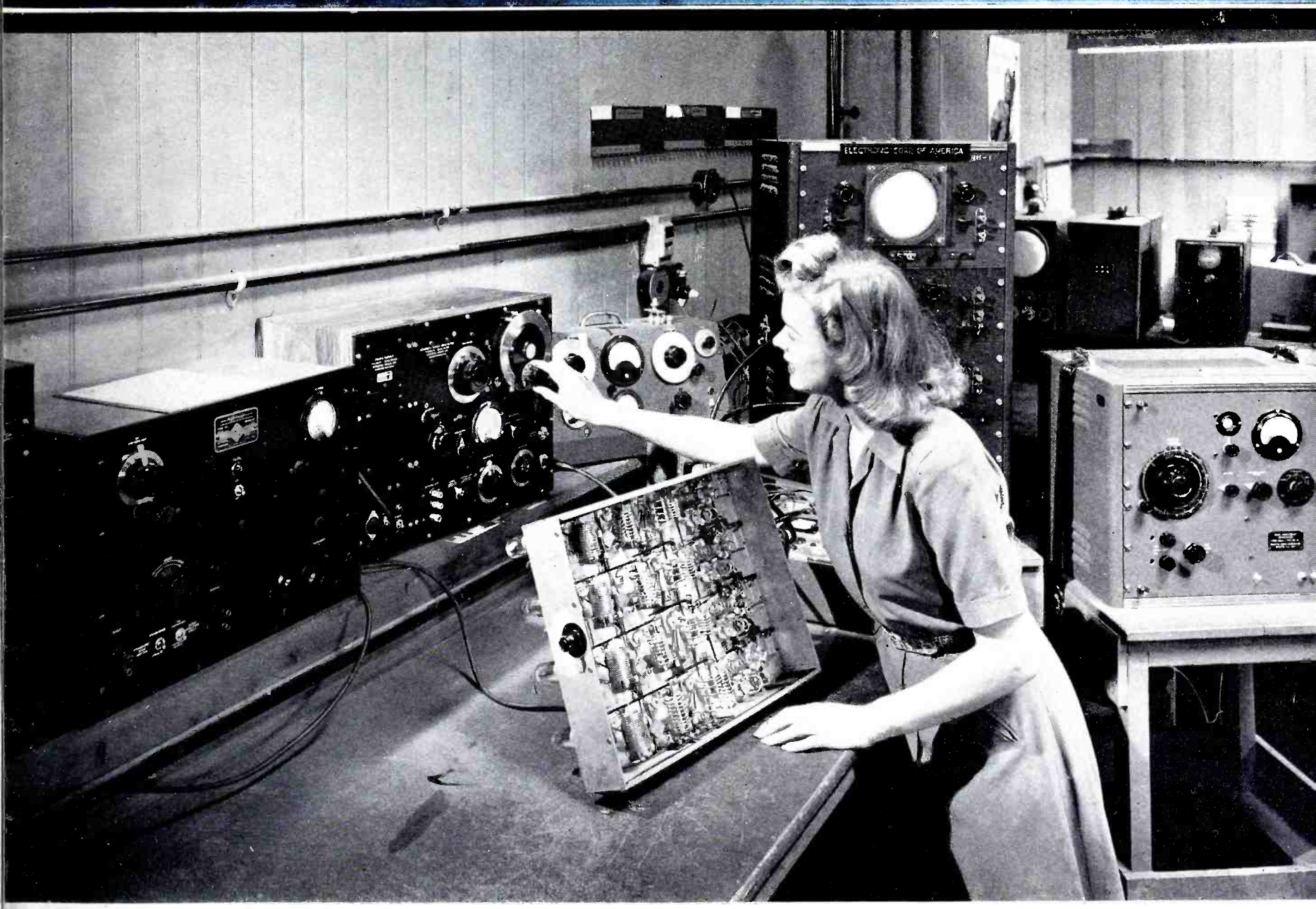
COMMUNICATIONS



AUGUST

★ RADIO ENGINEERING
★ ANTENNA ARRAY ANALYSIS
★ COMPENSATING A-F AMPLIFIER
★ DUAL-CHANNEL RECEIVER
★ SYNTHETIC REVERBERATION
★ AIRCRAFT COMMUNICATIONS

1943

REPRINTED TO SHOW REVISED PRICES

SELECT for SERVICE

NEW HYTRON TUBES

Type	Description	Price
836	Half-wave, high-vacuum rectifier	$11.50
837	12-watt, r.f. pentode	2.80
954	Sharp cut-off, acorn pentode	4.50
955	Acorn triode	2.75
956	Remote cut-off, acorn pentode	4.50
1616	Half-wave, high-vacuum rectifier‡	5.75
1625	25-watt, r.f. tetrode (12-v. heater)	3.50
1626	5-watt, triode oscillator	2.50
E1148	3.5-watt, u-h-f triode	2.25
VR105-30	Gaseous voltage regulator	1.25
VR150-30	Gaseous voltage regulator	1.25

OTHER POPULAR HYTRON TUBES*

Type	Description	Price
2C25	15-watt, medium-mu triode	$3.00
2C45	7.5-watt, triode (modulator)	2.50
10Y	15-watt, general-purpose triode‡	1.50
801A/801	20-watt, general-purpose triode‡	2.50
HY61/807	25-watt, r.f. beam tetrode	2.25
841	15-watt, high-mu triode‡	2.25
864	Non-microphonic voltage-amp. triode	1.00
HY24	2-watt, power triode‡	1.50
HY31Z	30-watt, high-mu twin triode‡	3.50
HY65	15-watt, r.f. beam tetrode‡	3.00
HY69	40-watt, r.f. beam tetrode‡	3.95
HY75	15-watt, u-h-f triode‡	3.95
HY1148	(2C24) 1.8-watt, u-h-f triode	2.25
HY615	3.5-watt, u-h-f triode	2.25

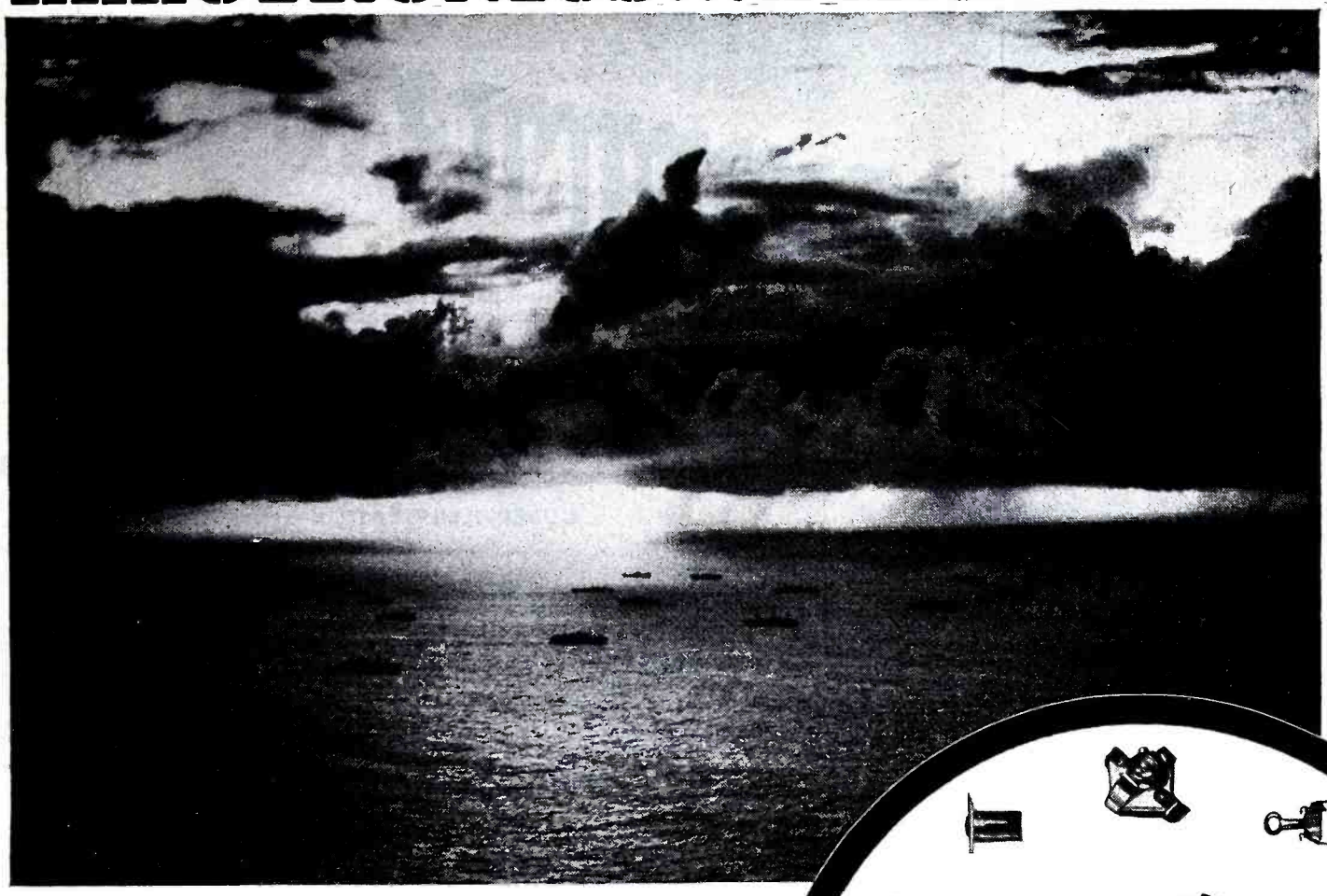
*This is not a complete list. Wattage ratings indicate maximum plate dissipation.
‡Instant-heating filament.
†For complete characteristics consult Government specifications.

On this list of tubes which have recently joined the growing legions of Hytron types already marching on to Victory, you may find just the ones you want for your War equipments. Whether you choose the tiny "acorns" or the husky 1616 rectifier, you will discover the same high quality and design refinements which have made other Hytron tubes famous. If you place your orders well in advance, you will also be pleased by Hytron's on-schedule deliveries. Not too infrequently, deliveries are made from stock.

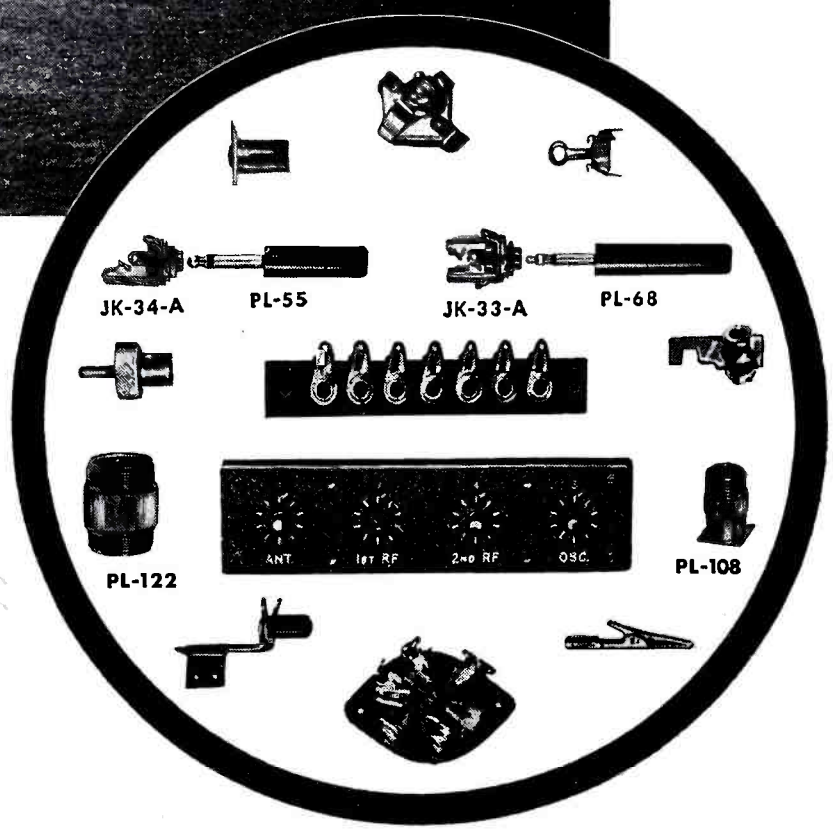
HYTRON CORPORATION
SALEM AND NEWBURYPORT • MASS.
Since 1921 Manufacturers of Radio Tubes

HYTRON RADIO TUBES

ELECTRONICS...A MIGHTY WEAPON



This is ELECTRONICS in operation . . . but not until the full facts are released will you be able to see all the technical developments.



ELECTRONIC equipment is comprised of many individual components . . . plugs, jacks, insulators, etc.

ELECTRONIC DEVICES physically, are assemblies of components, each one contributing its share toward making the instrument function. Among the many activities of American Radio Hardware is the manufacture of over one hundred parts used in ELECTRONIC equipment and applications. That our components are used in the production of this mighty weapon is in itself a fine tribute to our skill and our facilities.

With electrical and mechanical tolerances as critical as they are nowadays, all of our components have been improved to a commanding degree. When they are released for general use, they will be able to serve you better than ever before. Your inquiries regarding the entire ARHCO line are welcomed.

ARHCO RADIO PRODUCTS

American Radio Hardware Co., Inc.

476 BROADWAY • NEW YORK 13, N. Y.

MANUFACTURERS OF SHORT WAVE • RADIO • TELEVISION • SOUND EQUIPMENT

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COMMUNICATIONS

Including Television Engineering, Radio Engineering, Communication & Broadcast Engineering, The Broadcast Engineer. Registered U. S. Patent Office.
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AUGUST, 1943 VOLUME 23 NUMBER 8

We See...

THE RADIO ENGINEER was given a real pat on the back recently by none other than FCC Commissioner C. V. Durr. Our good friend pointed out that radio engineers and not our lawmakers may ultimately decide as to who shall use the air and how it shall be used. Commissioner Durr said that there isn't room on the air or time on the stations for all who want to have their say. These physical limitations accordingly mean that someone has to choose what shall and shall not be broadcast. However, he explained, someday we may have a frequency for everybody who wants to start a radio station. It's up to the engineer, it seems!

A SMALL STATION BOOM is in the offing as a result of a recent RCC ruling. According to the authorization, power of some 100-watt stations will be increased to 250 watts, and new 100-watt or 250-watt local stations will be permitted in certain localities.

Such applications will be granted provided idle equipment is available. In other words, the applicant for the new station must show that all required materials, except vacuum tubes, may be obtained without priority assistance. The applicant must also show a public interest need for the station. If any building construction is involved, clearance from WPB will be required.

Many have already declared a will to enter the business of broadcasting via this small station route. All aboard!

PLANS FOR THAT RADIO TECHNICAL Planning Board for the postwar era have been completed by committees of the IRE and RMA. The plans will be submitted to other industry organizations, including AIEE, ARRL, NAB, AIP, NIB, and F-M Broadcasters.

The RTPB should be able to serve the nation admirably. Everyone awaits its swing to action.—L. W.

