



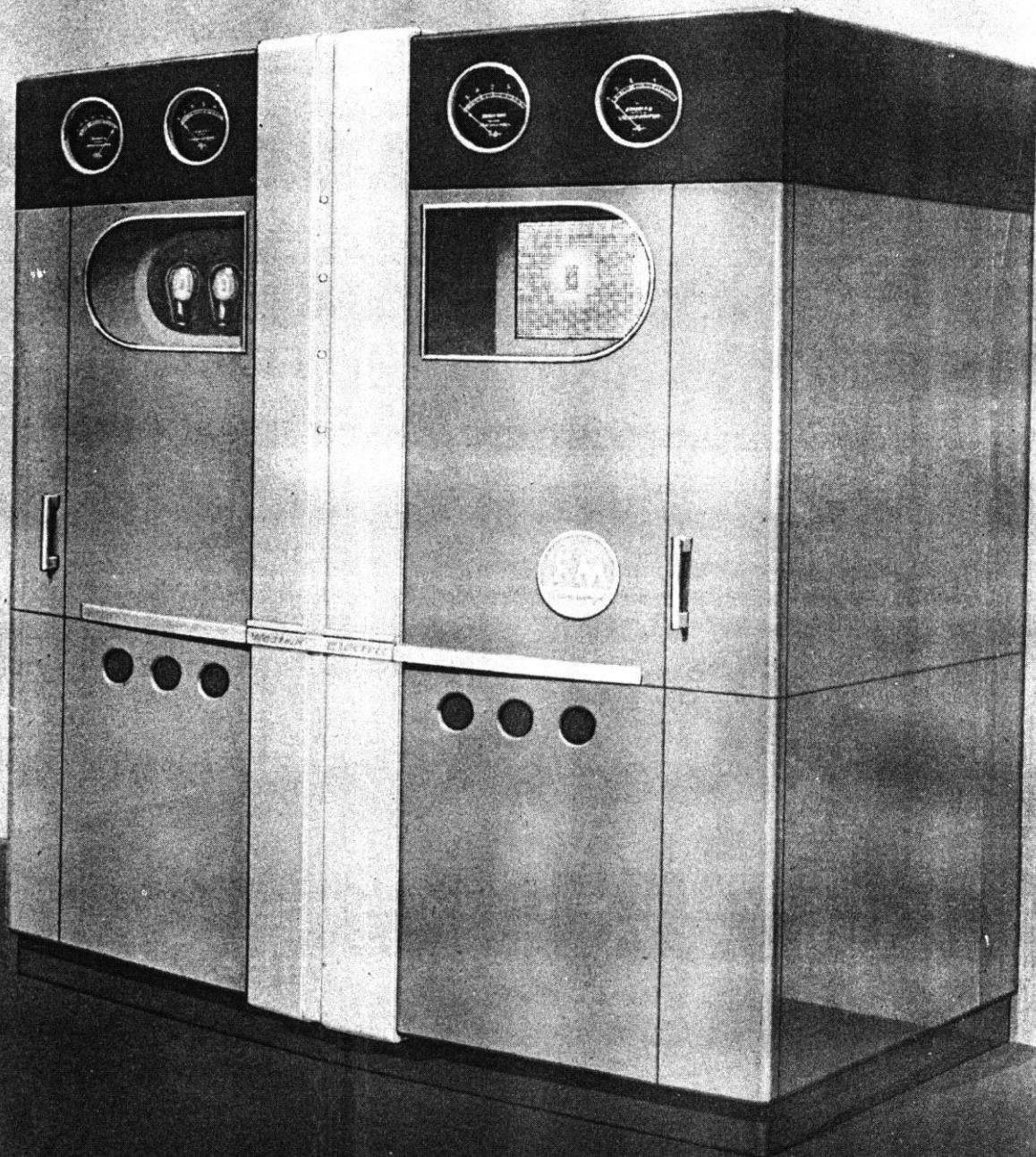
**SYNCHRONIZED FREQUENCY MODULATION
RADIO TRANSMITTING EQUIPMENT**

504A-1 – 3000 Watts

FREQUENCY RANGE: 42 To 50 Megacycles

by

Western Electric



Western Electric
Synchronized Frequency Modulation
Radio Transmitting Equipment 504A-1

