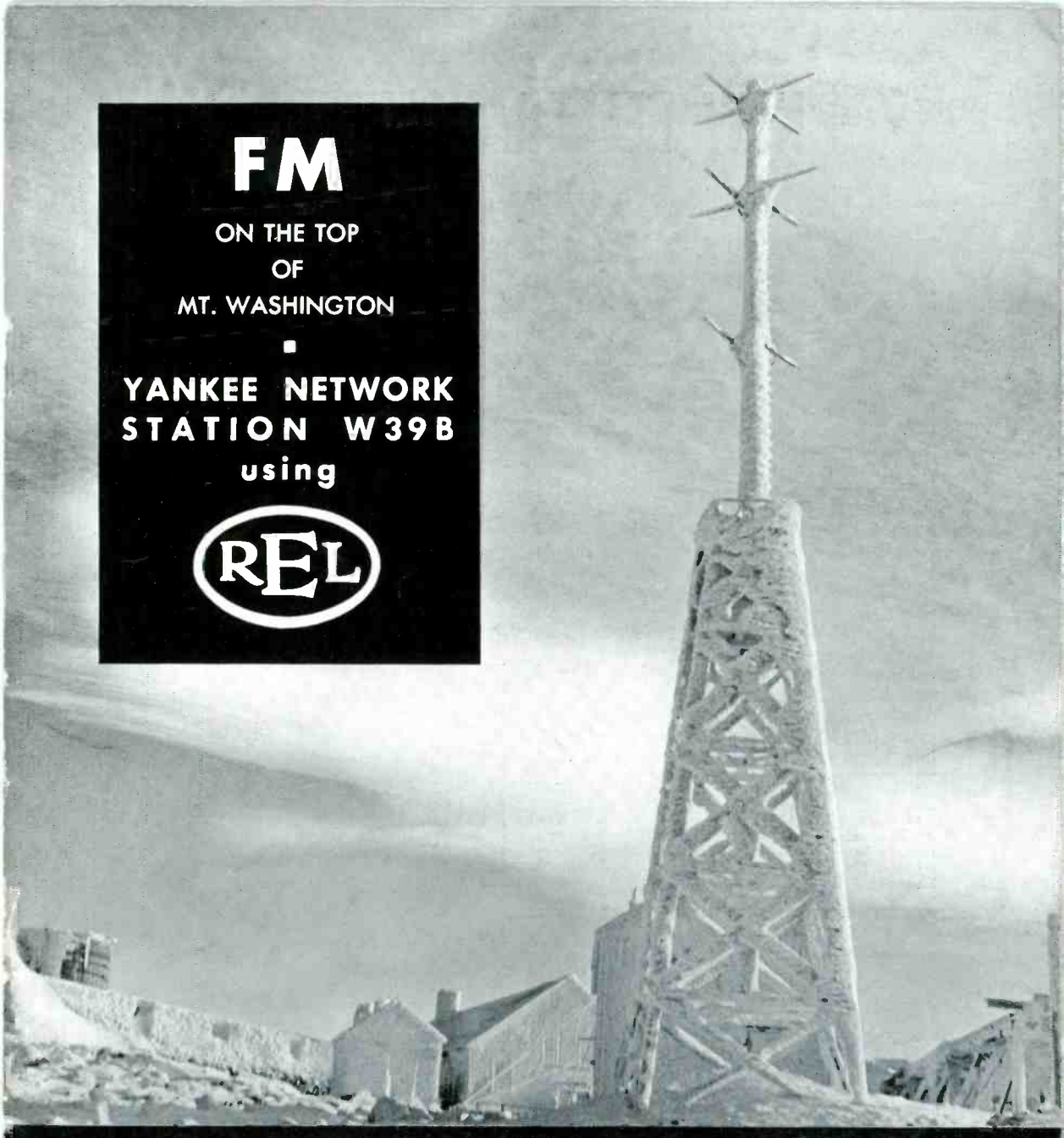


FM

ON THE TOP
OF
MT. WASHINGTON

■
**YANKEE NETWORK
STATION W39B**
using



NEW "DL" LINE OF FM TRANSMITTERS

COMPLETE FREQUENCY MODULATION TRANSMITTER INSTALLATIONS FOR STATIC-FREE,
HIGH-FIDELITY BROADCASTING AND COMMUNICATIONS—250 WATTS TO 50 KILOWATTS

RADIO ENGINEERING LABORATORIES, INC.

LONG ISLAND CITY, NEW YORK, U.S.A.

CABLE ADDRESS: RADENGLABS, NEW YORK CITY

NEW REL TRANSMITTERS

Five Transmitters, Comprising Coordinated Units and New Modulator, for 250 w. to 50 kw. Make up DL Line

BY FRANK A. GUNTHER *

THE first commercial FM transmitter produced was manufactured by Radio Engineering Laboratories, and was installed at station W2XAG, Yonkers, N. Y., in 1935. It is still performing satisfactorily after six years of operation.

Since that time, REL has built and installed ten complete FM broadcasting stations, of 1 to 50 kw., all of which are in daily service. Notable among these installations is the 50-kw. station at Paxton, Mass.,¹ and the 1-kw. transmitter atop Mt. Washington, N. H.² The latter, incidentally, will be replaced with a 10-kw. equipment as soon as the roads up the Mountain are open.

