And A 500,000 WATT

The tremendously rapid advance of the progress of WLW from a 20 watt successive power increases to 50, 500, 500,000 watt station described in this

Joseph A.

THE CONTROL CONSOLE

J. E. Whitehouse, Chief Transmitter Engineer, at the console which provides complete control, not only of the 500 kw. transmitter of WLW but the transmitters of the other Crosley stations, WSAI and W8XAL as well, W8XAL being a short-wave transmitter

BY the time this article reaches the eyes of readers it is probable that many of them will have heard the new 500 kw. transmitter of WLW, the Crosley station at Harrison, Ohio. At the time of writing this, the installation is nearing completion so that tests, to be carried on between the hours of 1 a.m. and 6 a.m., will start within the next few weeks.

This new transmitter will be by far the most powerful broadcast transmitter in America. In fact, there is no transmitter in the world employing such high power at the present time. It is expected that the area over which the new transmitter can be heard will be ten times that covered by WLW's present 50 kw. transmitter. It is felt that innumerable rural communities not now satisfactorily served by local stations will thus be provided with excellent radio programs at a signal level high enough in most cases to largely override local noise and static conditions.

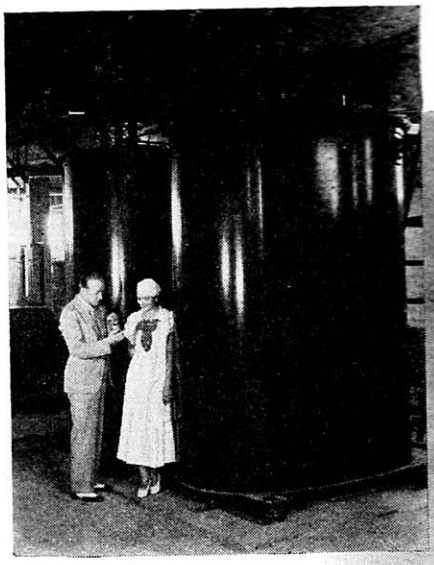
We have been working toward this 500,000-watt transmitter for the past five years, and our own technical staff worked up complete plans for such a unit. About a year ago we submitted our plans and predictions to the Federal Radio Commission and received permission to construct such a transmitter. Then came a series of meetings with many of the country's leading radio engineers. R.C.A. was given the contract to supply the material and install the entire 500,000-watt amplifier and modulator. Since it was an experimental transmitter of an entirely new design, it rapidly developed into an engineers' picnic. It was decided to incorporate as many new ideas as possible. It was necessary to design many new pieces of equipment. I am sure it is going to be the last word in broadcast transmitter design and will incorporate many features never before attempted.

Briefly, the new equipment is a radio-frequency amplifier capable of 2,000,000 watts peak output, an audio-frequency amplifier of sufficient size to modulate the radio-frequency amplifier and the necessary power supplies and control circuits.

The radio amplifier contains twelve RCA 100 kw., type 862 tubes. These are divided into three units of four tubes each. In each unit the tubes are operated push-push parallel. Each unit has its own grid tank and plate tank circuits. This arrangement, along with unusual mechanical design, results in a very stable amplifier. Each unit is individually neutralized. The tubes are operated as Class C amplifiers. The final audio stage or modulator contains eight of the 100 kw. tubes. These are divided into two units of four tubes each. They are also operated push-push parallel as Class B audio amplifiers. The output audio transformer is divided into two sections. There is one section for each of the modulator units. Secondaries of the two sections are connected in series and the output modulates the plate voltage of the final r.f. amplifier. Direct current is blocked out of the modulation transformer secondaries and a 500-microfarad audio coupling condenser is used. This amplifier is capable of delivering over 400 kw. of undistorted audio power.