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A development of Bell Telephone Laboratories, the Research Laboratories of the American Telephone and Telegraph Company and the Western Electric Company

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Foremost among the problems presented by frequency modulation is that of stability of the mean frequency. The solution of this problem is found in a new system - SYNCHRONIZED Frequency Modulation - developed by Bell Telephone Laboratories and incorporated in Western Electric's new Radio Transmitter, the 504A-1. The use of synchronized frequency modulation has made possible stability of the mean carrier frequency to better than ± 1000 cycles, and compared with the Federal Communication Commission's requirement of ± 2000 cycles.

The mean frequency in a frequency modulated signal is the total number of cycles occurring in a second, irrespective of their distribution in time over this interval. In SYNCHRONIZED Frequency Modulation this total number of cycles is, in effect, counted, compared with the number of cycles generated by a precise fixed frequency standard, and the tuning of the variable oscillator adjusted mechanically to keep the two always at exactly the same value. However, instead of counting millions of cycles each second, the procedure has been simplified tremendously by the use of a new technique - frequency division. This permits reducing the frequency to any desired degree. Actually, a frequency of about 5000 cycles or $1/8000$ of the carrier frequency is obtained. This low frequency, an exact submultiple of the carrier frequency, is then compared to the output of a low frequency crystal oscillator.

Here again another outstanding development, a 5 kc crystal oscillator, makes it possible to utilize the virtues of a quartz crystal in meeting the stability

requirements applying to the mean frequency in FM transmission. This new low temperature coefficient crystal oscillator has a stability well under one part in a million per degree Centigrade, making temperature control entirely unnecessary. This stability is equal to that obtained with the best crystals now in use in amplitude-modulated broadcasting.

The 504A-1 Radio Transmitting Equipment consists of an oscillator-amplifier unit and a power unit that supplies all DC power required for the entire equipment. These units are completely enclosed in a modern cabinet with access facilities for servicing the parts. Protective switches are provided to remove all voltages higher than 250 volts when access is required to compartments containing high voltage apparatus. This protection is arranged so that all doors of the oscillator-amplifier unit, except the doors of the power amplifier compartment, can be opened for inspection without interrupting operation. In the case of the power unit all voltages above 250 volts are disconnected when either the main front door or rear doors are opened. A blower located in the power unit provides filtering air for cooling this equipment. The purchaser is expected to provide suitable means for ventilating the operating quarters since approximately 7 kw are dissipated as heat nearly all of it in the air stream. The blower provided with the 504A-1 Radio Transmitting Equipment is designed to deliver approximately 600 cubic feet per minute but not to overcome the losses on any duct work provided by the purchaser to conduct air to or from the transmitting equipment.

Viewed from the front, the power unit is located to the left and the oscillator amplifier to the right. The power unit and oscillator-amplifier are each provided with a large front door and two rear doors for inspection or maintenance. The operating controls are normally concealed but readily accessible under hinged covers independent of the large front doors. These controls are manually operated. Windows are provided in the front doors for inspection during operation of important vacuum tubes and apparatus. Four 7" meters are provided. These meters are mounted behind the main front doors that are provided with suitable openings through which the meters can be seen. The cabinet is finished in two-tone blue and gray with black trim. The overall dimensions of this equipment are 80" wide x 84" high x 36-1/4" deep. A minimum clearance of 18" must be provided in the rear and 33" in the front for door swing.

Facilities are provided for termination of either a 7/8" or a 1-5/8" concentric transmission line. Arrangements can be made at a slight additional charge to connect to another type of line if desired.

ELECTRICAL CHARACTERISTICS

Frequency Range

42 to 50 megacycles.

When ordering, a single carrier frequency in the ultra-high frequency band of 42 to 50 megacycles should be specified.

Frequency Response

Flat within ± 1 db from 30 to 15,000 cycles per second.