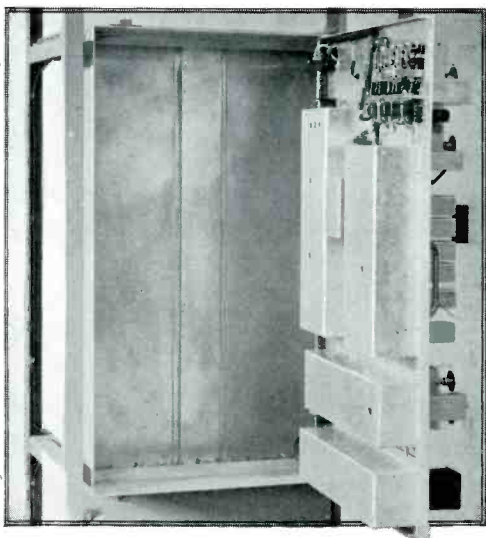
From the knowledge thus gained through experience, REL has now completed the development and design of an entirely new group of FM transmitters, known as the DL line, which will supersede current models.

* Vice President in Charge of Engineering, Radio Engineering Laboratories, Long Island City, N. Y.

¹ Gateway to Finer Entertainment, by Paul A. de Mars, FM Magazine, Nov. 1940, and W1XOJ Exceeds Expectations, by Paul A. de Mars, FM Magazine, March, 1941.

² More FM Service for New England, by A. F. Sise, FM Magazine, April, 1941.

FIG. 2. THE TYPE 558 MODULATOR PANEL SWINGS OUT OF ITS STEEL CABINET



No. 558 Modulator ★ The new designs incorporate an improved version of the Armstrong phase-shift method of modulation. This unit, type 558, is built directly into the transmitter cabinets, and is not furnished as a separate unit. However, it is arranged so as to be readily accessible for adjustment and maintenance, as will be seen from Figs. 1 and 2.

This modulator is built into the rear of the 250-w. and the 1-kw. basic transmitters, so that any of these units can be used as drivers for amplifiers of higher power.

Access to the modulator unit is provided through a door at the rear of the transmitter.

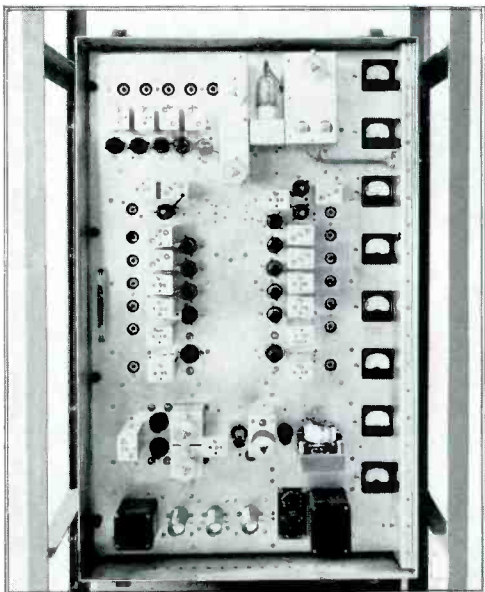


FIG. 1. IMPORTANT NEW DEVELOPMENTS ARE NOW AVAILABLE IN THE PHASE-SHIFT MODULATOR TYPE 558, SHOWN ABOVE

When the door is opened, all tubes and tuned circuits are exposed, Fig. 1. Then, in turn, the complete modulator unit can be swung out, if it is necessary to get at the rear, Fig. 2.

The audio line from the studio enters the cabinet at the bottom portion, and the RF output passes through two concentric lines at the top right. This single, compact unit con-

