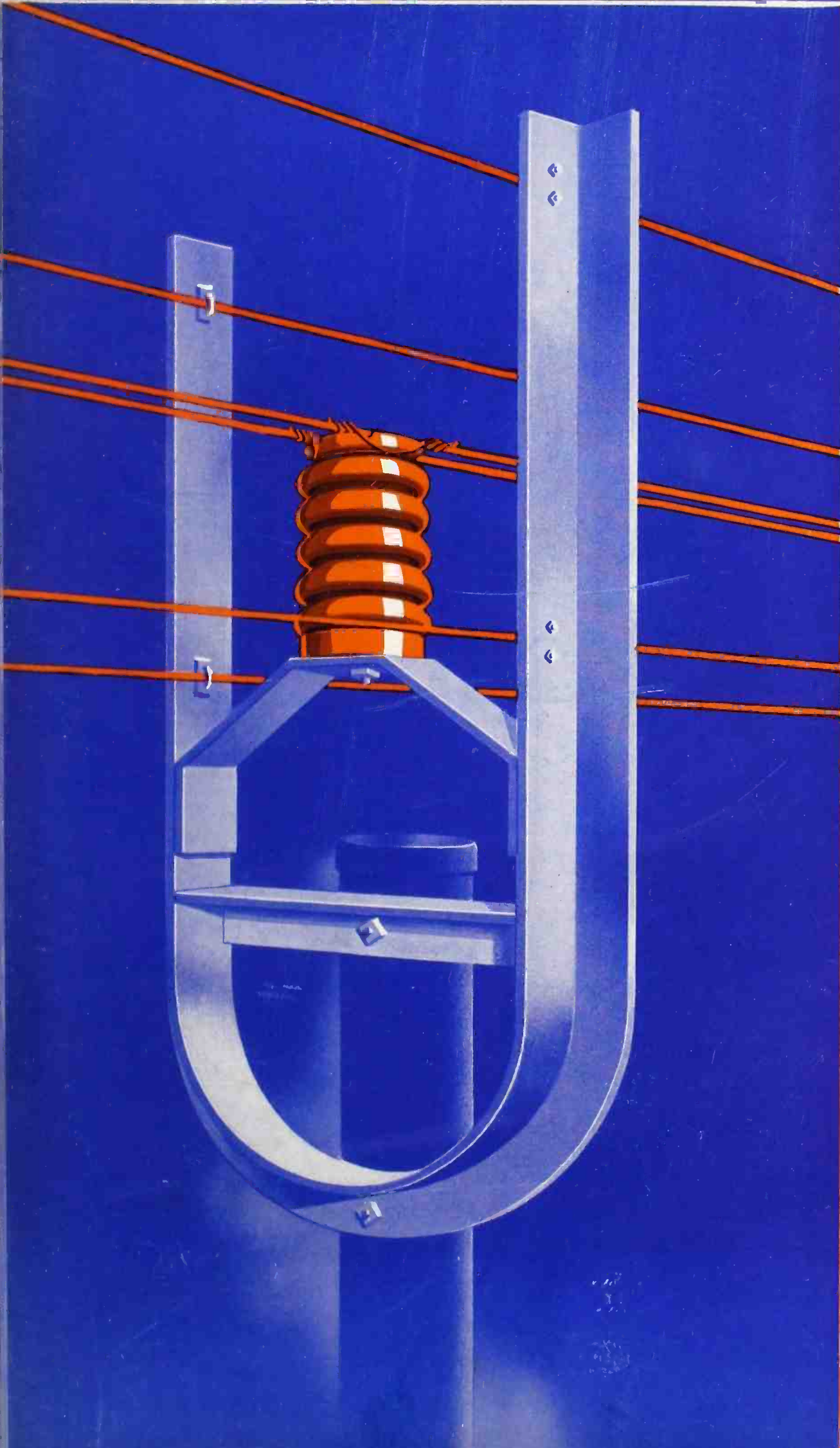
BROADCAST NEWS



In this Issue

LATERAL DISC RECORDING

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THE DECIBEL SCALE

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PATTERNS TAILORED TO FIT

FEBRUARY - - - 1941

RCA MANUFACTURING COMPANY, INC., CAMDEN, N. J.

RCA Manufacturing Company, Inc.

A Service of Radio Corporation of America

Camden, N. J.

"RADIO HEADQUARTERS"

ENGINEERING PRODUCTS DIVISION

MEADE BRUNET, Manager

AVIATION RADIO EQUIPMENT
BROADCAST STATION EQUIPMENT
COMMUNICATIONS TRANSMITTERS
FARADON MICA CONDENSERS
FACSIMILE APPARATUS
MEASURING EQUIPMENT
PUBLIC ADDRESS AND SOUND SYSTEMS
POLICE RADIO EQUIPMENT
SPECIAL ELECTRONIC APPARATUS
TELEVISION TRANSMITTING SYSTEMS
U. S. GOVERNMENT APPARATUS

TRANSMISSION EQUIPMENT SALES

I. R. BAKER, Manager

Affiliated Company Contact........C. L. Beach
Broadcast Transmitters........S. W. Goulden
Faradon Condensers........J. A. Fried

Measuring Equipment, Television Apparatus, Facsimile........T. A. Smith, H. E. Rhea
Speech Input Equipment, F-M Transmitters
C. M. Lewis, W. L. Lyndon

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BROADCAST NEWS

REG. U. S. PAT. OFF.

PAUL V. LUTZ, Editor

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Observation Foyer.

NEW STUDIOS FOR WIRE

Indianapolis Station Installs New Equipment in Studios

RADIO Station WIRE, Indianapolis, Indiana can proudly say that it has one of the finest and most modern studio and transmitting plants in the mid-west. A firm believer in the statement that "Good Engineering is Good Business," WIRE like many other leading stations has gone RCA — ALL THE WAY.

A little more than a year ago WIRE selected a new transmitter site seven miles northwest of the center of Indianapolis. On this site a spacious modernistic transmitter building was erected. The main transmitter room is very spacious, being 26 by 32 feet with a ceiling height of 18 feet. This room houses the RCA 5-D transmitter. Exhaust fans in the rear of the room are used to remove the heat given out from the transmitter.

After almost 14,000 hours of service the RCA 891-R and 892-R air-cooled tubes are still going strong, the filament voltage still being operated at 2 volts under normal.

To the front and center of this room is located the master control desk. From this point the operator has full control of the transmitter and directional antenna system. Four cabinets are located to the left of the master desk. These racks contain such equipment as RCA's new 311-A frequency monitor, 96-A limiting amplifier, 94-D monitor amplifier, 66-A modulation monitor, 303-A frequency-limit monitor and other auxiliary speech equipment.

Transmitter Building

Upon entering the transmitter building one finds himself in an observation foyer. From this point visitors may view all of the equipment in the main transmitter room. At the south end of the foyer is the office of the chief engineer and at the north end is a well equipped laboratory. Equipment in the lab includes RF and AF measuring units, signal generator, field intensity set and other measuring and test devices.

On the south side of the main transmitter room will be found two doors, one leads to the auxiliary transmitter room where a complete 1 KW composite transmitter is installed. It is ready for immediate use at all times. The other door leads to the power distributions and spare parts room.

The antenna system at WIRE consists of two 330 foot vertical radiators spaced one-half wave apart. Directional operation during the nighttime hours shields in the east and west directions. The ground system consists of 14 miles of number 8 copper wire bonded to 40 foot ground screens under each radiator.

Transmission Line

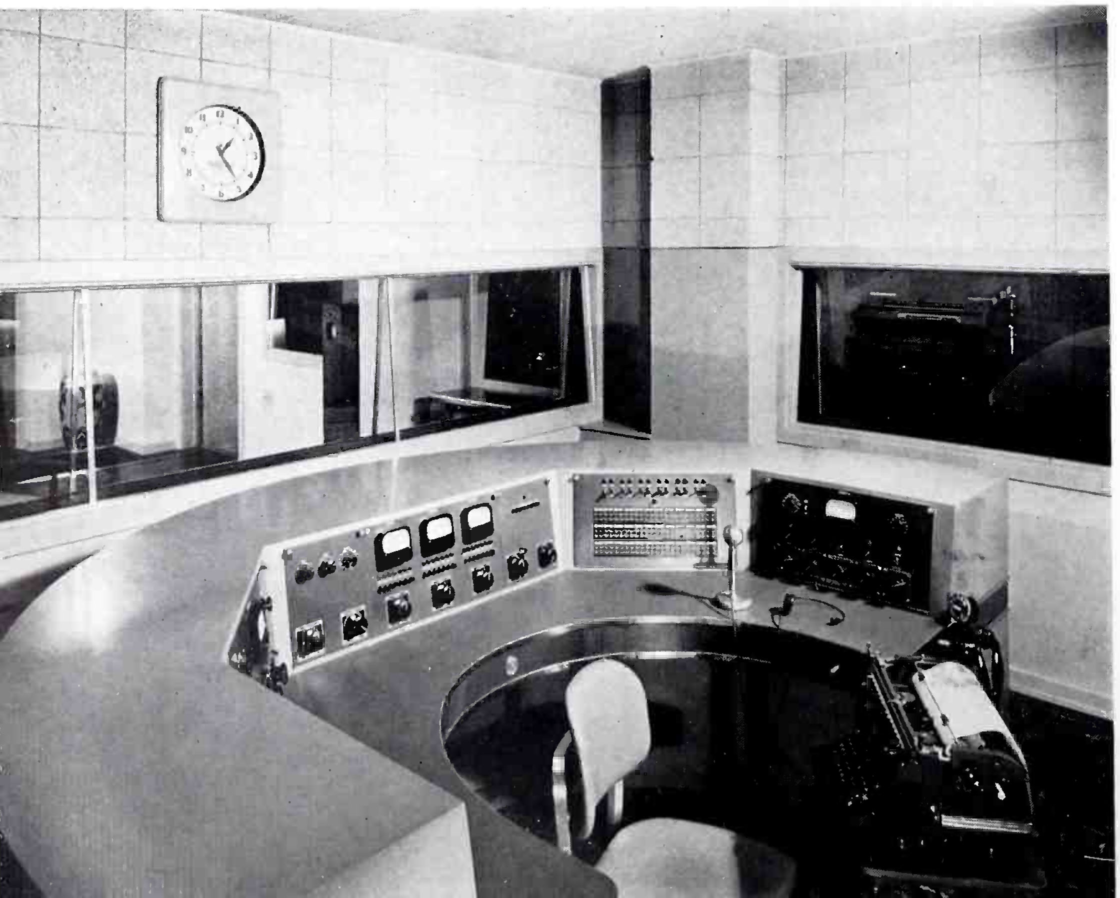
The transmission line feeding the south tower is 160 feet long and the line feeding the north tower is 230 feet long. To do away with any possibility of transmission trouble a 2½ inch concentric line was installed 18 inches above the ground. To give some degree of protection to the concentric line a 2½ inch steel conduit was installed directly above the feeders. In this conduit are the wires for lighting the tower lights and flashing beacons atop each tower, remote antenna meter wires, monitoring wires and relay switching wires for directional operation.

The main AC feeder lines for power service are brought in under ground from two separate sub-stations. During a storm should service from the north be interrupted, instantaneous switching to service from the south can be made.

Mobile Stations

Just outside the building leading from a large semi-circle drive there is a spacious parking area and garage. The garage houses WIRE's mobile truck and equip-

Master Control Desk at WIRE.



ment. The mobile stations are licensed under the calls WATB, WEII and WEIH.

Shortly after completing the transmitting plant the engineering department of WIRE turned its thoughts to the design and construction of new studios and offices.

The new studios and offices are located atop the Claypool hotel in the heart of downtown Indianapolis.

Neither words or pictures can do justice to the beautiful studios and offices of Radio Station WIRE. In all there are 23 offices, 3 studios, master control room, entrance lobby, clients audition room, observation foyer and recording laboratory. The main studio is equipped with two grand pianos, a Hammond organ, Nova-Chord and a complete set of Deagan chimes. Each noonday a chime concert is played for downtown Indianapolis over a powerful speaker system atop the Claypool hotel.

Air Conditioning

Ideal weather, which makes working a pleasure, is manufactured by a giant air-conditioning plant on the roof above the studios.

All rooms are completely air-conditioned with modern machinery developed by the Chrysler-Airtemp company. The air is washed, humidified and cooler heated so that even temperature is maintained at all times, regardless of whether the studio is occupied by one performer or by a large audience. The condensers and compressors for summer cooling are located on the roof, with feed and control lines terminating in the machinery room. In order to eliminate any sound of moving air, and to eliminate the possibility of having sound carry from one studio to another through air ducts, silencers have been installed at both the feed and exhaust outlets.

In designing the station a modified form of modern architecture was used, which makes the place very attractive and the atmosphere very cheerful. Visitor accommodations include a beautiful reception lobby and a spacious observation foyer. A lounge is also provided for announcers and artists. The executive and business offices total 23 in all, each very spacious and well lighted.

Expansive sheets of vision windows which are of slanting double structure are provided between each studio and the public space adjoining. The master control room has glass on three sides which gives maximum vision for the control technician.

All sound communication between any of the studios, control and audition rooms, has been eliminated by sound isolation treatment. The studio doors are over three inches thick and have rubber gaskets, special locks and automatic closures at the bottom to protect all door openings from outside noise.

Every effort was made to secure the finest available facilities for the WIRE audition room. A spacious sound insulated chamber has been constructed, with every comfort for the client, with the modern motif carried out in the furnishings and decorations. A high-fidelity RCA speaker has been provided and, from this room, any of 11 program and audition channels may be monitored. The audition room is equipped with microphones and signal lights and may be used as a studio should the need arise.

Organ Studio at WIRE.

Each studio is equipped with the latest type RCA microphones. The type of microphone used depends on the nature of the program.

Each executive office is supplied with a special finished RCA high-fidelity speaker and amplifier. A turn of a switch selects one of 11 program and audition channels.

Special precautions were taken in all the wiring throughout the station. Heavy conduit and special bonding reduce all strays to a minimum. Over 65,000 feet of shielded wire was used for interconnections between equipment.

Three factors were kept in mind when designing the equipment for the master control room, (1) reliability, (2) flexibility and (3) simplicity. The very latest type of RCA equipment has been used throughout.

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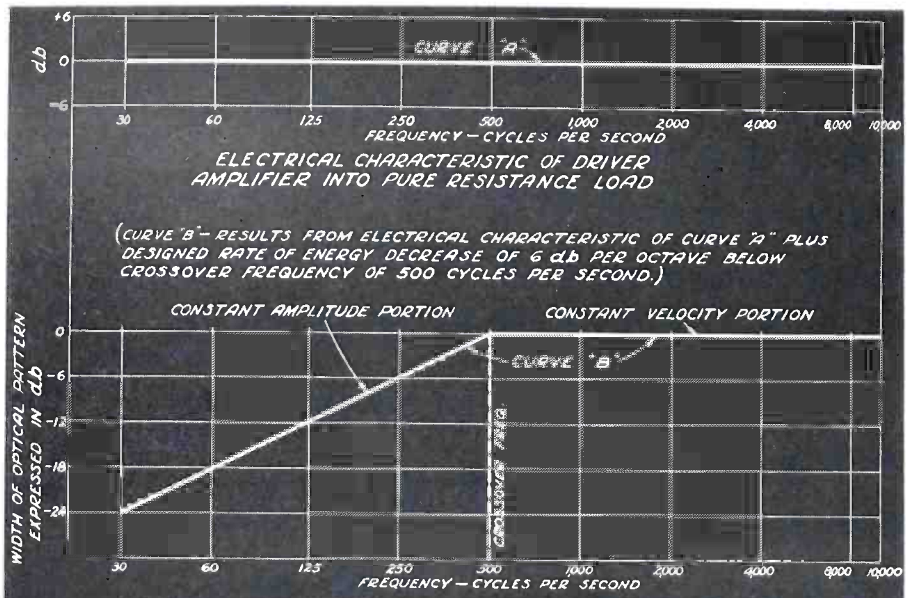
Stand-by Studio and Transcription Room.

LATERAL DISC RECORDING

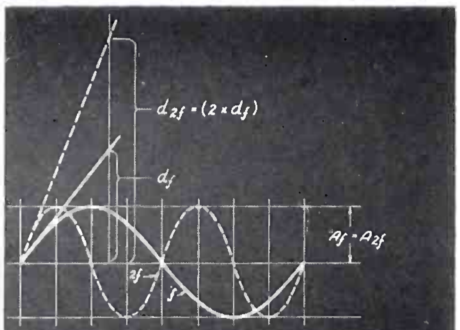
By B. F. FREDENDALL
NBC Audio Facilities Group
Reprinted from the A-T-E Journal



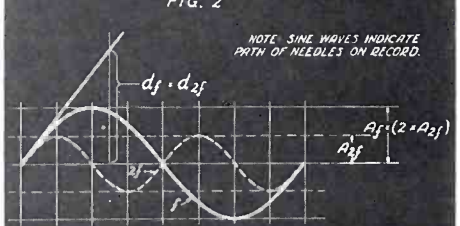
OPTICAL PATTERN OF ASSUMED RECORDING CHARACTERISTIC
FIG. 1

SOUND recording began about the year 1877 but, only since the introduction of the instantaneous playback lacquer coated disc, has there been a widespread demand for knowledge of the recording process. Although there are two general methods of disc recording, i. e. vertical cut and lateral cut, only the latter will be described since it is more widely used, and is the system of recording used by the NBC and RCA. This text outlines briefly the general theory of recording and, more specifically, the steps required to place a system into standard operation or to check the performance of an existing installation.

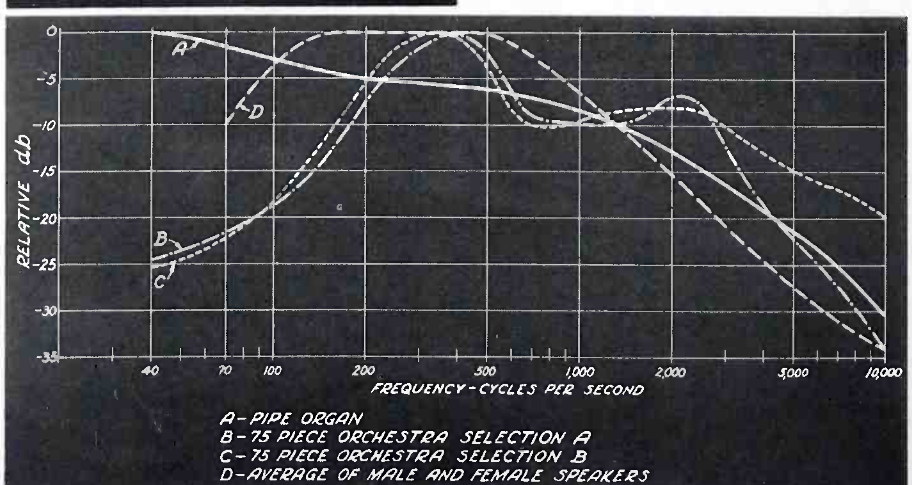
It is necessary to understand the basic theory of lateral recording before outlining in detail the various steps required to put that theory into practice. Accordingly this text is divided into two parts; Theory and Practice. Under Theory the subject is discussed according to the natural classifications of electrical, mechanical, electro-mechanical, and equalization; under Practice a description of the electrical and optical tests used in determining the required recording characteristic is given.



CONSTANT AMPLITUDE
(VARIABLE VELOCITY & SLOPE)
FIG. 2



CONSTANT VELOCITY
(VARIABLE AMPLITUDE)
FIG. 3



PEAK ENERGY PER INCREMENT OF FREQUENCY
FIG. 4

Emphasis is placed upon the need for clear differentiation in considering voltage, current, power, mechanical amplitude, and optical width while performing the necessary steps in lining up a recording system.

General

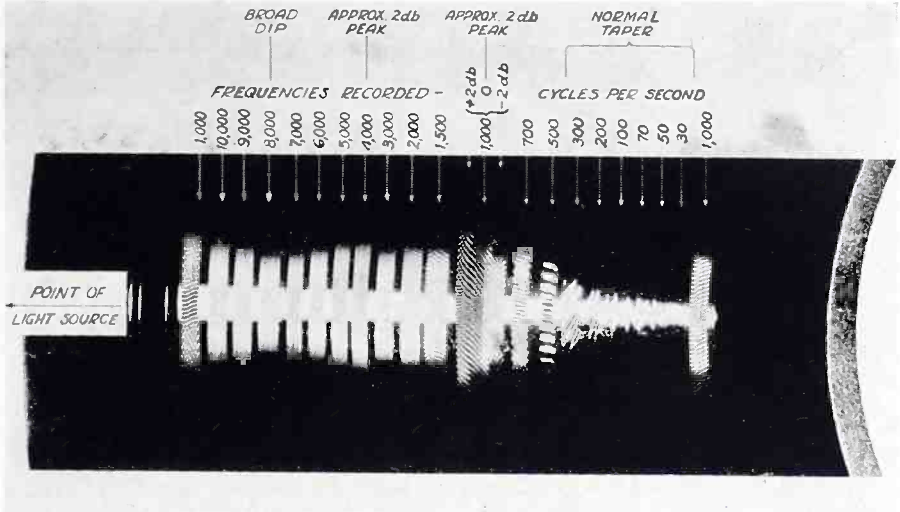
There are two general methods of lateral disc recording: namely, embossing and engraving.

In the method of embossing the inclined recording stylus, or needle, presses with continuous uniform force against the suface of the record, depressing and permanently deforming its surface without puncturing it. The resultant groove is an indentation of the record material which the playback needle must follow. In engraving, the recording needle, set almost at right angles to the record surface, cuts a chip or thread from the soft material, just as a machinist's lathe cuts a chip from the work revolving under the cutting tool.

Record materials vary considerably but fall into three broad classifications, namely, wax, lacquer, and film. Wax is the softest of the three, is generally used for making "processed" records but is not suitable for instantaneous playback. Being soft it offers less of a load to the cutting head than lacquer.

The term "lacquer" is used here to designate all those mixtures, applied to a structural base, having about the same degree of density or firmness. Manufacturing formulas are a secret but usually contain cellulose-nitrate as a basic ingredient plus resins, oils, lacquers, gylcerine, paint products, and some volitile solvent. The much used term "acetate" is not correct, since most of the manufacturers supplying "acetate" records do not use a cellulose-acetate base. The mixture is applied on a supporting base of aluminum or cardboard, aluminum being used exclusively for the higher quality recordings.