Speech Input Level

Program level about 0 vu for full modulation of ± 75 kc per second. Single frequency level of + 8 vu for same excursion.

Distortion

Typical measurements of r.m.s. audio frequency harmonic distortion with a distortionless FM audio monitor in the frequency range of 30 to 15,000 cycles per second show less than 1% at a modulation corresponding to ± 100 kc excursion of the carrier. Distortion measurements include all audio frequency harmonics up to 30,000 cycles per second.

Modulation Capability

Typical measurements of modulation capability show that the transmitter modulates to a degree corresponding to more than ± 150 kc per second at any frequency within the range of 30 to 15,000 cycles per second. The frequency swing can readily be limited, of course, to the ± 75 kc range now authorized by the F.C.C., and can be extended at any future time to permit a greater range if authorized, and providing Radio receivers are manufactured to accommodate it. The modulation action of this transmitter is independent of any carrier frequency stabilizing action and is also unrestricted as to the degree of modulation possible at any frequency including the extreme low end of the audio frequency range. The modulation capability of this transmitter, therefore, is unique among FM broadcasting equipments.

Noise Level

The FM noise originating in the transmitter is sufficiently below the F.C.C. system requirement to provide margin for contribution by other system components.

Frequency Stability

Synchronized Frequency Modulation is a system in which the stability of the carrier wave, so important in broadcasting at any carrier Frequency, but especially important in ultra-high frequency broadcasting by frequency modulated waves, is maintained well within 1000 cycles without the use of temperature control anywhere in the system. This stability is entirely independent of circuit variations. Moreover, the frequency synchronizer being external to the transmission path, no interruption in operation can be caused by failure of a vacuum tube or any other component in the synchronizing circuit.

Pre-Emphasis of Audio Frequencies

Pre-emphasis may be used if desired by cutting in the emphasizing circuit provided at the audio input. This circuit is designed to have a constant impedance of 600 ohms for all frequencies and a response characteristic rising between 400 to 15,000 cycles per second in accordance with RMA standards.

Primary Power

The 504A-1 transmitter operates from a power supply of 230 volts \pm 5%, three phase, 60 cycle and requires a power source of approximately 10 kvs for full power output. The power factor is approximately 90%.

INSTALLATION INFORMATION

The central structure is first placed in position and external electrical connections made before the cabinet is assembled onto the frame. This arrangement gives a maximum access to the apparatus, with a minimum hazard of damage to the cabinet while installing.

Dimensions

80" wide x 36-1/4" deep x 84" high.

Weight

Approximately 3900 pounds.

Licensing Information

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 license for the operation thereof.

SUGGESTIONS FOR FILLING OUT ITEMS 18, 19, 20, and 21 ON F.C.C. FORM 319 (ISSUE OF DECEMBER 1940) WHEN FILING ON WESTERN ELECTRIC 504A-1 RADIO TRANSMITTING EQUIPMENTS.

18 (a) - Fill in Western Electric name and equipment type number.

18 (b) to

18 (f) - Fill in "on file".

18 (g) - Indicate the name and type of modulation monitor to be used. If no approved type is available, state your intention of using an approved type when available.

18 (h) to

19 (e) - Fill in "on file" except as follows:

In 19 (c) after "calibrated frequency" give the crystal frequency as obtained by dividing the channel frequency, specified in 18 (a), by 8192.

19 (f) - Indicate the name and type of frequency monitor to be used. If no approved type is available, state your intention of using an approved type when available.

- 20 (a) - Since it is impracticable to predict with the precision implied in the Standards of Good Engineering Practice the characteristics of a system merely from a knowledge of the characteristics of the principal apparatus components, and since the process of adjustment of a system to meet the requirements will be difficult under the most favorable circumstances, the applicant may decide to quote the minimum acceptable performance figures as specified in the Standards when answering this question.

Typical performance data for the Western Electric 504A-1 Radio Transmitting Equipment alone is

Frequency characteristic - flat within $\begin{matrix} +0 \\ -1 \end{matrix}$ db of 1000 cycles.

Distortion - 1.5% RMS harmonics.

Noise - 62 db below 100% modulation.