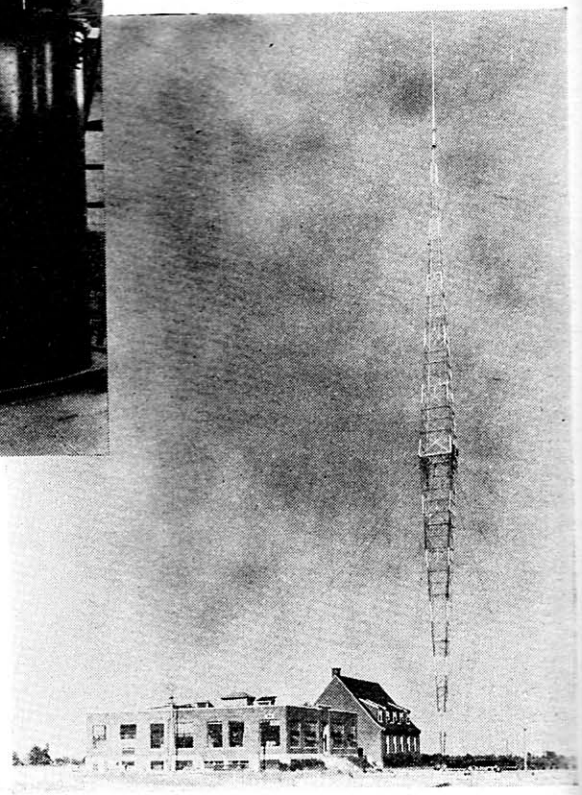
Three 1500-ampere generators connected in parallel provide 4300 amperes at 33 volts for the filaments. They are driven by three 75-horsepower, 2300-volt motors. These motor generators can be controlled individually or as a unit. Normally, they are controlled as a unit from the console on the transmitter floor, and a single control adjusts the voltage from all three generators. Naturally, the generators are of special design to have minimum ripple and other desirable characteristics.

The main plate supply rectifier will deliver 100 amperes at 12,000 volts. This is the normal voltage applied to



MODULATION TRANSFORMERS

To handle the tremendous audio power of 500,000 watts it was necessary to design and construct this pair of modulation transformers which weigh close to 50 tons and are submerged in 1400 gallons of oil

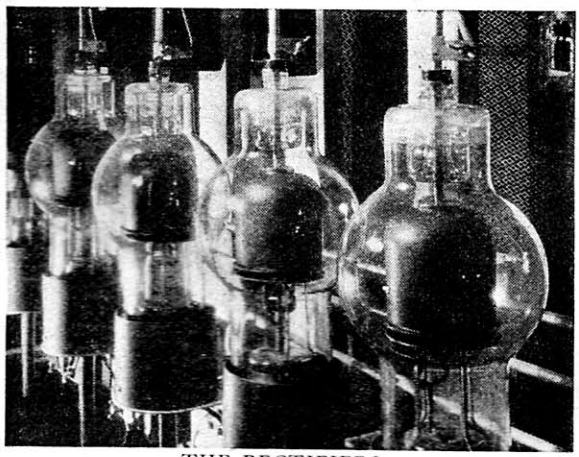


TRANSMITTER PLANT AND ANTENNA

This 831 foot tower is not an antenna support it is the antenna itself and is mounted on an insulating base capable of withstanding the load of 450 tons resulting from the weight of the tower plus the down pull of the insulated guy wires

Now:— SUPER STATION

radio broadcasting is exemplified in transmitter employed in 1922 through 1000, 5000, 50,000 watts, and finally the article and soon to be in operation



THE RECTIFIERS

The transmitter requires 1200 amperes at 12,000 volts for the plate supply. Six of these mercury vapor rectifier tubes, rated at 450 amperes each, are employed in the 3-phase, full-wave rectifier system

Chambers

all the tubes. At 100 percent modulation the peak voltage applied to the radio-frequency stages will be 24,000 volts. A three-phase, full-wave rectifier circuit is used, employing six special hot-cathode, mercury-vapor rectifier tubes, developed by the G. E. Company specially for this installation. This tube will be known as the RCA 870. A system of oil switches controlled from the control console on the transmitter floor permits the rectifier transformers primaries to be connected either Delta or Y. This permits two voltages, namely, 8000 and 12,000, as normal operating voltages. Automatic step starting is also afforded whereby the voltage is applied gradually.

High-level modulation is used and Class B audio amplifiers deliver the required audio power. This has various advantages, particularly in that it is more economical in power. All radio-frequency stages are operated Class C, which is the most stable and efficient arrangement. The audio amplifiers consuming large amounts of power are operated Class B for efficiency. Fortunately, the RCA 100 kw. tube is excellent as a Class B audio amplifier.