COVER ILLUSTRATION

A modern laboratory with one of the feminine members of the engineering staff conducting frequency checks. This specialized activity and a host of other allied phases have become the tasks of thousands of *women in industry* today. (See page 38, this issue)

(Courtesy Electronic Corporation of America)

Published Monthly by the Bryan Davis Publishing Co., Inc.

BRYAN S. DAVIS, President PAUL S. WEIL, General Manager
F. WALEN, Secretary A. GOEBEL, Circulation Manager

Advertising and Editorial offices, 19 East 47th St., New York. 17, N. Y. Telephone PLaza 3-0483. Cleveland, Ohio: James C. Munn, 10515 Wilbur Avenue. Pacific Coast Representative: Brand & Brand, 4310 Los Feliz Blvd., Los Angeles 27, Calif. Wellington, New Zealand: Te Aro Book Depot. Melbourne, Australia: McGill's Agency. Entered as second-class matter October 1, 1937, at the Post Office at New York, N. Y., under the act of March 3, 1879. Yearly subscription rate: $2.00 in the United States and Canada; $3.00 in foreign countries. Single copies, twenty-five cents in United States and Canada; thirty-five cents in foreign countries.

SCR-299

VANGUARD OF INVASION!

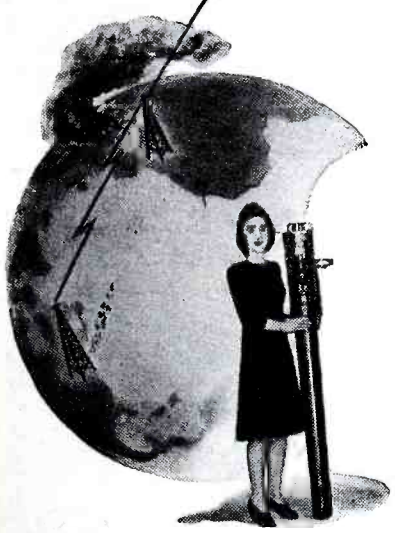
THE SCR-299 Mobile Radio Communications unit played a great part in the invasion of Africa and Sicily . . . these units were used as mobile radio stations, transmitting voice commands to fast moving armored units while in action, or as permanent radio stations . . . even under the most difficult operating conditions. A leading military authority said, "My observations in the theatres of war make it possible to say that the SCR-299 hit the jack pot in the mobile radio field as has the jeep in transportation."

BUY MORE BONDS!

the hallicrafters co.

CHICAGO, U. S. A.

THE WORLD'S LARGEST EXCLUSIVE MANUFACTURER OF SHORT WAVE RADIO COMMUNICATIONS EQUIPMENT



Whether for beaming a headline across the world or bringing it into your home, Federal is a leading manufacturer of radio transmitting and receiving tubes, including the giant tubes used by Mackay Radio in its world-wide Communications Service

In your morning paper
It's only an arrow
Creeping toward a dot on the map . . .

But out there
Where the angry earth
Convulses under your feet
From the thundering steamroller charge
It's hell on wheels
As the tanks attack at dawn

* * *

And close on their clawing heels
Spattered with the same mud and lead
As the mopping-up forces
Comes the soldier with the typewriter . . .
The war correspondent

* * *

When you read his eye-witness account
Of how this town was taken
Read between the lines
And give a thought
To the man under the helmet
Whose only command is . . .
Get the story!

* * *

Helping him get the story *through*
Relaying it from field radio
To command outpost
To towering Mackay Radio
Trans-Atlantic radio telegraph station
Is the voice and ear of electronics
The vacuum tube . . .
Giving wings to his words
Just as it helps plane and tank
"Work together better
Because they can talk together"

* * *

Here at I. T. & T.'s manufacturing associate
Federal Telephone and Radio Corporation
Where a great many of these tubes are made
Our hats are off
To the men who use them
To speed victory . . .
Some day they'll help men
Build a better world

I T&T

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION *67 Broad St., New York 5, N. Y.*

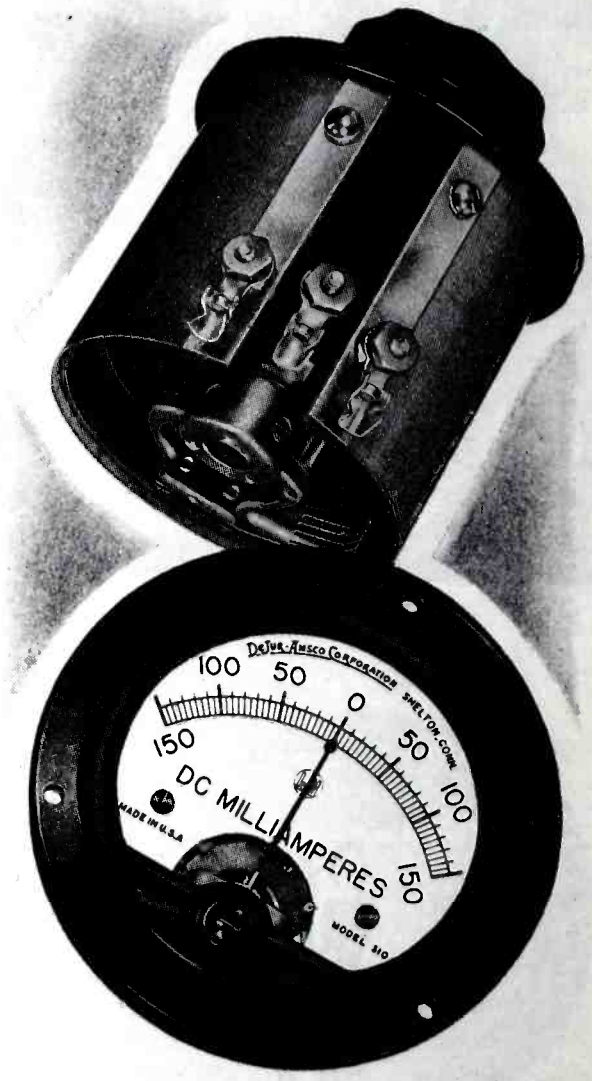
Manufacturing Associate:

FEDERAL TELEPHONE AND RADIO CORPORATION

ONE OF A SERIES OF ADVERTISEMENTS SHOWING DeJUR PRECISION PRODUCTS IN ACTION ON THE HOME FRONT

THEY LISTEN...

Around the clock, from Monday to Monday, America's "monitors of the air" sit at their posts—and listen. Serving in a thousand different ways, they check foreign news and propaganda, send and receive weather reports, keep air channels clear, ferret out renegade radio stations. Of prime importance in the apparatus used by monitors are meters and rheostats which assure absolute control and give accurate indications of volume, power, modulation and recording. In many instances the components chosen for dependability are products of DeJur laboratories. Built of the finest materials to exacting precision standards, DeJur instruments are backed by a tradition of twenty-five years of outstanding electrical accomplishment.



BACK THE ATTACK . . . SUPPORT THE THIRD WAR LOAN DRIVE

Awarded for Excellence in Production and Quality of Material

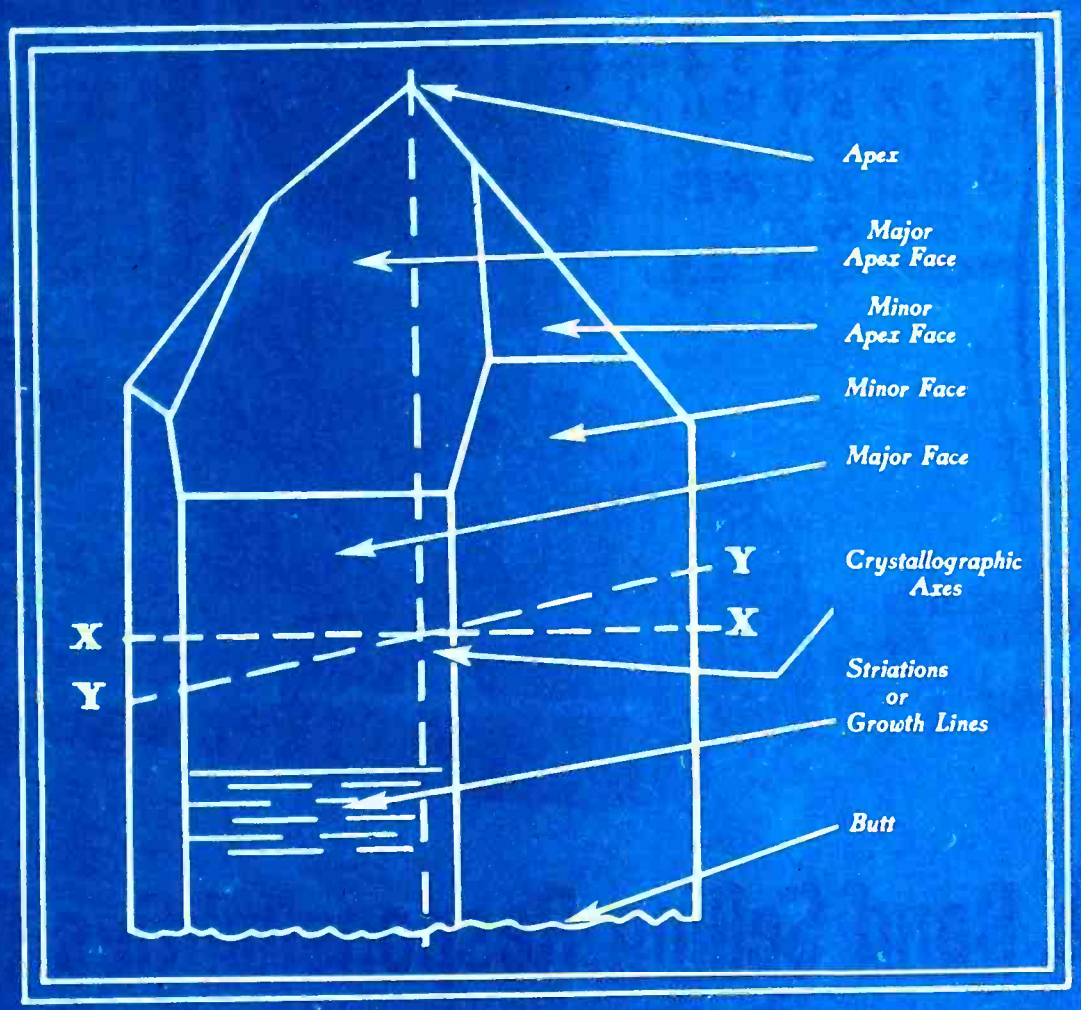
DeJUR-AMSCO CORPORATION

SHELTON, CONNECTICUT

NEW YORK PLANT: 99 Hudson Street, New York City • **CANADIAN SALES OFFICE:** 560 King Street West, Toronto

THE INSPECTION OF QUARTZ...

DIAGRAMMED BY CRYSTAL PRODUCTS



Quartz with the better piezo-electric properties are imported. The mineral is usually classified according to size with pieces ranging from 200 to 300 grams.

A shipment of quartz nearly always represents a cross section of the quartz supply . . . some crystals will have good faces and apexes, others only few faces and no apexes, and still others no faces or apexes at all. It is therefore necessary that they be expertly sorted, usually into three groups, each one to be treated in a different method before cutting.

Next, in order, comes the study of impurities in the different kinds of crystals. The impurities can be seen with the naked eye, by having a beam of light pass through the crystal. This shows up such impurities as fractures or cracks, foreign particles included within the crystal, bubbles, needles, veils, color and ghosts or phantoms. The latter are cases where the crystal contains internal colored bands or planes parallel to the faces of the crystal. These really represent stages of growth of the crystal and it appears to the eye as if one crystal has grown within another. Crystals with excessive amounts of impurities are, of course, rejected.

Crystal

PRODUCTS COMPANY

1519 McGEE STREET, KANSAS CITY, MO.

Producers of Approved Precision Crystals for Radio Frequency Control

Your Bond Selling Responsibilities Double!

Starting September 9th, your Government will conduct the greatest drive for dollars from individuals in the history of the world—the 3rd War Loan.

This money, to finance the invasion phase of the war, must come in large part from individuals on payrolls.

Right here's where YOUR bond selling responsibilities DOUBLE!

For this extra money must be raised *in addition* to keeping the already established Pay Roll Allotment Plan steadily climbing. At the same time, every individual on Pay Roll Allotment must be urged to dig deep into his pocket to buy *extra* bonds, in order to play his full part in the 3rd War Loan.

Your now *doubled duties* call for these two steps:

1. If you are in charge of your Pay Roll Plan, check up on it at once—or see that whoever is in charge, does so. See that it is hitting on all cylinders—*and keep it climbing!* Sharply increased Pay Roll percentages are the best warranty of sufficient post war purchasing power to keep the nation's plants (*and yours*) busy.

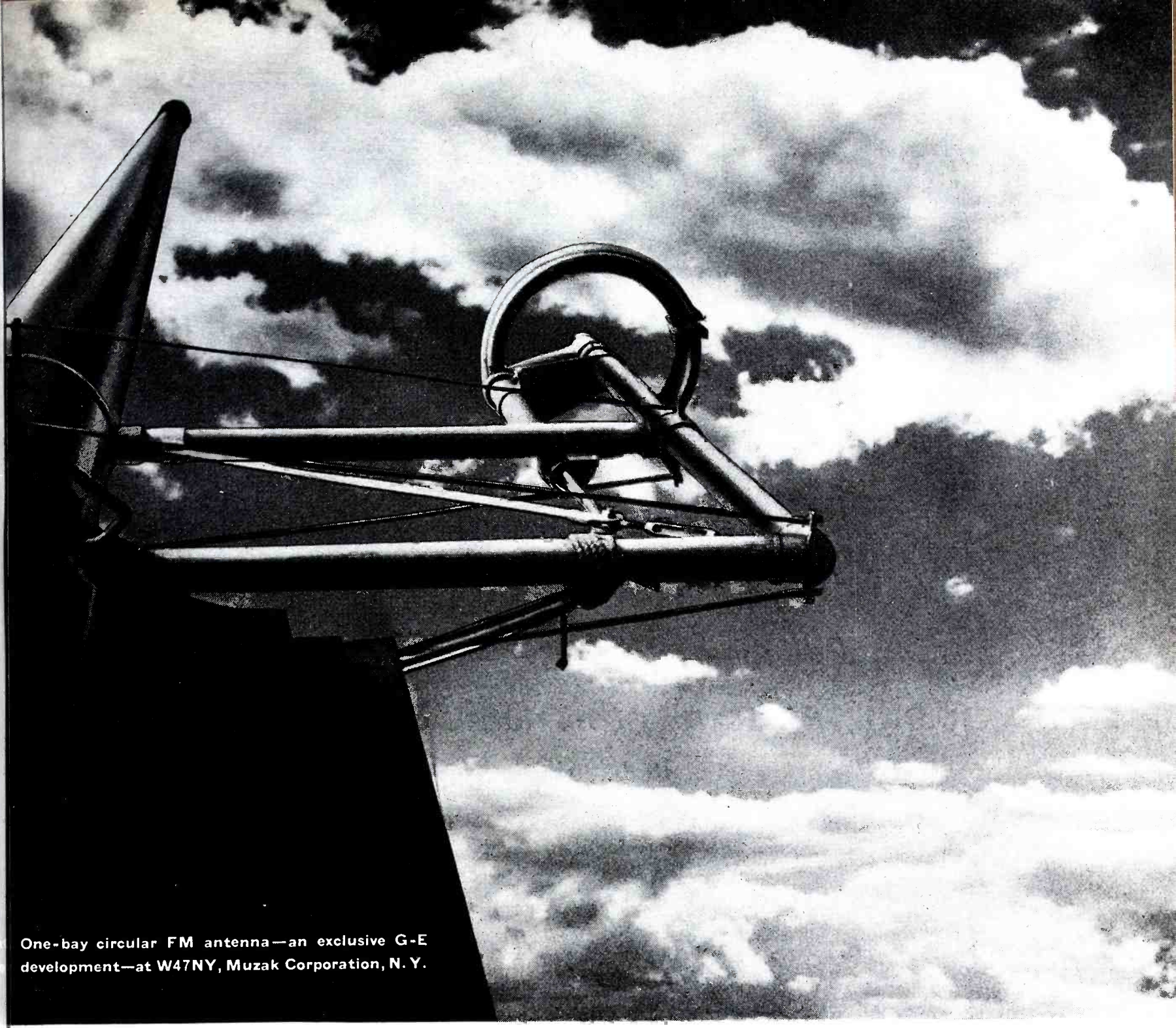
2. In the 3rd War Loan, every individual on the Pay Roll Plan will be asked to put an *extra two weeks salary* into War Bonds—over and above his regular allotment. Appoint yourself as one of the salesmen—and see that this sales force has every opportunity to do a real selling job. The sale of these *extra* bonds cuts the inflationary gap and builds added post-war purchasing power.