- 20 (b) - It will ordinarily be necessary to obtain this information from the Telephone Company, or other suppliers of the wire line, if used.

- 20 (c) - If Western Electric 618, 630, 633, or 639 type Microphones are to be used, answer "on file". Otherwise, obtain information from supplier.

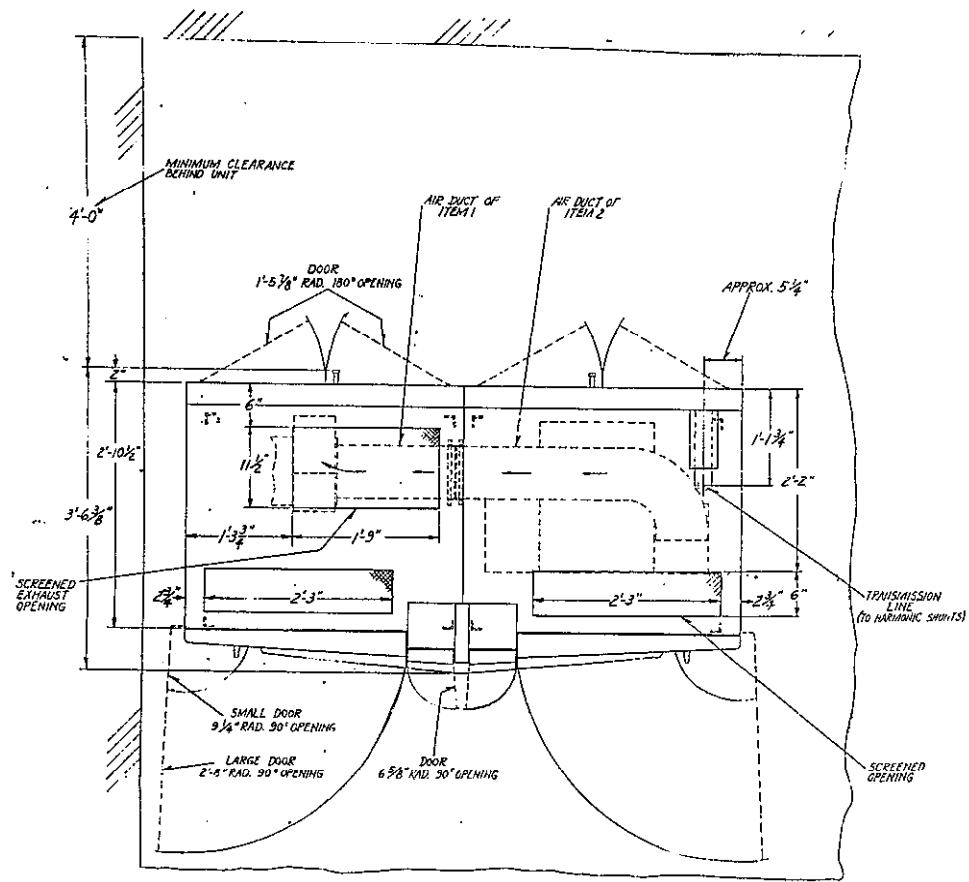
- 21 - Fill in "on file".