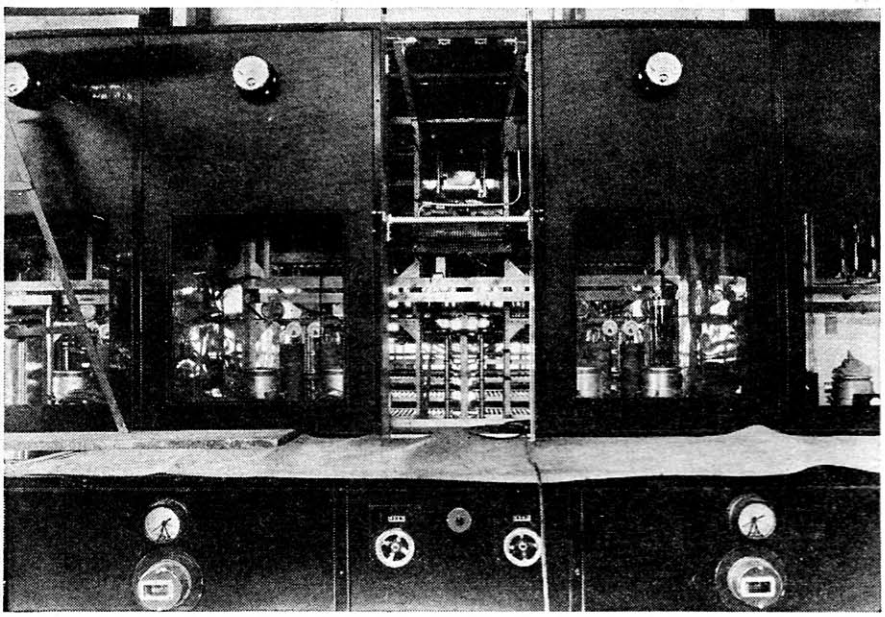
ONE OF THE R.F. UNITS

This view shows one of the three 180 kw. r.f. units. Each of these units employs four 100 kw. tubes. This view shows only about one-fifth of the main transmitter panel which is 54 feet long and 16 feet high

High-quality audio amplification is obtained. The biggest single problem was the design and construction of the tremendous audio transformers used as modulation transformers. These weigh close to 50 tons and are shown in one of the accompanying illustrations.

Some interesting problems resulted from this high-power Class B amplification. Constantly varying power is drawn by the modulators; very low power in between words and high power at peaks of modulation. In order to maintain constant voltage under this highly variable load, the entire power supply system had to offer very low reactance. A condenser of 260 microfarads is used in the main rectifier filter. The rectifier transformers were special low-reactance units. In co-operation with the engineers of the Union Gas & Electric Company, a power supply substation was planned with low-reactance equipment throughout. Special lines were installed to our transmitter to meet our load conditions.

In view of the fact that all the power equipment has low reactance, this reactance cannot be counted upon for protection in case of short circuits or rectifier tube flashbacks. Almost unlimited power would be fed into any fault. To supply the necessary protection under these conditions and also to meet various other control requirements, the G. E. Company developed a special high-speed circuit breaker as rectifier primary control. This breaker is rated at 100,000 amperes interrupting capacity and is so fixed that the time from the energizing of the trip coil till the arc is extinguished is only 1/12 of one second. It closes just as fast and the transmitter control circuits are so arranged that under certain conditions this breaker may open three times under short-circuit conditions in less than a second.

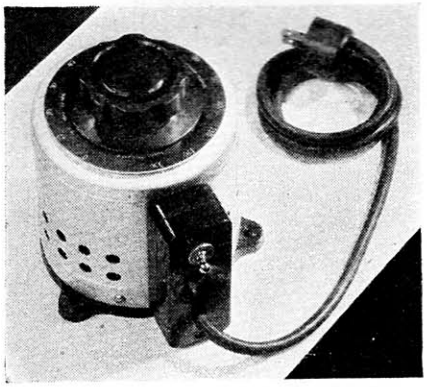


The output of the radio-frequency amplifier is transmitted to the antenna proper by a concentric type transmission line. This type transmission line, particularly at 500 kw., involved quite a few problems. It was designed after the tower had been completed and measured and was made to match the tower impedance without the necessity of any coupling system whatsoever. This eliminated quite a bit of equipment with its corresponding losses and harmonic radiation. The particular advantage of the concentric type of transmission line is the reduction of harmonic radiation, which represented quite a problem with 500,000 watts power.

The tower itself serves as the antenna and was quite an engineering accomplishment. It stands 830 feet above the surface of the ground and its foundation extends 70 feet beneath the ground. The steel itself weighs 136 tons. This weight, combined with the down pull of the eight guy wires, makes a total load on the base insulator of about 450 tons. The base insulator is made up of two porcelain cones so connected in the middle that swaying of the tower will not put any twisting forces in the porcelain. As long as most of the load is direct compression, this insulator will stand up to about 1500 tons load. Fifty-six guy wire insulators were used in the guy wires to insulate the tower from ground and to break up the guy wires so that they could not distort the pattern. All eight guy wires fasten to the tower near the center.