Financing this war is a tremendous task—but 130,000,000 Americans are going to see it through 100%! This is their own best *individual* opportunity to share in winning the war. The more frequently and more intelligently this sales story is told, the better the average citizen can be made to understand the wisdom of turning every available loose dollar into the finest and safest investment in the world—United States War Bonds.

★ ★ ★

BACK THE ATTACK With War Bonds!

This space is a contribution to victory today and sound business tomorrow by COMMUNICATIONS



One-bay circular FM antenna—an exclusive G-E development—at W47NY, Muzak Corporation, N. Y.

To 144* broadcasters planning FM stations right after the war

No other manufacturer offers so much FM equipment and experience.

From helping you select the best transmitter site to providing a full line of FM equipment, G. E. offers you complete service.

For instance, G. E. can supply its exclusive S-T relay equipment to bridge the gap between studio and transmitter *without wires*. You locate the station for maximum coverage, the studio for maximum convenience.

General Electric has built more FM broadcast transmitters than any other manufacturer . . . more than a third of existing stations.

General Electric is the only manufacturer that has built both FM transmitters and FM home receivers.

General Electric's line of FM equipment includes: Broadcast apparatus, studio equipment, police radio, military radio, complete S-T FM relay equipment, monitoring equipment, high-gain antennas, home receivers.

General Electric is the only manufacturer who offers a complete promotional plan and local promotional effort on the day your General Electric FM station opens its doors. In newspapers, over local radio, with publicity releases and through every General Electric dealer in your vicinity, the sale of FM home receivers is pushed in a determined drive to help you establish your station and FM in your area.

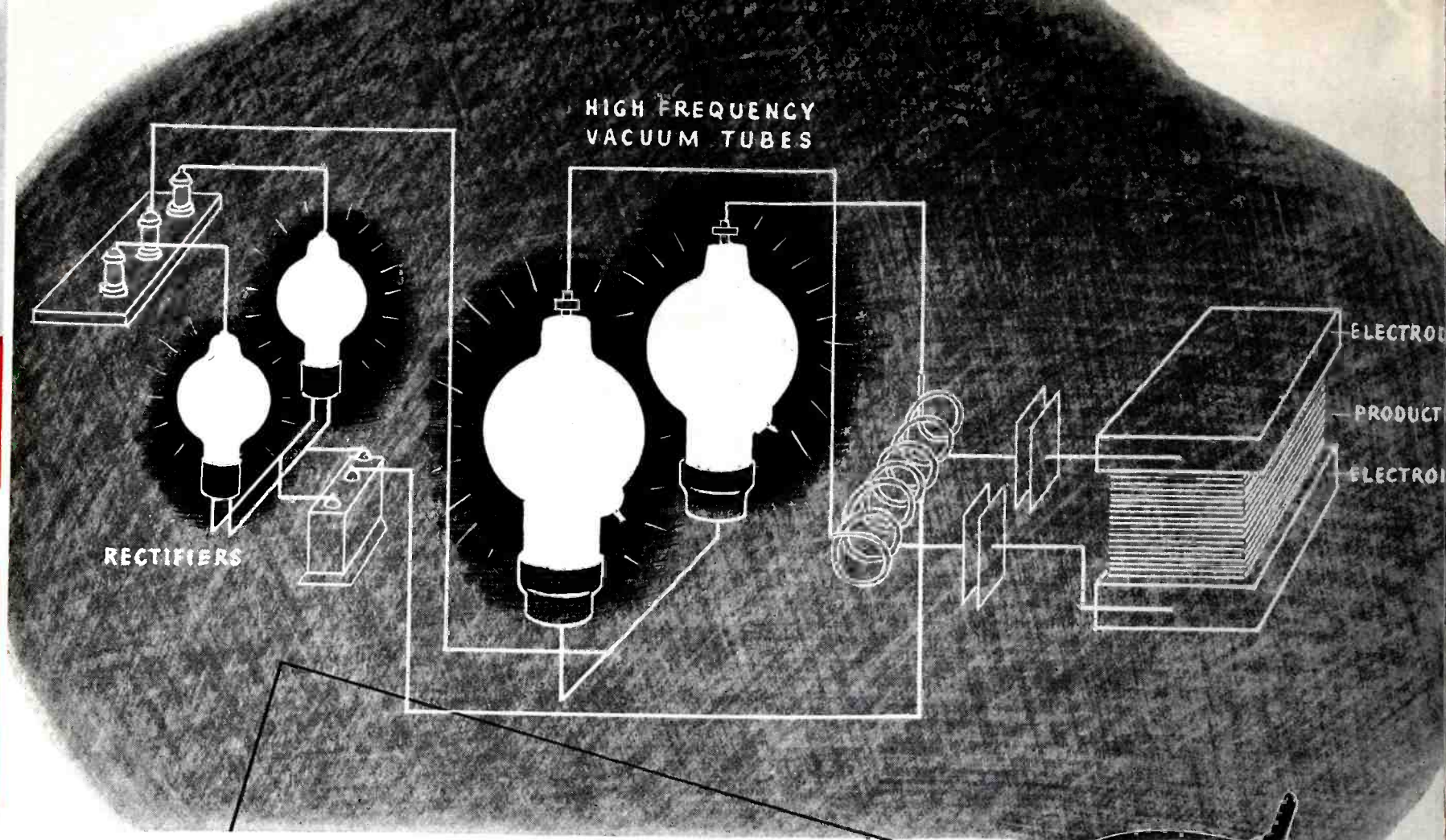
It's not too soon now to start detailed plans for the years following Victory. We invite your inquiries. Write to *Electronics Department, General Electric, Schenectady, New York.*

Tune in "THE WORLD TODAY" and hear the news direct from the men who see it happen, every evening except Sunday at 6:45 E.W.T. over CBS. On Sunday evenings listen to the G-E "Hour of Charm" over NBC network.

**According to a recent G-E survey of broadcasters.*

GENERAL ELECTRIC FM · TELEVISION · AM

160-B7-6912



ELECTRONIC BRIEFS: Electrostatic Heating

High frequency electrostatic heating is simply the use of electricity to create friction between the molecules of a substance. The generation of heat in non-metallic substances by molecular friction is accomplished by the application of high frequency current, which is converted from a standard power supply. The equipment used employs the basic electronic circuit used in radio transmitters. The output of the power amplifier is connected direct to the material to be heated exactly as the output of a transmitter is connected to antenna and ground. The energy is sufficient to cause the molecules within the material to distort and rub against one another very rapidly. The friction thus caused creates heat within the material.

As with all things in the field of electronics, Electrostatic heating is wholly dependent upon the vacuum tubes employed. Eimac tubes are first choice of the world's leading engineers, first in the key sockets of the important new developments in electronics. You'll get long life, dependability and superior performance with Eimac tubes in the key sockets Today Eimac tubes are proving their superiority in the most gruelling test — WAR.

Wide awake and ready...

Engineers, like fighter pilots, are cool and calculating individuals . . . fellows who believe in nothing unless proven. Along with them, we know that the future holds out promises of many new and revolutionary developments . . . and every angle and possibility is being carefully analyzed. However, like your true engineer, we make no predictions . . . we're simply wide awake and ready.

Meanwhile, there's work to be done . . . important war work . . . and this occupies our immediate attention. It isn't new to us because our experience goes back to the beginning of radio. We've manufactured sound systems, test equipment and numerous electronic devices. We maintain a model organization where management-labor relations are the most cordial . . . making for the highest standards of quality and efficiency. Yes, ECA is busy . . . but, occasionally, our production schedules enable us to take on additional contracts.

Now . . . more than ever . . . invest every dollar you can spare in United States War Bonds and Stamps.

ELECTRONIC CORP. OF AMERICA

ELECTRONIC CORP. eca OF AMERICA

45 WEST 18th STREET
NEW YORK 11, N. Y.
WAtkins 9-1870

COMMUNICATIONS

LEWIS WINNER, Editor

* * AUGUST, 1943 * *

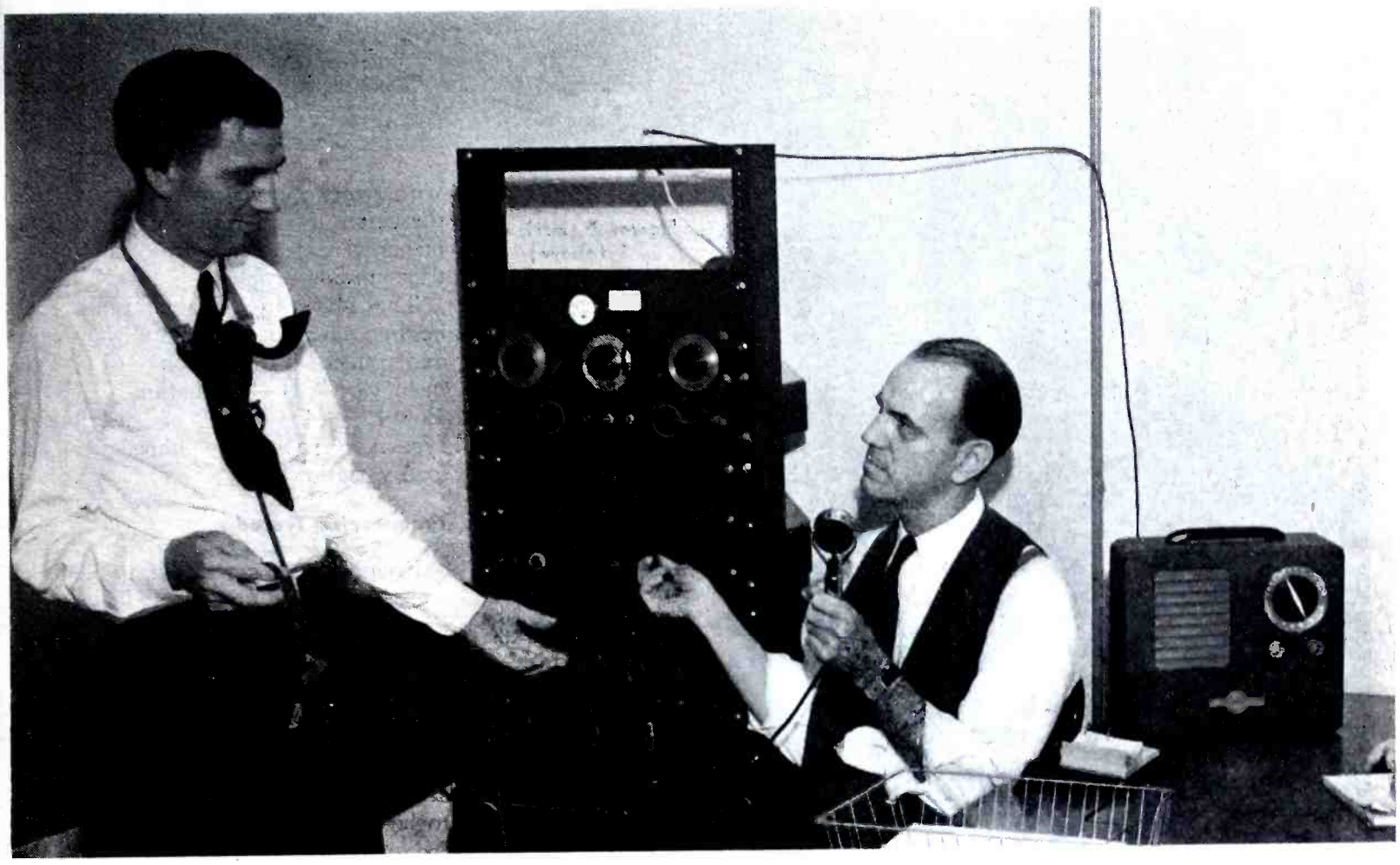


Figure 1
Perry Wightman (right) operating a typical carrier current transmitter. Receiver at right has been converted to tune from 100 to 200 kc.