Film is frequently used for embossed lateral recording in the form of a continuous belt. A sufficient amount of film may be loaded into a long time recorder so that a 24 hour recording may be placed on one loop of film. So far it is mainly used for such recording service as plane to ground communication, where intelligence rather than quality is primary, but it may be used for quality reproduction by increasing the speed of film travel. The film used in the above process should not be confused with a mechanical-optical film method which will only be mentioned here. It employs a long narrow film coated on one side with a layer of opaque material which passes under the cutting needle. When vertical modulation is placed on a "V" shaped needle it cuts through the opaque surface revealing the transparent base material and leaving a variable area optical sound track as well as a vertical mechanical sound track. The optical pattern is used in reproduction by passing the film in front of a photo-electric cell.



OPTICAL PATTERN OF TYPICAL TONE RECORD
FIG. 6

Electrical

The fidelity of the electrical circuits should be approximately equal to the standards of other broadcast amplifying equipment that is, flat within one db in the frequency band required. In present day recording this may be taken as extending from 30 to 10,000 cycles per second. In taking measurements of the electrical amplifying equipment proper, nominal input and output terminations should be maintained. In the case of the final power amplifier whose output impedance is, for example, 15 ohms, this means that the temporary load for this amplifier should be a 15 ohm pure resistance termination during this part of the electrical test. See Curve A, Fig. 1.

Mechanical

The most interesting and fundamental part of recording—its mechanics—is the part where the greatest confusion exists with regard to standards and to the underlying factors involved in the determination of those standards.

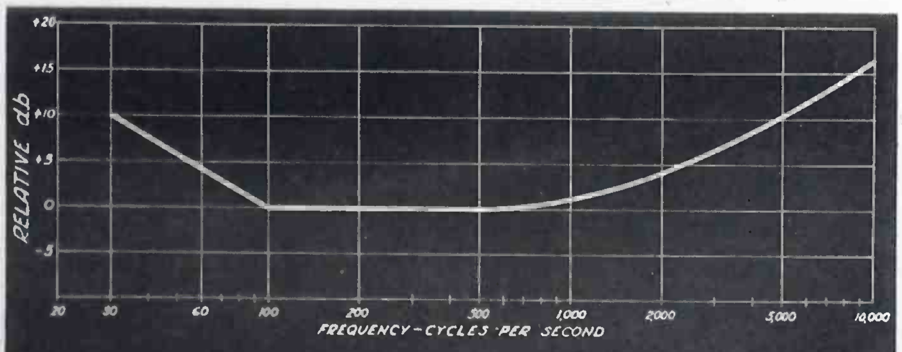
A—Constant Amplitude

An understanding of the terms "constant amplitude" and "constant velocity" as applied to a modulated groove is essential. Fig. 2 shows two frequencies of constant amplitude whose frequency difference is one octave. i. e. one is twice the frequency of the other. It is important to note that for constant amplitude recording the maximum slope of the wave is proportional to frequency. Thus the distance d_{2f} which is proportional to the slope of the higher frequency, is exactly twice the value of d_f of the lower frequency. Similarly, for higher frequencies, the slope is proportionately greater. Lateral velocity of stylus travel and slope of resultant groove are related—one is the cause and the other the effect. The maximum lateral velocity of a cutting needle is attained as it crosses the center of the groove i. e., zero axis, and at this point the slope is obviously greatest. It is useful to note in passing that a constant amplitude characteristic is essentially that of a crystal type cutter.

B—Constant Velocity

Fig. 3 shows two frequencies of *constant velocity* or slope whose frequency difference is one octave. In constant velocity recording the slope of the wave at the zero axis is constant for constant power

(Continued on Page 16)



IDEAL ELECTRICAL CHARACTERISTIC
OF ORTHACOUSTIC AS APPLIED IN RECORDING

FIG. 5

THE DECIBEL SCALE

By S. V. PERRY

Courtesy of RMA Engineering Department

THE decibel, as a unit of power ratio was introduced and defined some years ago and is now in almost universal use in acoustic and communication engineering and allied arts. However, even at this late date one finds so much misunderstanding and confusion in its use, and so many engineers who are completely unfamiliar with it, that a new explanation from a different approach seems to be justified.

Since the decibel is intended primarily for use as a unit of measurement in acoustic work, having been extended to the electric circuit in communication engineering because the electrical energies are intended ultimately to produce sound, it seems logical that we approach an explanation of the decibel scale of measurement purely from considerations of sound transmission and hearing.

Sound is transmitted through air by means of compressional waves. Hence to determine the magnitude of a sound we ordinarily measure the rms. value of the excess pressure (above atmospheric pressure) which it sets up. Sounds normally encountered may vary in pressure from about .0002 dynes per square centimeter to about 2000 dynes per square centimeter.

Now it may be shown experimentally that a sound wave of given frequency and pressure (say .001 dynes per square centimeter) will produce a certain sensation of loudness in the mind of a given listener. Furthermore, other sounds of the same frequency but of .002, .003, .004, etc. dynes/cm.^{2} will produce greater sensations of loudness, but the increment of loudness produced by each increment of pressure is increasingly less as the pressure is raised. This effect is so great that while a change of .001 dynes/cm.^{2} from .001 to .002 dynes/cm.^{2} is readily noticeable by the average human ear (being about 10 times the minimum discernible change), the same .001 dynes/cm.^{2} change from 1.000 to 1.001 dynes/cm.^{2} is not distinguishable to any ear.

From the foregoing it seems obvious that since we wish our sound measurements to readily indicate to us how the device under test will sound when we listen to it, then a linear scale of pressure amplitude will not be the most useful, but instead we should use an amplitude scale which follows the same law as the human ear.

Now the amplitude law of hearing is highly complicated, is variable from individual to individual, and is perhaps not accurately known for any one person. However, the Weber-Fechner law of psychology has proved to be a good approximation to the true law for the average of all people. It states that equal increments of a sensation are produced by equal increments of the logarithm of the stimulus; or, alternatively, the magnitude of a sensation is proportional to the logarithm of the stimulus. Hence, if increasing stimuli p_0, p_1, p_2, p_3, etc. produce increasing sensations S_0, S_1, S_2, S_3, etc., we may write:

$$S_0 = K \log p_0$$

$$S_1 = K \log p_1$$

$$S_2 = K \log p_2$$

$$S_3 = K \log p_3, \text{ etc.}$$

$$\text{and } S_n = K \log p_n$$

If the increments in sensation be defined $\Delta_1 S = S_1 - S_0$; $\Delta_2 S = S_2 - S_1$; $\Delta_3 S = S_3 - S_2$, etc., it follows that $\Delta_1 S = S_1 - S_0 = K(\log p_1 - \log p_0)$ or

$$\Delta_1 S = K \log \frac{p_1}{p_0},$$

$$\text{similarly } \Delta_2 S = K \log \frac{p_2}{p_1},$$

$$\Delta_3 S = K \log \frac{p_3}{p_2}, \text{ etc.}$$

$$\text{and } \Delta_n S = K \log \frac{p_n}{p_{n-1}}$$

Now, if these sensation increments be equal, then from the first statement of the Weber-Fechner law as given above,

$$\log \frac{p_1}{p_0} = \log \frac{p_2}{p_1} = \log \frac{p_3}{p_2} = \text{etc.}$$

$$= \log \frac{p_n}{p_{n-1}} = \frac{1}{n} \log \frac{p_n}{p_0}$$

Hence, if we wish to divide the stimulus range from p_0 to p_n into n increments each corresponding to n equal increments in sensation from S_0 to S_n then our increments of stimulus must be defined by the equation

$$\Delta P = \frac{1}{n} \log \frac{p_n}{p_0}$$

Now if we wish to make calculations we must assign some definite numerical value to a unit of stimulus increment as defined by the above equation (in exactly the same manner and for the same reason that, for instance, the volt may be defined as that electromotive force which causes the flow of one ampere through a resistance of one ohm). Since we ordinarily deal with logarithms to the base 10 it seems logical that we select a stimulus ratio $\frac{p_n}{p_0} = 10$ as the basis for a unit since $\log \frac{p_n}{p_0}$ will then be unity, and no numerical constant will be involved. The name applied to the resulting unit is the bel (in commemoration of the work of Alexander Graham Bell), and it is numerically defined as follows:—"The bel is the power ratio whose common logarithm is unity." Obviously this is a power ratio of ten. It is a large unit, and is therefore for convenience subdivided into ten smaller units known as decibels and defined as follows:—"The decibel is the power ratio whose common logarithm is 0.1." This is a power ratio of 1.26. It is a practical unit since it represents approximately the least change in sound level that can be detected by the human ear, at any sound level.

Mathematically expressed, the number of decibels N represented by a change in power from P_0 to P_1 is given by the relation

$$N = 10 \log \frac{P_1}{P_0} \qquad (1)$$

Now, if we are dealing with electrical powers W_1 and W_0 in which

$$W_1 = \frac{E_1^2}{R_1} = I_1^2 R_1$$

$$\text{and } W_0 = \frac{E_0^2}{R_0} = I_0^2 R_2$$

we may write

$$N = 10 \log \frac{W_1}{W_0}$$

$$= 10 \log \frac{E_1^2 R_0}{E_0^2 R_1}$$

$$= 10 \log \frac{I_1^2 R_1}{I_0^2 R_0}$$

Now, if $R_1 = R_0$,

$$N = 10 \log \frac{W_1}{W_0} = 20 \log \frac{E_1}{E_0}$$

$$= 20 \log \frac{I_1}{I_0} \qquad (2)$$

It should be noted that equation (2) is a particular case of the general law expressed by equation (1) and is true only if the power ratio $\frac{W_1}{W_0}$ is correctly represented by the square of the voltage ratio $\frac{E_1^2}{E_0^2}$ or by the square of the current ratio $\frac{I_1^2}{I_0^2}$. In general, in the electrical circuit, this requirement is met only if the resistances associated with W_1 and W_2 are equal.

In certain cases, where power is not of interest (as perhaps in speaking of the voltage gain of voltage amplifiers), it is customary to write $N = 20 \log \frac{E_1}{E_0}$ without reference to resistance. This is a somewhat dangerous practice permissible only if it is clearly stated that only voltage ratio is referred to. For example, the statement that the gain of an amplifier is 30 decibels really means that the output power exceeds the input power by the ratio $10^{30/10}$: 1 or 1000 : 1. However, if we say the voltage gain of the amplified is 30 decibels, we usually mean that the output voltage exceeds the input voltage by ratio of $10^{30/20}$: 1 or 31.6 : 1. The power ratios in this case may be anything at all, depending entirely on the unspecified ratio of the input and out resistances.

Now, let us consider a particular case. If a change in power $\frac{W_1}{W_0} = 4.0$ is produced by a change in voltage $\frac{E_1}{E_0} = 2.0$, the resistance of the circuit remaining constant, then

$$N_1 = 10 \log 4 = 20 \log 2$$
$$= 6.02 \text{ db}$$

Similarly, if

$$\frac{W_2}{W_0} = 2.0 \text{ and } \frac{E_2}{E_0} = 1.414$$

then

$$N_2 = 10 \log 2 = 20 \log 1.414$$
$$= 3.01 \text{ db}$$

Whence it is shown that a 2 : 1 change in power is 3 db, whereas a 2 : 1 change in voltage is 6 db. This sometimes is a source of confusion to the student who erroneously assumes the apparent inconsistency to be due to the mathematical definition of the decibel given in equation (2). If, however, it be remembered that the decibel is the natural psychological unit of change in stimulus level, it will be seen that the above statement of ratios should logically be made in the form "A change in level of 6 db requires a change in power of 4 to 1, or a change in voltage or current of 2 to 1 if the resistance remains unchanged." It is obvious that the required change in power and the required change in voltage, *both of which represent the same change in stimulus* (*six decibels*) are represented by different numbers in the linear system purely because of the square law ratio between power and voltage.

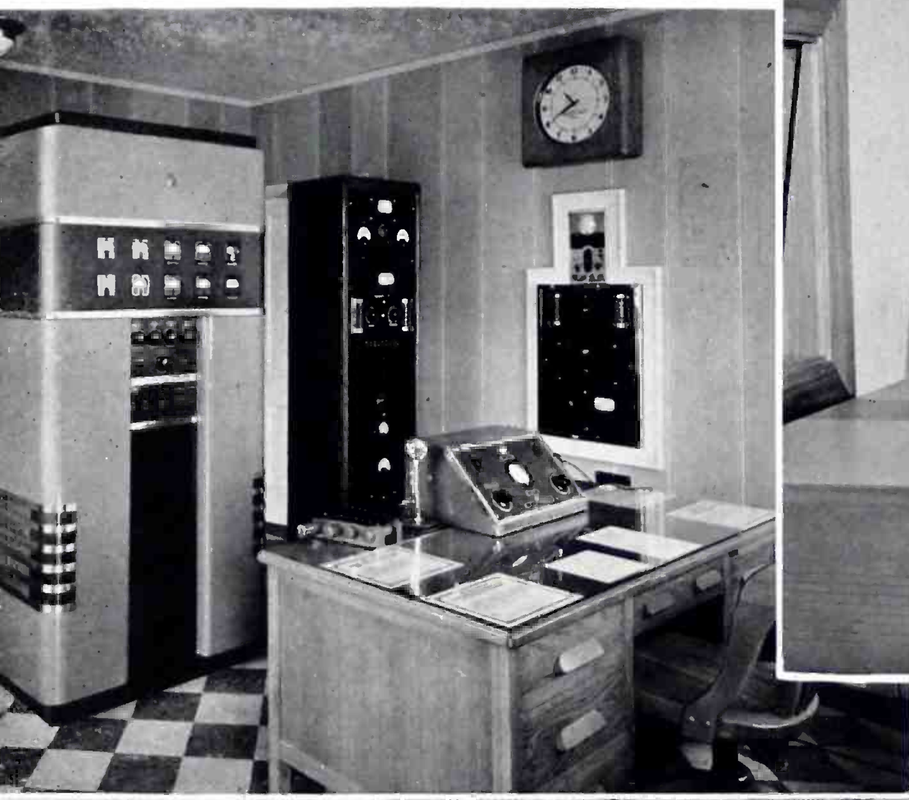
Inasmuch as there is a well known and convenient relation between voltage, current, power, and resistance in the electric circuit, and since we have defined (Eq. 2 above) voltage changes, current changes, and power changes in terms of decibels, it would seem logical and convenient to also define resistance (and impedance) changes in decibels. In a constant current circuit, we may write the power $W = I^2R$ and the voltage $E = IR$ in which the power and voltage are both proportional to the resistance. Hence, if we double the resistance the power will also double, which is a change of +3 db. For convenience, we must then define the resistance change in decibels in such manner that doubling the resistance will be known as a +3 db change so that the change in resistance and the change in power would be equal in decibels. Now in the same circuit doubling the resistance will double the voltage which is a change of +6 db. For convenience we must then define the resistance change in decibels in such manner that doubling the resistance will be known as a +6 db change. Consideration of the constant voltage circuit produces similar results, but with the addition of a negative sign.

(Continued on Page 24)

RCA 250-K's GET AROUND

A Quick Visit to Stations Throughout the Country

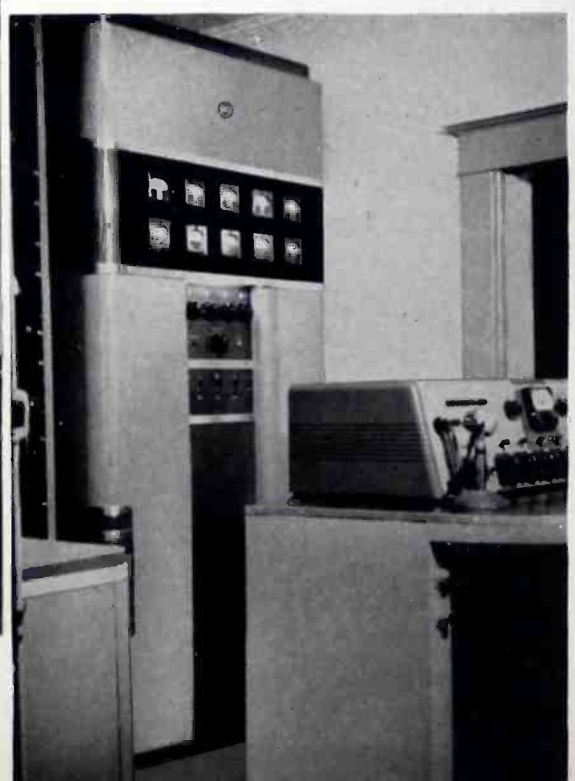
▼ KFPW, Fort Smith, Ark., one of the Southwest's leaders.

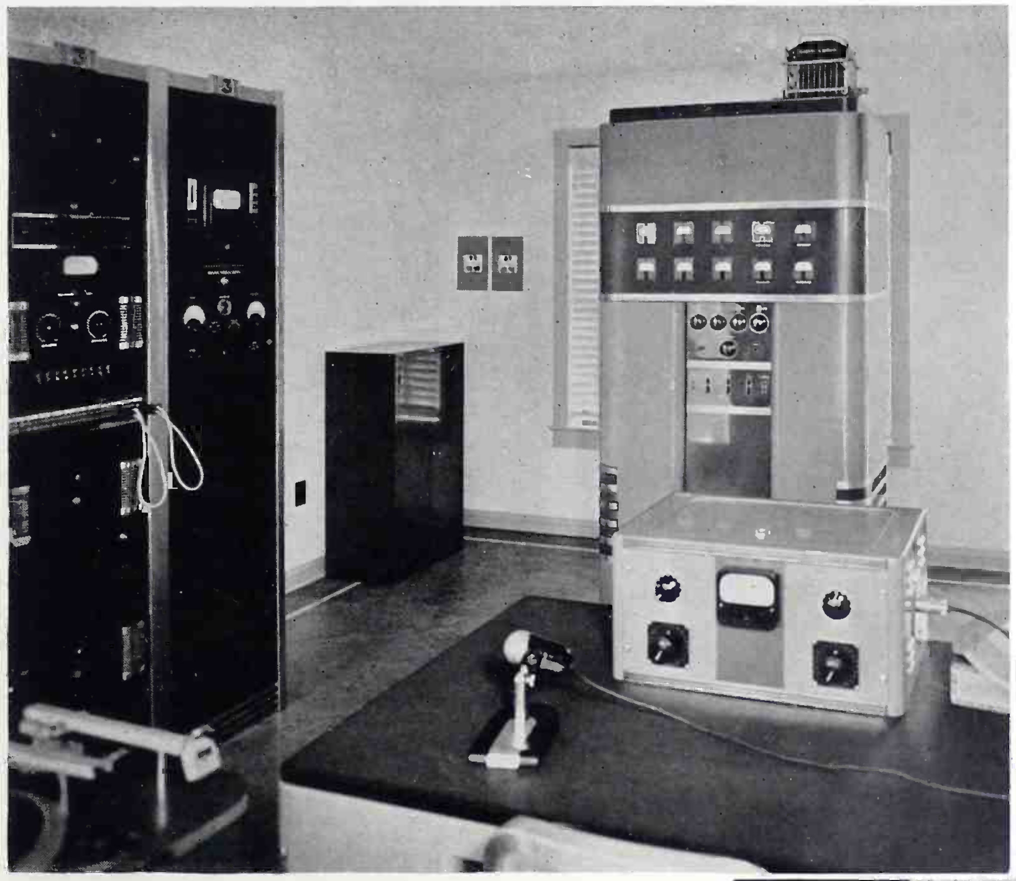


▲ WMOB, Mobile, features the 250 K and 76 B Consolette in its layout. WMOB was the first 250 K on the air.

▲ A DeLuxe 250 D Installation at WSPB, Sarasota, Fla. One of the South's finest "RCA-All-The-Way" installations.

▼ WSLB, Ogdensburg, N. Y., dispays compact arrangement of equipment.

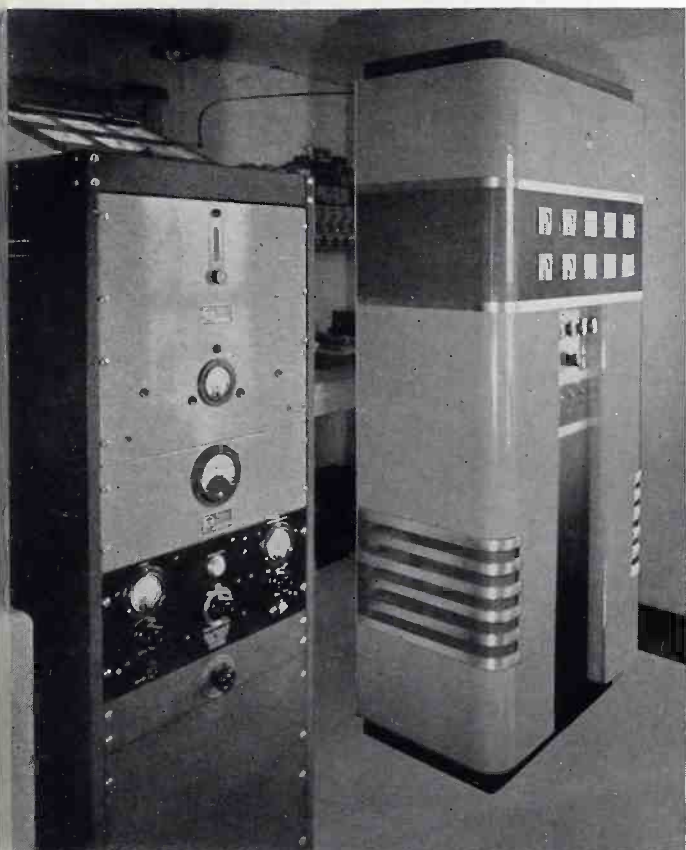




A few of the many 250-K's now in service are shown here and on the preceding page

◄ In Jacksonville, Fla., WJHP puts its programs on the air with a 250-K.

WSOO, Sault Ste., Marie Mich., has an excellent set-up.



▲ WFIG, Sumter, S. C., is doing a swell job with the 250-K shown above.

