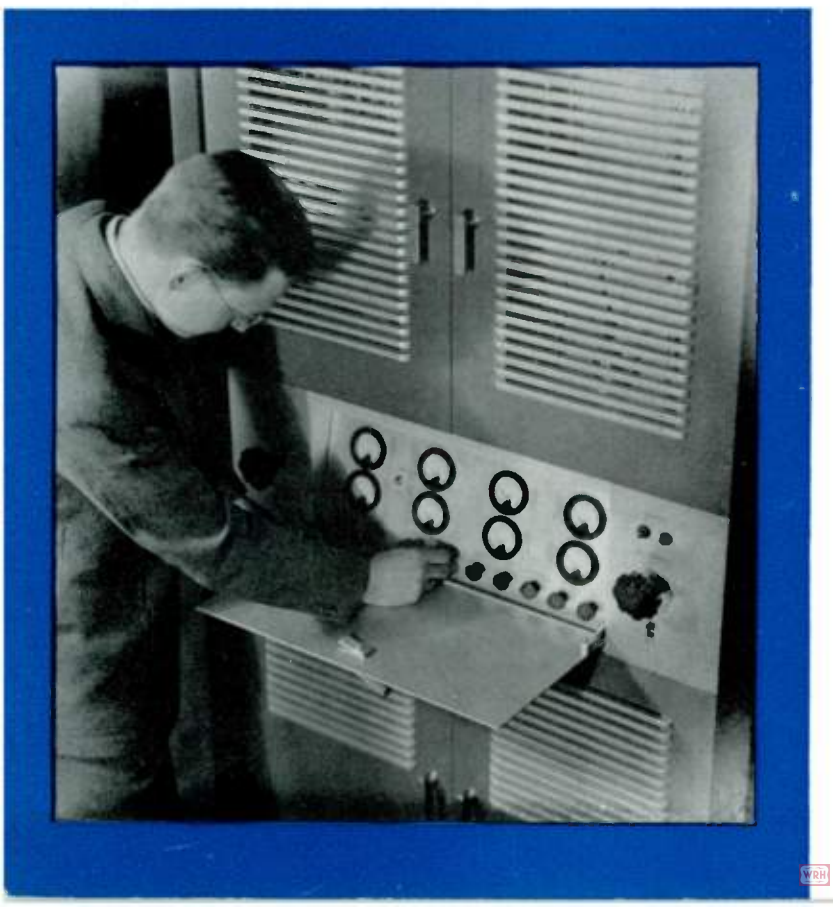

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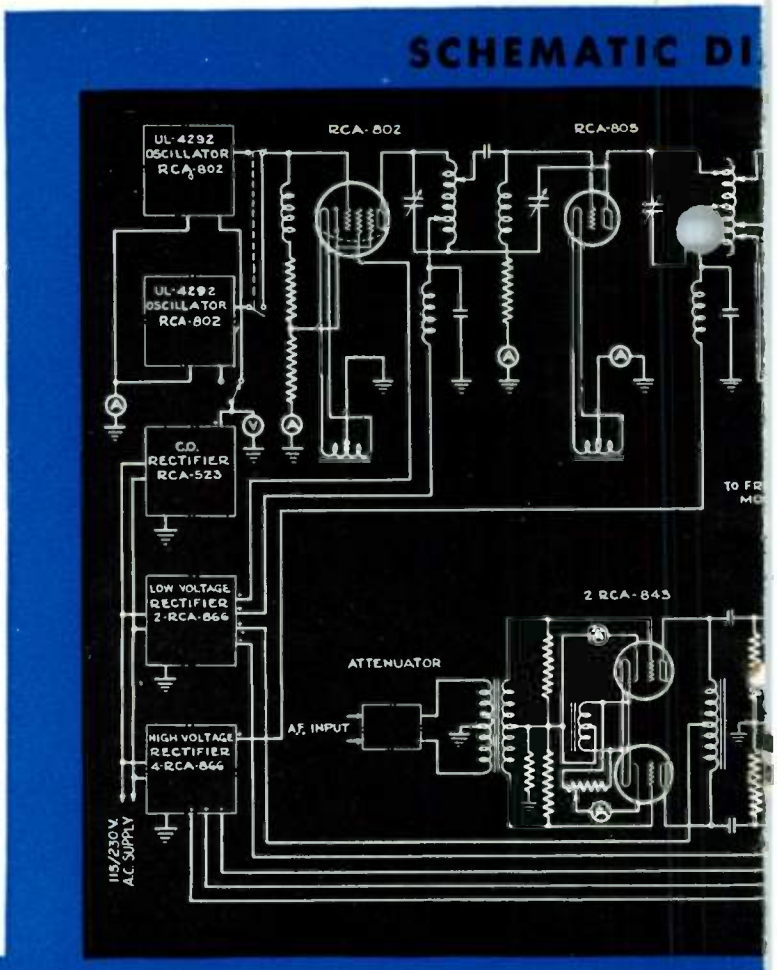