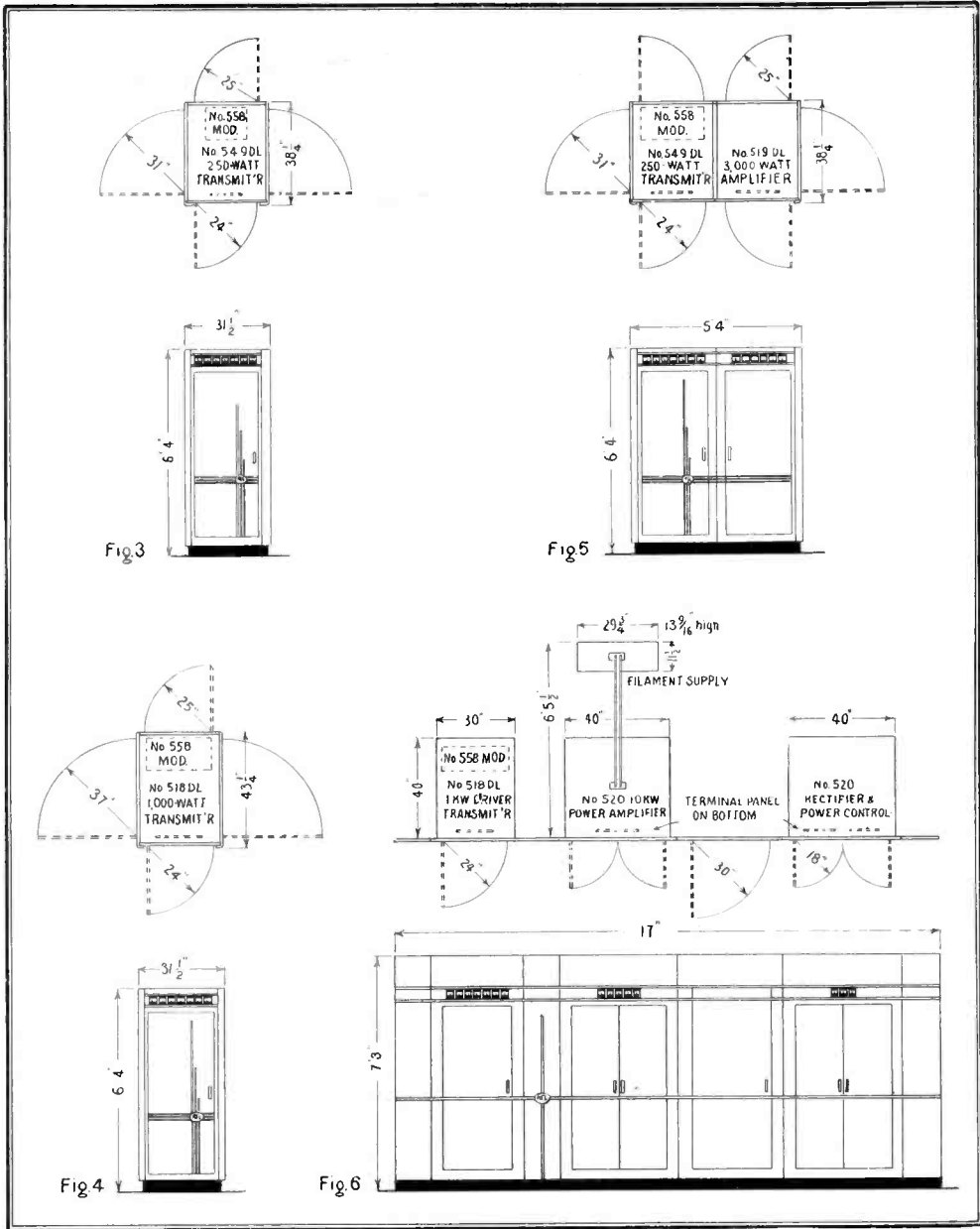


FIG. 3. TYPE 549DL 250-W. TRANSMITTER—FIG. 4. TYPE 518DL 1-KW. TRANSMITTER—FIG. 5. THE 549DL IS USED AS A DRIVER FOR THE 3-KW. AMPLIFIER—FIG. 6. THE 518DL DRIVES THE 10-KW. AMPLIFIER. SEPARATE FILAMENT SUPPLY AND RECTIFIER ARE ADDED

tains the entire modulator and multiplier, which has an output of 20 watts at the operating frequency.

Power Ratings ★ The DL line comprises transmitters of the following ratings:

- No. 549DL—100 to 250 watts
- 518DL—250 to 1,000 watts
- 519DL—1,000 to 3,000 watts
- 520DL—3,000 to 10,000 watts
- 521DL—12,500 to 50,000 watts