A 76-B1 Consolette and 74-B Mike conveniently located for the operator at WFIG. ►

"RADIO CARACAS"—ONE OF VENEZUELA'S FINEST

Pioneer station installs latest-type RCA equipment for greater public service

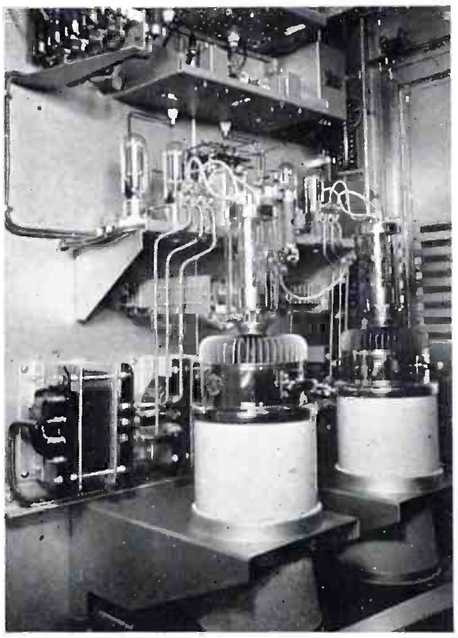
CARACAS, capital of Venezuela, has many fine, RCA-equipped broadcasting stations built to exacting Ministry of Communications regulations. The Ministry is patterned after our own F.C.C. The pioneer among them has been Radio Caracas. The present owners of this station, then as now, were agents for the entire country for RCA Victor, and in December, 1930 a small 100 watt transmitter was inaugurated to fulfill the need for a well-organized commercial broadcast service. Sales of RCA Victor radios and improvements to the station increased apace. Two years later a 5-KW equipment, the old RCA Model 5-A long wave transmitter was inaugurated as YV1BC on a frequency of 960 kc., on which channel it has continued to this day.

This power increase, together with the addition of a complementary transmitter in the 49 meter band, brought more receiver sales, better programs and revenues, and, like all other successful ventures, competition.

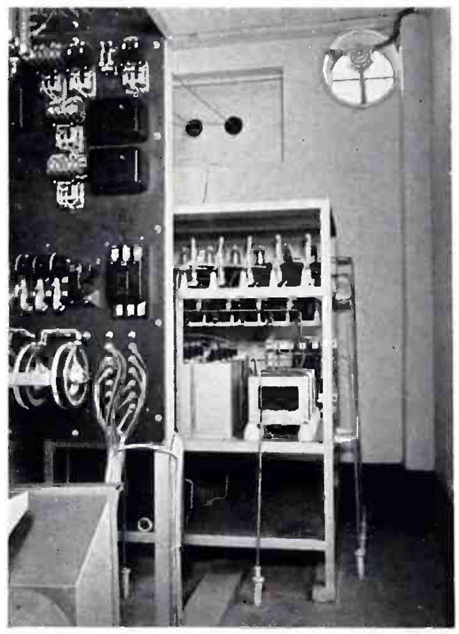
Greater Coverage Required

After some years of service and an increasing number of stations being established in Caracas, the need became apparent for greater coverage of the interior of ths vast country, while retaining a strong primary service area in the capital and the surrounding Federal District. Experiments on short wave had meanwhile indicated the advantage of the 62 meter band over 49 meters for continuous day and night coverage of a 400 mile East-West radius, thereby avoiding the interference and crowded condition of 49 meters and minimizing fading effects. Actually, at this time both the Republics of Colombia and Venezuela were pioneering 62 meter operation.

The 5-A long wave equipment was, therefore, reconstructed for 62 meter operation and an RCA 1-G, 1000 watt transmitter was



RCA 891-R Modulators.



Details of high voltage rectifier and control circuits in the RCA ET-4750 at Caracas.

(Below) Front view of the ET-4750, 7.5 KW high frequency transmitter installed.

Transmitter building on hills outside Caracas. Top of the main tower is 4000 feet above sea level.

purchased for use on 960 kc for local coverage. At this time two completely new air-conditioned, acoustically-treated studios, a welcome innovation in that part of the world, were inaugurated, 100% RCA-equipped.

Clear Channel

In 1939 a regional frequency convention for the 62 meter band was held in Bogota between Venezuela, Colombia, Brazil, Ecuador and Peru at which time the present 4920 kc. wave was assigned as a clear channel for Radio Caracas with a power of 5000 watts. Continuing their policy of keeping abreast or ahead of all other stations in their territory and to fully utilize their new channel, Radio Caracas requested the RCA Manufacturing Company, Inc. to submit the design of a high frequency transmitter.

Prime requisites for the new transmitter were for minimum operation and service costs with simplicity of installation and the provision for covering all short wave channels down to the 13 meter band in case of possible future changes of frequency assignments. Also the elimination of water-cooling equipment was desired.

At this time RCA was completing their latest Model ET-4750 high frequency broadcast transmitter designed for just such requirements for government and commercial stations throughout the world. This equipment which is now available for general sale, includes many new features giving high fidelity operation with a remarkable low cost.

Use of the new RCA-889R air-cooled triodes in the final stage of this transmitter gives an antenna output of 7½ kilowatts carrier power down to the highest frequencies at which this equipment is designed to operate.

Since the ET-4750 transmitter is likely to be of general interest, technically, to our readers it may be mentioned that an exceeding simple yet effective tube line-up is used. In the radio frequency portion an 807 crystal oscillator is followed by an 807 buffer/doubler stage, an intermediate power amplifier stage of four 813 beam-power pentodes driving the two air-coooled RCA-889R's which constitute the final Class C modulated-amplifier. These tubes are modulated in turn by two air-cooled RCA-891R's in Class B, driven by four RCA-845's, two RCA-807's and two RCA-1603's in turn. The use of straight Class B audio is made by reasons of simplicity of operation and to obtain best possible audio qualty. Inverse feed-back over the audio portion of the transmitter by means of a resistance filter loop further aids this purpose with the result that residual noise and ripple components of the carrier are 50 db. or better below 100% modulation while the audio frequency characteristic does not vary beyond 1.5 db. from 30 cycles to beyond 7500 cycles.

Vertical Construction

Mechanically the transmitter is composed of four main panels mounted vertically in back of a unified front. On the front panel are located meters, controls, and indicator lights necessary for the proper operation of the equipment. The left vertical panel inculdes the control circuit parts; the next panel includes the low power radio frequency and the high power output tubes; the fourth panel includes the radio frequency output plate and transmission line coupling circuits. The rectifiers and their associated equipments are located in a separate angle frame constructed unit. The plate transformers for the 6000 and 4000 volt rectifiers are separate units. The modulation transformer, reactor, and associated parts are mounted on a separate sub base. The complete equipment requires floor space of approximately 11 feet wide by 10 feet deep. The height over the frames is 72⅞ inches. The total equipment weighs approximately 9000 pounds.

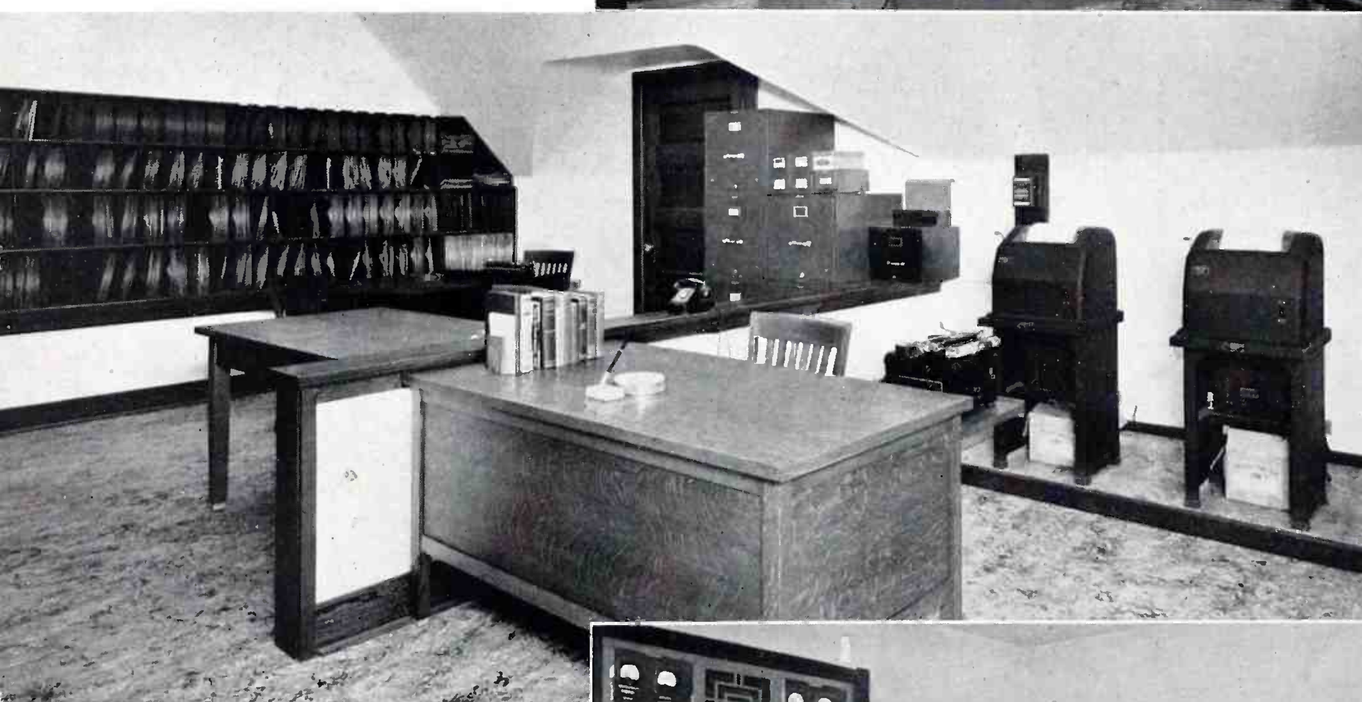
Radio Caracas is operated by C. A. Almacen Americano, owned by Mr. W. H. Phelps, Jr., this organization being one of the oldest and best-known importing houses in Venezuela, handling the entire RCA line from RCA Victor home receivers to the largest sized RCA Transoceanic Communications equipment for the Venezuelan Government Radiotelegraph Service. Almacen Ameri-

(Continued on Page 21)

BALTIMORE LISTENS IN ON WCBM

▲ Studio C facing Control Room showing Transcription Turntables.

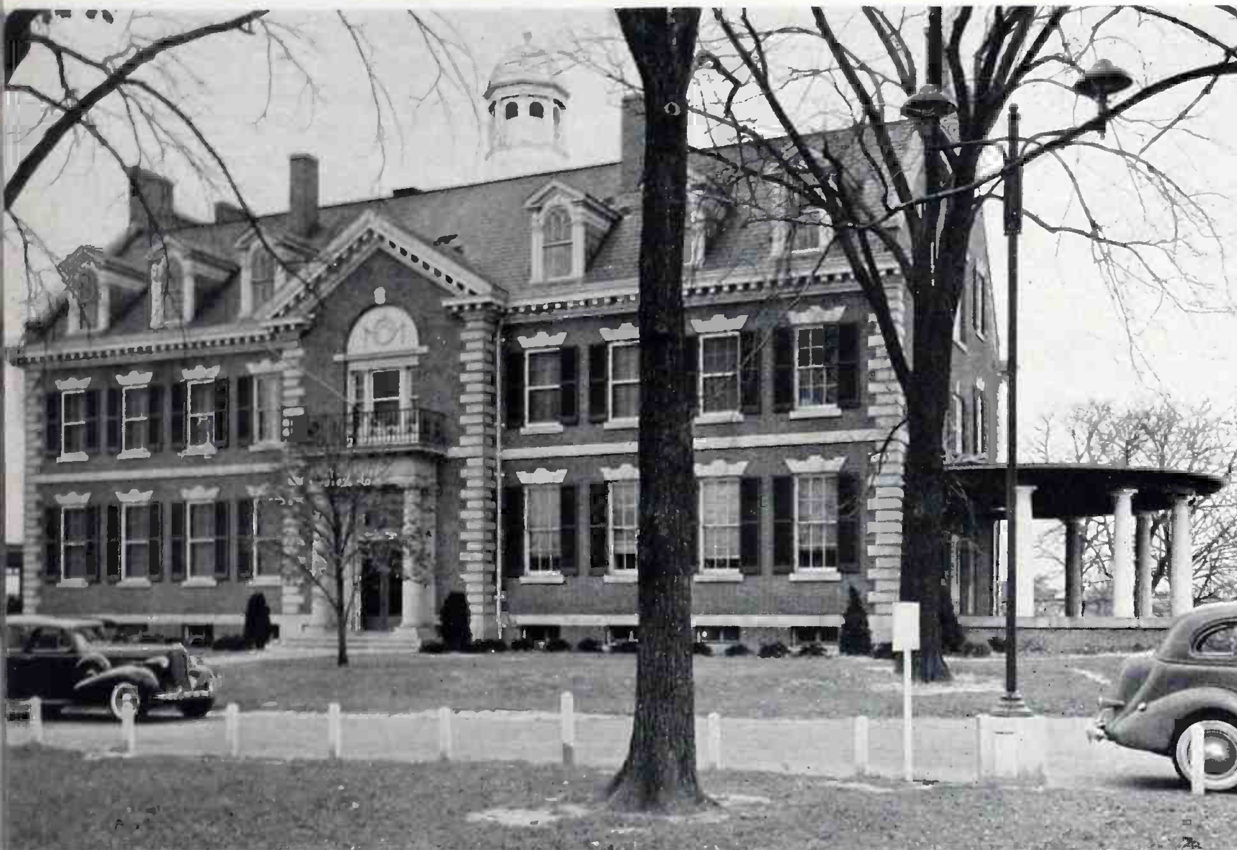
▶ MC Facing Studios B and C. 76-B1 Consolettes Placed for Convenient Operation.



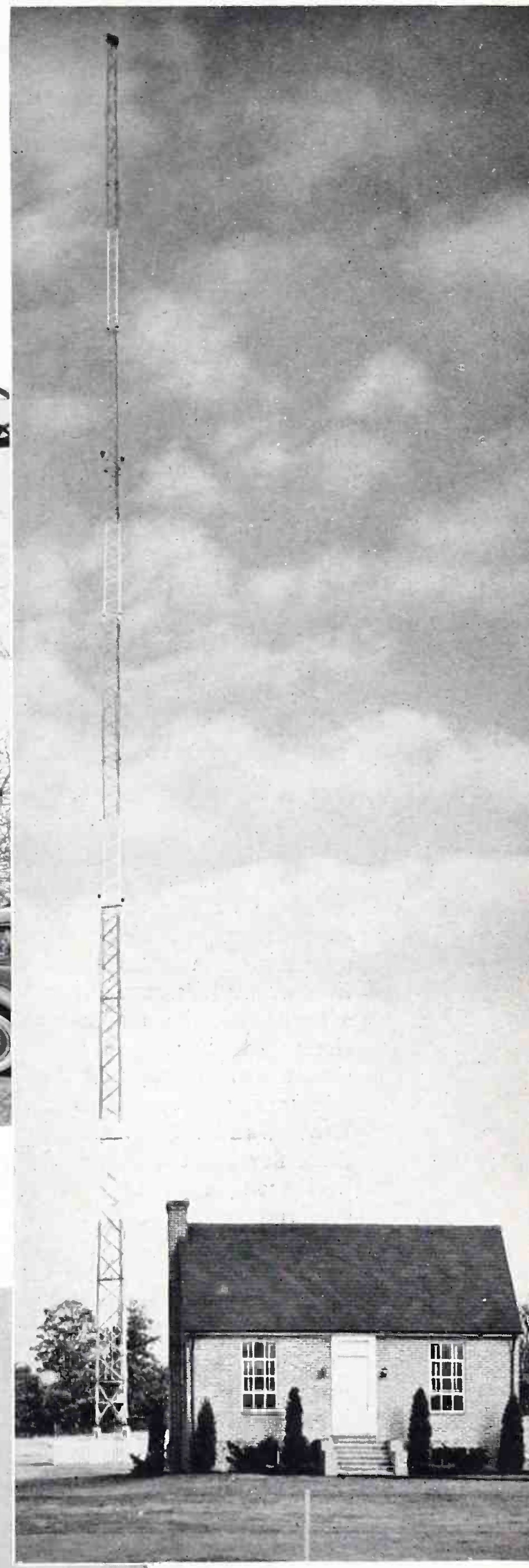
▲ Record and News Room.

▶ WCBM Baltimore Transmitter Plant showing RCA 250-D.

IN THE FREE STATE THIS 250 WATTER HOLDS A PROMINENT PLACE



▲ Studios—2nd and 3rd Floors and Auditorium in Rear.



▲ Transmitter Building and Antenna at Baltimore Station.

◄ Studio A. Note 64-B Speaker and 44-BX Microphones.

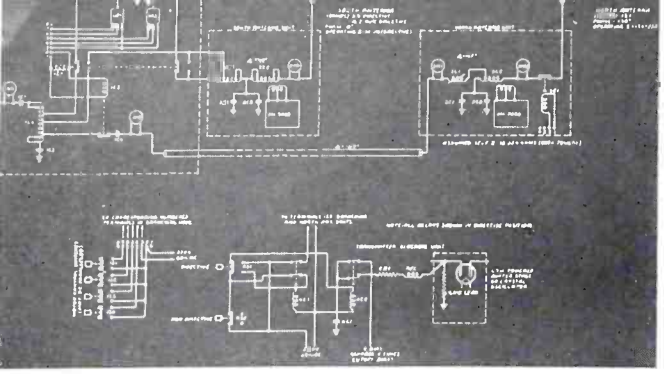


Fig. 1

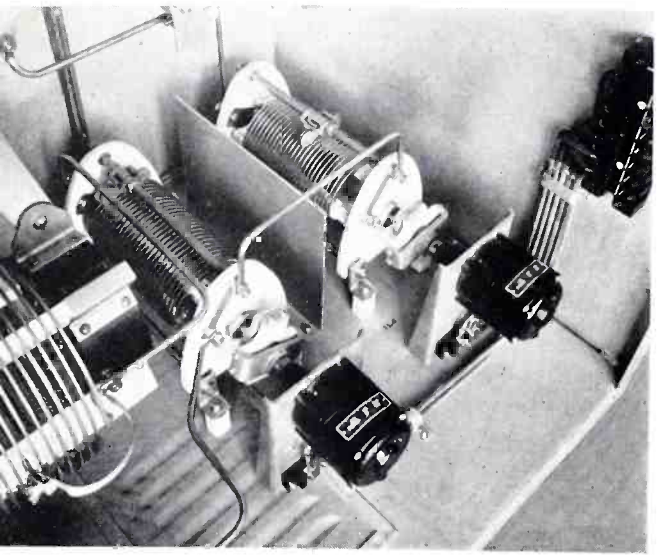


Fig. 2(a)

PATTERNS TAILORED TO FIT

RCA Antenna Phasing Equipment Aids Stations Having Special Problems

By J. E. EISELEIN

IN this article are discussed some of the more important practical problems that frequently occur with the installation of multi-element directional arrays and the suggested solutions of these problems. The theoretical aspects have been adequately described by G. H. Brown, and others. Considerable difficulty has sometimes been experienced in realizing the theoretical power distribution and in recent months this problem has received the attention of a rather large group of engineers.

The two-element symmetrical array is today sufficiently well known to make possible accurate predictions of its performance. In the three-element array, difficulties are multiplied because of not-too-well known effects on current distribution in the radiators. Four-and six-element arrays have been rather limited in use and pertinent data based on experience is not too broad. When these arrays become asymetrical, which may occur through the use of more than one type or height of tower, the problem of predicting the required networks, the control system, the tower base currents and the phase of such currents with respect to the actua' radiation field is greatly increased. To a large extent, therefore, predictions and design must be based upon actual experience.

Control Systems

Flexibility of control is highly desirable but this feature should not be carried beyond the limits of its economical value. In the more complicated arrays exact prediction of the circuit required to control phase and amplitude with minimum interlocking becomes difficult and approaches the impossible from a standpoint of practicability. Further, there is no theoretical possibility of true isolation of control of phase and amplitude at the individual radiator. Any change in one will cause a change in the other. It becomes necessary to place variable elements in portions of the networks which will permit a preponderance of control of current over phase or the reverse.

In arrays of two elements or more, variation of current or phase in the feed circuit to one radiator may affect either current or phase, or both in all probability, in the other elements of the array. From a design standpoint, therefore, it is desirable to use as many variable elements as reasonable cost will permit; the remainder to be adjustable and fixed circuit elements. Design must also give consideration to mechanical flexibility so that the variable elements may be shifted to various portions of any given phasing or impedance matching section to satisfy the peculiarities of an array which is difficult of prediction.