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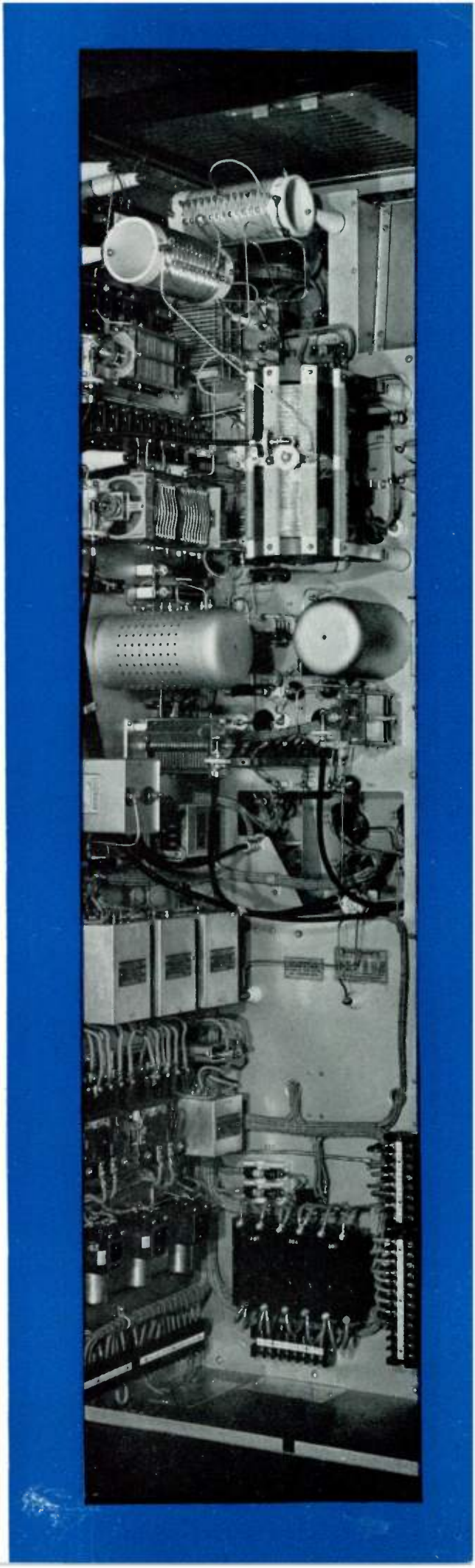
The audio circuit includes three stages, all connected push-pull. The input may be coupled through fixed pad attenuators (11 db. in 2 db. steps) and the input transformer, to the grids of the RCA-843's which make up the first stage. This stage is impedance-capacity coupled to the second stage, which consists of a pair of RCA-845's. These latter operate Class A and are connected through a stepdown transformer to the output stage, thereby insuring the well-regulated driving power required by the Class B modulators. The latter are RCA-805's which, operating Class B, are capable of easily providing the required audio power