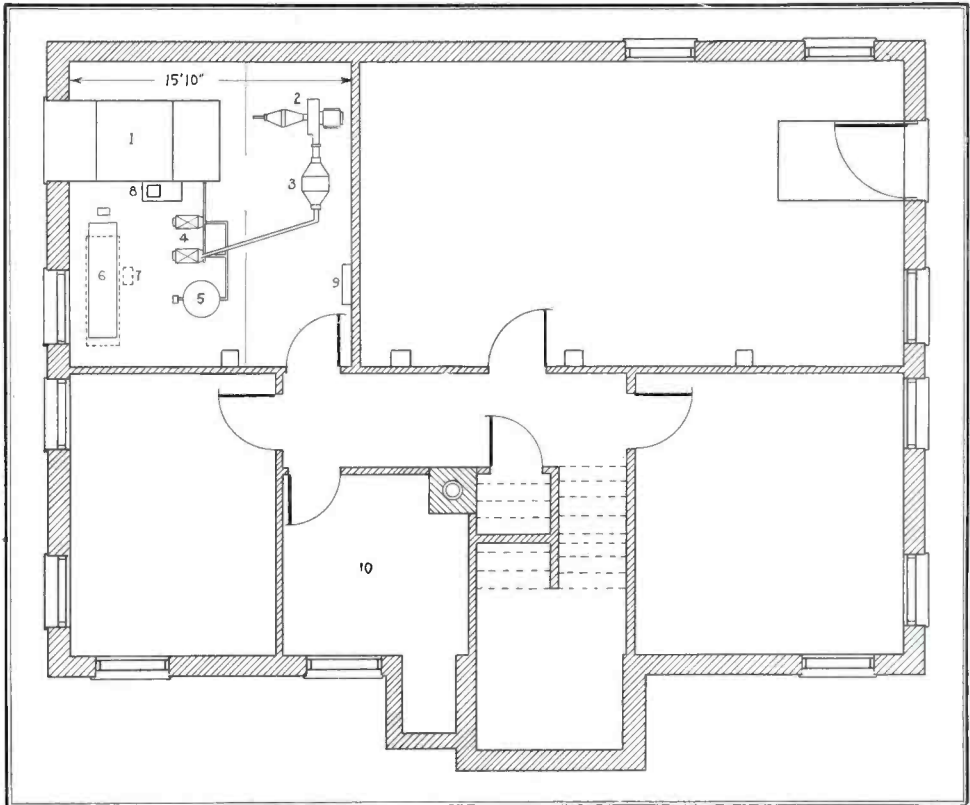


FIG. 7. PLAN OF THE BASEMENT OF W55M'S FM TRANSMITTER BUILDING. THIS SHOWS THE ARRANGEMENT OF THE COOLING EQUIPMENT, REQUIRED BECAUSE OF THE HEAT GENERATED BY THE HIGH-POWER TRANSMITTING TUBES. BOILER ROOM IS MARKED 10 ON THE PLAN

The 250-w. transmitter can be used as a driver for the 3-kw. amplifier, and this, in turn, is planned to drive the 50-kw. amplifier. In the same manner, the 1-kw. transmitter is intended for use as a driver for the 10-kw. amplifier.

The general overall characteristics of these transmitters are:

Operating Frequency ★ Available to operate on any predetermined frequency from 40 to 50 mc. The exact frequency must be specified when the order is placed.

Frequency Stability ★ These transmitters are guaranteed to maintain their frequency within less than 200 cycles of the assigned frequency. The frequency is directly controlled by a single crystal employing a multiplication of only 72 times from the crystal to the operating frequency.

Fidelity ★ The overall response is within plus or minus 1 db from 30 to 15,000 cycles.

Distortion ★ The measured r.m.s. harmonic dis-

ortion is less than 1% for all signal frequencies between 50 and 15,000 cycles at ± 75 kc. swing.

Noise Level ★ The signal-to-noise ratio is 70 db, measured at the output of a monitor receiver. This is an unweighted measurement, with 150 kc. maximum swing, and includes hum.

Input ★ The audio input to the transmitters is zero level, 500 ohms, 6 milliwatts.

Finish ★ All metal cabinets are finished in two-tone grey, with chrome trim.

250-Watt FM Transmitter ★ An outline drawing, to show overall dimensions, is given in Fig. 3. This is the complete unit, including the built-in ventilating system and air filters. The 558 modulator is mounted at the rear. The output of the modulator drives the final amplifier, a pair of HK-257 tubes. A step type of regulator controls the plate voltage to the final amplifier, by means of which the power output can be adjusted from 100 to 250 w.