Experience indicates that any array, once properly adjusted, should not and will not change except with variations in the radiation system itself and that the

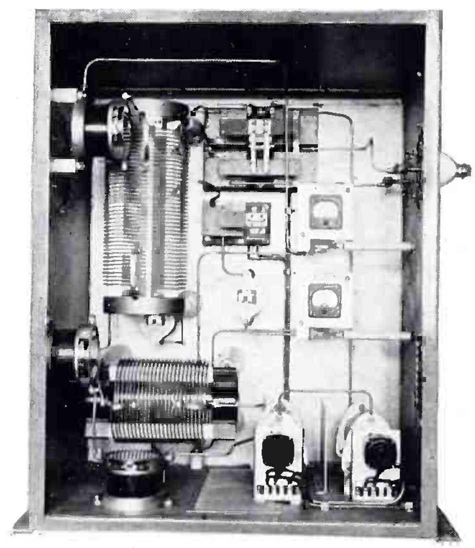
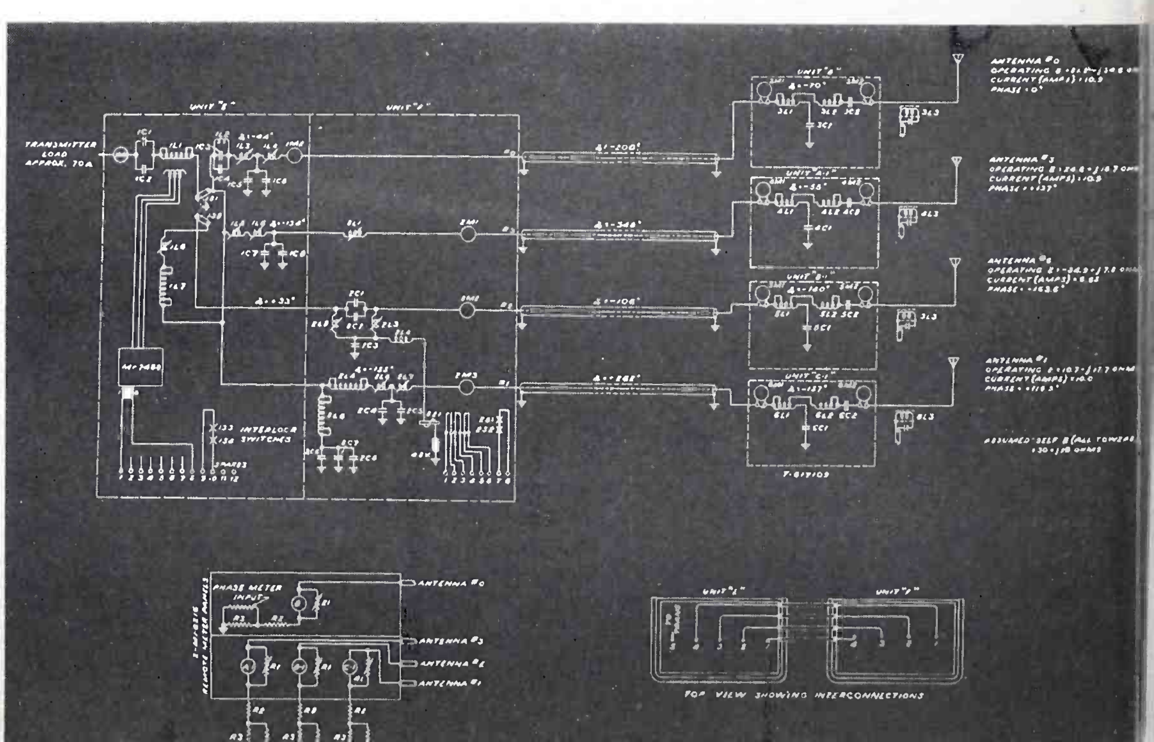


Fig. 2(b)

Fig. 3



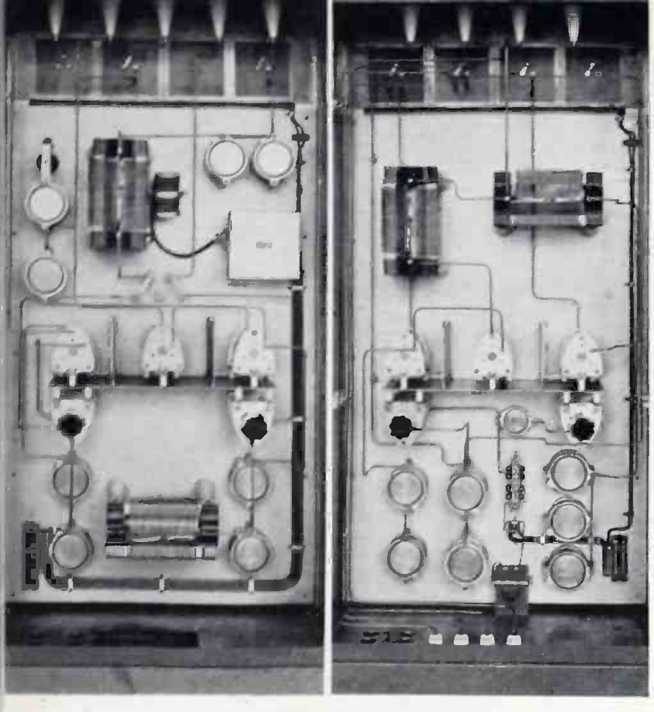


Fig. 4

preponderance of change is in the reactive components of the tower impedances. Changes in soil conditions, ground system impedance and surface growths with the seasons and with the passage of time seem to affect the reactive far more than the resistive component. If, therefore, facilities are available for making small variations in the compensating reactive branch of the impedance-matching sections at the bases of the radiators, such changes may be readily corrected and the constants of the array held to the original values.

RCA has recently made available remote electrical control of such tuning from the transmitter house. Coupled with a minimum of panel-controlled variables at the distribution point, it becomes a relatively simple matter to maintain an array in adjustment. In cases where the arrays are complicated and the transmission line lengths involved are great, it is definitely advantageous to have power distribution at one of the radiators with remote electrical control from the transmitter house. A number of such installations are now in operation.

A schematic circuit diagram of the remote control system designed for Station WDBO is illustrated in Figure 1. Figure 2 shows two views of the motor-driven reactance control units. Proper placement of such equipment makes it possible to effect a considerable saving in the lengths of transmission line required in many installations.

In Figure 3 is shown a conventional transmitter-house distribution network for a four-element array installed at Station WMAL. Negative power in two of the elements has complicated to some extent the arrangement of the networks since phasing and impedance matching must be in the reverse direction to insure proper operation. When such a condition exists, it is not always possible to obtain an optimum distribution from one or two of the towers and therefore a central point of distribution becomes a requirement. This will illustrate some of the many complications encountered in designing a system of power distribution that is both efficient and economical. The power distribution equipment employed at Station WMAL is shown in Figure 4.

Multiple-Pattern Operation

Under ordinary circumstances switching from directional to non-directional operation has little effect upon the design of the phasing gear. Cost is increased only by the number of radio-frequency contactors required and by the additional labor involved in the mounting and wiring of those parts. However, in cases where switching from a day pattern to a separate and distinct night pattern is involved and where the phase and current ratios change sufficiently to require radical variations in the networks, each pattern must be treated individually. It is frequently necessary to utilize additional phasing sections and switching facilities. The exact switching requirements of each installation therefore must be considered fully from a cost and design standpoint.

Radiation Efficiency

Another factor of prime importance which must be investigated carefully during the design period is the overall radiation efficiency of the system. The type of radiators, the horizontal and vertical pattern characteristics, the soil conditions, the ground system, the total lengths of transmission line involved and the losses in the power distribution and phasing networks have each a definite share in the overall result. Antenna arrays more commonly erected have symmetrical systems (all towers identical in height and structure) and radiators which are at least a quarter wave in height and spaced a quarter wave or greater apart. Under such conditions, the r-m-s value of the radiation field of the array should, and will approach, the

Continued on Page 31)

Fig. 5 (3)

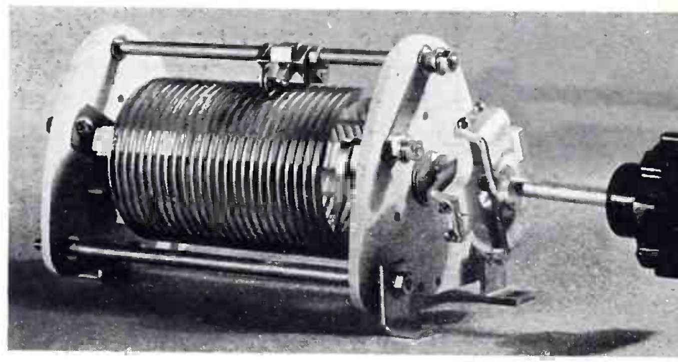


Fig. 5 (1)

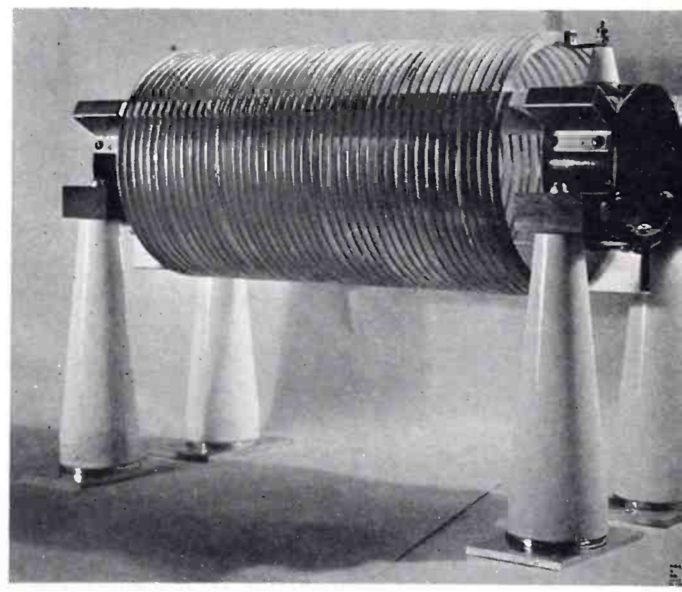
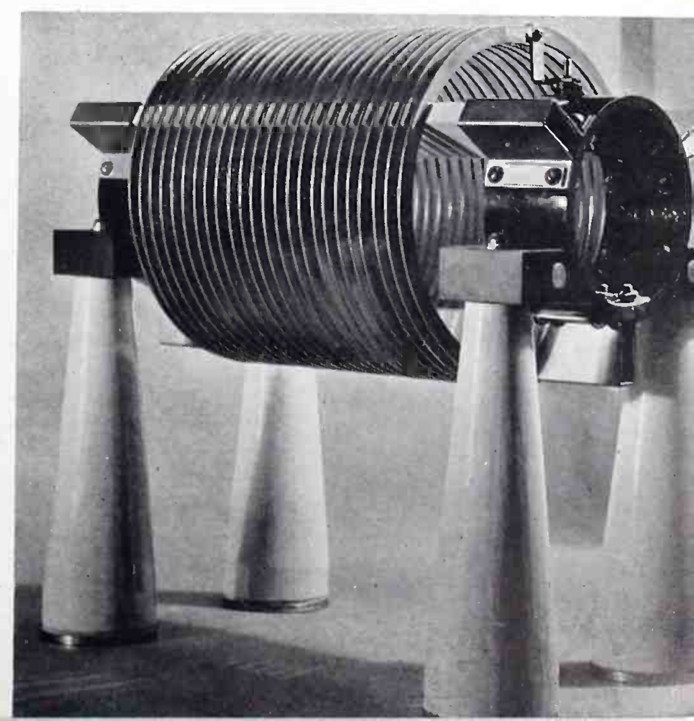


Fig. 5 (2)



LATERAL DISC RECORDING

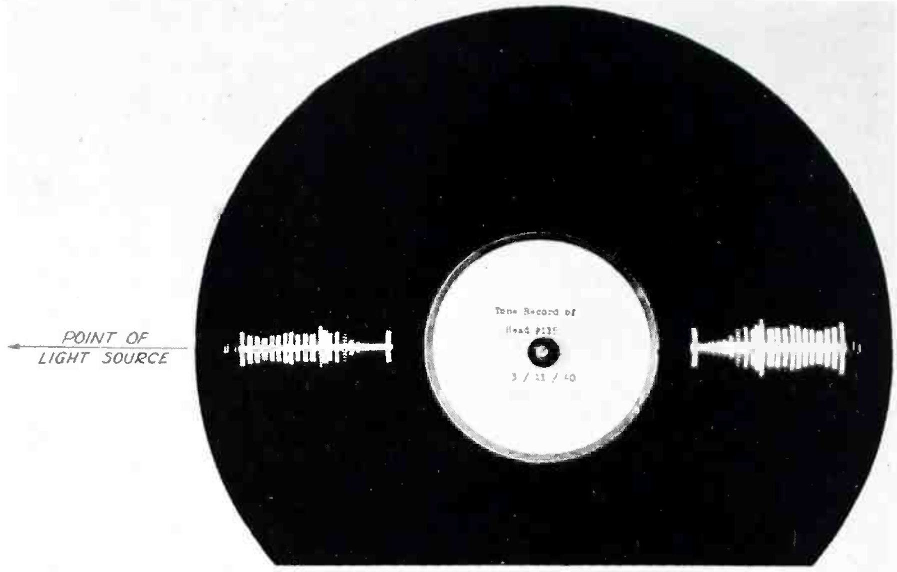
(Continued from Page 5)

output, i. e. for a "flat" condition, and the amplitude of the wave is inversely proportional to frequency. Thus, the height A_2 of the higher frequency is just half the height A_f of the lower frequency, but it should be especially noted that the slope at the zero axis is the same. Similarly for higher frequencies, the amplitude is proportionately less for the same power output. It is also useful to note that the constant velocity characteristic is essentially that of the electromagnetic cutter.

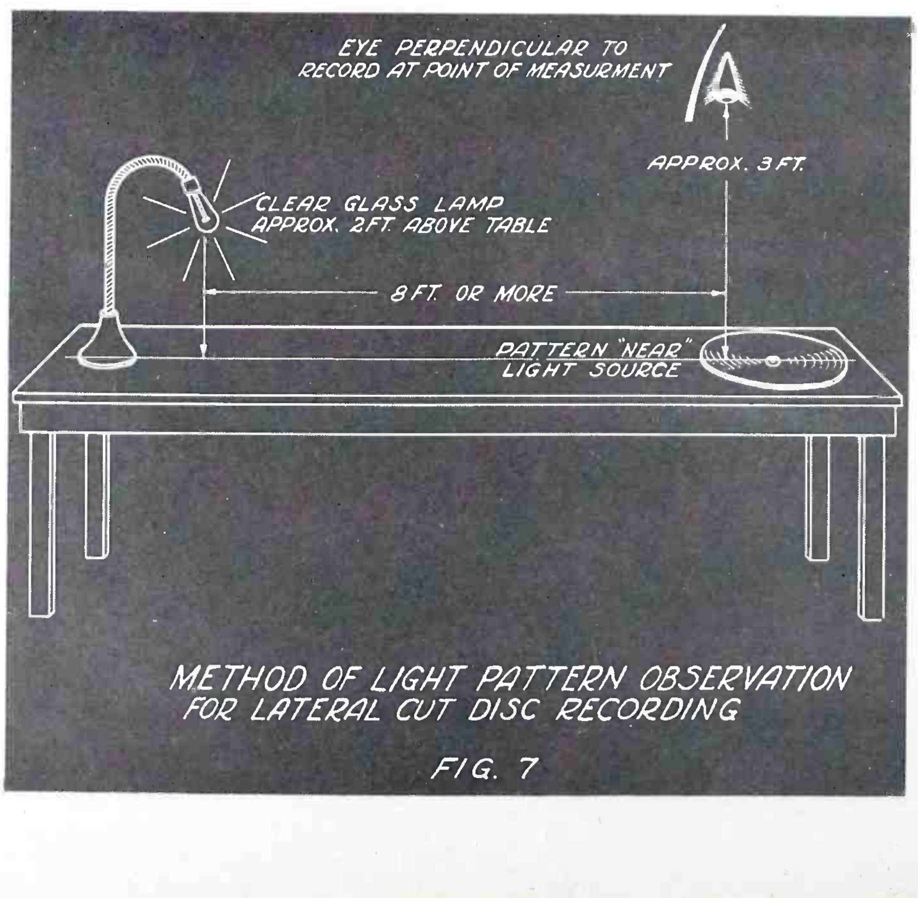
In order to understand some further mechanical considerations, consider a perfectly efficient, magnetic type, electromechanical transducer, otherwise known as a cutterhead, which would engrave all frequencies without loss. Such a "constant veloctiy" head would oscillate with large amplitude at low frequencies and small amplitude at high frequencies. A 5,000 cps wave would have twice the amplitude of a 10,000 cps wave. In a band from 30 to 10,000 cycles per second there are 8¼ octaves and thus, for a given amplitude at 10,000 cycles, the amplitude at 30 cycles would be $2^{8¼}$, or 320 times greater. Current practice allows approximately 0.0016 inch amplitude modulation at 500 cycles per second. If the perfectly efficient magnetic cutter were used there would be 0.00008 inch amplitude at 10,000 cps, 0.0016 inch at 500 cps, and 0.025 inch at 30 cycles. Allowing 0.005 inch groove width, as in current practice, and modualtion space on either side of the groove equal to expected peak amplitude at 30 cps, there would be 0.005 inch groove plus 2 X 0.025 inch modulation or a total equal to 0.055 inch for center to center spacing of grooves. Note that the modulation space would have to be ten times wider than the groove. A 16 inch diameter disc allows about 4¼ inch usable space before being limited by slow cutting speeds, or $\frac{4.25}{0.055} = 77$ grooves. At 33 ⅓ rpm this is only $\frac{77}{33.3} = 2.3$ minutes playing time and obviously some modification of said efficient electromagnetic cutter would be necessary.

Unfortunately, the necessary modifications of the above described efficient "constant velocity" cutting system have not been standardized. There are several schools of thought with regard to standards. One school calls for a constant mechanical amplitude on the record for any frequency from the top down to the lowest frequency. Another school of thought calls for a constant velocity system above a given frequency and a constant amplitude below that same frequency. Thus, progressing down the frequency scale, from the highest frequency down to a given frequency the amplitude would linearly increase and below the given frequency the amplitude would be held constant. The point in the frequency scale where the two meet has been called the "cross-over point." See Curve B of Fig. 1.

In selecting the cross-over point there are two limitations to consider. If too low a frequency is chosen the amplitude of the low frequencies becomes too great to allow closely spaced grooves for a fifteen minute recording on one disc. If a high frequency cross-



VARIATION OF OPTICAL PATTERNS OF TYPICAL TONE RECORD
FIG. 8



METHOD OF LIGHT PATTERN OBSERVATION FOR LATERAL CUT DISC RECORDING

FIG. 7

over is chosen, the resulting modulated groove at high frequencies contains a wave front so steep that the physical slope of the cutting needle, which has a fixed clearance angle, would have trouble in cutting it. Of secondary importance, the power of the amplifier driving the magnetic cutter would of necessity have to be greater due to the choice of the higher cross-over frequency. This latter reason is more of an economic than a mechanical one but is a consideration in any practical system.

The term "constant amplitude," considering the record itself, should not be confused with the value of the electrical voltage, current or power in the electrical circuits of the recording channel. These may or may not follow—depending upon the type and design of the cutterhead and amplifier driving system.

With the present method of constant rpm disc recording there is an important variable which cannot be overlooked — that of variable cutting speed or groove speed due to variable radius. When recording from outside to inside, for example, any single frequency would have a continuously diminishing wave-length, resulting in a steeper or greater wave slope, and for this frequency there would be a critical cutting radius where the slope of the wave would reach the maximum limit value, i. e. both cutting and reproducing would be practically impossible at a higher level. Progressing to a very small groove radius (resulting in a slower cutting speed) the given frequency, forced and held to its maximum cutting slope, would result in a gradually lower value of amplitude as the cutting speed decreases, even though the power to the channel is held constant. The limiting process begins at the highest frequency and passes on to each succeeding lower frequenty as the cutting speed is reduced.

As a result of the two basic considerations, first, that of limiting the maximum amplitude of modulation (at low frequencies) in order to secure closely spaced grooves thus providing a greater length of recording time, and second, limiting the maximum slope of the wave at high frequencies, present day practice calls for spiral grooves of from 96 to 140 lines per inch at both 33 $^1/_3$ and 78 rpm usually in an outside-in direction.

Electro-Mechanical

When the mechanical limitations are realized and the standard recording characteristic has been decided, it is possible to correlate the electrical amplifiers and the design of the cutterhead to produce the desired modulation pattern.

The most commonly used cutters are of the electro-magnetic type although crystal cutters have been used recently to some extent. A *crystal cutter* following a "flat" amplifier, results in a *constant amplitude* recording due to the fact that the crystal displacement or distance of motion is proportional to voltage and not to frequency, excluding resonance conditions. In this case, if an assumed recording characteristic is desired, as follows; constant amplitude below a cross-over frequency of 500 cycles and a constant velocity above this frequency, the crystal cutter requires a filter to decrease gradually the amplitude of all frequencies *above* 500 cycles per second. Similarly if an "efficient" electro-magnetic cutter were used following a "flat" amplifier, a *constant velocity* recording will result as described previously. To produce a standard characteristic the perfectly efficient electro-magnetic cutter would require a filter to decrease gradually the amplitude *below* 500 cycles.

The term "perfectly efficient" electro-magnetic cutter has been used to simplify the explanation of how electro-magnetic cutters work. Such a cutter cannot actually be realized. In practice it is easier to obtain the constant amplitude characteristic at the low end by taking advantage of the natural change in impedance of an electro-magnetic cutter toward the low end. It is therefore possible to design a cutterhead having the required characteristic on the low end with the proper cross-over point.

The proper taper on the low end is obtained partly by electrical mismatch. For example, the nominal 15 ohm cutterhead is designed to operate from a 15 ohm output amplifier. At all frequencies where the source and load are equal, a maximum power transfer is thus obtained, (not necessarily maximum undistorted power) but at wide impedance variations the transferred power to the load is greatly decreased. In practice the impedance of the electro-magnetic cutterhead is 15 ohms at one frequency only, rising above the nominal value at high frequencies, and dropping to as low as one ohm at low frequencies.

A simple explanation of how this produces a decrease in armature amplitude at the low frequency end follows: If we assume a 15 ohm amplifier output impedance and a frequency at which the cutterhead is 15 ohms, the total *EMF* in a constant impedance output electrical circuit is divided, for example, into (15 + 15) 30 parts, 15 of which appear across the cutterhead, or $\frac{15}{30} =$ 0.5 of the *EMF*. At a low frequency where the cutterhead is only one ohm we may assume the same *EMF* as being divided into (15 +1) 16 parts, 1 of which appears across the cutterhead terminals, or $\frac{1}{16} = 0.0625$ of the *EMF*. The ratio between these two load voltages at the two frequencies is $\frac{0.0625}{0.5} = 0.125$ or 18 db less voltage is delivered at the lower frequency. A 10 ohm resistor is used in series with the cutterhead to increase this loss by about 2 db and to keep a more nearly constant optimum load impedance on the amplifier at all frequencies.

Special Equalization

In addition to the two basic considerations of maximum amplitude and maximum slope of the recorded groove, there are other factors which enter into the choice of a standard recording characteristic. One of these factors is the signal to noise ratio

(Continued on Page 29)

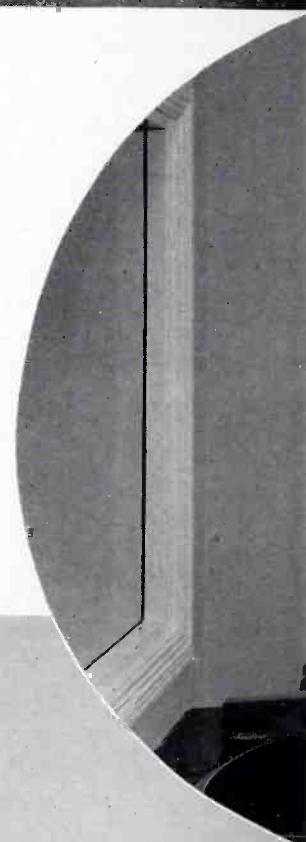
SMARTNESS PLUS EFFICIENCY=WREC

Memphis Station Installation Among the Best

The office of Mr. Hoyt B. Wooten, owner of WREC, is equipped with a monitoring loudspeaker and selector box which permits instant monitoring of any studio, network or competitive station. ►

▲ Studio B is equipped with an RCA 90-C Boom Microphone Stand.

Glass doors are used in the entrance to the studios from the hotel lobby. ►



▼ The WREC Transmitter Plant is attractively landscaped.