FOR FURTHER INFORMATION

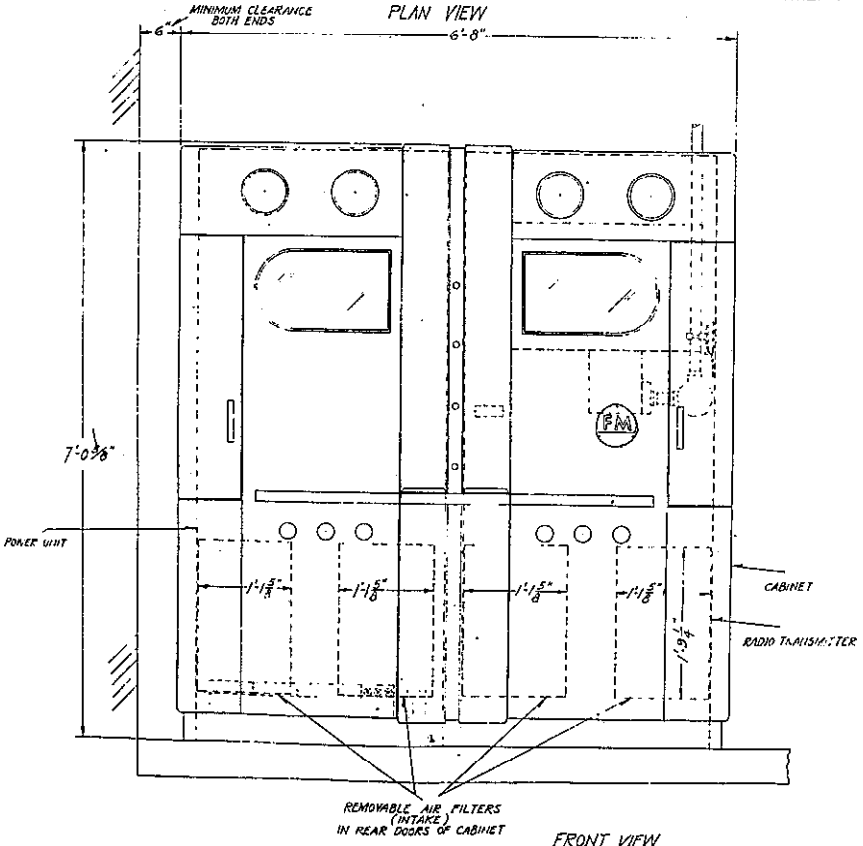
For further information regarding Western Electric's 504A-1 Synchronized Frequency Modulation Radio Transmitting Equipment you are requested to address the Western Electric distributor listed on the last page of this bulletin.

FEATURES

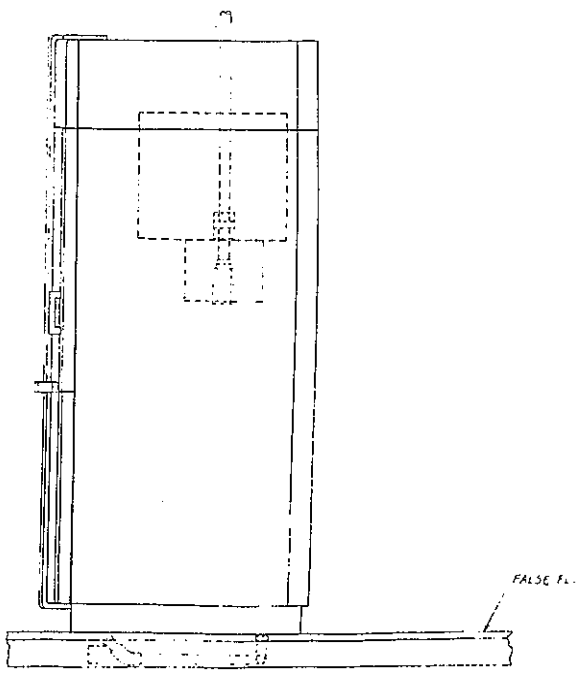
- Synchronized Frequency Modulation.
- Carrier frequency stability at least twice as efficient as the present F.C.C. requirement of ± 2000 cycles.
- Improved high-quality and noise-free transmission through use of balanced modulated oscillator and balanced control tube circuit.
- Linear modulation to ± 100 kc without critical adjustments at any audio frequency between 30 and 15,000 cycles per second.
- Unique use of negative feed back in modulated oscillator minimizes distortion over a wide range.
- Interruption of carrier frequency control does not cause departure from assigned frequency.
- Complete isolation of carrier frequency control from modulation and program circuits.