CARRIER CURRENT TRANSMISSION

At 150-160 KC

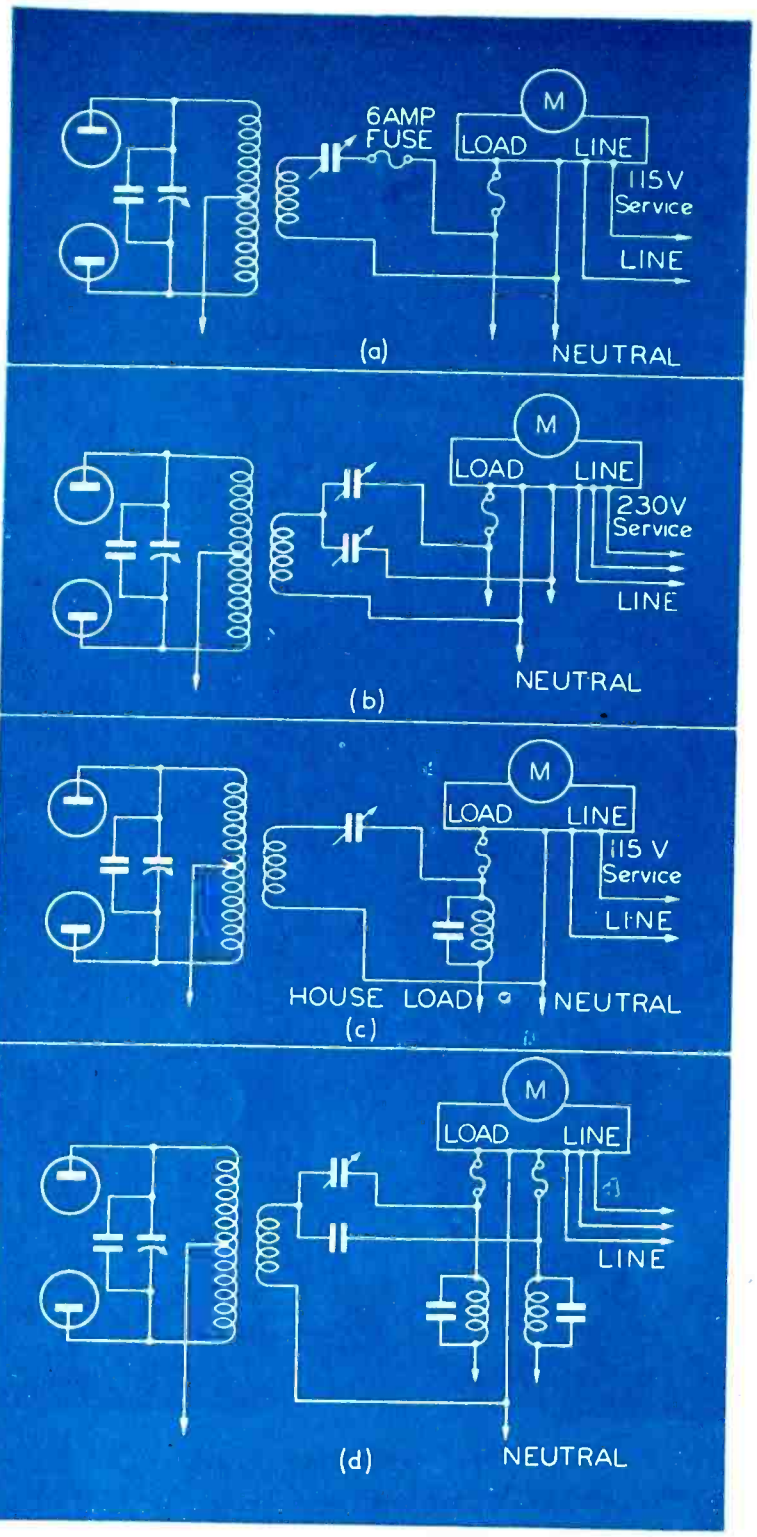
by PERRY E. WIGHTMAN and HENRY H. LYON

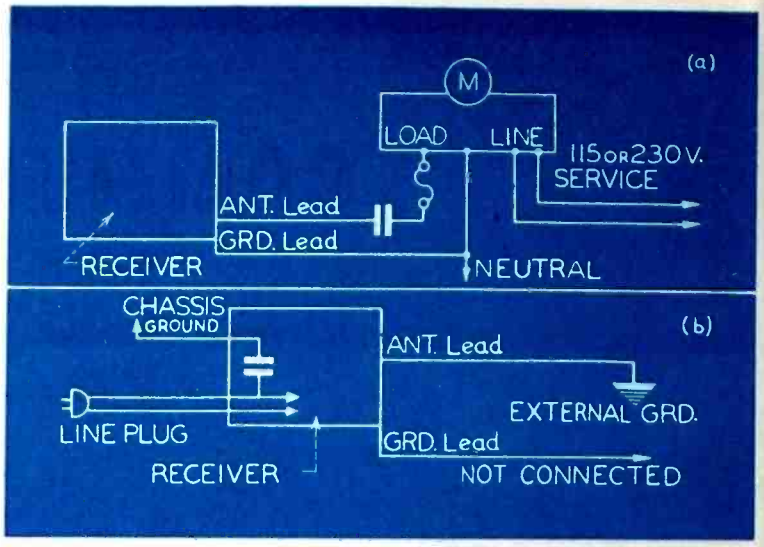
Radio Aide
Prince George's County,
Maryland

Chief Engineer,
WOL,
Washington, D. C.

Methods evolved to provide effective transfer of energy from the secondary distribution system into the primary distribution system are analyzed in this paper.

SOME years ago we visited a laboratory engaged in the development of street light control with superimposed frequencies on power lines. The frequency used at that time was 720 cycles, involving considerable power to accomplish the purpose. It occurred to us then that this method of





Figures 2 (left) and 3 (above)

In Figure 2 appear methods of coupling a transmitter to the power line. At (*a*) is a two-wire 115-volt service without isolating units. At (*b*) we have a three-wire 115 - 230 - volt service also without isolating units. In (*c*) and (*d*) appear these two- and three-wire services with isolating units. It will be noticed that in the two-wire service a single capacitor is used in the matching impedance. In the three-wire circuit, two capacitors are used.

In Figure 3 appears two methods of coupling receivers to the power line.

control could be actuated by electronic circuits, at a considerably higher frequency and with much less input energy.

Problems with First Unit

Our first experiments employed a circuit with a self-excited 45 oscillator, that was modulated with 60 cycles, through self-rectification, using frequencies in the broadcast band. Not having access to a high voltage distribution system, we tried feeding the output into the house outlet. To determine the radiation and the distance that the signal would travel over the power circuit, an automobile receiver covering the broadcast band was used. We found that by tuning the receiver to the frequency of the oscillator, the signal could be followed under the power line for a distance of 7½ miles. This was on, of course, an overhead feeder circuit. Radiation from the power line was found to be low, the signal fading away at distances averaging 200 feet. Radiation was found to vary in proportion to the frequency.

Second Unit Tried

This particular circuit was too rich in harmonics, causing interference to other services, and thus unsuitable for our work. We then tried a self-excited oscillator and buffer circuit, coupled to a final. This proved satisfactory because of reduced harmonics and increased frequency stability.

Voice and Music Transmission Study

Although our original plans concerned control circuits, experiments with voice proved so effective that thereafter the majority of our experiments were devoted to voice and music transmission problems.

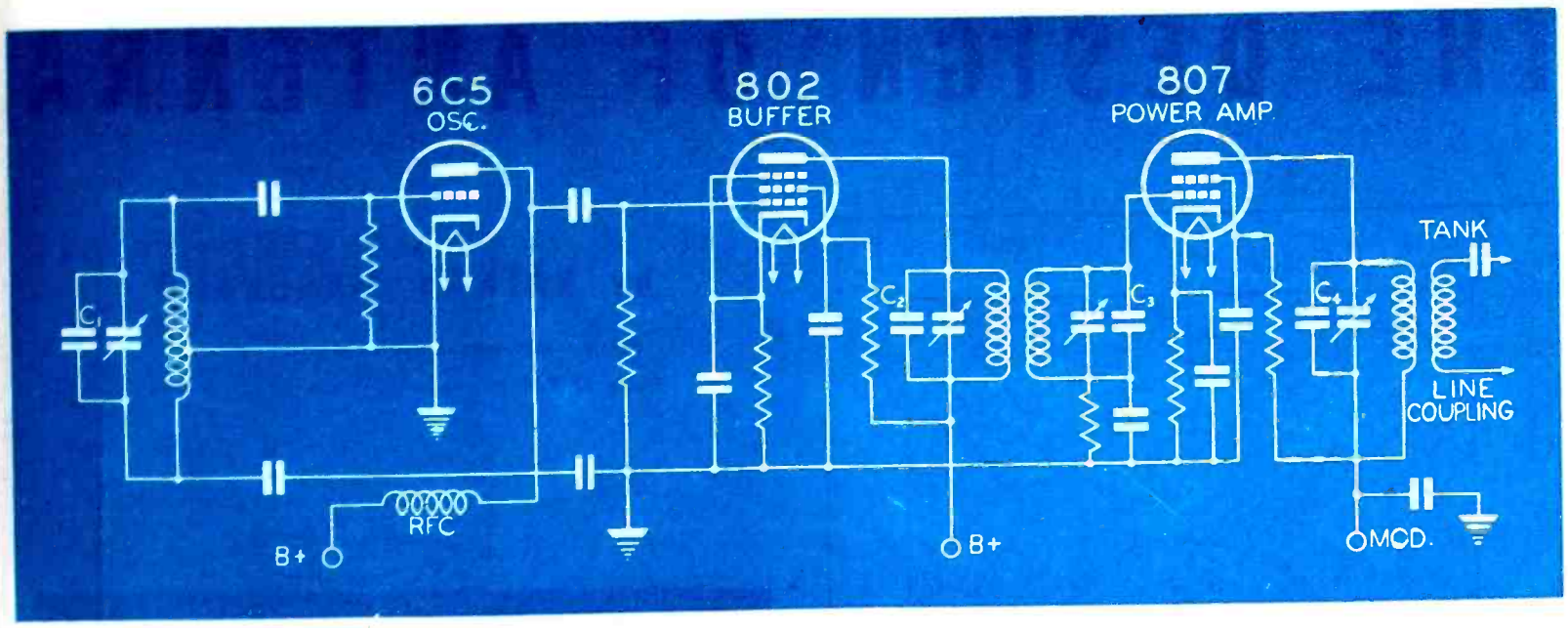
The following considerations soon became apparent in the study of voice and music transmission: (1)—Frequency. (2) — Radiation. (3) — Power. (4)—Type of distribution systems. (5)—Line impedance and load variations.

Frequencies Tested

Frequencies from 550 kc to 3,000 kc were tried. Tests showed that as we approached 1,200 kc, and from there on up to 3,000 kc, radiation became a real problem. At 3,000 kc, it was practically all radiation. In other words, a major portion of the signal would leave the feed lines as radiated energy at this frequency. Induction was found to be an important factor in coupling from the lower voltage feeders to the high voltage lines. For instance, with a signal being injected into the 115-230-volt secondary, energy transfer occurred not through the distribution transformer into the high voltage primaries, but rather by induction. This was caused by the fact that the low voltage feeders ran parallel to the high voltage feeders. Also, frequencies above 500 kc would not pass *through* the transformer coupling, but by *induction* from the feeders themselves, where these feeders ran close enough together to affect such transfer. As the frequency was lowered, more and more of the energy seemed to pass from the low voltage to the high voltage feeders and back again into the system by virtue of the transformer coupling.

Frequencies Chosen

Of course, it was necessary to find frequencies that would afford maximum energy transfer with minimum interference and loss. The frequen-



cies arrived at were between 150 to 160 kc. This frequency range seemed to satisfy the requirements. Frequencies lower than this were not used because of the possibility of interference with existing public utility frequencies. Some of the public utility frequencies are from 10 kc to 150 kc. They are used for communications, control and relay protection.

Power Inputs

As we stated before, the higher the frequency the greater is the radiation from the feeders. Also the higher the power input, the greater the radiation. Therefore various power inputs became a necessary source of study. Powers from a fraction of a watt to 250 watts were tried. Power of up to 40 watts, fed into the feeders was found most satisfactory. Beyond this power, varied difficulties were encountered. These were increased radiation, and possible damage to distribution transformers and household appliances, as well as house wiring. Flickering of house lights occurred on light loads when 40 watts were used in some instances as modulation occurred. Accordingly, lowering the power inputs to 25 watts eliminated this difficulty, and proved sufficient, as present practice in existing units have proved.

Transmitters of 15 to 20 watt inputs offered 100-square-mile coverage on open wire overhead feeders.

Line Noises

Line noises, always a source of trou-

•

Figure 4

Circuit of one type of transmitter now being used. $C_{1, 2, 3}$ and $_4$ are mica capacitors with the variable condensers of smaller value being used as trimmers.

•

ble, entered here, too. Very low power inputs are not practical, since they do not override peak line noises. The 20-watt power chosen, however, provided a generally satisfactory signal over the average line noise.

Methods of Distribution

Probably one of the most important phases of carrier current transmission is the method of distribution. There are two general types of power distributing systems . . . the overhead and the underground. Either one can be a high or low voltage network, or both. And accordingly, transmission results vary. Tests showed that the overhead distribution systems proved most practical. The underground systems were not satisfactory because they are of such low impedance due to heavy loading, that it is impossible to feed sufficient energy to secure effective coverage. This is particularly true on low voltage distribution networks. Underground systems with characteristics similar to overhead systems, however, were found to behave as effectively as overhead systems.

Low voltage underground systems are usually found in the heart of metropolitan areas. Unfortunately, therefore, these areas at the present time, are not very suitable for carrier current work. Overhead systems which are ideal for carrier current distribution, are found in suburbs and rural areas.

Impedance Matching

Impedance matching of transmitter to the power system has been a subject of controversy among many. A perfect match can never be obtained due to variations in the line load. However sufficient coupling over wide variations of line load can be obtained to pass the necessary energy. As close an impedance match to a power line,

(*Continued on page* 74)

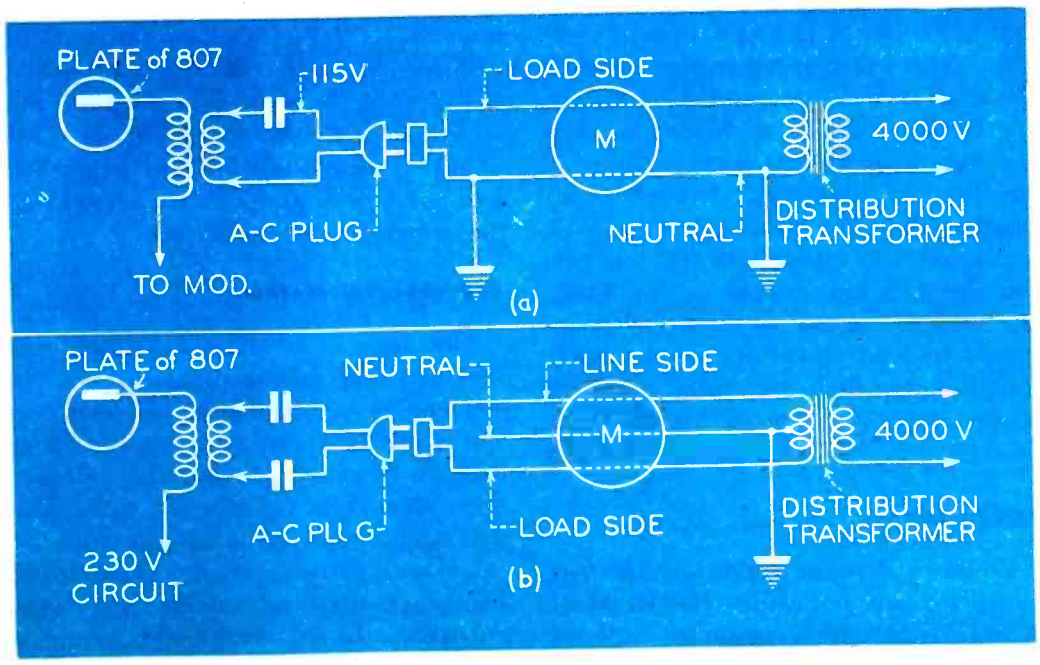


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Figure 5

Distribution system coupling methods used to achievo effective impedance matching of transmitter to power system. At (*a*) we have a 115-volt circuit, and at (*b*) a 230-volt circuit. The plate returns of the 807 go, of course, to the modulator in each instance. Tapped coils are used on the secondary side of the 807 coupling coil.