▲ Control Room for Studio B is provided with two announce positions and an RCA 76-B1 Console. The Studio C Control Room and Master Control Racks may be seen through the window.

◄ The WREC Transcription Recording Room is equipped with two RCA 73-A DeLuxe Recorders. Note the RCA 64-B speaker mounted in the ceiling.

▲ The WREC Business Office is equipped with modern steel desks and sound treatment. The daily program schedule is on the left wall.

◄ Studio A provides space for a large orchestra and audience. Regular sound treatment has been made more effective by the use of non-parallel walls. Complete visibility is obtained from the raised individual control room. Tubular fluorescent lighting is employed in all studios and offices.

DOWN SOUTH IN SAVANNAH

WSAV Sends Out Strong Signal With RCA-250-K

DOWN in Savannah, Georgia, WSAV sends a sharp, clear signal out beyond the normal expectancy of a local station. And the story of this signal is the story of a happy combination of excellent engineering, fine factory built equipment and seven miles of copper wire strung out as radials like the spokes of a wheel from the transmitter tower.

Transmitter

WSAV's transmitter is located one mile east of Savannah in an old rice field on the banks of the Savannah river. A hundred and ninety foot Lingo tubular type tower, with static drain insulators, sends WSAV's signal out into the air, dwarfing the masts of the ships that steam behind it out of the port of Savannah to ports all over the world. Inside the white transmitter house, a 250-K RCA transmitter, RCA's latest development, combines with the other RCA equipment to do their part in making the WSAV signal so clear and strong.

This transmitter equipment is given every advantage by an elaborate ground system consisting of a thirty foot expanded copper screen at the base of the tower. This screen has running out from it at three degree angles seven miles of bare copper wires. These wires are just below the surface of the ground. The distant end of each wire is driven down until it rests permanently in water. As the permanent water table of the transmitter site lies only two feet below the surface at low tide, the copper radials are always grounded in salt water varying in depth from a few inches to more than a foot.

The carrying power of the WSAV signal is further strengthened by the fact that the Savannah area has one of the lowest attenuation factors in the United States and because of a criss-cross of tide water drainage canals in and around the city of Savannah. Since the WSAV transmitter is adjacent to one of these canal systems, the signal tends to travel the whole network.

Studios

The WSAV Studios are located on the ninth floor of the Liberty National Bank Building in down town Savannah, at the crossroads of the city's two busiest streets. Strikingly modernistic in color and treatment, they were designed and decorated by J. Bolton McBride, well known architect of Nashville, Tennessee, and seldom fail to draw compliments from both technical and decorative minded people. Much of the furniture is custom built, including the announcers' desks in the broadcast studios. These are gray and black with chrome trims and have built in cueing speakers.

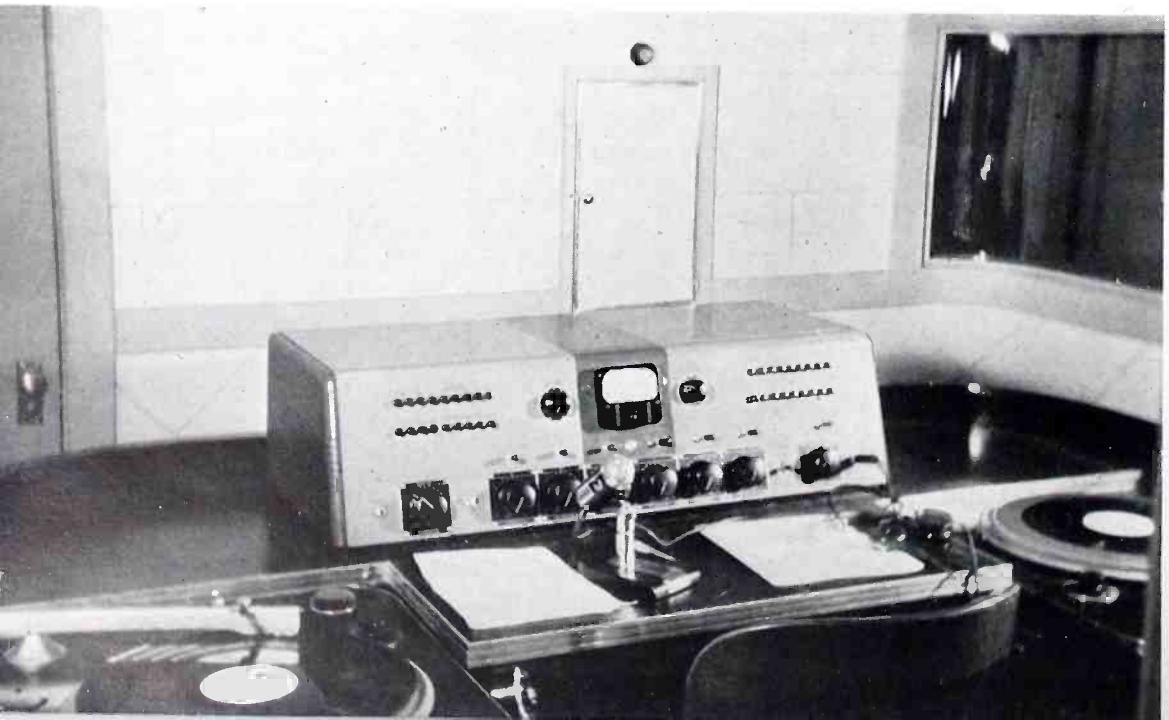
Studio A, the audience studio of WSAV, is a striking example of scientific planning for acoustical effect with its curved walls, curved glass panels and floating floors. All wall surface is covered with special acoustically treated board lightly sprayed with casein paint, and no wall surface presents the same surface plane. The result of this unusual treatment is a studio capable of almost perfect tone reproduction.

WSAV's Speaker Studio employs the live end-dead end acoustical principle. Its wall surface is also covered with acoustically treated board.

RCA microphones are used in all WSAV studios. The types selected by M. E. Thompson, WSAV's Chief Engineer, are 88-A's and 44-BX's.

Corner of the Continuity Room at WSAV.

Consolette Turntables—everything within reach for convenient and efficient operation.



Control Room

The Control Room at WSAV is, according to visiting engineers, one of the most complete and convenient they have ever seen. The 76-B RCA Consolette is built into a custom made central desk. This desk also encloses two 70-C RCA turntables, one to the right and one to the left of the operator. Lighting is by modernistic fluorescent lamps. Instead of a jack panel to handle the many remote lines, Chief Engineer Thompson designed and built a unique switch panel which not only more than doubles the remote line capacity of the consolette, but completely eliminates patching, as well. This was found necessary because of the many remotes run from the clubs, theatres and hotels of one of the South's gayest and most colorful cities.

A typical example is a complete remote studio, glassed in and sound proofed, at the Lucas, Savannah's finest theatre. This studio is used to originate many audience participation programs.

For all remote broadcasts WSAV employs 62-A RCA remote amplifiers.

The RCA 250-K at WSAV. Speech input racks are located at the left of the window.

News Room

Probably the most fascinating place at Savannah's newest station is the WSAV news room. WSAV is served by a full leased International News Service wire, day and night. In the news room a battery of new noiseless type teletypewriters click out the news in a setting decorated with striking photo murals of news scenes and news worthy personalities including the President of the United States and Secretary of State Cordell Hull.

88-A and 44-BX "Mikes" used in Studio B.

Reception Room, Continuity Room and Offices

WSAV's modernistic treatment is carried out through business offices and reception rooms as well as studios. The main reception room presents a restful arrangement of leather furniture combined with gray floors and harmonizing pastel walls and ceiling, sound treated.

The continuity room, also sound treated, not only houses desks for continuity but also contains the NBC teletypewriters.

Other offices include that of the General Manager, Harben Daniel, offices for the program and commercial departments and offices for the engineering staff. Special keys admit the WSAV staff to Studio X, just down the hall from the main studios.

RADIO CARACAS

(Continued from Page 11)

cano have branch stores located in all cities of importance throughout the Republic and in addition to handling RCA Victor, also represent many other well-known American lines. This prominent house is an important link in the chain of increasing goodwill and closer commercial relations between the two Americas.

Program service has gradually increased throughout the years at Radio Caracas and now under the direction of Mr. Ricardo Espina, the well-known manager. Program time amounts to 18 hours continuous daily entertainment. Of all the Latin American stations in this region, Radio Caracas is probably the most noted for the number of radio celebrities appearing on its programs. Cuba, Mexico and other countries send their stars regularly for Caracas engagements.

UP NORTH IN CANADA

CBC Modernizes Facilities Serving Canada's Largest City

By J. W. SANBORN

THE Canadian Broadcasting Corporation has taken another forward step in its program for providing first class broadcasting service in Canada, with the inauguration of its new station CBM near Montreal. The RCA Victor Company has again been privileged to cooperate with the CBC in this project and is proud of the part it has been able to play, since the Type 5-DX Transmitter, although smaller than its fifty kilowatt sisters at CBK and CBA,* is equally important in the Dominion Network and is equally effective in the service it is called upon to render.

The new station is located some twenty miles east of Montreal at the edge of the town of Marieville, Quebec. It is to be used for programs in the English language, as other stations serve the French speaking population. With this in view, the site was chosen after a careful study as one which would make possible good coverage, not only of Montreal, but also of English speaking groups in Sherbrooke, St. John and many other smaller cities and towns in the so-called "Eastern Townships" part of the Province of Quebec, these groups in practically all cases being too small to justify the cost of serving them through local stations. Effective coverage of such a considerable area with a 5,000 watt transmitter is due in large part to the use of a highly efficient antenna, which is a uniform cross-section vertical radiator. The height of the radiator is 525 feet, or slightly over a half wavelength at the operating frequency of 960 kilocycles. The ground system of 120 radial copper wires, one half wavelength long, is also designed with a view to maximum efficiency. The whole plant is an excellent example of planning for maximum results from a reasonable investment, and reflects great credit on the CBC engineering staff.

Profiting by experience in designing buildings for their four high power stations, the Architectural Department of the Corporation, under the able direction of Mr. D. G. McKinstry, worked out plans which resulted in a building combining excellent appearance, both outside and in, with an equally excellent layout from the standpoint of convenience and of utiliization of space. The photograph shows the main operating room, with the control console and the two racks of speech input and monitoring equipment so arranged that the operator has all station controls at his finger tips. The door visible at the left end of the transmitter enters the storage room for tubes and other spare parts. At the left of this room, behind the speech racks, there is a well equipped shop. The opposite side of this floor provides space for an office and a combined kitchen and lounge which may well prove a life saver to the staff when one of Quebec's storms turns even the short miles of highway to Marieville into a continuous snowdrift. Transformer vault, switching room, and space for heating equipment, air-conditioning units and water pump and storage tank, are found in the basement. Garage facilities and a room for standby power equipment are provided in an extension of the building on the far side. These arrangements are clearly shown on the floor plans. The lighting provisions in the main Transmitter Hall are notably excellent, due to the use of a glass brick wall for daylight illumination and of powerful "sunlight" lamps and indirect ceiling lights for night.

Comment on the architectural features of the building would hardly be complete without mention of the conventionalized circuit diagram which is so artistically worked in as a decorative pattern at the front entrance. This diagram, it should be added, gave rise to a diplomatic incident of some proportions when Mr. G. Sarault, Quebec Regional Engineer for the Corporation, discovered that it depicted a short circuit from plate to ground on one of the tubes. Fortunately this "short" was eliminated without serious consequences to the structure and peace was restored.

* See "North of the Border"—Broadcast News—March, 1940.

The RCA 5-DX and associated equipment installed at CBM.

Main entrance with conventionalized circuit diagram.

On the equipment side the station is "RCA All The Way" from the incoming program line to the antenna ammeter at the base of the vertical radiator. Many special features for insuring effective operation of the station under abnormal conditions were planned and provided by Mr. H. M. Smith, Design and Construction Engineer for the CBC, and his staff. Against possible power supply failures there is a standby engine-generator set, with control gear for automatically switching over to this supply if voltage on the incoming power line fails. Induction voltage regulators with automatic control insure that correct voltage will be supplied to the transmitter at all times.

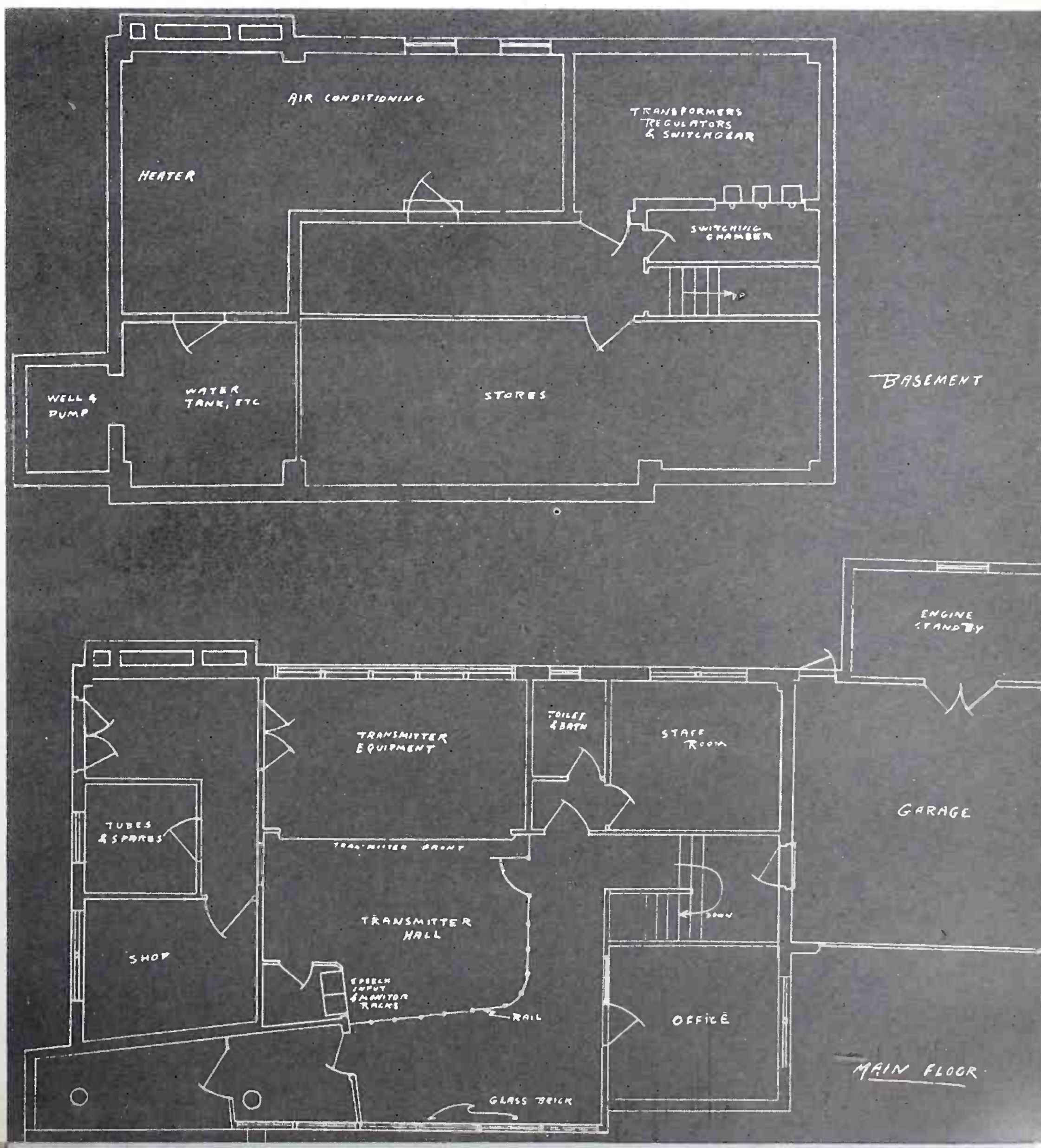
On the program side, although programs are normally fed from the studios in Montreal, a microphone and turntable, with specially designed amplifiers and switching controls, have been provided to give immediate change-over to local operation in case of program line failure. Another interesting feature is the provision of clocks on the monitoring rack which are so arranged as to indicate both the time of occurrence and the duration of any interruption in the carrier wave of the station. These are in addition to the more usual facilities for checking the operation of the station, which include the Modulation and Frequency Monitors, and provision for connecting the Type 64-B Loudspeaker either to incoming program line or to transmitter output. All these factors combine with the known reliability of the 5-DX Transmitter to provide the excellent quality and high dependability of broadcasting service which is characteristic of CBC stations.

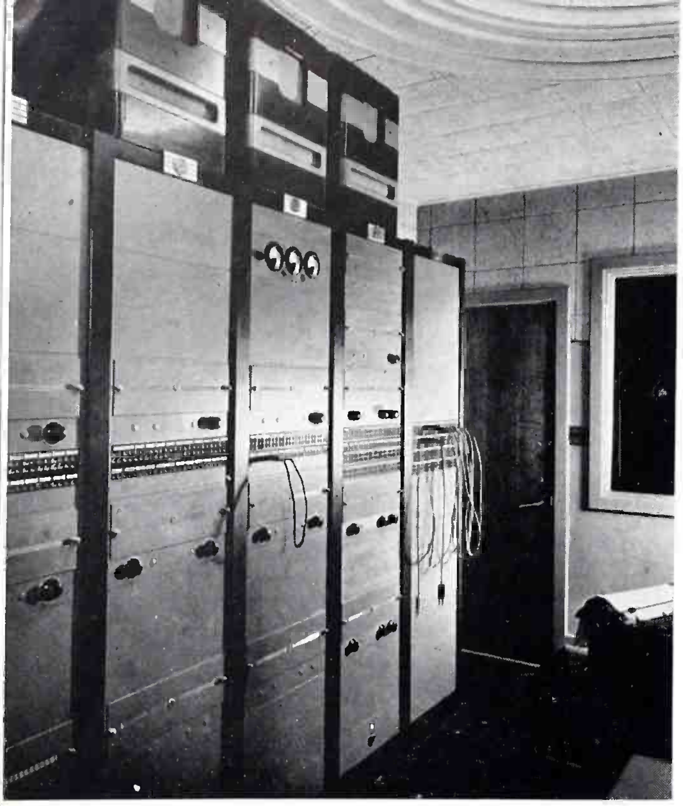
RCA 311-AB BROADCAST FREQUENCY MONITOR

The new RCA Type 311-AB Broadcast Frequency Monitor incorporates several features unique in instruments of this sort. Designed for extreme precision and stability, it not only meets the new stringent FCC requirements with respect to transmitter frequency maintenance, but actually enables the station operator to know his frequency, to within a few cycles, well within the required 20 cycle limit. Two frequency scales are provided; the ±20 cycle being normally used, and a ±100 cycle range which can be used in the event of crystal difficulty or transmitter adjustment. A large 6⅜" meter indicates deviation of frequency and is easily visible from across a large room.

A new feature is a self-contained limiting amplifier for removing modulation from the applied R.F. input signal. Normally, a small amount of such modulation will be present, even though signal is taken from the driver stage of the transmitter, because of stray pick-up, imperfect neutralization, and other factors. The two stage limiting amplifier in the 311-AB effectively eliminates any detrimental effects that might otherwise appear on the deviation meter.

Floor plan of CBM.





Cabinet racks in WIRE control room.

WIRE

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Five cabinet type racks have been installed for equipment mounting and termination facilities. All racks have jack strips to provide input and output jacking for every piece of equipment used either in the rack or at the control desk. Normal operation requires no patch cords. Stress has been placed on the location of all equipment for convenience of operation as well as accessibility for servicing.

Each studio panel on the master desk has four microphone inputs, four mixer controls, master gain control, four microphone switches, audition and on air switch, monitor and talk-back switch, monitor selector switch and VU meter.

The complete set-up includes three program channels and three audition channels. When needed, one or more of the audition channels may be used for a program channel. Separate amplifiers and mixers are used for NBC and Mutual programs.

All studio and channel switching is done by push-button operation. The equipment at WIRE has been designed with such flexibility that the technicans have yet to find an operating problem which they cannot handle.

Indianapolis can proudly point to WIRE as one of the show places of the city.

THE DECIBEL SCALE

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Obviously all these conditions cannot be met by a single definition of resistance change in decibels unless it be encumbered with a complicated ruling such as for instance: "The change in current in db will equal the change in resistance in db, but the change in power in db will be only one half that number, etc., etc." Such a definition would hardly be a mathematical convenience. Furthermore, since we normally do not work with either constant voltage or constant current circuits, but rather with cricuits in which the voltage, current, and power will all change whenever the resistance is change, such a definition would find little, if any practical application. For these reasons resistance and impedance changes are not defined in decibels.

A few facts about decibels which are of interest follow:

(1) The decibel is the natural psychological unit of change in stimulus level.

(2) Curves plotted in decibels present to the eye a more accurate picture of what the ear (and brain) hears.

(3) A curve whose ordinate scale is linear in decibels has the same percentage accuracy all over the ordinate range, even at the bottom of the page. This is particularly important with automatic or semi-automatic curve tracing equipments, in which case, the accuracy from a linear ordinate scale is so poor as to render the curve useless at or below 5% to 10% of full scale deflection.

(4) Curves plotted in db (to the same scale) may be directly compared by superimposing them over a light source (if on semi-transparent paper). This saves a tremendous amount of replotting and calculating, particularly when comparing curves of considerable irregularity, as for instance, sound pressure curves.

(5) Curves employing a decibel ordinate scale are not necessarily smoother than the same data plotted to a linear scale. It is purely a matter of scale selection. If the curves occupy the same ordinate space, the decibel curve will exhibit lower peaks but deeper dips.

(6) The decibel being a unit of power *ratio*, it is necessary to specify the reference level when giving performance indices in decibels. To state that the power output of an amplifier is 40 decibels is meaningless unless a reference level is also stated, as for instance, 40 db above one milliwatt. In this respect, the industry is guilty of loose usage of the decibel as an index of performance, and one repeatedly sees microphone sensitivities, amplifier hum and noise, amplifier output, phonograph pick-up outputs and line power levels specified in db without mentioning a reference level. In all cases, a reference level is implied, but since many of them are not yet standardized, the figures given are, to say the least, ambiguous. Sound levels, intensity levels, loudness levels and noise levels may be correctly stated in db without mentioning the reference, since for acoustic work, zero level of intensity has been standardized (at 10^{-16} acoustic watts per square centimeter).