Convenient Output Coupling Arrangement

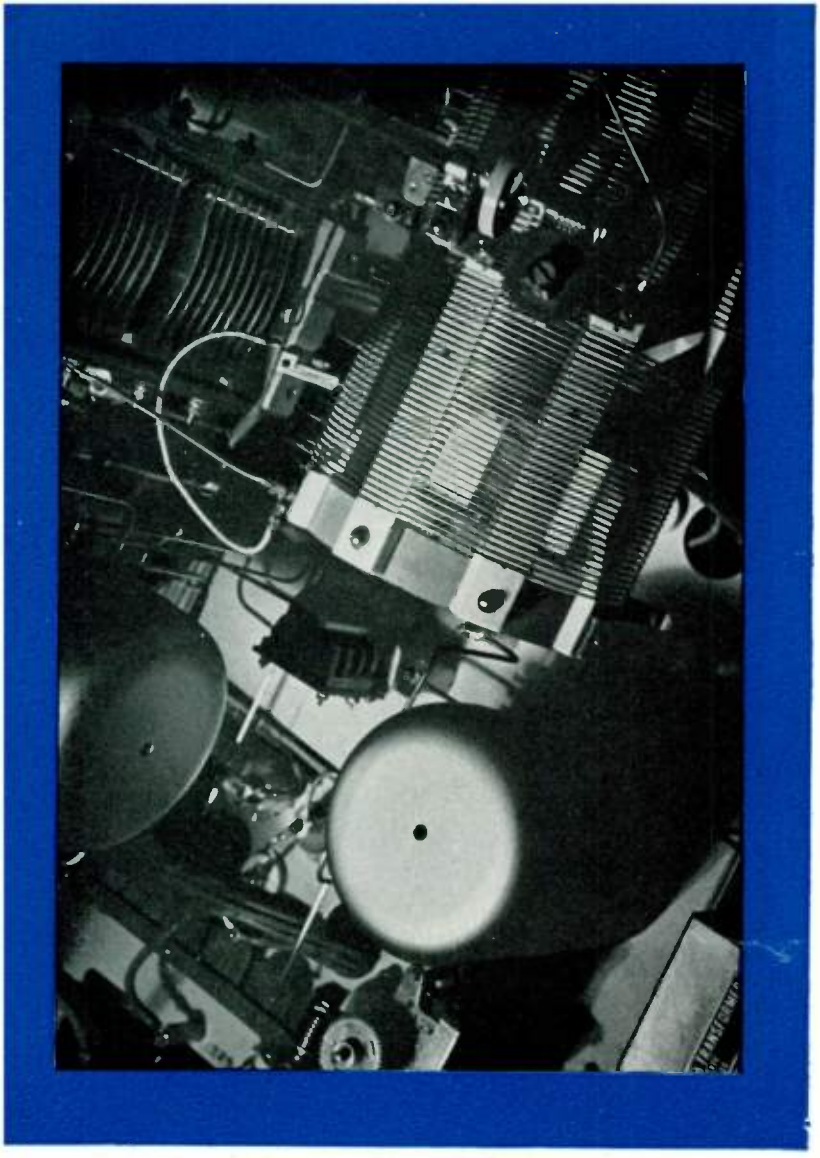
Various means of coupling a transmitter to the antenna may be used. In some installations the transmitter is located close to the base of the antenna and it may be desirable, as a matter of economy, to feed the antenna directly. When the antenna is more remote, it is necessary to use a transmission line. If the station is located in the open, a two-wire 500-ohm line may be used. In other cases, particularly where construction of an open-type line is difficult, a concentric-type line may be preferable. In order to provide for most convenient installation under any of the conditions that may be encountered, the 100-H and 250-D transmitters are designed to match either type of line or to feed the antenna directly. As a result, these transmitters can be used *without modification* in any situation. RCA transmitters are almost alone in providing this wide application flexibility. Moreover, the means of adjusting the power fed to the antenna is the most convenient possible. The antenna coupling coil is connected through a flexible shaft to a control on the front panel. Operation of this control rotates the coil, thus varying the coupling and permitting easy and accurate adjustment of loading as desired.

Built-in Connections for Monitors

Provision for coupling frequency, modulation, and aural monitors is a part of the design of the 100-H and 250-D transmitters. One terminal is provided from which the r-f energy necessary to excite the frequency monitor can be obtained. Since this should preferably be unmodulated energy, this consists of a capacity coupling to the tank of the intermediate stage. Another terminal is provided for exciting the modulation indicator. It, of course, is coupled to the output circuit. A resistor is placed in this lead and arranged to be shorted out by a relay for 100/250-watt operation. This relay is in parallel with the relay which reduces the power of the transmitter. Thus, for 100/250-watt operation, the excitation to the modulation monitor is automatically reduced in the proper proportion when the power change switch is operated. Finally, for aural monitoring, a pair of



R.F. VERTICAL CHASSIS



terminals are provided. These are the secondary leads from a transformer across part of the modulating circuit with a 500-ohm termination. Audio output identical to the modulation wave appears across these. Approximately zero level is available, which is sufficient, since a monitoring amplifier will usually be employed to drive the monitoring loudspeaker.