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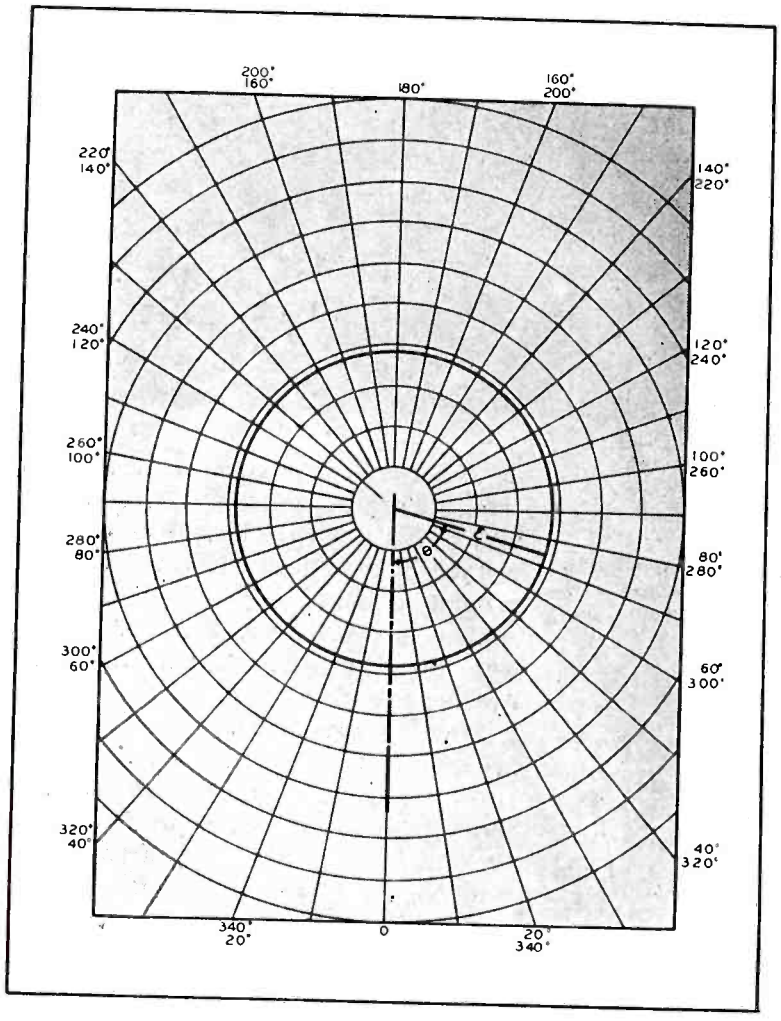
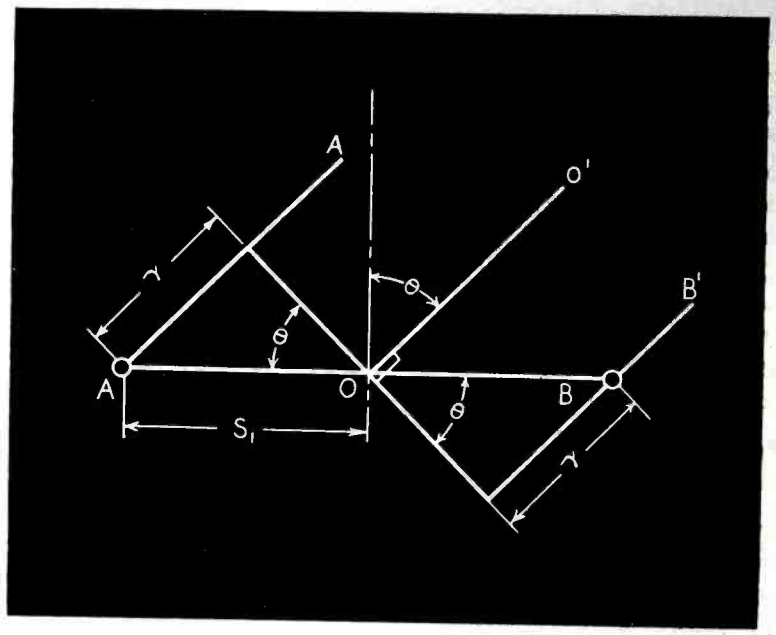
THE DESIGN OF ANTENNA

by NATHAN MARCHAND

Senior Antenna Development Engineer
Federal Telephone and Radio Laboratories





Figures 1 (left) and 2 (right)

Figure 1 illustrates the horizontal pattern of a single antenna. In this paper each radiator in the array is assumed to have a pattern in the horizontal plane which is circular, as shown on this polar diagram. Figure 2 shows a fundamental unit of antennae array. It will be noted that there are two antennae spaced a distance of $2s_1°$ apart.

THE purpose of this paper is to show how an antenna array may be chosen so as to duplicate a predetermined radiation pattern. This is done by means of a change in the coordinate system and then the use of Fourier analysis as described in the text. This method has been used successfully as far back as 1941 and the practical applications have worked out very close to the calculated results. The discussion will be limited to horizontal patterns obtained by a combination of radiators arranged in a straight line. This type of array can be used to create a null, perpendicular to the line of the antennae, or it may be used to create a maximum perpendicular to the line of antennae, depending on whether they are parallel fed or cross connected. Combinations of the two may create a null or lobe in any direction. Each radiator in the array is assumed to have a pattern in the horizontal plane which is circular as shown on the polar diagram of Figure 1.

$$\varepsilon = E_o. \qquad (1)$$

Alford Loop

Equation 1 is the algebraic equation for this polar diagram. The constant in this equation is assumed to be *1* without any loss of generality. E_o is the voltage employed and ε is the field intensity. The pattern given in Figure 1 is very closely approached when using a horizontal loop of the Alford type or a vertical dipole. All of the distances used in this paper are measured in degrees of wavelength at the frequency of radiation.

Experimental Method

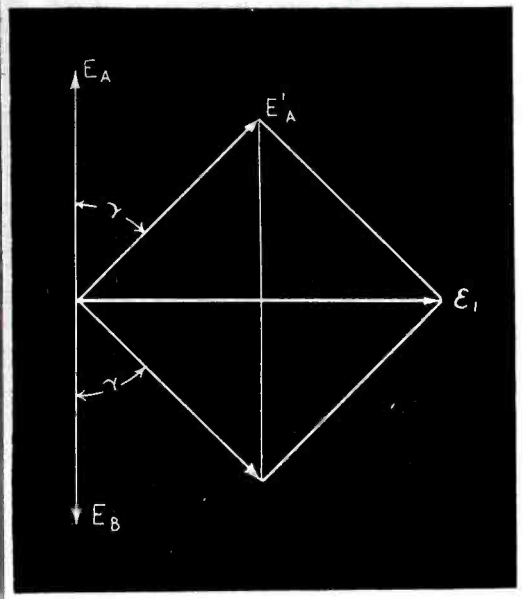
One way of creating a pattern of a specified shape using the above type of element, is to arrange the elements in a straight line and guess at the spacings of the elements and the voltages necessary to be fed to each pair. The pattern is then calculated and from the calculated pattern, changes are made in the spacings and voltages fed to the antennae. In this manner by means of a series of intelligent guesses it is possible to closely approximate the desired pattern. This is a long tedious job. However, in most practical cases the most important thing is to obtain the pattern desired and this method has given very good results.

Fundamental Theory

The fundamental unit of the arrays to be discussed consists of two antennae spaced a distance of 2s degrees apart as shown in Figure 2. One antenna is designated as *A* and the other antenna as *B*. In order to create a null perpendicular to the antennae, both antenna *A* and antenna *B* are fed with the same magnitude of voltage but opposite in phase. The vector diagram for Figure *2* is shown in Figure 3. Let us assume that antenna *A* is fed with a voltage E_A which leads a reference voltage 90° while antenna *B* is fed with the same magnitude of voltage E_B which lags 90° as shown in Figure 3. The physical center *O* of the two antennae as shown in Figure *2* will be used as the center of radiation. The receiver is assumed to be so far away from the array that all lines connecting the receiver with points on the array can be assumed to

ARRAYS BY FOURIER ANALYSIS

A Discussion of Practical Methods of Calculating Antenna Arrays When the Desired Radiation Pattern is Known



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Figures 3 (top) and 4 (right)

Figure 3 is a vector diagram of the two antennae shown in Figure 2, fed 180° out of phase. In Figure 4, are the polar patterns for equation 5 for two values of s_1. It will be noted that some lobes are marked plus and others minus so as to indicate that the radiation in each of these lobes is 180° out of phase.

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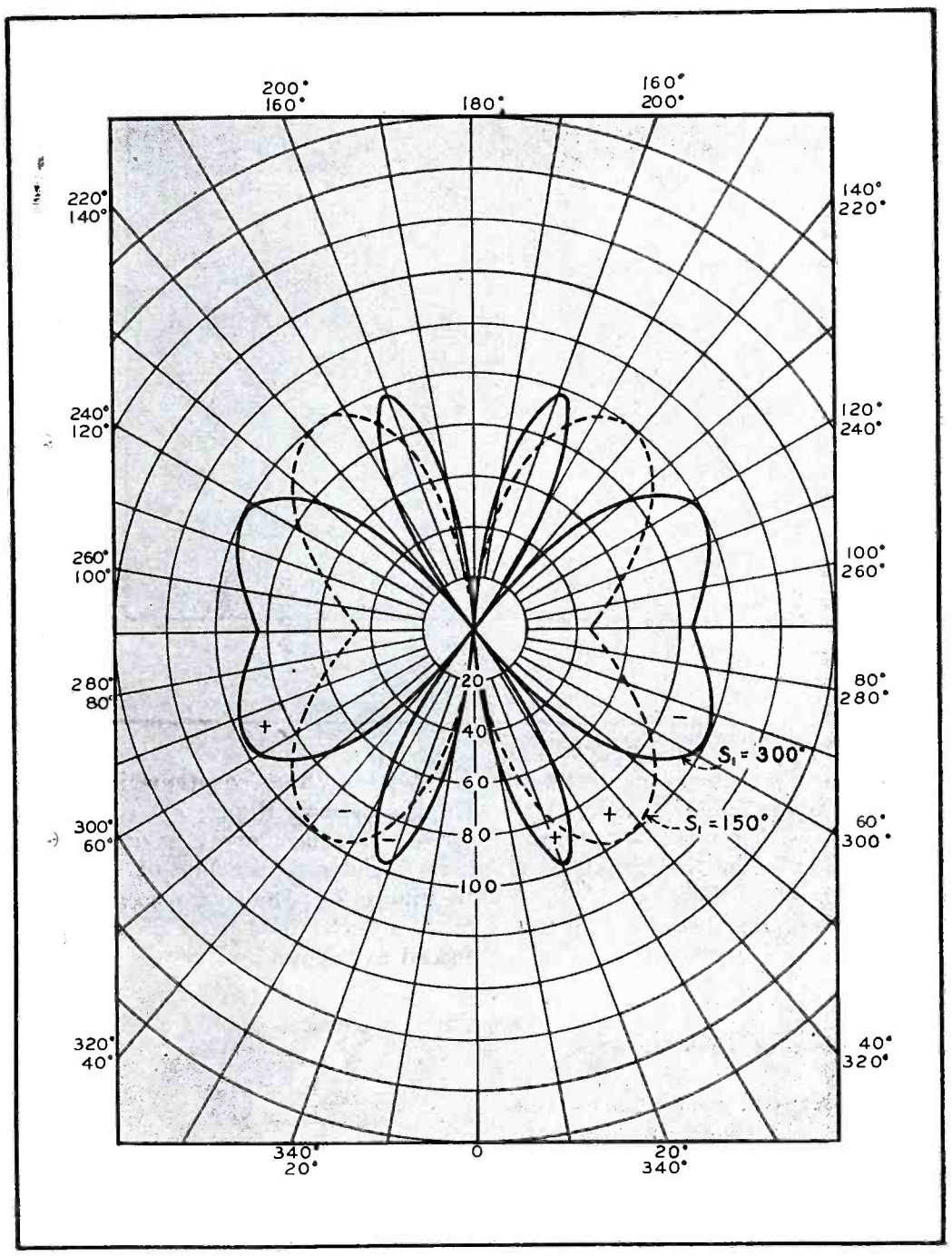


be straight lines. When the receiver is situated at an angle of $\theta°$ to the center line of the antenna array, the radiation from antenna A will have to travel the extra distance $\gamma°$ while the radiation from antenna B will lead by $\gamma°$. These voltages are shown in Figure 3 as E_A' and E_B' and the resultant ε_1 is given by the following equation:

$$\varepsilon_1 = E_A' \sin\gamma + E_B' \sin\gamma \qquad (2)$$

Since the magnitudes of E_A' and E_B' are equal, equation *2* becomes

$$\varepsilon = 2\,E_1 \sin\gamma \qquad (3)$$

where E_1 is equal to E_A and E_B. Returning now to Figure *2* since the receiver is assumed to be at a great distance from the antennae so that AA′ and BB′ are parallel to 00′ then:

$$\gamma = s_1 \sin\theta \qquad (4)$$

substituting equation *4* in equation *3*:

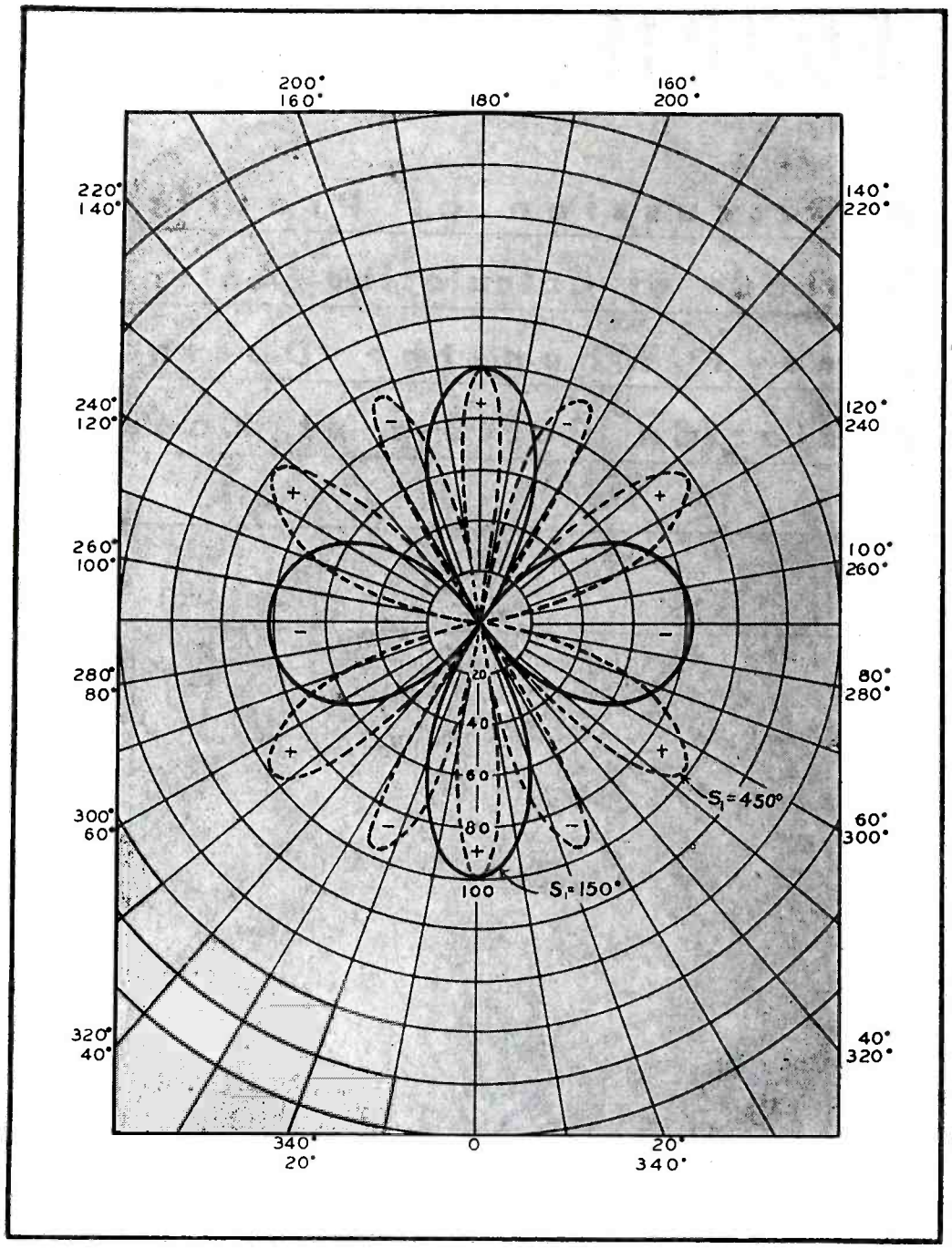
$$\varepsilon_1 = 2\,E_1 \sin(s_1 \sin\theta) \qquad (5)$$

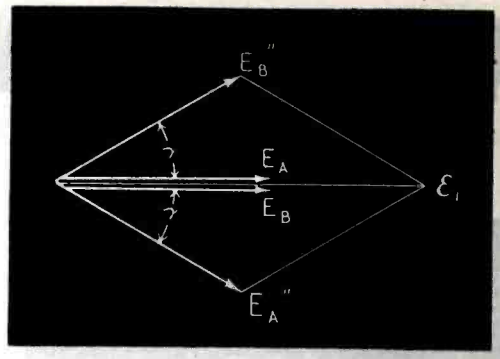
Polar patterns of equation *5* for two values of s_1 are shown in Figure 4. Some lobes are marked + and others — in order to indicate that the radiation in each of these lobes is 180° out of phase.