PLAN VIEW

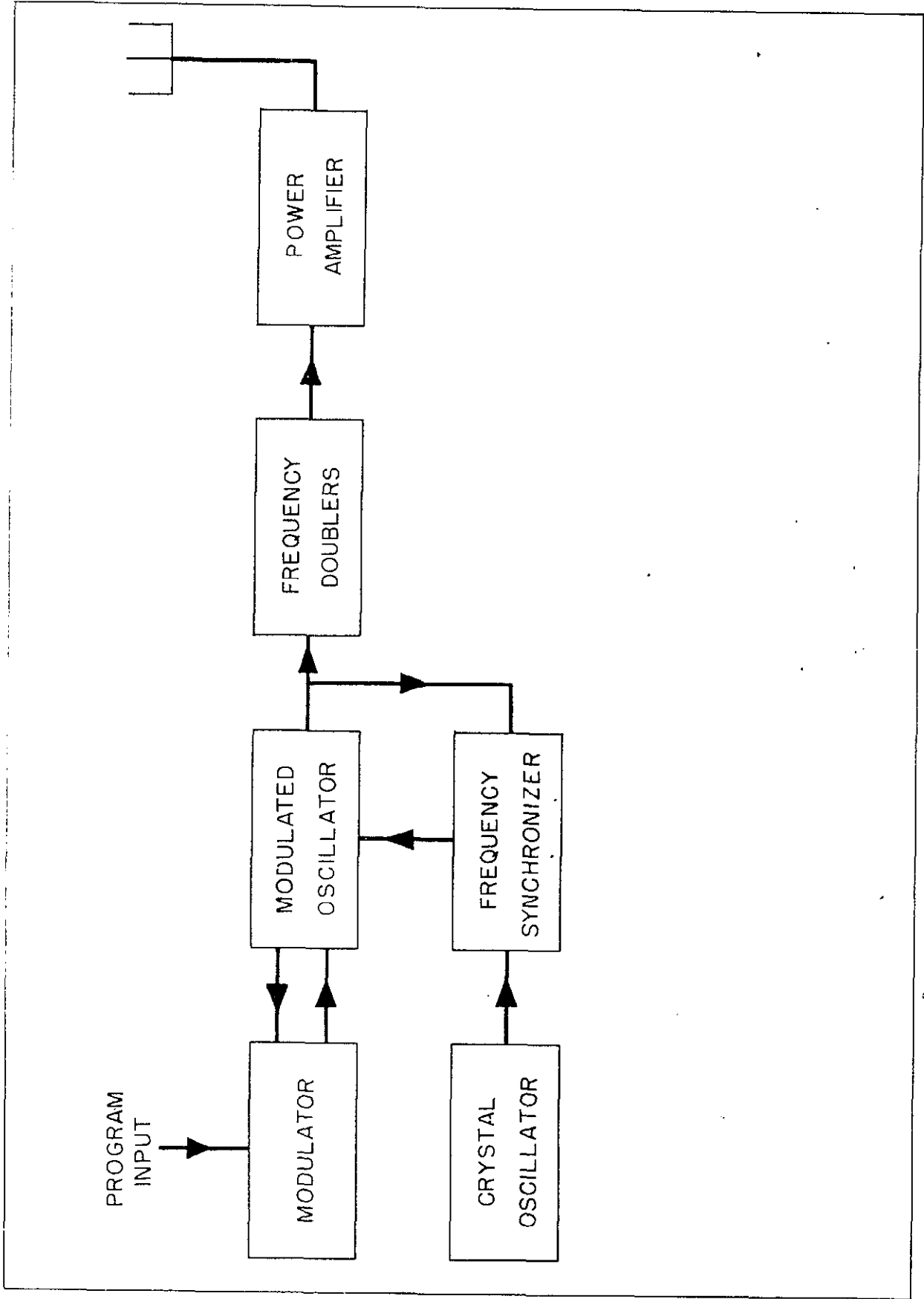


FRONT VIEW



SIDE VIEW

504A-1 Radio Transmitting Equipment
Dimensional Outline



Block Schematic - 504A-1 Radio
Transmitting Equipment

DISTRIBUTOR IN THE UNITED STATES

Graybar

ELECTRIC COMPANY

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A NATIONAL ELECTRIC SERVICE

The Western Electric Company, Incorporated reserves the right to make any changes or modifications, consistent with good engineering practices, that it may deem to be necessary with respect to the design of or the material used in any of its products.