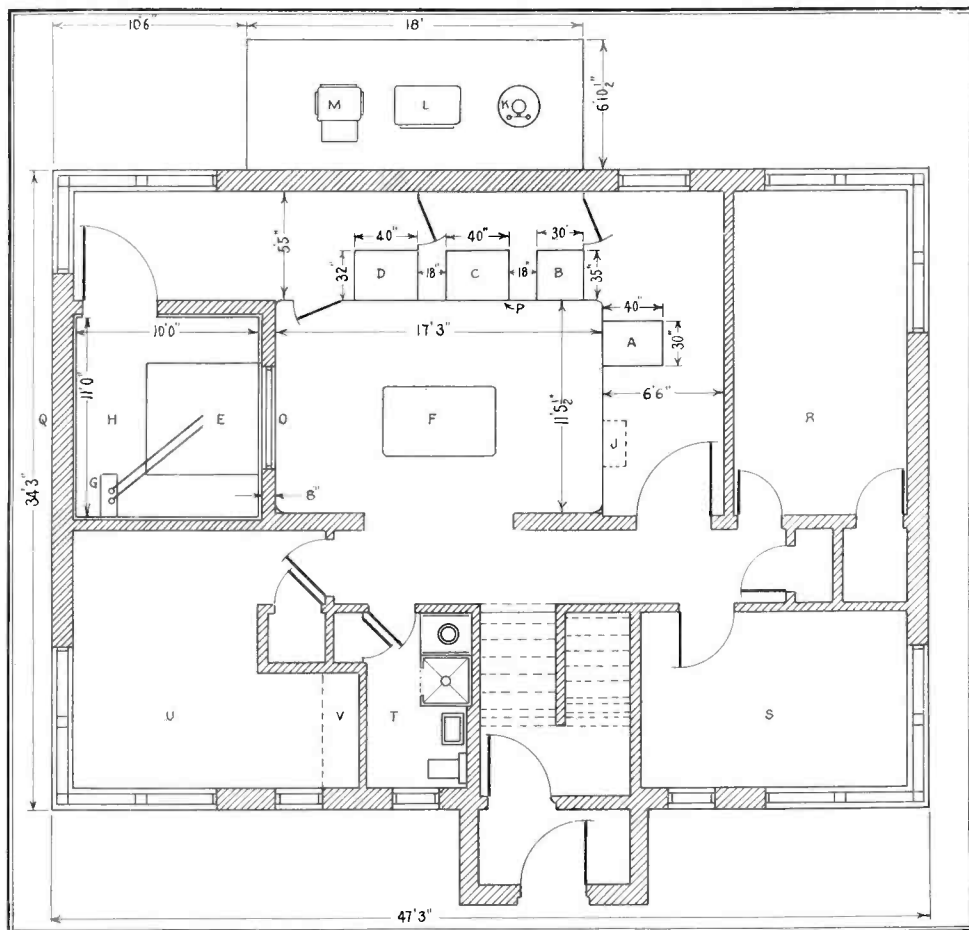


FIG. 8. GROUND FLOOR PLAN OF TRANSMITTER BUILDING AT W55M, ACCOMMODATING RADIO EQUIPMENT AS WELL AS PROVIDING QUARTERS FOR OPERATING CREW. POWER CONTROLS ARE MOUNTED ON REAR OUT-DOOR PLATFORM. TRANSMITTER UNITS ARE GROUPED AROUND CONTROL DESK F. AMPLE SPACE IS ALLOWED FOR WORKSHOP R, AND SPEECH EQUIPMENT ROOM S

Primary power requirements are 205 to 230 volts, 60 cycles, single-phase at 1,200 w. for maximum output.

The output connection from the transmitter is designed to operate into a single $\frac{7}{8}$ -in. concentric line at 72 ohms.

1,000-Watt FM Transmitter ★ This is also a completely self-contained unit, including the ventilating system and air filters, of dimensions given in Fig. 4. It is the same in width as the 250-w. unit, but slightly deeper. The 558 modulator, mounted at the rear, drives a pair of HK257 tubes as an intermediate amplifier. These, in turn, drive the final amplifier, with two Eimac 304TL tubes. Power output can be adjusted from 250 to 1,000 w. by means of a

step type regulator controlling the voltage to the final amplifier.

Primary power requirements are 205 to 230 volts, 60 cycles, single phase at 3,200 w. for maximum output.

The output connection from the transmitter is designed to operate into a single $\frac{7}{8}$ -in. concentric line at 72 ohms.

3,000-Watt FM Transmitter ★ This equipment is contained in two cabinets with a common front panel, as shown in Fig. 5. Interconnections are made above the floor, thus eliminating any need for wiring under the floor.

At the left is the 250-w. transmitter, No. 549DL, with the 3-kw. final amplifier at the right. The final amplifier employs two Eimac

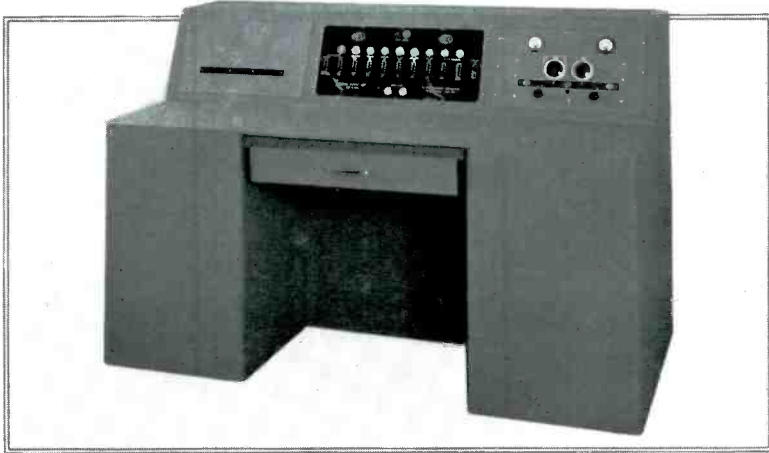


FIG. 13. FM CONTROL CONSOLE LOCALIZES ALL THE TRANSMITTER CONTROLS AND MONITORING EQUIPMENT FOR CHECKING AUDIO, MODULATION, AND FREQUENCY

type 1500T tubes which use lines in the plate circuit. Output is adjustable from 1 to 3 kw. by means of a step type regulator which controls the plate voltage to the final amplifier.

Primary power requirements are 205 to 230 volts, 60 cycles, 3-phase at 7.5 kw. for maximum output.

Output connections from the transmitter are designed to operate into two $\frac{7}{8}$ -in. concentric lines at 72 ohms.

10,000-Watt FM Transmitter No. 520DL ★ Three units, mounted with a common front panel, comprise the 10-kw. transmitter, as shown in Fig.

6. When the transmitter room is planned, it should be arranged so that the ceiling will be furred down to the top of the transmitter panel. Similarly, the side walls should be built out to meet this panel.

The three units comprise the 518DL 1-kw. transmitter with the 558 modulator, a 10-kw. power amplifier, and the rectifier and power control. In addition, there is a filament supply unit, located directly behind the power amplifier. Fig. 14 shows the 10 kw. amplifier.