In order to create a maximum, perpendicular to the line of antennae, it is necessary to feed both antenna *A* and antenna *B* in phase. This is shown in the yector diagram in Figure 5. At an angle $\theta°$ to the center line of the antenna array we would then have the same effect as mentioned in the discussion of the perpendicular null array. The radiation from antenna *A* will lag by $\gamma°$ and the radiation from antenna *B* will lead by $\gamma°$. This is shown on the vector diagram as E_B'' and E_A''. The sum of these two voltages will be equation 6.

$$\varepsilon_1' = 2\,E_1 \cos(s_1 \sin\theta) \qquad (6)$$

It can be seen that equation *6* is a cosine function where again we can assume that E_A and E_B are both equal





Figures 5 (top) and 6 (left)

A vector diagram of two of the antennae, shown in Figure 2, fed in phase is illustrated in Figure 5. Both antennae A and B are fed in phase so as to create a maximum perpendicular to the line of antenna. In Figure 6, we have the polar patterns for equation *6*. This equation is a cosine function where we can assume that E_A and E_B are both equal to E_1. The only difference between equation *6* and *5* is that one is a sine function and the other a cosine function. However, this is a very important point as the Fourier analysis application reveals in this discussion.

to E_1. The only difference between equation *6* and equation *5* is the fact that one is a sine function and the other is a cosine function. This is a very important point as will be brought out in the discussion of the Fourier analysis application to antenna patterns.

Polar Patterns of Equation 6

Polar patterns of equation *6* for two values of s_1 are shown in Figure 6. Again we have + lobes and — lobes.

In order to create specified patterns of the type that have a maximum perpendicular to the line of antennae, again it is necessary to space pairs of these antennae and distribute power among these pairs and take the algebraic sum of the antennae patterns of the individual pairs. This is true since the medium of air is considered to be completely linear and the phase of the various radiations are either in phase or 180° out of phase.

In order to better illustrate the application of these equations in calculating a pattern, Figure 7 is calculated for a six-element array having a null perpendicular to the line of antennae In Figure 7 is shown a pattern, made up to a series of 3 pairs of antennae, spaced as follows:

$$s_1 = 150°$$
$$s_2 = 300°$$
$$s_3 = 420°$$
$$E_2 = \tfrac{1}{2}\, E_1$$
$$E_3 = \tfrac{1}{4}\, E_1$$

The subscript is used to designate the pairs. Substituting these values in equation *5* and adding the results of the 3 pairs, equation *7(a)* is obtained

$$\varepsilon = 2\,E_1 \sin(150 \sin\theta) + 2(\tfrac{1}{2}\,E_1)\sin(300\sin\theta) + 2(\tfrac{1}{4}\,E_1)\sin(420\sin\theta) \qquad (7a)$$

or

$$\varepsilon = E_1\,[2\sin(150\sin\theta) + \sin(300\sin\theta) + \tfrac{1}{2}\sin(420\sin\theta)\,] \qquad (7b)$$

A polar diagram of equation *7b* is shown in Figure *7*. It can be seen that as the distribution of power is changed and the spacings are varied the pattern can be made to assume complex shapes. The same type of combinations are possible with equation *6*, only it would create a lobe perpendicular to the array. Combinations of equation *5* and equation *6* may be used to create a lobe or null that can make any angle to the center line of the array.

The Application of Fourier Analysis

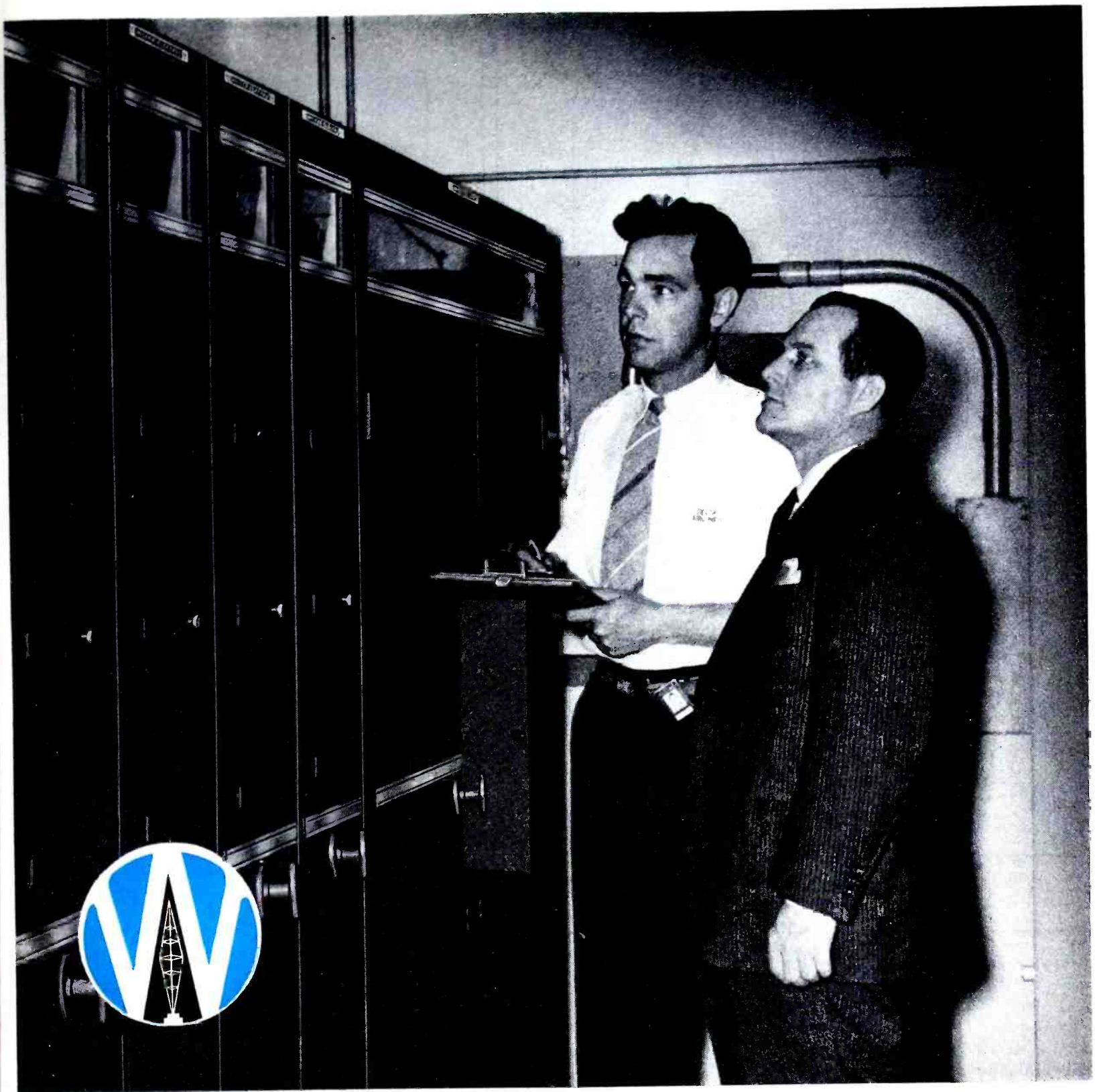
A method of combining a number of antennae pairs which has proved quite satisfactory is the application of the Fourier analysis to this problem. This method will now be derived for the general condition which is an array made up of 2n number of pairs of antennae. This is the sum of *n* antenna equations using equation 5 and n antenna equations using equation 6.

$$\varepsilon = 2\,E_1 \sin(s_1 \sin\theta) + 2\,E_2 \sin(s_2\sin\theta) + \ldots + 2\,E_n \sin(s_n\sin\theta) + 2\,E_1' \cos(s_1'\sin\theta) + 2\,E_2' \cos(s_2'\sin\theta) \ldots + 2\,E_n' \cos(s_n'\sin\theta) \qquad (8)$$

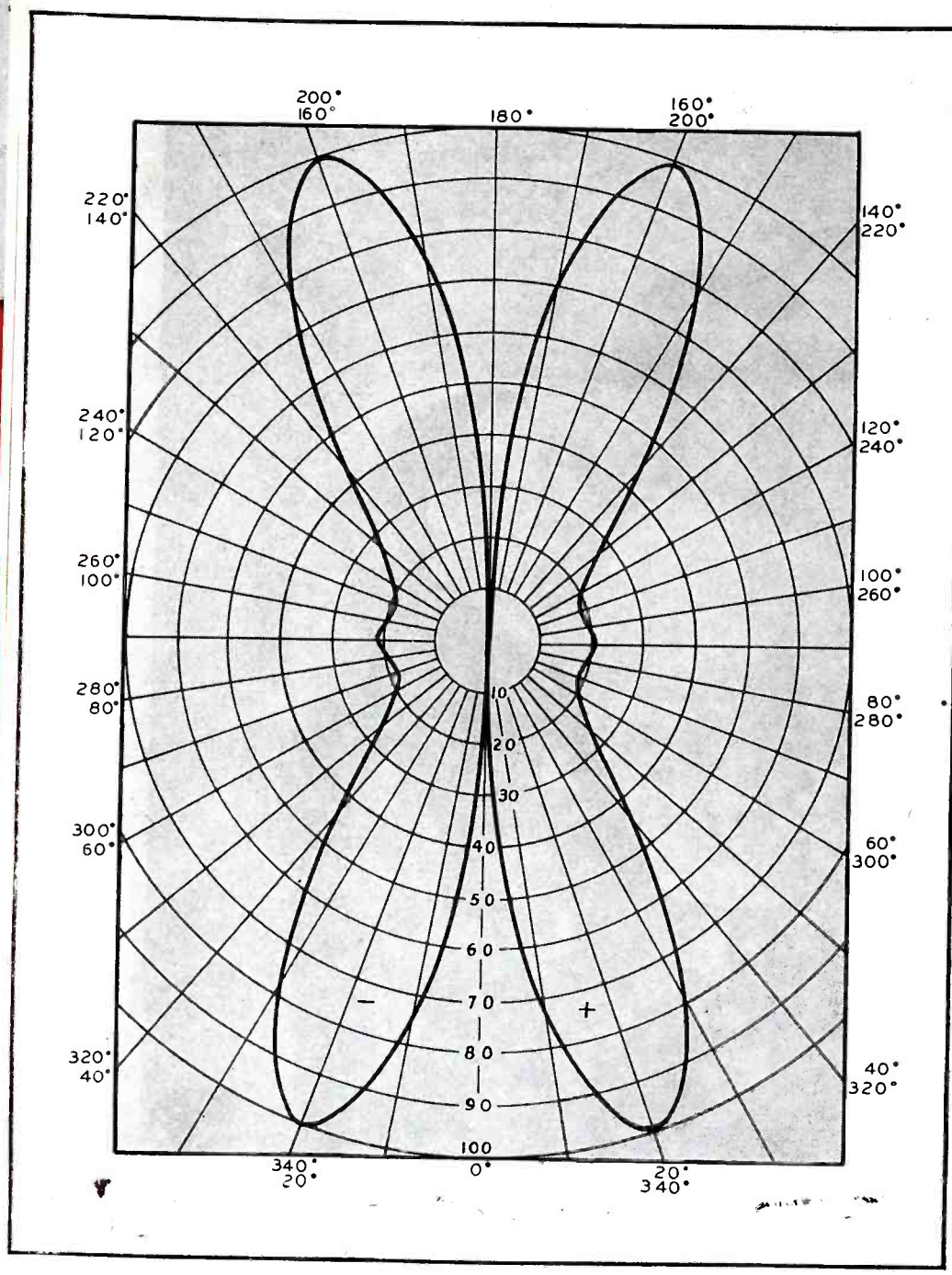
where pairs which are fed 180° out of phase are designated without a super script while the pairs that are fed in phase are designated by a prime super script. Equation *8* may be condensed into equation *9*:

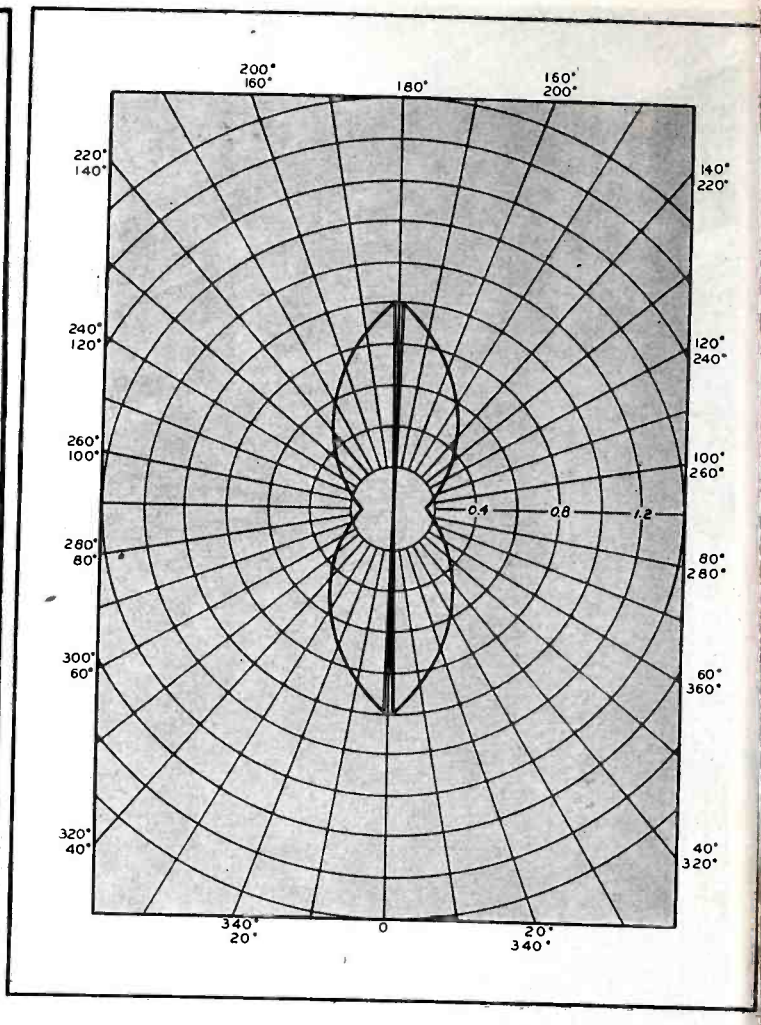
$$\varepsilon = \sum_{k=1}^{k=n} 2\,E_k \sin(s_k \sin\theta) + \sum_{l=1}^{l=n} 2\,E_l' \cos(s_l' \sin\theta) \qquad (9)$$

with the use of summation signs as



(Right) L. T. Campbell, Supt. Communications, Delta Air Lines, with J. B. Kramer, at Wilcox installation, Atlanta Station.