Complete Control And Protective Circuits

The control circuits of the 250-D transmitter stress simplicity and reliability, while at the same time providing all necessary protection for equipment and personnel. The operations previously performed by line and plate contactors are taken care of by overload switches. These are so mounted at the bottom of the vertical chassis that they may be controlled or reset from the front in the simplest possible manner and with least possible loss of time. They will, of course, need to be operated only after an "off" due to overload. The two regular control switches, one for filament voltage and the other for bias and plate voltages, are located on the main control panel. A time-delay relay prevents application of plate voltages before the proper time interval has occurred. Door interlocks are provided on all doors, so that plate voltages are removed when any of these are opened. In addition, the whole control system is so arranged (and terminals provided) that, when this unit is used as an exciter for higher power units, the control circuits may be tied in with the control systems of the added units, so as to provide proper overall starting sequence for either manual or automatic operation.

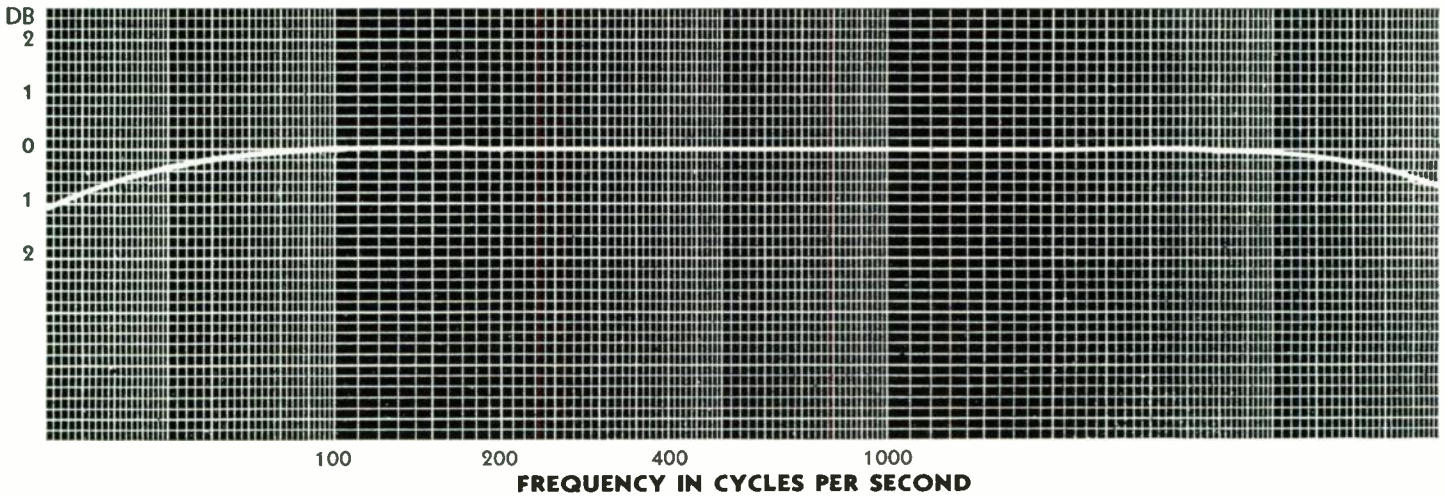
The use of De-ion type breakers assures a rapid opening of power circuits in case of an overload and the absence of destructive arcs during the breaking of the circuit.

The 250-D is thus designed for maximum operating convenience as well as for the highest performance standards.