(7) Transposition from linear units to decibels can be most easily accomplished on an ordinary polyphase slide rule or log slide rule if the C, CI and D scales are used for voltage and current values and ratios, and if the A, B and B1 scales are used for power values and ratios. The result of a calculation then can be read directly in decibels on the L scale, remembering to multiply by 2 (since the L scale is 10 units long whereas the slide rule is 20 decibels in length). Care must be taken to locate or define zero db correctly.

Crystals of precipitated chalk magnified 24,000 times. This study, conducted by the American Cyanamid Co., proves that infinitesimally fine particles possess the same crystalline character evident in larger pieces.

THE ELECTRON MICROSCOPE GOES INTO ACTION

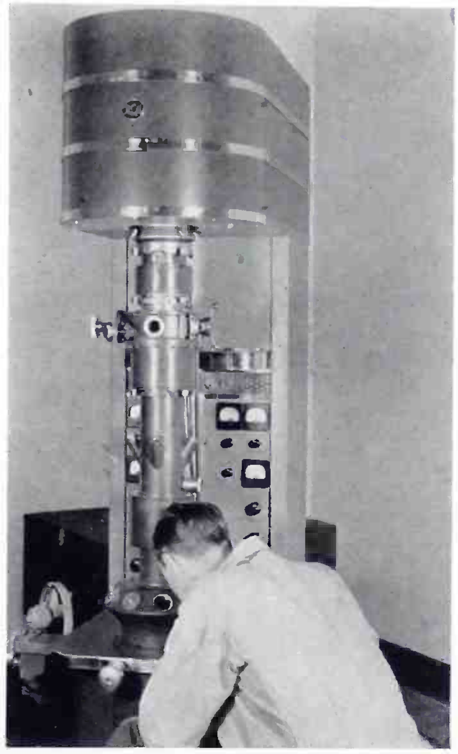
American Cyanimid Company Employs New RCA Instrument in Industrial Research

AMERICA'S first commercially built electron microscope, which enables scientists to picture minute objects at 100,000 times natural size, is now being operated in the Stamford Laboratories of the American Cyanamid Company, Stamford, Conn. Although several experimental microscopes of the kind have been built and used, the first American commercial instrument is being used by American Cyanamid's scientists to develop new chemicals for industry and medicine. The instrument was developed and built by the RCA Research Laboratories in Camden, N. J.

Results already obtained by American Cyanamid research workers in the study of pigments used in the paper industry (precipitated chalk and magnesium oxide) show that infinitely fine particles of these materials possess the same crystalline structure in small as in large pieces. This disproves the theory widely held heretofore that such pigments lose their crystalline character when precipitated as infinitesimally fine particles.

Photographs made directly in the electron microscope show the object magnified 20 to 30 thousand times. However, details are so clearly pictured in these photographs that they can be readily enlarged to give a total useful magnification of 100,000 times natural size. An average human hair subjected to such huge magnification would appear to have a diameter as great as California's giant trees, and an object an inch long so magnified would appear to be more than one and one half miles in length! The limit of magnification of the best optical microscopes is about 1000 times natural size.

Photographs made in preliminary tests of the instrument show what are presumed to be individual giant molecules, the shapes and sizes of colloidal particles, and intimate details of certain types of bacteria, which the weaker power of optical microscopes could not reveal. Individual giant molecules of poly-vinyl chloride resin have been pictured with the aid of the electron microscope. Particles of colloidal carbon appear generally spherical in shape and on a diameter of about four ten-millionths of an inch. Photographs of anthrax baccilli, germs of pneumonia and typhoid bacteria show these to possess strangely intricate structures. These micro-organisms apparently are not the simple bits of jelly-like substance seen by customary light microscopes.



The Electron Microscope installed in the American Cyanamid Co. laboratories.

Applications of the new instrument in the American Cyanamid laboratories are expected to uncover new and important facts about the action of catalysts, which mysteriously promote chemical reactions; about the action of chemicals on the bacteria of disease, since it may be possible to see how the drug actually killed the germ; and about the nature of synthetic resins and the processes by which they are formed. Other fields in which the laboratory is actively engaged, and to which the new instrument will be applied, include the flotation of ores and the recovery of metals by cyanidation; the manufacture of special chemicals used in the leather and paper industries; the treatment of textiles; rubber chemicals and their action in prolonging the useful life of rubber goods; synthetic resins, and plastics and enamels into which they enter; insecticides and fungicides, important

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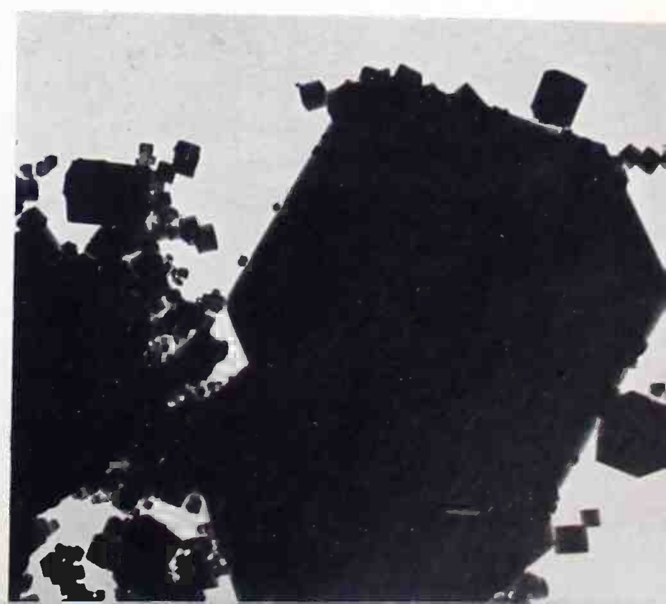
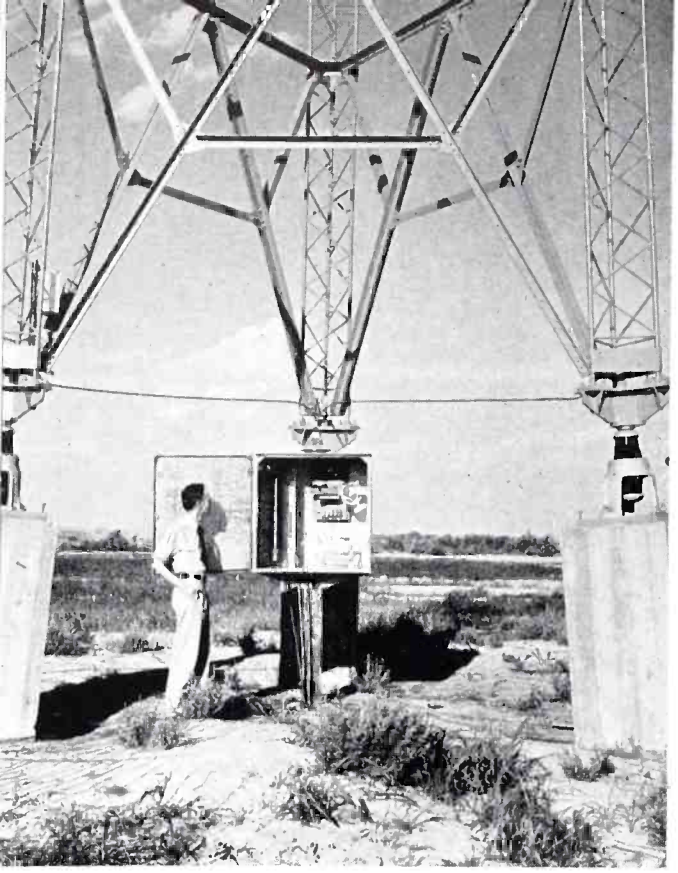
Magnesium Oxide particles magnified 26,000 times.





Base of the 335′ Tower and Coupling House.

A TWO-FIFTY IN TEXAS

KROD Installation Sets Pace for Low Power Stations

DOWN in the Lone Star State they do things in a big way and that's the reason KROD is one of the biggest and best equipped small stations in the country. Mr. Dorrance D. Roderick believed that the local station had a real purpose and place in the scheme of broadcasting and went ahead accordingly. No expense was spared to make KROD one of the Southwest's outstanding stations regardless of power.

The studios and office building are located on one of El Paso's main traffic arteries. In keeping with the historic background of the section the beautiful home of the station is modeled after the Spanish architecture of the region slightly modified by modern influences. White stucco has been used on the exterior with brilliant Spanish colors as a trim. Handmade Mexican glazed tile in blue, red, green, orange and yellow, outlines the main entrance and the tower windows. Blue call letters of concrete are mounted on the four sides of the tower and illuminated by floodlights at night.

Interior

The Spanish treatment was carried out in the Entry Hall, Public Lounge, and Clients' Room. Adzed redwood beams with Spanish stenciling support these ceilings. The ceiling area between the beams is a faint blue and is made of special insulating and acoustical material.

The walls are a textured plaster finish. This wall treatment is used throughout the building, with the exception of the three studios, control room and sound locks. Flooring in all the ground-floor offices, and corridors is asphalt tile in variegated dark reds.

Visitors in the Public Lounge are made comfortable in roomy, hand-carved, furniture of natural oak in ranch style. A 64-B speaker brings the programs direct from the control room and there is a large double-glass window looking into Studio A. The lounge and the Clients' Room are acoustically treated for good listening.

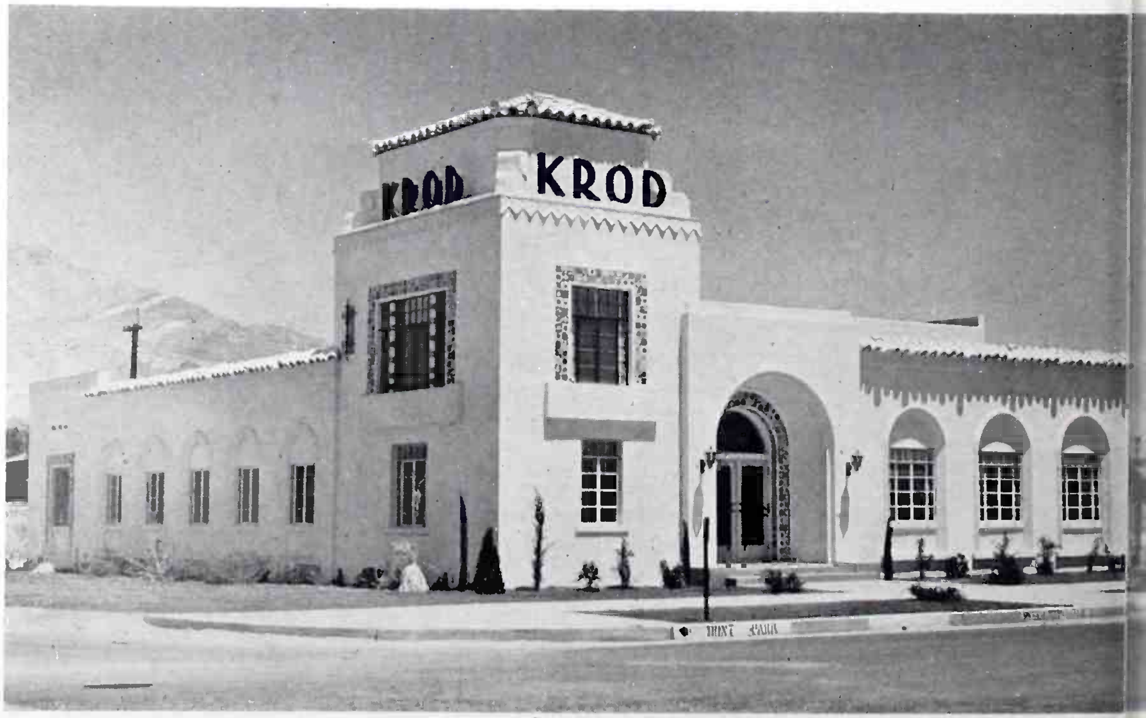
KROD's Clients' Room is furnished to give a living-room atmosphere. The redwood beams are stenciled and the ceiling between is a faint blue. Drapes of a Spanish design are at the steel casement windows.

Offices

The office of Dorrance D. Roderick, owner of KROD, is finished in New Mexico Indian style. The walls are rough Spanish plaster and ceiling beams are peeled vigas or logs. Spanish drapes are at the large steel casement windows. A Navajo rug is on the floor while an antique center lamp hangs from a viga. The ranch style furniture, desk and chairs are handcarved oak. Radio receivers in the owner's and manager's offices can be tuned to any station on the air or switched to a direct line from the control room for auditions.

The office of Merle Tucker, general manager of KROD, has an acoustical tile ceiling for noise reduction. The walls are Spanish white, like all the interior walls

Exterior of Studio and Office Building.



Control Room showing RCA Consolette and Turntables.

of the building with asphalt tile flooring. This same flooring is in the lobby, public lounge, bookkeeper's office, commercial department, announcers' room, artists' lounge, program and continuity room, and chief engineer's office.

In order, after the manager's office, are the secretary-bookkeeping office, commercial office, artists' lounge, traffic and announcers, musical director and continuity, news room, and the chief engineer's office.

All of these offices except the artists' lounge are furnished with modern steel furniture in metallic gray with deep red leather upholstery. The artists' lounge, where those waiting to go on the air may relax in comfortable chairs, has Monterey furniture.

Two teletypes in the traffic department handle CBS communications and regular telegraph business. Two more teletypes in the news room bring in the stories and feature articles of International News Service.

The office of Edward P. Talbott, chief engineer of KROD, is on the northeast corner of the building. Besides a desk and test bench, remote equipment is kept in this room so that it will be handy and ready to be taken out for a broadcast of a grid-iron battle, baseball game, or any other outside event.

Music Library

With 2500 numbers and orchestrations already installed, KROD has one of the finest radio sheet music libraries in the country. A file system, cross indexed and otherwise labeled, enables the librarian to find any desired number without delay.

The orchestrations include every type of music. There are opera selection, light opera, comic opera, ballet music, suites, marches, waltzes, symphonies, overtures, symphonic poems and mood music available for background music for dramatic presentation.

Heating and Cooling

The basement holds the York heating and air-conditioning equipment. A refrigeration cooling system is combined with gas-fired warm air heating. The system gives absolute automatic control of inside temperature and humidity, winter or summer. The entire installation was planned to preserve the low noise level required in the studios.

Dorrance D. Roderick, Owner of KROD.

Studios

The three studios and control room are isolated from the offices by the main corridors. On the opening program sixty pieces of the El Paso Symphony Orchestra performed with excellent ballance in Studio A. When the artists are few, a studio audience of 100 can be seated in one end. The dimensions are 24 feet by 48 feet with 16 foot ceiling. Studio B, 12 feet by 20 feet is for smaller groups and solists. Studio C is the newscast room and is also used for speakers.

The control room has a raised floor to improve vision into all three studios. Entrance may be had only through sound locks which have sound-proof doors.

The speech equipment comprises a 76-B1 Consolette and Power Supply, two 70-C turntables with vertical and lateral pick-ups, a 72-C recorder, a 9-AJX Cabinet Rack, and a 64-B Monitor Speaker. OP 5 and OP 6 remote amplifiers and an assortment of RCA microphones complete the technical set-up. The console is mounted on a table

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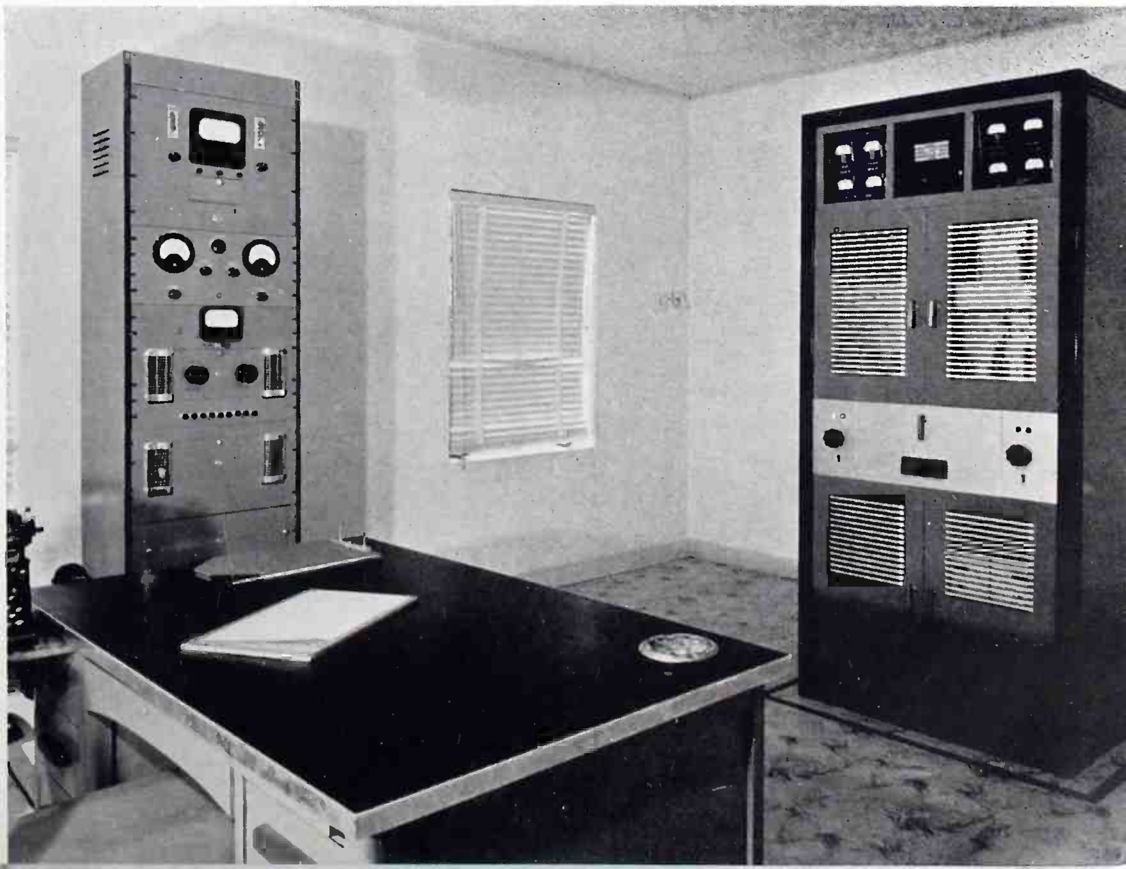
Transmitter Room at KROD.



KROD

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designed and finished to match the turntable cabinets. There is also a transcription file cabinet.

Cueing speakers are provided in each studio and also microphone warning lights and "On the Air" signs at the doors. Monitor speaker lines run to the Clients' Room, Public Lounge, Owner's office, Manager's office, and Chief Engineer's Office.

The large studio is equipped with two Steinway pianos and a Hammond organ. Studio B has another grand piano.

Studio Acoustic Treatment

Two major problems, one sound isolation or sound-proofing, and the other acoustic treatment, were involved in KROD's three studios.

The floors, walls, and ceilings are all floated on steel springs and felt pads away from the construction of the building. In each studio, construction consists of a box within a box. The inner box is suspended and has no contact with the outer box, except through steel springs and felt pads. In addition to this, the walls are built with double rows of studding and a rock wool blanket is laced between the studs.

Control windows were soundproofed by making them of double sheets of plate glass of two different thicknesses. They are mounted at a slight angle to each other so that there will be no sound reflection between the two panes of glass. The glass is suspended in the frames on sponge rubber and felt.

Special soundproof doors, designed by the Riverbank Acoustic Laboratories, were used weighing 208 pounds each.

Air ducts which bring in air from the cooling systems are lined with rock wool to prevent noise transmission through the ducts. Each room has a separate duct back to the basement with no branches, so there will be no connection between studios by means of the ventilating system. The ducts are covered on the outside with heat insulating material.

The acoustic treatment in KROD was computed carefully to give exactly the correct balance between reverberation and absorption, so that programs would have natural reproduction. Careful balance also was obtained in the absorption of low and high notes, so that neither was unduly emphasized or suppressed.

Mercury switches are used for lights, because there is no clicking sound. Fluorescent lighting in the main studio has proved to be excellent for script and music reading besides cutting down the heat load on the air-conditioning system. The fixtures used are phased to eliminate strobocsopic effect and are power factor corrected.

All electric conduits passing through studio walls were made with flexible connections so that there would be no conduction of sound through rigid piping.

Transmitter Site

The transmitter building and radiator are located outside the populated area of the city on a 16 acre site in an old river bed of the Rio Grande just a quarter of a mile from Mexico. Water is only 7½ feet below the surface.

KROD uses water from Elephant Butte and Caballo Dan reservoirs. It is taken from the Franklin Canal to irrigate the portion of the 16-acre site not taken up by the building. This acreage has been planted in alfalfa. The green of the crop enhances the appearance of the entire tract and retains moisture.

Radiating System

A Truscon, self-supporting tower 335 feet high, a half-wave length at 1500 kilocycles, is the radiator. An excellent ground has been obtained by burying 12 miles of heavy copper wire in the 16-acre field surrounding the tower. These wires were buried, with plow and tractor, about eight inches deep in 240 furrows radiating from the base of the tower for 410 feet. The wires, with a total weight of 1995 pounds, are all brazed together at the base of the tower.

The radio frequency energy is fed from the transmitter out to the base of the tower through two underground coaxial lines.

Transmitter Building

Spanish architectural design of KROD's transmitter building corresponds to that of the Studio Building. The brick walls are painted Spanish white. The tile trim is cream colored and the door and window trim is Spanish blue. Blue windows, "ventanas azules," are said to bring luck in Spain and Mexico. On the left of the entry hall is the transmitter room, 15 x 17 feet.

In the room are the transmitter, monitor apparatus, and operator's control desk. The ceiling is acoustically treated for better monitoring. Lighting is from fluorescent tubes and a silent blower over the ceiling carries off the heat of the transmitter.

A special control desk was built to match the transmitter which is a DeLuxe 250-D. One of the first of the new model RCA-311-A Frequency Monitors is installed in the monitor rack along with a 66-A Modulation Monitor, 96-AX Volume Limiter Amplifier and an 82-B Monitor Amplifier. Test runs with beat frequency oscillator and distortion meter showed all the equipment to exceed specifications as to frequency response, distortion, and noise level.

Opening to the right of the entry hall are living quarters for one of the operators. These comprise a bath with shower, bedroom furnished with Monterey type furniture, complete kitchen, with sink, cabinets, electric water heater, refrigerator, and electric stove. The building has its own well, 65 feet deep, and is equipped with an electric pump.

Although this is a new station with no past to serve as a guide to requirements, the buildings have already shown themselves so well suited in arrangement, size, and details of equipment, that hardly a change would be made if they were to be rebuilt today.