Figures 7 (left) and 8 (above)

Figure 7 shows a pattern that was made up with a series of three pair of antennae spaced in the following way . . $s_1 = 150°$; $s_2 = 300°$; $s_3 = 420°$; $E_2 = \frac{1}{2}E_1$, and $E_3 = \frac{1}{4}E_1$. The subscript indicates the pairs. Figure 8 shows the desired antenna of problem 1. In this instance it was necessary to have a pattern with a very sharp null but with a great deal of power right off the null point.

shown. Here s_m need not be equal to s_m'. If they are made equal then the two pairs of voltages may be combined directly at the antennae, so that the same pair may be used with the sine function and the cosine function. In these calculations s_m and s_m' will be made equal, which results in a simpler method of handling. If now the distances are chosen so that:

$s_k = k\, s_1$

$s_1' = 1\, s_1$

then equation *9* becomes:

$$\varepsilon = \sum_{k=1}^{k=n} 2\, E_k \sin (k\, s_1 \sin \theta) + \sum_{1=1}^{1=n} 2\, E_1' \cos (1\, s_1 \sin \theta) \qquad (11)$$

To equation 11, add the effect of a single antenna set in the center at 0 of Figure *2*. This means adding to equation *11*, equation *1*. In order to show more clearly the relationship of Fourier analysis let:

$$s_1 \sin \theta = \varphi \qquad (12)$$

Equation *12* then becomes:

$$\varepsilon = E_0 + \sum_{k=1}^{k=n} 2\, E_k \sin (k\, \varphi) + \sum_{1=1}^{1=n} 2\, E_1' \cos (1\, \varphi) \qquad (13)$$

Equation 13 is the equation for a

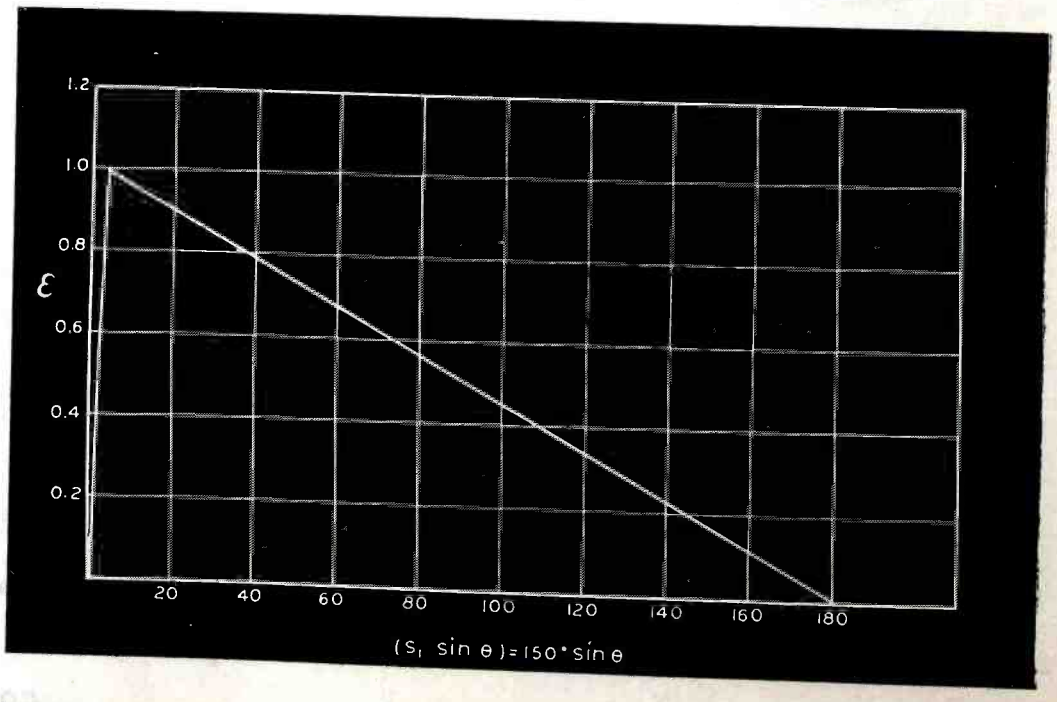


Figure 9

The plot of ε versus 150 sine θ for example 1. Note that this is very close to a perfect sawtooth whose Fourier analysis yields equation 14 (page 76). From these data we can see that the d-c component is zero, or that the center antenna will have no voltage in it and may be left out.

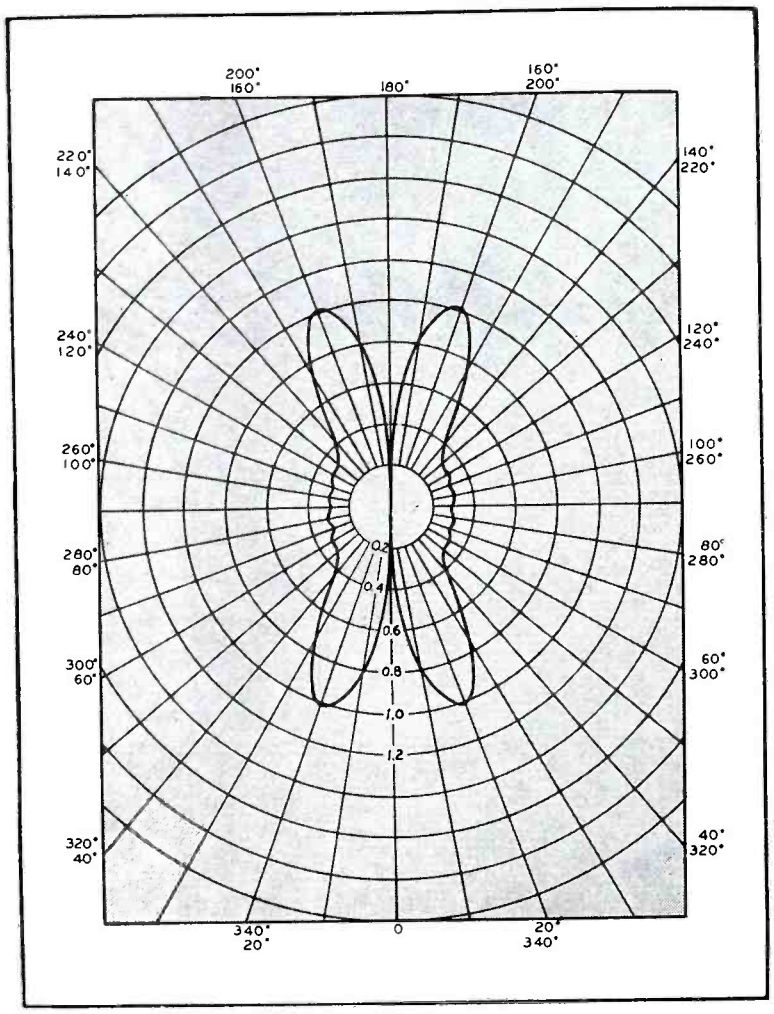


Figure 10
Problem 1, result with three pair of antennae.

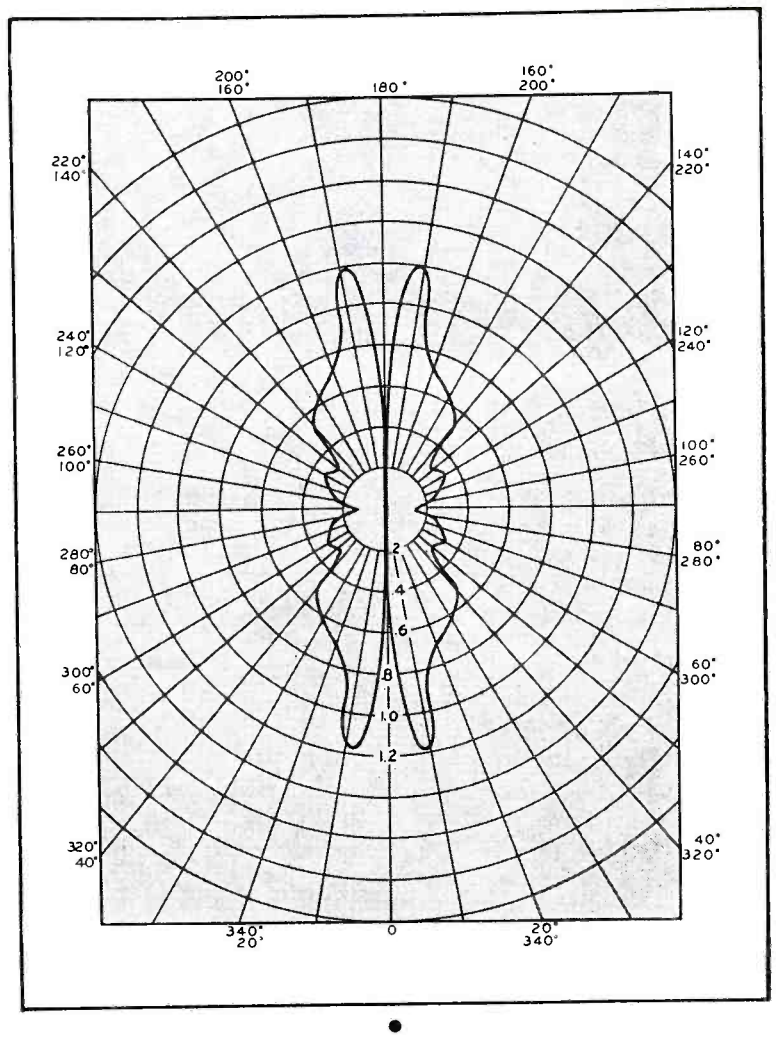
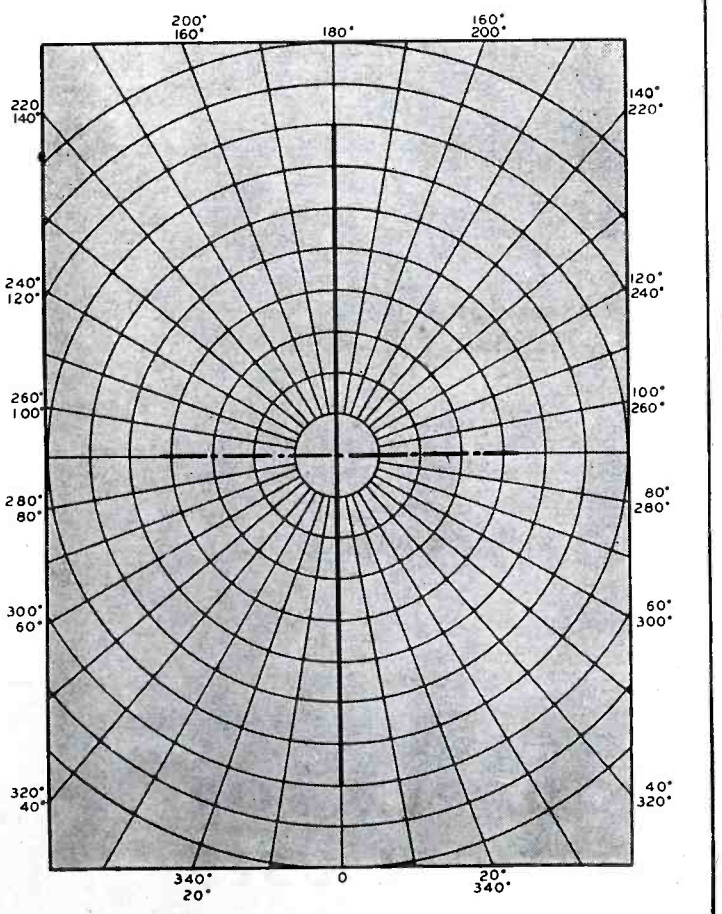


Figure 11
Problem 1, using six pair of antennae.

Fourier series when k and l become infinite.

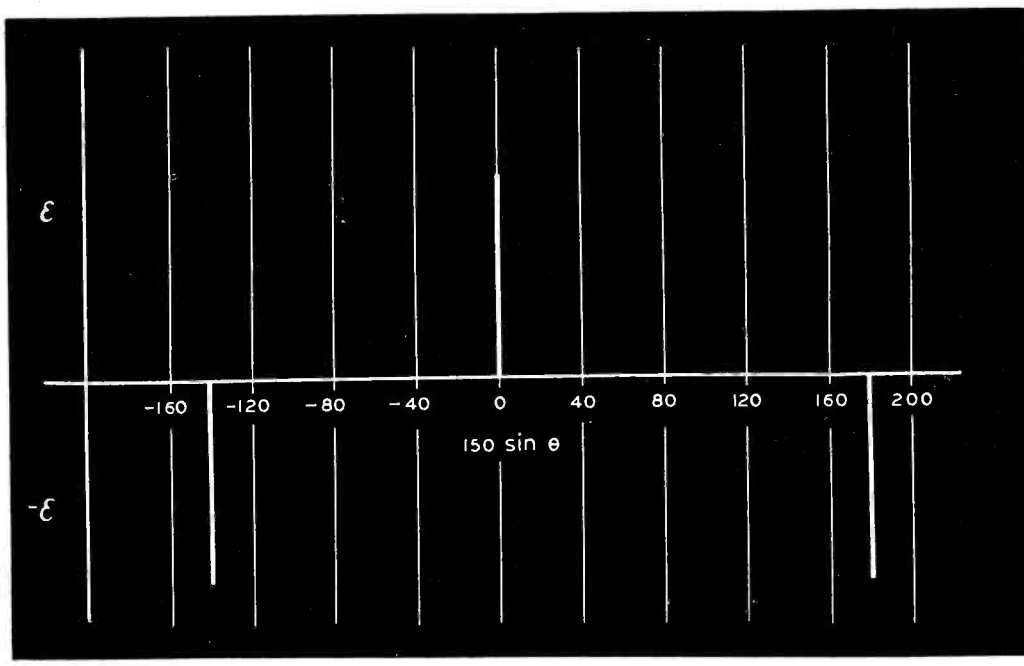
The limiting factor introduced is that the antennas have to be chosen so that s_2 must be double s_1, s_3 triple s_1 and so on. Thus s_1 can be any reasonable value but once chosen determines all the other spacings. In addition s_1 should be chosen less than 180° as will be shown in the examples. Equation *13* now yields a method for the

(*Continued on page 76*)



Figures 12 (left) and 13 (below)

In Figure 12, we have the desired pattern of example 2 (see page 78). This is a very sharp lobe perpendicular to the antenna array. Replotting Figure 12 in rectangular coordinates with (150 sine θ) as the abscissa, we secure the results shown in Figure 13. The analysis is simplified if we put a negative pulse at — 180° and + 180° as shown. When this plot is analyzed by means of any convenient Fourier analysis, equation 15 results. (See page 78.)