By actual measurement the use of this antenna (*Continued on page* 565)

speed control for small motors, over voltage and under voltage testing on electrical household appliances, brilliancy control for sign lighting installations, etc. The Variac is made in two models: Type 200-CM has



a protecting case, an attachment cord, and an outlet receptacle and is intended for laboratory and experimental use. The other model is supplied without the case and is available for those who wish to build the control into other equipment. The maximum current rating of this voltage control is 5 amperes. Models for larger and for smaller currents are under development.

Maker—General Radio Co., Cambridge, Mass.

Test Oscillator

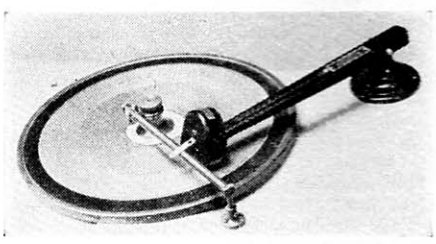
Description—This new portable Dayrad series 31 test oscillator is designed to produce frequencies from 105 to 1650 kc. The instrument is sturdily constructed and is fully shielded and by-passed. It is equipped with an attenuator, separately shielded, to vary the intensity of the signal

for properly aligning and neutralizing radio receivers.

Maker—The Radio Products Co., Dayton, Ohio.

Recording Unit

Description—The photograph illustrates the new Universal feed screw phonograph recording device. This unit is simple to



operate, easily installed and is designed for use with any standard recording cutting head. The device grooves its own record and is capable of cutting 80 grooves an inch. It can accommodate records up to 12 inches in diameter. This new recording mechanism is especially adapted for use in home recording, transcription studios and broadcasting stations who make their own recordings and transcriptions.

Maker—Universal Microphone Co. Ltd., Centenela at Warren Lane, Inglewood, Calif.

A 50 KW. Station

(*Continued from page* 547)

this antenna with the 50 kw. transmitter resulted in an average of 40 percent improvement in signal strength over an antenna of normal design and in most cases eliminated distortion fading as well as moving our primary fading zone out about 50 percent.

To summarize some of the outstanding features of the transmitter, I want to point out:

First: The normal carrier delivered to the antenna is 500,000 watts.

Second: 100 percent modulation of this 500,000 watts is obtained.

Third: This means that 2,000,000 watts is radiated at peaks of modulation.

Fourth: An average of 1800 kva. of power is required.

Fifth: The frequency characteristic of the entire transmitter is flat (within 2 db.) from 30 to 10,000 cycles.

Sixth: The total audio-frequency harmonics do not exceed ten percent up to ninety-five percent modulation.

Seventh: The radio harmonic radiation is so low that at any point the harmonics will not be greater than 1/100 of one percent of the fundamental.

Eighth: Rectifier filaments which required 30 minutes to heat up are turned on by a time clock; a spare tube is kept hot at all times.

Ninth: The starting control system will start the entire transmitter automatically in proper sequence and with proper time delays, if desired, or individual control of any part of the sequence is obtained by switches on the control console.

Tenth: In case of momentary failures, such as arc-overs or tube flash which can be cleared by removal of power, the transmitter is automatically restarted in about 1/5 of a second.

Eleventh: In cases of failure requiring attention, the unit containing the failure is automatically isolated and the transmitter automatically restarted in about one second and continues operating at slightly reduced power

Twelfth: 22,500 cubic feet of air per minute is circulated for cooling various parts of the transmitter.

Thirteenth: 500 gallons of distilled water and 700 gallons of city water are circulated each minute for tube cooling. A spray pond 75 feet square is used for cooling the city water.

Fourteenth: A .58 wave vertical radiator, 830 feet high, is used as an antenna.

To those who may be alarmed about local blanketing, may I point out that the increased signal over what we now have is the same as the increase when we went to 50 kw. from 5 kw. There was considerable alarm at that time over the blanketing, and it was not at all serious. In the meantime, receiver selectivity is very much improved and we expect even fewer complaints when we go from 50 kw. to 500 kw. than when we went from 5 kw. to 50 kw. *Joseph A. Chambers,* Technical Supervisor, Broadcasting Division, Crosley Radio Corp.