Forced air cooling is provided for the two 889R's in the power amplifier. The intake to



FIG. 9. THIS ARRANGEMENT AT PAXTON, MASS. IS SIMILAR TO W55M LAYOUT, SHOWN IN FIG. 7

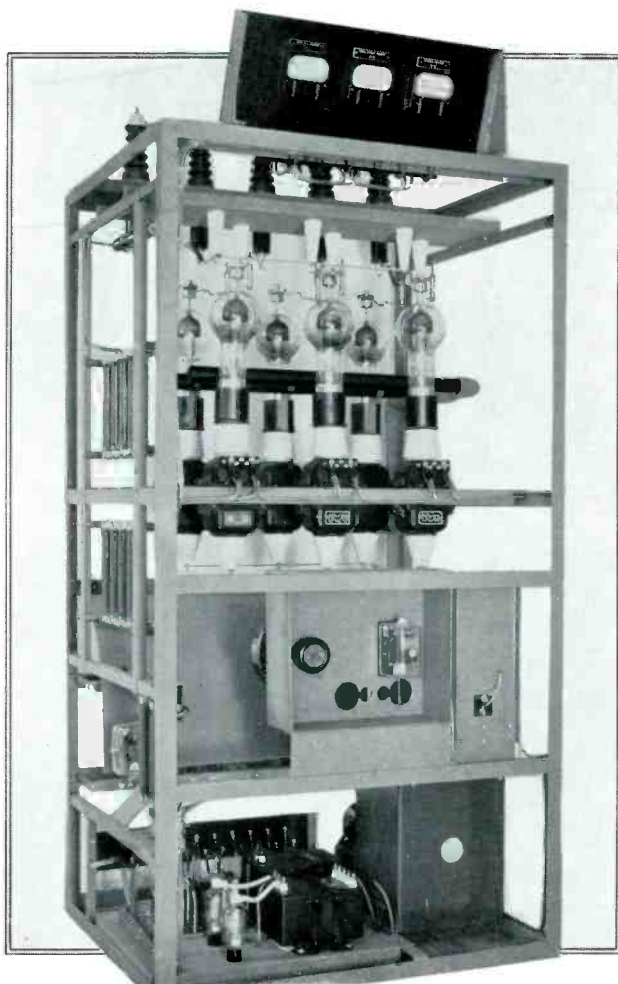


FIG. 10. THE 15,000-VOLT RECTIFIER, SUPPLYING THE 50-KW. AMPLIFIER. THIS UNIT IS MARKED C IN THE FLOOR PLAN, FIG. 8

this cooling system should be connected by a duct either to the outside of the building or to an existing air-conditioning system. In either case, the ambient temperature at the air intake must not exceed 45° C. at any time. Since considerable heat is dissipated in cooling these tubes, a means for exhausting the air in the transmitter room must be provided.

This involves installing an exhaust ventilator capable of moving approximately 2,000 cubic feet per minute.

The 889R tubes are mounted on the top of the tubular plate lines, through which air is forced for cooling purposes. These tubular plate lines also serve as the plate tank circuit.

This transmitter is so designed that, in case of failure in the power amplifier, the 1-kw. driver can be connected directly to the an-

tenna. Thus, the driver alone can be used as an emergency transmitter.

By means of a step type voltage regulator, controlling the plate voltage of the final amplifier, the power output can be varied from 3 to 10 kw.

The primary power requirements are 205 to 230 volts, 60 cycles, 3-phase, at 24 kw. for maximum output.

The output connections from the transmitter are designed to operate into two $1\frac{5}{8}$ -in. concentric lines at 72 ohms.

50,000-Watt FM Transmitter No. 521DL ★ The 50-kw. transmitter is comprised of several separate units. If a new transmitter building is being constructed, these units can be used as the nucleus around which to plan the structure.

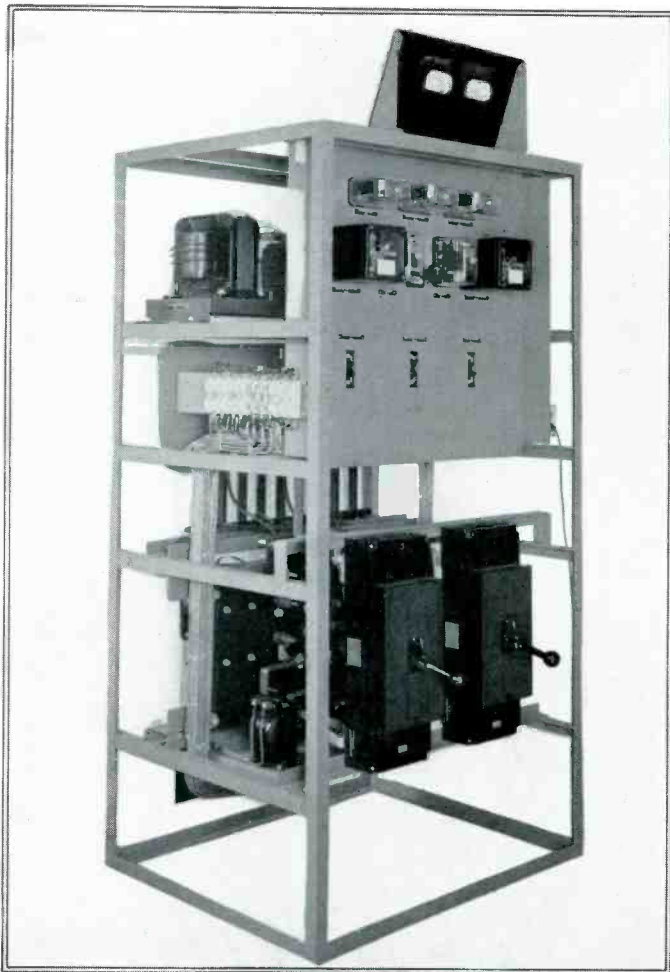


FIG. 11. POWER CONTROL AND RELAY RACK FOR THE 50-KW. FM TRANSMITTER. THIS UNIT IS MARKED D IN THE FLOOR PLAN, FIG. 8

On the other hand, this unit design has great advantages when the equipment must be fitted into an existing structure.