CRYSTAL OSCILLATOR UNITS

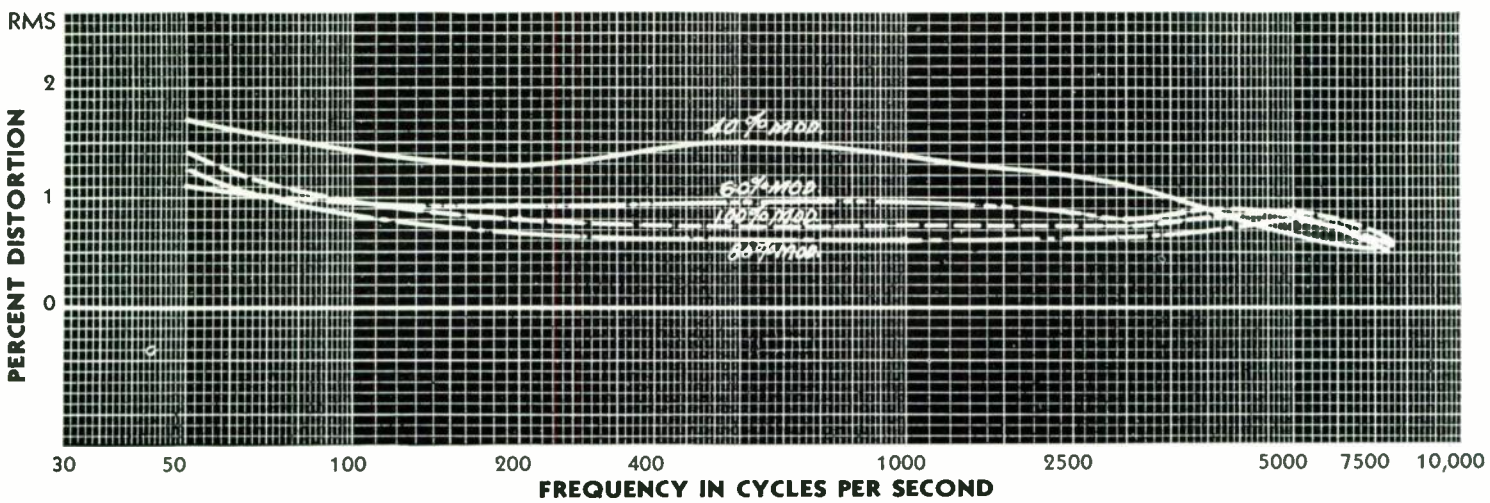
UNIFORM FREQUENCY RESPONSE

The frequency characteristic of this transmitter is substantially flat (that is within ±1 db) from 30 to 10,000 cycles. This is a range which includes all of the audio frequencies that it will ever be practicable to use and a uniformity of response which is within the limits of perception. In other words, the performance can hardly be improved upon in this respect.



MINIMUM HARMONIC DISTORTION

Harmonic distortion in this transmitter, for any of the three modes of operation, is less than 3% (RMS sum) at any frequency between 50 and 7,500 cycles and for any degree of modulation between zero and 100%. Previous transmitters have been guaranteed, as to distortion, only at one audio frequency, and usually at only one modulation level. Low distortion at all levels and over the whole middle-frequency band represents a much higher degree of performance. Laboratory measured characteristics of one transmitter are shown on this page.



LOW BACKGROUND NOISE LEVEL

Background noise level in this new transmitter is guaranteed to be more than 60 db below maximum modulation level (unweighted measurement). Together with the 100% modulation capability, this low background level assures an unusually extended dynamic volume range. Engineers estimate that a 55 db. range will include all of the volume levels that can be utilized in practice. The 250-D transmitter not only provides this range, but provides it with a definite margin.

SPECIFICATIONS OF THE 100-H AND 250-D TRANSMITTERS

Rated Operating Power:
- 100-H Transmitter ..... 100 watts
- 250-D Transmitter ..... 250 or 100/250 watts

Radio Frequency Range ..... 550 to 1600 kcs.
Radio Frequency Stability ..... ± 10 cycles
Radio Frequency Harmonics below ..... .05%
Modulation Capability 100%
Audio Input for 100% Modulation ..... –6 db.*
Audio Input Average Program Level ..... –12 db.*
Audio Frequency Response (± 1 db.) .. 30 to 10,000 cycles
Audio Distortion (50 to 7500 cycles) max. ..... 3% RMS
Background Noise and Hum Level (unweighted) .. –60 db.
Power Supply ..... 110/220 volts, 50/60 cycles
Power Consumption (average):
- 100-H Transmitter ..... 1400 watts
- 250-D Transmitter ..... 1700 watts

Dimensions (over-all) ..... 37½" x 27" x 84"
Weight ..... 1400 lbs.
Operating Cost Per Hour (at power cost of 2c per kw. hour and 3000 hour tube life) for 250 watts output approximately 9c

*Zero db. equals 12½ milliwatts.

TUBES

	100-H	250-D
R.F.	3—802†	3—802†
	3—838	3—805
A.F.	2—843	2—843
	4—845	2—845
		2—805
Rectifiers	6—866	6—866
	1—5Z3	1—5Z3

†Including spare oscillator.

Accessibility of vertical chassis construction is demonstrated during the installation of a 250-D Transmitter at WMBO, Auburn, N. Y.

Transmitter Section

RCA MANUFACTURING COMPANY, INC.

CAMDEN NEW JERSEY, U. S. A.

1270 SIXTH AVENUE
NEW YORK CITY, N. Y.

2211 COMMERCE ST.
DALLAS, TEXAS

492 PEACHTREE ST., N. E.
ATLANTA, GA.

589 E. ILLINOIS STREET
CHICAGO, ILL.

170 NINTH STREET
SAN FRANCISCO, CALIF.

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