In these "wide open spaces" where the nearest 50 kilowatt station is over 600 miles away, the daylight coverage of KROD is phenomenal for 250 watts. Reliable, every-day, listening is being reported from points over 100 miles away in every direction.

LATERAL DISC RECORDING

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of the recording. The distribution of noise is mainly at the extreme high frequency and of the spectrum known as scratch or surface noise, and at the extreme low frequency end, known as rumble or mechanical noise, caused by the recording machine gears and driving system. Special equalization may be used to increase the signal to noise ratio and thus obtain better overall performance of the recording system.

Accordingly, a system of pre-emphasis and de-compensation called "ORTHACOUSTIC" has been evolved, which increases the recorded level of a portion of the low frequency spectrum, and of all the frequencies above the cross-over point. This Orthacoustic system is based upon a frequency-energy analysis of speech and music which indicates that the low and high frequency parts of the audio spectrum normally contain a lower energy level than the broad middle portion lying between 150 to 500 cycles per second. See Fig. 4.

The importance of this discovery is the evidence that both the low end and the high end of the frequency spectrum can be increased in amplitude on a recording without danger, at the low frequency end, of over-cutting and without danger of too steep a wave front for cutting and playback tracking at the high end. This possibility derives from the aforementioned fact that the energy content of sounds in nature at both the high and low ends was normally substantially less than in the significant middle portion. In other words, it is not as heretofore was considered necessary, to provide for a flat system at the high and low ends since it would rarely ever be required under normal conditions—organ music being the most important single exception. To preclude possibility of over-cutting at low frequencies due to organ music, or as a general precaution, the maximum level allowed to pass through the recording system is limited by a special type of automatic audio gain control device, such as is done to prevent overmodulation at broadcast stations. For the electrical characteristic of Orthacoustic as applied to the recording channel see Fig. 5.

Part II—Practice

To set up and adjust a recording system according to a preconceived standard characteristic, it is important to know of and distinguish between two methods of measurement, both of which are used in obtaining the final recording characteristic. The first method is the electrical response, or amplitude vs. frequency characteristic of the amplifier system which is used ahead of the cutterhead. The second method is that of optical measurement of the record itself by means of the light pattern reflected from its grooves. This latter measurement is important in checking the performance of the entire recording system and serves to indicate that it has been adjusted correctly and that the proper characteristic is actually being cut on the record.

Electrical Tests

By substituting a pure resistance termination for the cutterhead the frequency characteristic of the cutter driver amplifier at normal operating levels can be measured. This test should indicate a flat ±1 db response from 30 to 10,000 cps for an assumed standard of constant velocity above 500 cps and constant amplitude below 500 cps.

Optical Tests

The optical measurement of actual cutter operation is accomplished by making a test record at 78 rpm. Tone shoud be supplied to the input of the channel at constant program level for each selected frequency between 10,000 and 30 cps recorded; for example 10 seconds of tone and 5 seconds spacing with no modulation. The 1,000 cycle reference frequency should be recorded at three levels in one continuous band; (a) 2 db below normal input level, (b) normal level, and (c) 2 db above normal level. This will help in identifying the reference frequency and in being able to interpret the variations in amplitude of the optical pattern in terms of db. The high frequency end of the spectrum should be recorded on the outside of the disc. In addition to the regular tones, 1,000 cycles at normal level should be recorded as the first and last frequencies of the tone run. See Fig. 6.

The interpretation of the optical pattern thus produced may be arrived at as follows: Direct illumination per method in Fig. 7 is quite important; diffused light is particularly troublesome. The line of sight should be perpendicular to the record, directly over the observed spot as determined by an image of the eye found by reflection from the uncut portion of the surface. The light source should be somewhat removed from the record, at least 8 ft., and as close to the plane of the record (approx 2 ft.) as will give a brilliant pattern. With this set-up there will be two patterns, one on each side of the center of the record, one *toward* the light and one *away* from the light source. See Fig. 8. Use the pattern lying toward the light source

There are other ways of illuminating and observing the optical pattern. For example, the pattern lying on the side of the record *away* from the light source could be used but movement of the observer's eye seems to cause a greater pattern change. There seems to be less than 1 db observation error between the near and far patterns and although an average of the two would be more accurate the "near" pattern contains less errors of eye placement and seems to check other measurements closely. A small area light source of high brightness is best, as the small area produces a sharply defined image. In practice the record may be placed on a low table with the light source to the left, slightly above the level of the record. With the eye at as great a distance from the record as practical and perpendicular to the spot of measurement, use a pair of dividers to measure the width of the reflected light pattern for each frequency. The desirable condition is a characteristic based on a cross-over frequency of 500 cycles per second, which is determined when each of the three 1,000 cycle per

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second bands which are at normal input level have approximately equal widths and all those frequencies from 500 cycles to 10,000 cycles are within 2 db of this measured width. Without resorting to physical measurement, visual observation will show whether this is true by comparing the widths of each frequency band with the 1,000 cycle centrally located bands.

The frequencies below 500 cycles should taper off materially. The 250 cycle band should be half the 500 to 10,000 cycle band widths. Similarly a 125 cycle width should be half the 250 cycle value or one quarter of the 500 cycle value. Since these low frequency band widths are difficult to measure accurately by an optical method, they may be verified by playing them back electrically through a completely flat pickup head and amplifying system. Such a system may be obtained by using the MI-4856 playback head connected to 700 ohms or more load. Make certain all equalizers are disconnected and play back only the low frequency end. The resulting electrical energy of this constant amplitude portion should be reproduced with a taper of 6 db per octave. The higher frequencies cannot be measured successfully with this head due to the mechanical resonance composed of cutterhead plus record material, which, with lacquer coated records, appears to be around 6,000 cycles per second, thus giving a false interpretation of the record. The high frequency end of the spectrum should only be interpreted by physical measurement of the light pattern widths. After each frequency is measured with the dividers to the nearest hundredth of an inch, the characteristic may be translated into an electrical relationship expressed in db by using the relation that the width of each frequency band is proportional to the voltage which that band would produce in a perfect electro-magnetic playback head. For example, with two frequencies on the record, one of which was twice as wide as the other, the wider band would be 6 db higher in level than the second band, etc. Use the middle normal level 1,000 cycle tone as a reference value and compare all others to this by expressing each measured width in relation to the 1,000 cycle width as a fraction. The resulting figure then represents the voltage which would be generated at one frequency as compared to the 1,000 cycle voltage. This voltage ratio may be expressed in db by using the *voltage* column of a db table.

The resulting figures should be plotted and compared with the theoretical characteristic showing a downward slope of 6 db per octave below 500 cycles and a flat characteristic above 500 cycles. At present, a tolerance of 2 db from theoretical is permissible. If the cutter power amplifier and head do not fall within these limits under actual operating conditions equalization is necessary. The proper equailzer for each head must then be designed and installed, preferably ahead of or following the cutter driving amplifier. It is possible to locate equalization within this power amplifier, but in such case means should be provided to remove this equalization when electrical tests are made to determine if this amplifier itself has a normally "flat" electrical characteristic.

ELECTRON MICROSCOPE

(Continued from Page 25)

to agriculture in the control of insects and diseases of plants; fertilizers and plant hormone substances; and a wide variety of chemical products, many of which are made from the company's basic raw material, calcium cyanamide.

The electron microscope supplements an imposing array of special apparatus already employed in American Cyanamid's Stamford Laboratories in solving abstruse problems of producing and applying chemicals in industry. Ultraviolet and infra-red spectographs, used to measure colors invisible to the human eye, form the nucleus of one of the most complete spectroscopic laboratories in American industry today.

The equipment of the Stamford Laboratories, to which the electron microscope has now been added, is complete and modern and ranks it as one of the leaders among the nearly 1800 research laboratories now operated in the United States for the benefit of industry.

The electron microscope is based on the fact that fast-moving electrons possess a wave length far shorter than that of visible light. In the best optical instruments, the wave length of visible light places a lower limit on the size of the smallest detail in an object that can be seen, however, great the magnification may be. Practically, this limit is reached when the object is magnified one to two thousand times. If ultraviolet light of shorter wave length is used in a microscope provided with quartz lenses, still small objects can be photographed and studied. The limit of magnification of an instrument of this type is about twice that of a microscope using visible light. In the electron microscope, the radiation involved is an actual stream of infinitesimally minute electrically charged entities, called electrons, whose associated wave length is of the order of a hundred thousand times smaller than the wave length of even ultraviolet light. As a result of this minute wave length the limit of the useful magnification of the present electron microscope — and this may be substantially increased by future development — is approximately one of two hundred thousand times actual size. Thus, objects whose dimensions are one-one hundredth to one fiftieth those of the smallest object to be seen with visible light can be pictured with electrons in equal detail.

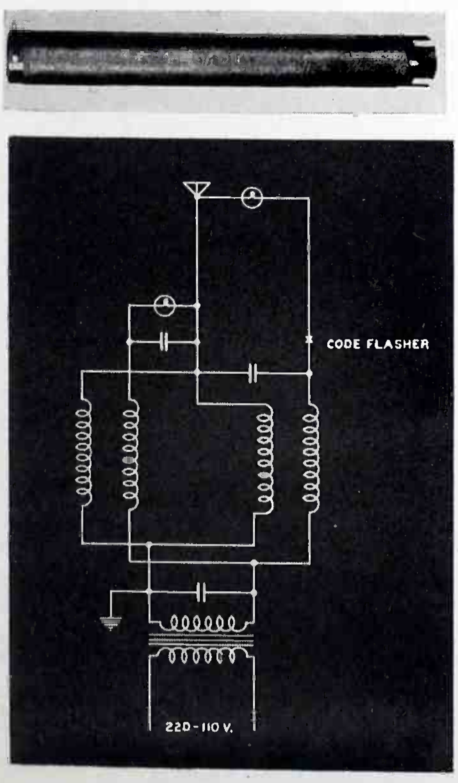
PHASING EQUIPMENT

(Continued from Page 15)

theoretical value for the type of radiator employed. Allowance for variation from the theoretical value must be made for any appreciable effect of a multiplicity of radiators on the vertical pattern. The predicted maximum deviation in the ground plane for two elements is eight per cent, which may be additive or subtractive. In nearly all cases, the "squashing" effect does not exceed four or five per cent and, unless the case is borderline, this effect may be ignored since it is within the overall accuracy of the predictions and computations. For three or more radiators this effect may become twenty-five per cent or greater and must be calculated for each design.

In instances where the radiators are below 90 degrees, the effect of the mutual impedances may force the operating resistance of one or more of the radiators to a value so low as to be comparable with the loss resistance of the ground system. If then, appreciable power is to be fed to a particular radiator, the losses may become definitely excessive and it may be impossible to obtain a radiated r-m-s pattern approaching even closely to the predicted value for a single radiator. In such cases, therefore, every consideration must be given to the losses in the circuit elements of the distribution equipment. Recent designs have made possible a group of inductors with an effective "Q" as high as 450 to 500. Although these equipments may seem over size for the rated power of the station, they are definitely necessary to make possible an efficent overall system. Inductors of the type generally employed in five and ten-kilowatt arrays are illustrated in Figure 5. The first (No. 1) which is known as the MI-7487-A, has an inductance of 120 microhenries and a nominal current rating of 17.5 amperes up to two megacycles. The second (No. 2) is the MI-7487-B and is identical in construction with the first type but has an inductance of 60 microhenries. The third one (No. 3) is known as the MI-7493-A or, more familiarly as the "trolley car coil" and has an inductance of 21 microhenries rated at 15 amperes.

Fig. 6



Where the losses are unduly large, it is important to give every consideration to an extensive ground system, since it may well become the limiting factor in attaining predicted operation.

Transmission Lines

Many words of description and discussion have been written about the relative merits of various types of transmission lines. Electrically, there seems to be little or no advantage in favor of either a well-constructed open wire or concentric line. However, in the design of equipment for distribution in the higher-powered arrays (25 kw or greater) the selection of the type of transmission line has an appreciable bearing not only upon the cost but upon the selection of distribution and phasing equipment.

The concentric type line having an impedance of 60 to 70 ohms requires higher current ratings in many branches of the power and phasing sections. The 240-ohm open-wire line greatly minimizes the current requirements in these same positions. The 350-ohm open-wire line, on the other hand, though still further reducing the

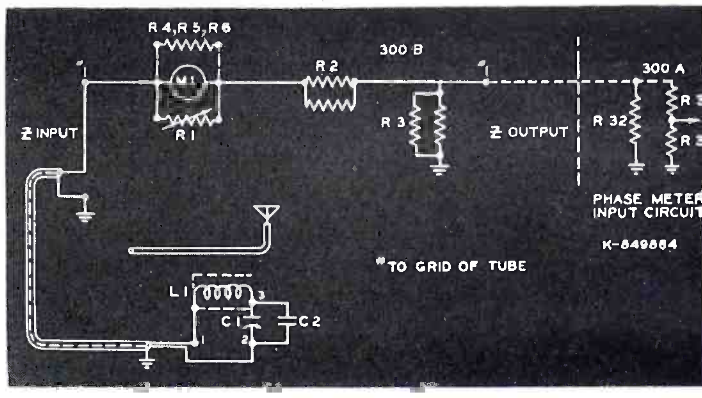


Fig. 7

current-carrying requirements may result in excessive voltages or impedance transformation ratios. Most frequently, transmission-line impedances of from 175 to 250 ohms will be found optimum from a design standpoint. Consideration, therefore, should be given to the choice of line, bearing this in mind in addition to those factors usually considered.

Tower Lighting

There are three methods commonly employed for feeding power to the side lights and the flasher beacons. The first and most frequently used is the solenoid type high-reactance choke built with either a single- or a multiple-layer winding. Normally, two circuits are provided for distribution of load and to permit a separate circuit for flashing the code beacons. A typical wiring diagram and a photograph of the well-known RCA Type 92-A tower-lighting choke are shown in Figure 6. The Type 92-A is quite satisfactory for all lighting loads now commonly encountered. Voltage limitations and length of leakage path limit its use to powers under 25 kw, unless the impedance of the radiator is so low that the voltages are nominal.

The second system supplements the first and is used in the higher-power ranges where the voltages are of such magnitude as to preclude the use of the former. For such applications, toroidal-type interlocked windings with air-gap insulation are most commonly found. These transformers are available in all of the usual power ranges and with facilities on the secondary side for an additional circuit to the flashing beacons. In this instance, the

(Continued on Next Page)

flasher would be mounted on the tower, whereas with the choke method, the flasher may be mounted either on the tower or in the tuning house. A static-drain choke is a desirable adjunct to the toroidal-transformer system of feed.

The third system, less frequently found, requires a special inductor wound with tubing of such diameter as to permit the passage of the tower-lighting feed conductors. This inductor is then tuned with a capacitor to parallel resonance at the operating frequency. Although satisfactory electrically, it is necessary to make a design for each band of frequencies and to tune each installation individually. This is relatively expensive and is impracticable from a standpoint of manufacturing and stocking.

Tuning Houses

It has become a practice to construct a small building at each tower to house the tuning and auxiliary equipment. This procedure is very desirable since the additional cost of the building is more than compensated for by the savings in the avoidance of additional metal housing for the auxiliary equipment and in the reduction of time required for tuning the array. A small tuning house makes possible the convenient installation of a power outlet for heating or for maintenance work, the installation of a telephone-communication system and the provision of a shelf for test equipment. The antenna lead may be brought in through a bushing, similar to the Lapp No. 5499, using $\frac{3}{4}$-inch copper tubing. This single downlead then provides an r-f path and permits the use of three No. 10 conductors for the lighting circuits.

Monitoring

One of the points most subject to controversy is the method to be employed in obtaining a sample of the antenna current for operation of the remote antenna-current indicator and the phase meter. The RCA Type 300-B Remote Antenna-Current Indicator operating in conjunction with the RCA Type 300-A Phase Meter is shown in Figure 7. The sampling coil is a 50-turn, 3-inch inductor equipped with an electro static shield and tuned to series resonance at the operating frequency to eliminate reactance error. With reasonable spacings from the antenna conductor, sufficient voltage will be developed to drive the 150-milliampere remote indicators. This system has been found to be reasonably accurate, especially where the array is symmetrical. Where the radiators are asymmetrical, the phase and current indications are still referred to the base and the instruments may be used only for monitoring. This limitation is true of any method unless the actual current loops are established and a sampling coil is mounted and coupled directly to the radiator at that point.

For reasonable stability of measurements, it is necessary to use a line, the constants of which will not change. A gas-filled ($\frac{1}{4}$-inch or $\frac{3}{8}$-inch) sampling line has been found satisfactory in this respect. Any changes in leakage across the insulators with changes in moisture in the line will cause a sufficient change in the velocity of propagation and the characteristic impedance to affect the phase and current indications and, for this reason, it is particularly difficult to maintain identical readings on the antenna ammeter and the remote indicators. Temperature effects, too, are difficult to control.

A second method depends upon the construction of a sampling loop on the antenna proper. This has an obvious objection in that it is necessary to construct an isolation circuit of the sampling line itself in order to bring the circuit over the base insulators. Further, unless the loop is coupled to the proper point for each individual radiator, the phase and current readings will still be relative and will not indicate directly the field ratio and phase. The cost of this system seems disproportionate to any advantages that might be gained. A modification of this method which uses a separate support for the sampling loop, such as a 20 or 25 foot pole mounted adjacent to the radiator, obviates the need of an isolation circuit for the sampling line.

The sampling loop, irrespective of the type employed, requires a reasonable amount of electrostatic shielding. Magnetic shielding is also desirable where feasible. If such precautions are not taken, it is almost impossible to

RCA Antenna Phasing Equipment coming off the line.

maintain linearity of readings with changes in pattern or in power. Actual experience indicates that with any of the methods outlined there will be some drift unless every precaution is taken to make a good installation mechanically and electrically.

Design Data

The following outline covers the basic information required for design of power dstribution equipment. Although some of the questions may seem irrelevent, their effect is appreciable in securing an optimum mechanical layout and in minimizing cost.

A. General characteristics of the array.

1. Number of elements.
2. Field ratio.
3. Relative phases.
4. Tower spacings.
5. Physical characteristics of each tower, that is, height, base dimensions, insulated or grounded, self-supporting, guyed, tubular mast, or uniform cross-section.

B. A plot layout showing the location of each tower, dimensional reference to the point of power distribution, transmitter building or otherwise.

C. Type of transmission line to be employed, its characteristic impedance and the individual line lengths from the distribution point to each radiator. This is important for it is impossible to even approximate the design of the phasing sections without this information.

D. Is a tuning house to be constructed at each tower?

E. Is the array to function directionally both day and night, night alone or with two separate directional patterns? This information determines the requirements for switching.

F. A full description of the ground system makes it possible, within limits, to predict efficiencies.

G. If the tower is to be sectionalized or top-loaded, a full description will be required.

If practical, it is desirable to measure the charcteristics of a single radiator before the other elements of the array are erected. Measurements of the base characteristics should be made and a field pattern for a single radiator established. It is then possible, and convenient, to make ratio comparisons of the final pattern after the array is in adjustment. Knowledge of the field ratios at such predetermined points of measurement provides a more accurate picture, since the question of conductivity is eliminated. Measurements of the mutual impedances between the elements after the array is completly erected would make possible a check against the computed values in the final design of the distribution equipment.

If all or most of the information outlined herein is available to the design engineer recommendations can be made for a system which offers the greatest advantages in electrical efficiency, convenience, and economy. Of the many RCA installations which are now in operation, no two are identical. In every case, the electrical design and the mechanical layout have been adapted to meet every detail of the individual requirements of the station. With the experience gained in past years, it is now possible to prepare a preliminary design for quotation within a very short period of time so that, to all intents and purposes, the customer may be served as quickly as if fixed designs were employed.

On the opposite page are several photographs of RCA phasing equipment in production. These should serve as ample evidence of the rapid trend toward the obsolescence of single radiator systems for broadcasting stations.

The following list outlines some of the stations where RCA Antenna Phasing Equipment has been sold to produce patterns of all descriptions:

Station	Power (KW)	Number of Elements
KGKO	5	2
KWKH	50	3
WELI	5	2
KVOD	1	2
WTAG	5	3
WPRO	5	2
WDAE	5	2
WMEX	5	2
WSUI	5	3
WDRC	5	2
KFRO	1	3
WJBO	5	3
WLOL	1	2
WXYZ	5	2
KWFT	5	2
WAVE	5	2
WDAY	5	3
WMAL	5	4
WCSH	5	2
WGAN	5	2
WLAW	5	3
WAKR	5	2
WOV	10	2
WDBO	5	2
WFLA	5	2
KFBI	5	3
WBRC	5	2
KGLO	1	3
WBEN	5	2
WFDF	1	3
KECA	5	2
WMUR	5	4
WTRY	1	2
KPRC	5	2
WHIO	5	3
KDTH	5	3
WWL	50	2

COVER ILLUSTRATION

Our cover shows the new MI-19421 Transmission Line Bayonet Assembly for 5 and 50 KW broadcast service. Of sturdy welded construction and unique shape, the double bayonet combined with a special Fog Type, low-loss, insulator provides a simple assortment of stock parts for use in erecting the new RCA Six Wire line.

Six No. 6 stranded hard drawn conductors suspended in the MI-19421 assembly comprise an extremely low-loss line of 230-ohms characteristic impedance suitable for main or branch feeders in all types of arrays.

Engineered for universal application, the bayonet may be bolted to steel or wooden poles. In addition to the special insulator, four streamlined ground wire clamps are furnished as part of the assembly.

Electrical characteristics and installation details will be discussed in the next issue of Broadcast News.

A COMPACT SET-UP FOR KHAS

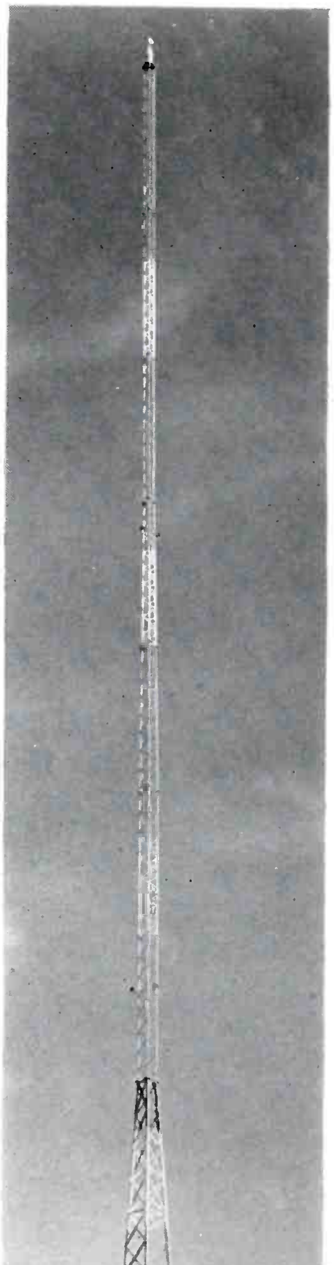
Hastings, Nebraska Station Solves Problems by Going "RCA-all-the-way"

TO operate a small station successfully, that is to show a profit, it becomes necessary to hold the investment and operation costs to a minimum. This does not mean buying the cheapest equipment on the market since a lower investment may be more than offset by higher maintenance cost.