A typical installation is the Yankee Network station at Paxton. This was the first 50-kw. FM transmitter ever built.

Another mountain-top installation is The Milwaukee Journal's station W55M, at Richfield, Wis.³ Floor plans of this station are shown in Figs. 7 and 8.

In the basement of this structure, besides the heating plant and other appurtenances required for the maintenance of the building, there is housed the rotating machinery required for the operation of the transmitter. By

³ FM Featured in \$500,000 Plant, FM Magazine, February, 1941; and photographs of construction, page 37, FM Magazine, April, 1941.

referring to Figs. 7 and 9, it will be noted that this apparatus is located in a room 16 ft., 2 ins. by 15 ft., 10 ins. It includes the following items:

- 1—Evaporative cooler, provided with fresh air intake and discharge ducts connected to the outside.
- 2—Pressure blower necessary for the cooling of the 50-kw. tube seals.
- 3—Air cooler installed in the power blower discharge line. This utilizes circulating cold water for reducing the temperature of the air supplied to the seals of the tubes.
- 4—Water circulating pumps. Two are provided, one of which is a spare.
- 5—100-gallon copper water storage tank.
- 6—Motor generator used to supply DC to the

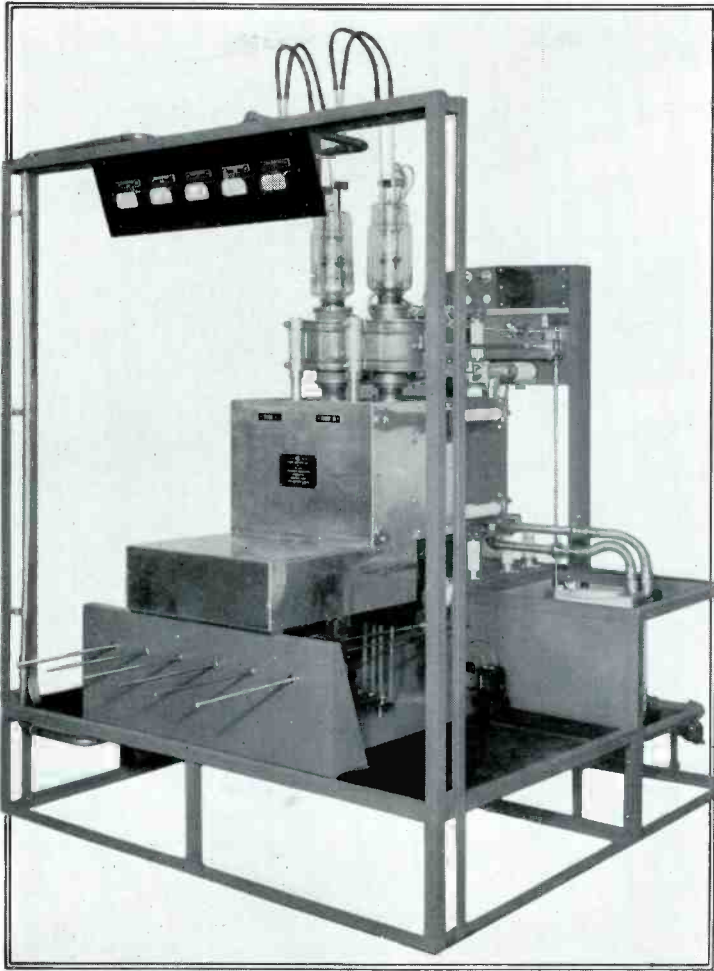


FIG. 12. THE 50-KW AMPLIFIER. SIX SHAFTS AT THE FRONT EXTEND THROUGH THE WALL OF THE AMPLIFIER ROOM H, SHOWN IN THE FLOOR PLAN FIG. 8

filaments of the two 899A power amplifier tubes.

- 7—Motor generator wiring connection box.
- 8—Spray pump used in connection with the evaporative cooler.
- 9—Sub-control panel which houses the various motor starters and other associated equipment required for operating this rotating machinery.

The first floor includes space for the various activities of the operating personnel:

- R—Workshop.
- S—Shielded speech equipment room.
- T—Wash room.
- U—Operators' quarters.
- V—Kitchenette.

Units of the transmitter are arranged as follows:

- A—250-w. basic transmitter, No. 549DL.
- B—3-kw. intermediate amplifier, No. 519DL.
- C—15,000-volt rectifier, shown in Fig. 10.
- D—Power control rack, containing circuit-breakers, relays, and overload protective devices. Fig. 11.
- F—Centralized operator's desk, from which position full control of the entire transmitter is obtained. The audio, frequency, and modulation monitors are incorporated in this desk. This is shown in Fig. 13.
- E—50-kw. power amplifier stage, Fig. 12.
- G—Filament cabinet.
- H—Copper-shielded room for the 50-kw. amplifier.
- J—Proposed location for a spare modulator or 250-w. basic driver.
- O—Double glass window providing a full view

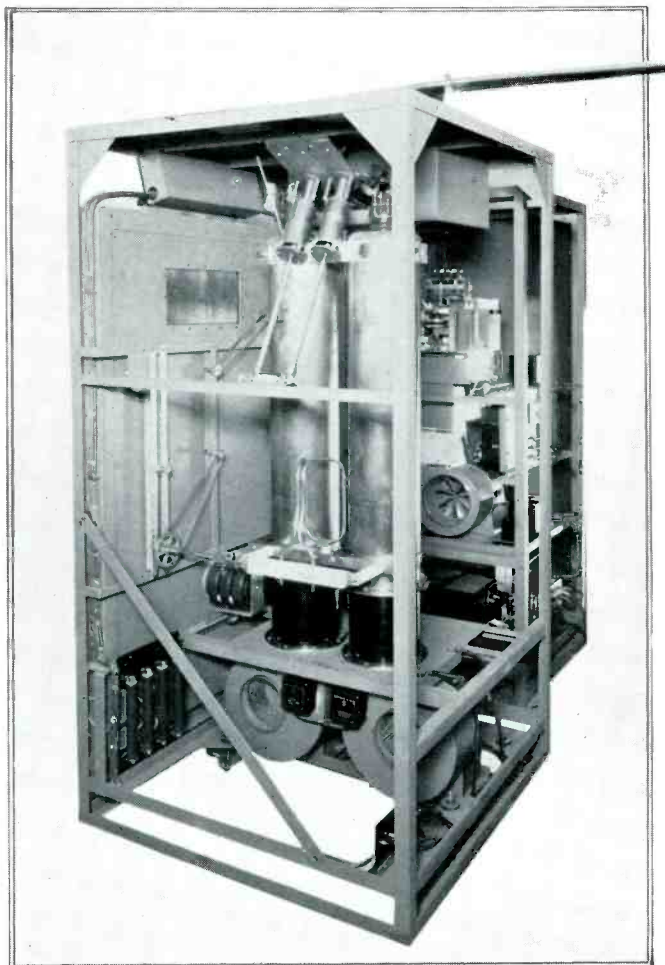


FIG. 14. THE 10-KW. AMPLIFIER WITH THE SIDE PLATES REMOVED. THE 1-KW. DRIVER CAN BE SEEN BEHIND THE AMPLIFIER ASSEMBLY. DIMENSIONS ARE GIVEN IN FIG. 6

of the power amplifier. Fig. 12 shows 6 shafts which project through the wall at O. These are centralized controls for adjusting all the variable tuning circuits.

Q—Two $3\frac{1}{8}$ -in. concentric transmission lines enter room H at Q. They feed the output of the final stage to the phasing and matching unit at the base of the antenna tower.

A sheet metal enclosure forms three walls of the room where the operator's desk is located, and serves as a front panel for the transmitter units. This enclosure, 7 ft., 3 ins. high, is finished in two-tone grey and chromium.

At the rear of the building is the out-door equipment, mounted on a concrete slab, and surrounded by a chain-link fence. It includes:

K—Filter reactor.

L—High-voltage plate transformer.

M—Motor-driven voltage regulator.

The high-voltage leads from K and L are carried through the wall of the building in high-voltage insulators, to the rectifier unit C. The low-voltage lines from L and M run underground to the power control rack D.

By means of the motor-driven regulator, the plate voltage on the final amplifier can be adjusted to vary the power output from 12.5 to 50 kw.

Under actual test, a similar installation, at Paxton, Mass., an output of 57 kw. was attained with two Westinghouse 899A tubes in the final stage.

In case of failure in the final output stage, the antenna can be connected directly to the

3-kw. driver, making it available as a spare, in the case of emergency.

50-Kw. Transmitter at W45D ★ The 50-kw. REL installation for The Detroit Evening News, station W45D, is located on two floors of a typical skyscraper building. The units of the transmitter are the same as those described above, however, except that their relative positions have been changed to meet the space requirements.

This gives further emphasis to the advantages of designing transmitting equipment of this power in several independent units, so as to facilitate erection. Many installations are planned for the upper floors of tall buildings where adequate space is not available on one

floor. Furthermore, in many cases, elevators capable of carrying large units are not available.

FM Antennas ★ Practical radiating systems for use on these frequencies and capable of carrying 50-kw. of power have not been commercially available to the purchaser of a 50-kw. transmitter. REL, therefore, has undertaken to furnish complete turnstile antennas for FM broadcasting stations such as the two-bay antennas at station W55M, Milwaukee and station W45D, Detroit. These employ the proven and successful design developed by Paul A. deMars and in use at the Yankee Network station, Paxton, Mass.

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Here's Another 50 kw FM Transmitter Launching by **REL**



Photo of the REL 50 kw FM transmitter just completed and ready for delivery to W45D, The Detroit Evening News.

REL delivers its 50 kw FM transmitter to The Detroit Evening News which joins Major Armstrong's Alpine and Yankee Network's Paxton stations as the only high powered FM broadcasters in regular operation. Because of industry-wide recognition of dependable delivery and quality of REL FM transmitters, there are more REL-equipped FM stations today than the combined number of all other FM manufacturers. REL invites your investigation of its FM transmitters . . . and urges you to join the rapidly growing list of satisfied REL broadcasting clients.

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