To hold operating costs down it was decided to pick one location for both studios and transmitter. A down town location is most desirable for studios and business offices, so a study of the buildings was made. The one building available which seemed most desirable was not selected until tests had proved the site usable. To make the location tests on the Tribune Building, a forty foot wood mast, supporting the copper antenna wire, was erected and held in place with guy wires. Sixteen insulated copper radials were used for counterpoise and a fifty watt transmitter was used to supply an unmodulated signal. Permission was granted to test on the assigned frequency of 1200 kilocycles during daylight hours. The slight loss in efficiency due to mounting the tower on the building was more than offset by the lower operating cost.

Orville Rennie, Manager.

The KHAS antenna mounted on the roof of the Tribune Building.



Walter Ely, Chief Engineer.

An array of RCA equipment that saves time, space and money for KHAS.

Ground System

After the location was approved, we selected the equipment. It was necessary to use a self supporting tower since a guyed tower could not be anchored satisfactorily on this building. We bought a two hundred and ten foot Truscon. The radiator is series fed. The ground system consist of one hundred and twenty copper radials connected to the ground. They are supported by a wood framework seven feet above the roof. There is enough room between counterpoise and roof to allow for most necessary work.

When buying the transmitter and speech equipment we considered price, reliability, maintenance cost, and appearance. After receiving bids from several manufacturers and considering all the above points we decided to go RCA all the way. In order to keep all equipment at top notch performance, test equipment is necessary. We have a beat-frequency oscillator, distortion meter attenuator panel, oscillograph, tube tester, volt-ohmeter and a condenser tester.

250-K Does the Job

By using the 250-K transmitter we find it requires very little attention. One operator can watch it, as well as take care of all studio operations. The transmitter and associated equipment is mounted in the wall directly in front of the operator at the speech console. The workshop and store room is directly back of the transmitter for the most convenience.

The control room is twenty feet square. At the operator's left are two studios; one is twelve by twenty-two feet, the other is twenty-two by thirty-three. At the right is the auditorium and stage. The open front stage and both studios are visible from the control room.

The old saying about listeners not appreciating high fidelity is not entirely true. We have received many compliments on the quality of our broadcasts because most listeners today have developed their critical faculties. Give them quality and they like it.

THE ULTRA SENSITIVE D. C. METER

The RCA Ultra Sensitive D.C. Meter is a general purpose instrument of considerable utility in the radio laboratory. The meter makes use of a high gain, extremely stable, D.C. amplifier in which a negative feed-back circuit is employed. It is useful for measuring voltages ranging from .1 to 500 for currents between .02 to 10,000 microamp. and for resistances from .01 to 1000 megohms.

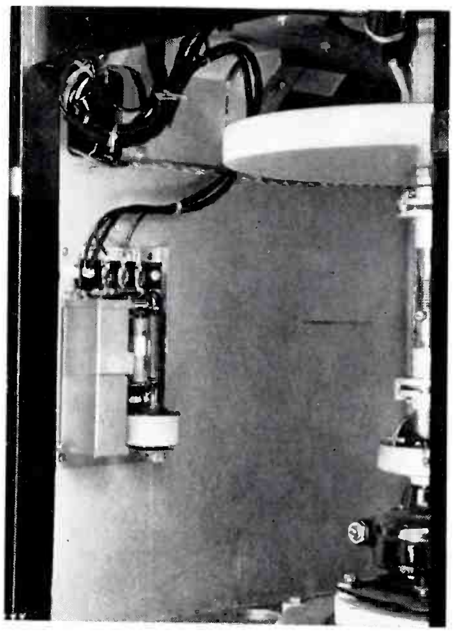
It is especially applicable for accurate observation of extremely high resistances and minute currents. Also the meter is valuable for measuring voltages across high impedance circuits such as those encountered in AVC rectifiers, etc., because the high internal resistance of the meter does not load down the circuit being measures.

ORTHACOUSTIC REPRODUCING FILTER MI-4914

The MI-4914 Orthacoustic reproducing filter has been designed to operate in conjunction with the RCA type MI-4856 and MI-4856-A (Type 70-B and 70-C) permanent stylus transcription reproducer heads. This filter permits the full realization of the advantages of Orthacoustic recordings by all who are endeavoring to obtain the best possible reproduc- and is a unit that should be used tion from their transcription service.

In addition to the MI-4914 filter, there is included in the kit all leads, cables and a switch required to install the equipment in the type 70-A (converted), 70-B or 70-C transcription turntables. The switch is provided so that the selection of either the regular compensation or the Orthacoustic compensations is possible and full instructions are included with each kit as to how the equipment should be installed in each of the RCA 70 series of turntables.

The MI-4914 Orthacoustic Filter is available for immediate delivery. The price for the complete kit is $12.50, f.o.b. Indianapolis, Indiana.



MI 4914 Mounted in 70 C Turntable.

Specifications

Source impedance — MI-4856 or MI-4856-A heads or 250 ohms unbalanced.

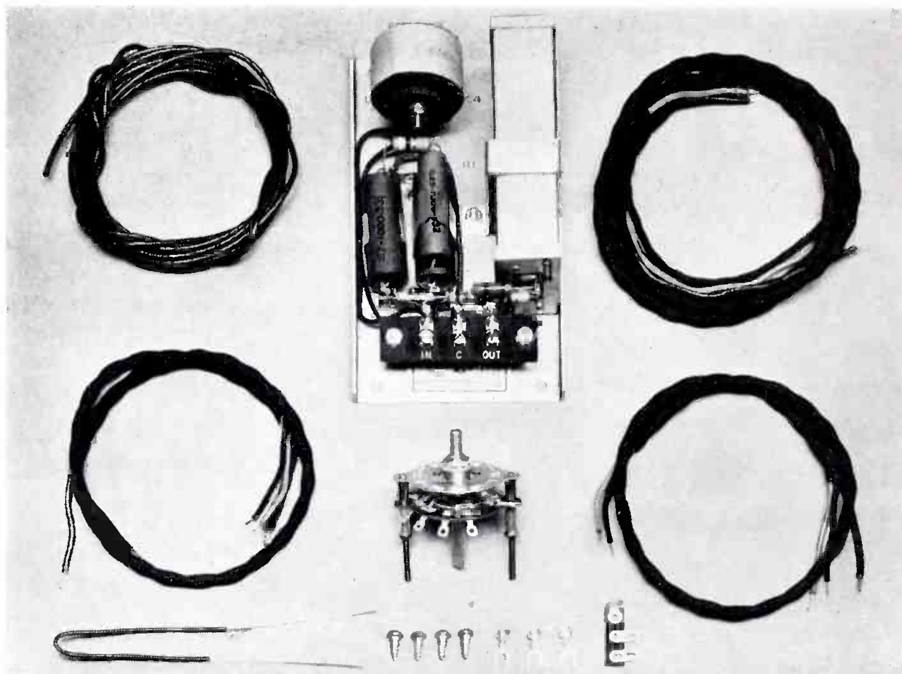
Load impedance—250 ohms (unbalanced).

Insertion loss — 27 db at 1000 cycles.

Noise Level—Better than —120 db (.001 w. reference level).

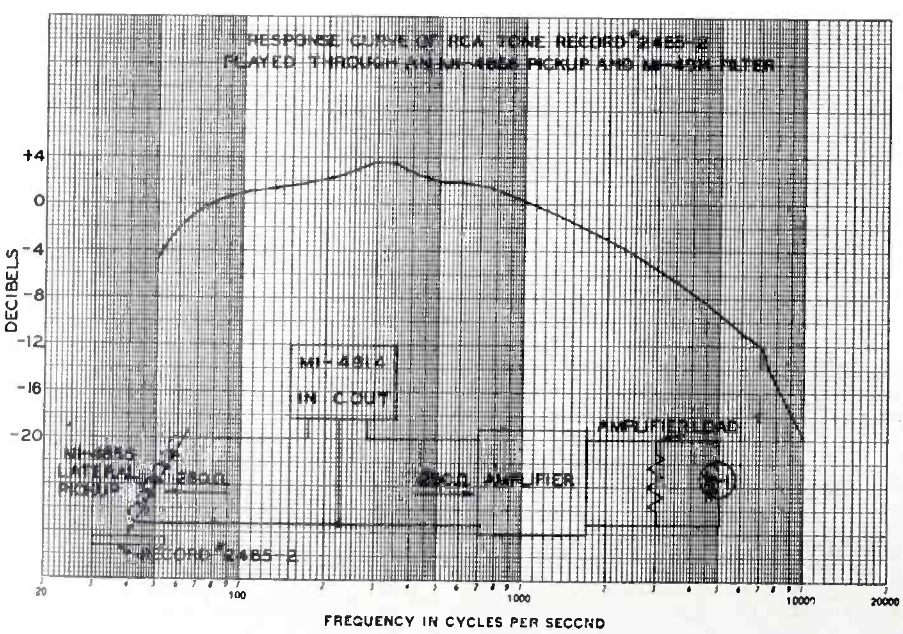
Filter dimensions—$4\frac{1}{16}$" wide, 7" deep, 2½" high.

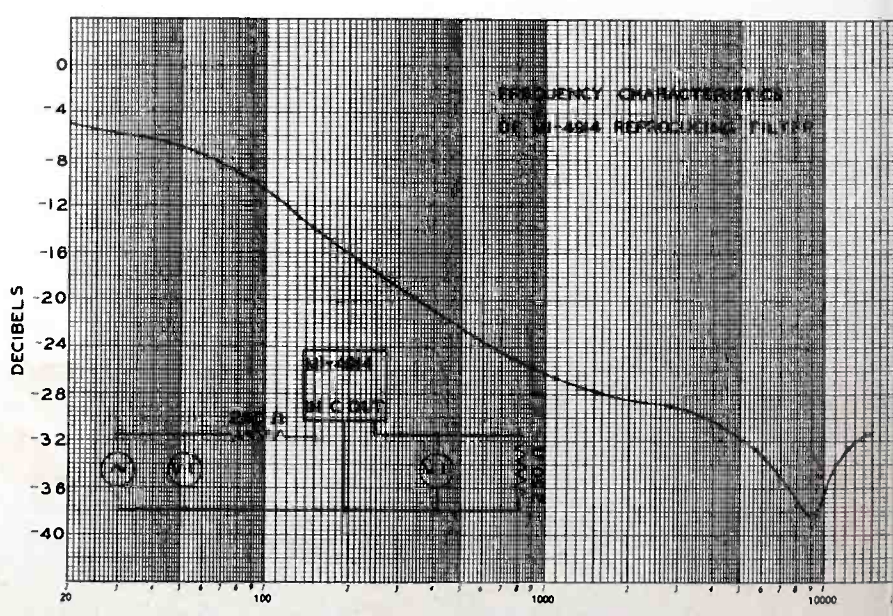
Weight (unpacked)—2¼ lbs.



The MI-4914 Kit.

(Below) Performance curves on the MI-4914.

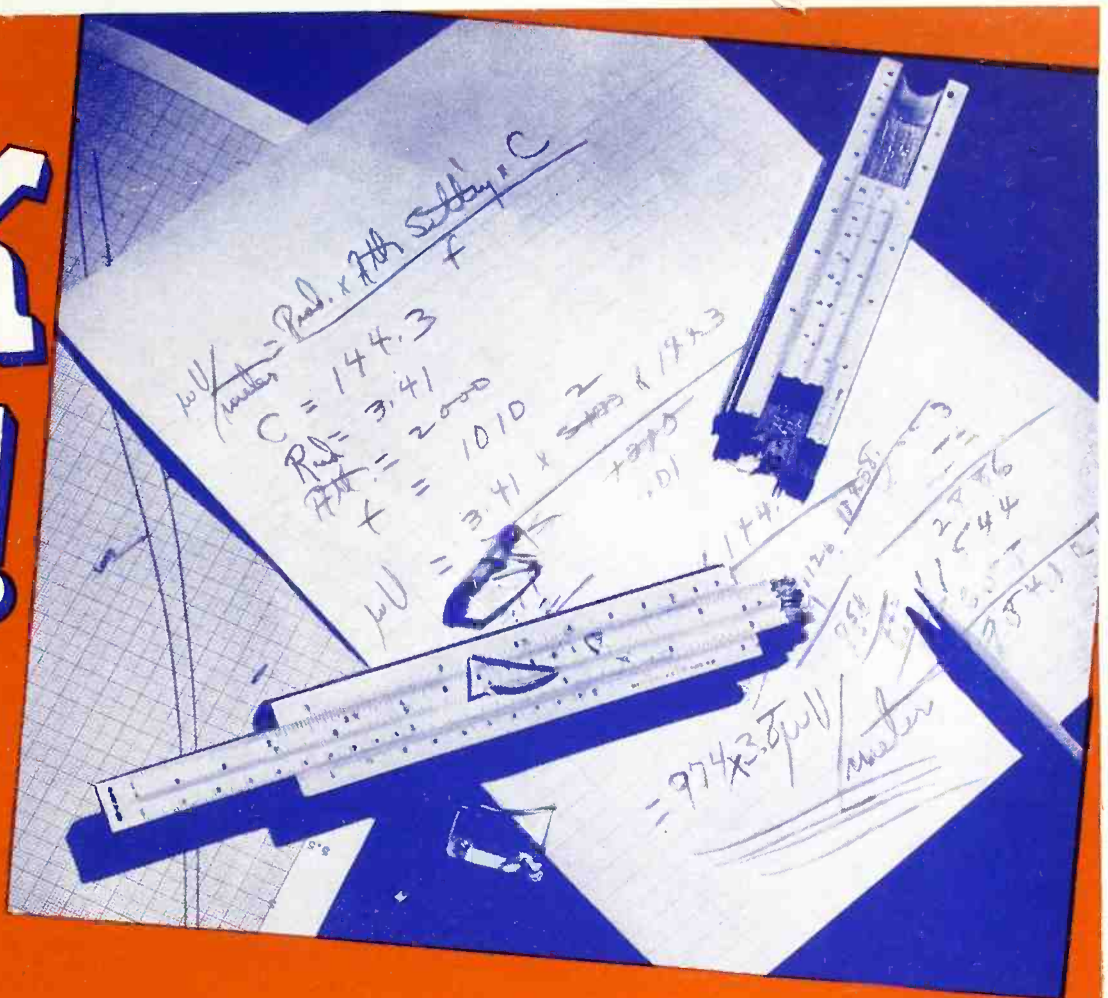




BREAK IT UP!

...NO MORE CALCULATIONS

on Field-Intensity Surveys with this



New RCA Direct-Reading Field Intensity Meter

FIELD intensity measurements are important to every station . . . to check coverage, service area, antenna efficiency. But old-style field intensity measuring *methods*—methods that mean calculations for each of the hundreds of individual survey points —are time-wasting and costly.

Here's the RCA answer: the new model 308-A *direct-reading* Portable Field Intensity Meter. Quick and simple to use, the 308-A is *more* accurate than old methods... yet gives field intensities *without* calculations by direct-readings from the attenuator scale, in a few *seconds!*

Three easily interchangeable shielded loops cover 6 bands—from 120 kc. to 18,000 kc. Wide intensity range, from 20 microvolts to 10 volts per meter, permits measurements within a stone's throw of the antenna itself—or out where the signal lies barely above the noise-level.

Write for complete data and descriptive literature on this time-saving, cost-saving new RCA instrument—or ask your technical staff to investigate.

★

Use RCA Radio Tubes in your station for finer performance

- ★ **Quick and Accurate—No Calculations**
- ★ **Light Weight—Portable—Convenient**
- ★ **Wide Frequency Range: 120 to 18,000 kc.**
- ★ **20 Microvolts to 10 Volts per Meter**

New York: 1270 Sixth Ave. Chicago: 589 E. Illinois St. Atlanta: 530 Citizens & Southern Bank Bldg. Dallas: Santa Fe Bldg. San Francisco 170 Ninth St. Hollywood: 1016 Sycamore Ave.

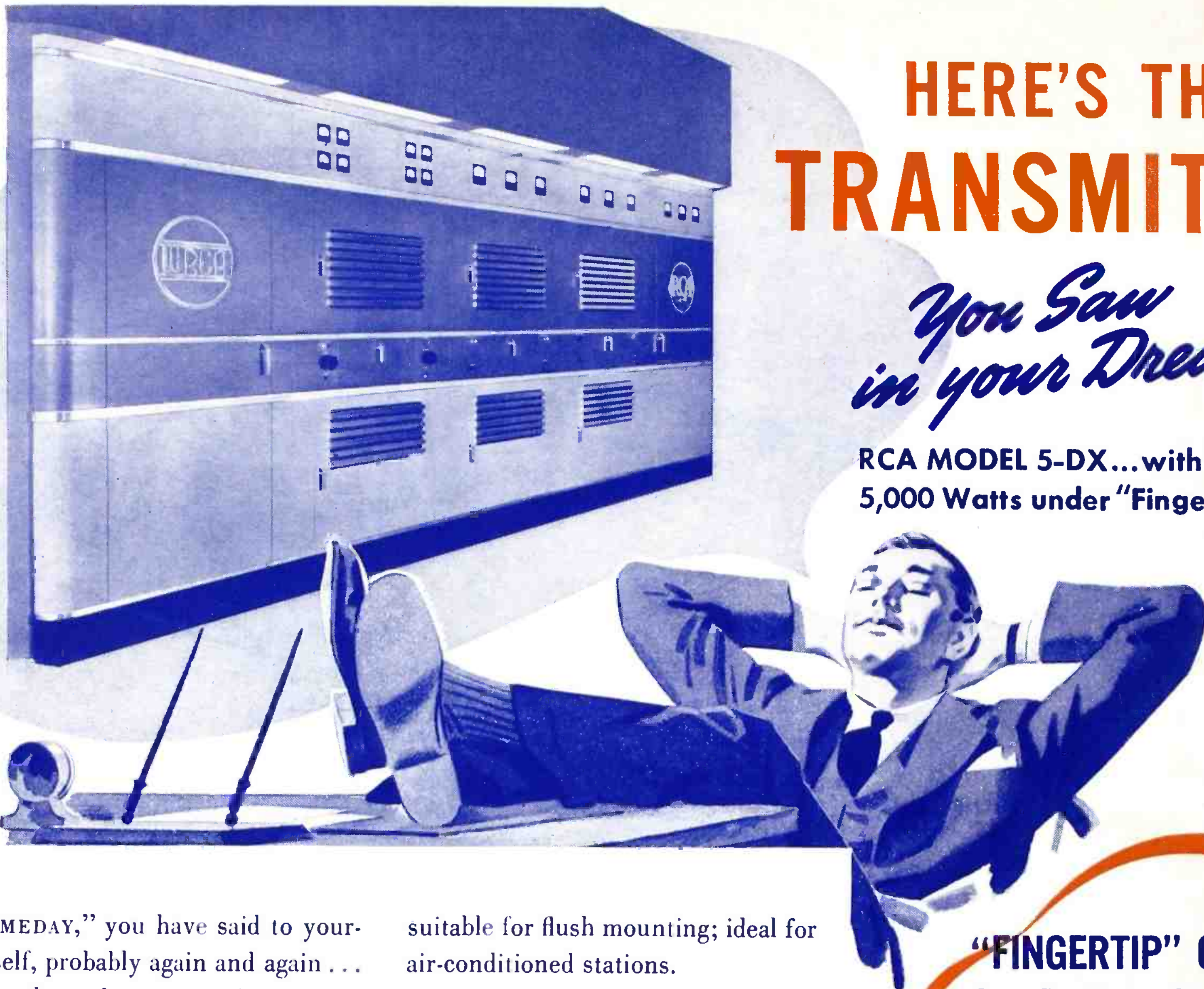
RCA

Broadcast Equipment

FOR FINER PERFORMANCE... GO RCA ALL THE WAY

Microphones
Speech Input Systems
Associated Equipment
Transmitters

RCA Manufacturing Company, Inc., Camden, N. J. • A Service of the Radio Corporation of America



HERE'S THE TRANSMITTER

You Saw in your Dreams!

RCA MODEL 5-DX...with Unified Front
5,000 Watts under "Fingertip" Control!

"SOMEDAY," you have said to yourself, probably again and again . . . "Someday we're going to 5,000 watts! And *when we do* . . ."

In the back of every broadcaster's mind, we think, there has *always* lurked the vision of a transmitter like the RCA 5-DX . . . and in designing it we've tried to be true to your dream. We honestly believe it's the finest 5,000-watt de luxe transmitter you've ever seen anywhere. For instance:

Notice the beautiful, streamlined, functional "Unified Front" Panel . . . formerly available only on custom-built and 50 KW transmitters.

This functional styling means easiest accessibility. Easiest installation. Easiest operation! It's especially suitable for flush mounting; ideal for air-conditioned stations.

Cooler! Quieter! Lower Operating Costs!

Each chassis is vertically arranged for natural air-flow convection cooling. All circuit-components on *all* chassis are easier to reach; all circuit components operate cooler. Air-cooled metal-anode tubes are under forced draft: no water, water-pumps, or water-problems.

And far in advance of present standards is the *performance* of the 5-DX! Highest fidelity; highest efficiency! Lowest distortion; lowest operating costs! Write for the 5-DX booklet that tells the whole story.

"FINGERTIP" CONTROL for Better Operation!

Put the transmitter on the air ... switch the tower lights on and off, .. switch between studio lines . . . all with a finger-flick! Complete audio, monitoring and power circuits — the *complete* station is instantly controllable from the "Fingertip" console—exclusive with RCA.

Use RCA Radio Tubes in Your Station for Finer Performance

FOR FINER PERFORMANCE... GO RCA ALL THE WAY
Microphones
Speech Input Systems
Associated Equipment
Transmitters

RCA *Broadcast Equipment*

RCA Manufacturing Company, Inc., Camden, N. J. • A Service of the Radio Corporation of America

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