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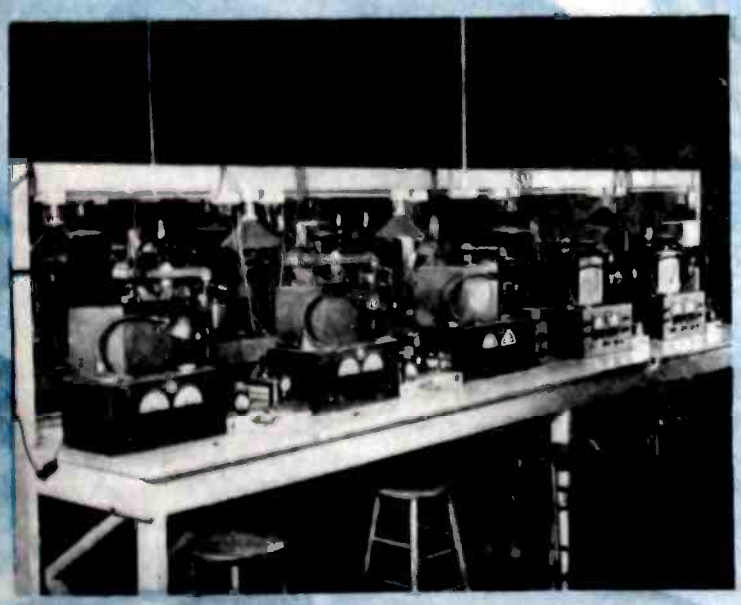

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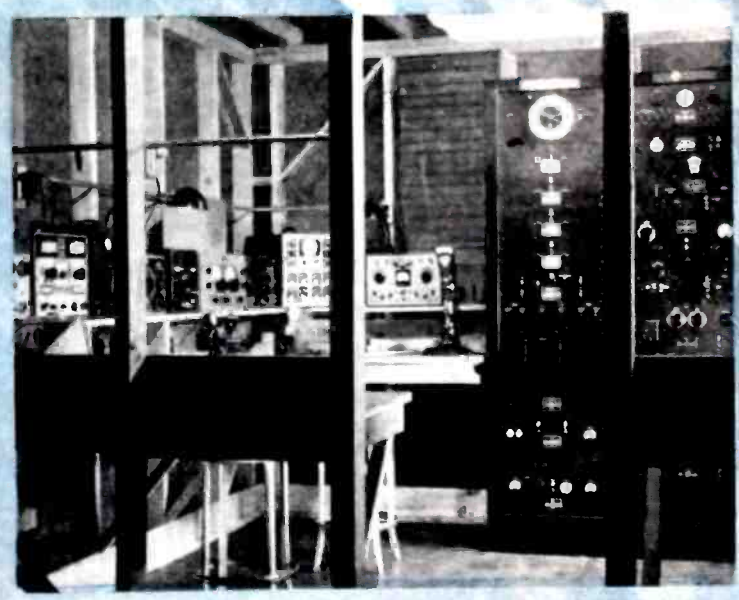

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A RECTANGULAR WAVE-GUIDE

Nomogram

by FREDERICK C. EVERETT

Transmitter Engineer, WTAM

WHEN wavelengths become short enough that they are the same order of magnitude as the outside conductor of a concentric transmission line, power may be transmitted through the tube without the use of the central conductor and the losses may be lower without it. The center conductor has a smaller perimeter and therefore contributes the larger share of the conduction losses. When it is eliminated the necessity for any insulating support is removed, with the attendant losses in the insulators. The simplification in the mechanical and electrical set up is obvious. Because of skin effect, any current which flows in the conductor itself exists only on the surface of the inside of the tube. Stray radiation and unwanted coupling is obviated.

Wave Guide Transmission

When waves are transmitted down such an arrangement, called a wave guide, the transmission is comparable to the propagation of waves in space, except that here the waves are "guided" and the walls of the conducting tube become a boundary for the wave. As a matter of fact, propagation is started down the guide by means of *antennas* inside the end of the guides.

TM and TE

Various modes of transmission may be set up within the tube. They are classified as to whether the magnetic lines of force are transverse (TM), or the electric lines are transverse (TE) and have no magnetic or electric lines respectively, down the guide, in the direction in which the waves are being propagated. Subscripts (in the case of the rectangular guide) then refer to the number of half waves in the cross section of the tube at the cut-off wavelength, referred to as the height and width. The mode of operation depends upon the dimensions of the tube, and the manner in which the waves are started within the tube. Thus there is no great difficulty in utilizing these wave guides in the province where they are useful. Since the guide size is roughly a half wavelength in cross section dimensions, it is particularly suited for high frequencies.

Design Factors

A number of factors enter into the design of the guide, such as the mode desired. Of course, using the mode which gives the longest cut-off wavelength, means that the smallest-sized tube will be used for a particular wavelength. In the case of waves such as the $TE_{0,1}$ it may be advantageous to choose the width so as to maintain the cut-off wavelength at a desired value and adjust the height for the minimum amount of attenuation or for the characteristic impedance which is necessary. Or the height might be selected to obtain the best proportion between the cost of the guide and the amount of attenuation. Or again the dimensions can be chosen so that one mode may exist and another will not. Of course, where the distances covered are short, the matter of convenience may be the deciding one. The use of a nomogram gives a rapid means for checking the conditions which will exist, as attempts are made to reconcile the various factors involved.

The Nomogram

The accompanying nomogram gives in combination the commonest modes of operation of the rectangular wave guide. A straight line drawn between the outer dimension lines gives the cut-off wavelength for the $TE_{1,1}$ and $TM_{1,1}$ mode from the vertical line, and the cut-off wavelength for the $TE_{0,1}$ and $TM_{0,1}$ immediately adjacent to the width line.

Scale Versatility

The scales may be multiplied or divided by a suitable factor to bring the problem to a suitably divided part of the scale, provided all dimensions and wavelengths are multiplied by the same factor.

Lowest Attenuation Mode

The $TE_{0,1}$ is the mode which requires the smallest amount of material for the tube for a given cut-off wavelength and it also has the lowest attenuation. Further, it can be radiated directly into space from the open end of the wave guide efficiently.

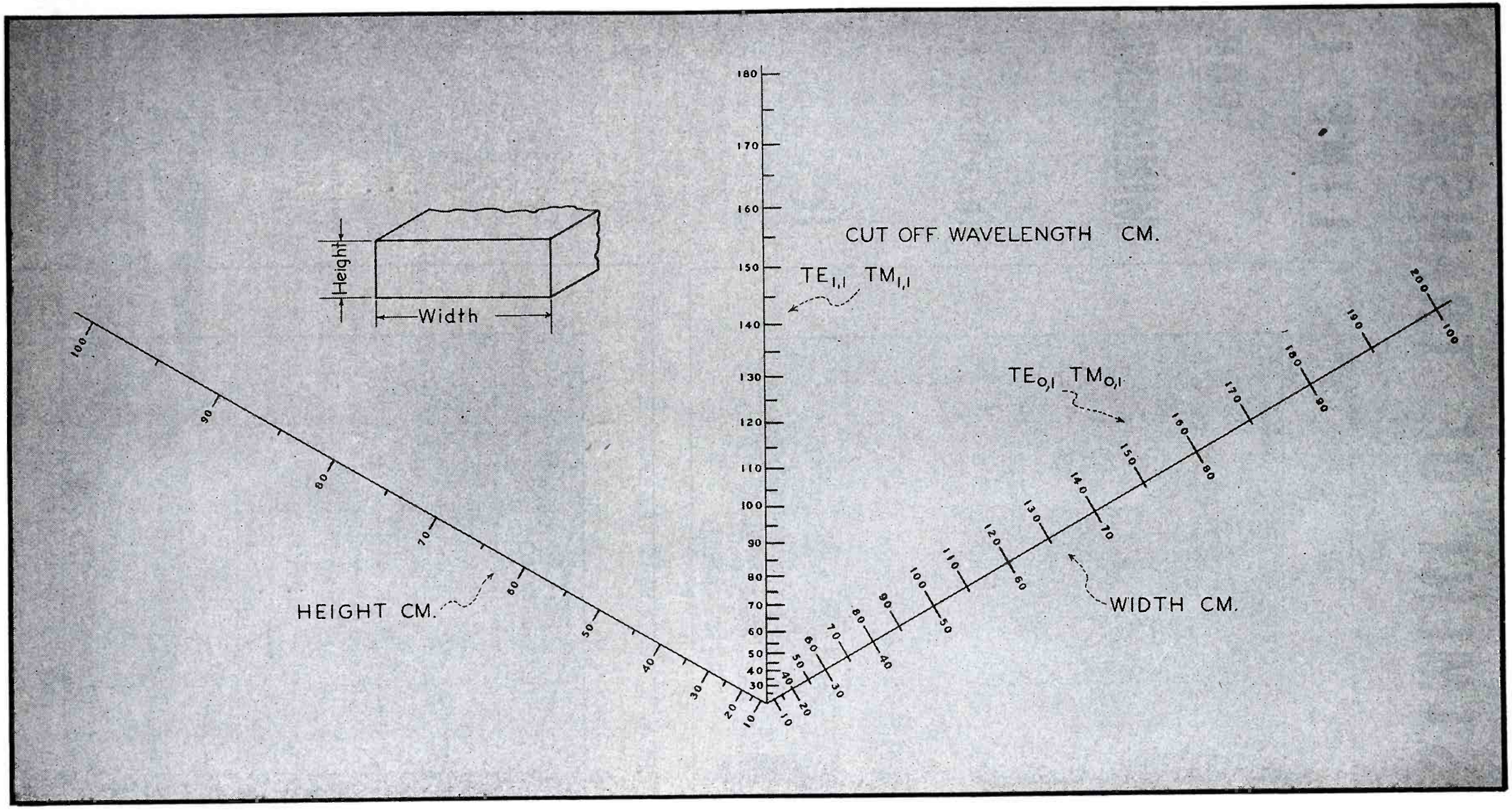
Guide Size Determination

The size of the guide should be made somewhat larger than the exact cut-off wavelength, as the attenuation is infinite at the cut-off wavelength, but drops off rapidly to a minimum. The dimensions should then be checked to see whether the higher modes can exist.

Wave guides of course can be cylindrical, square or rectangular. Copper and brass are used in their construction. Brass is usually employed since it is easier to work, and it is usually silver plated. Wave guides are vastly superior to coaxial feeds at very high frequencies because of their lower attenuation factor. It has been found, for instance, that the attenuation factor at 10 centimeters, for a typical hollow wave guide, is less than .02 db per meter as compared with .4 to 5 db per meter for the coaxial line.

A wave guide may also be used as a resonant element by closing one end and tuning by means of a close-fitting piston. It may also be used as a directive element by flaring the transmitting end.

NOMOGRAM FOR RECTANGULAR WAVE GUIDES



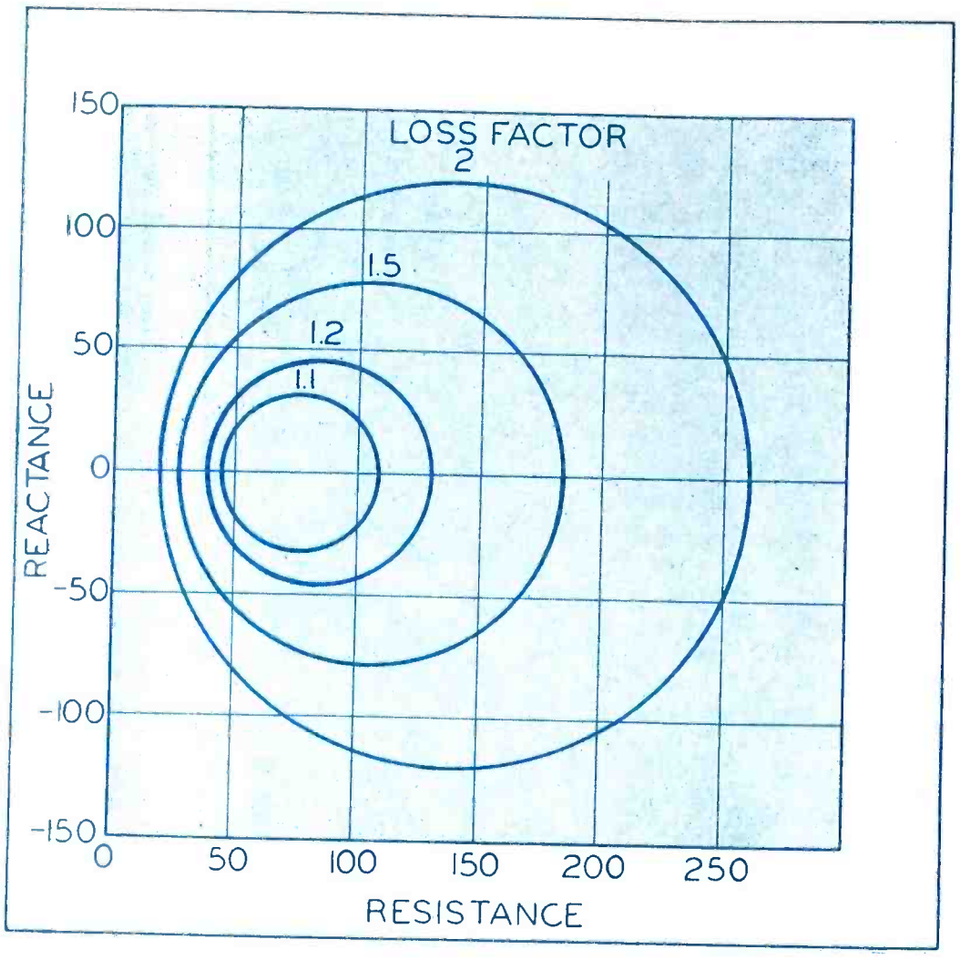
The above nomogram can be used to rapidly determine the cut-off wavelength of rectangular wave guides. These data are particularly helpful, since wave guides function as high pass filters in the transmission of radio waves.

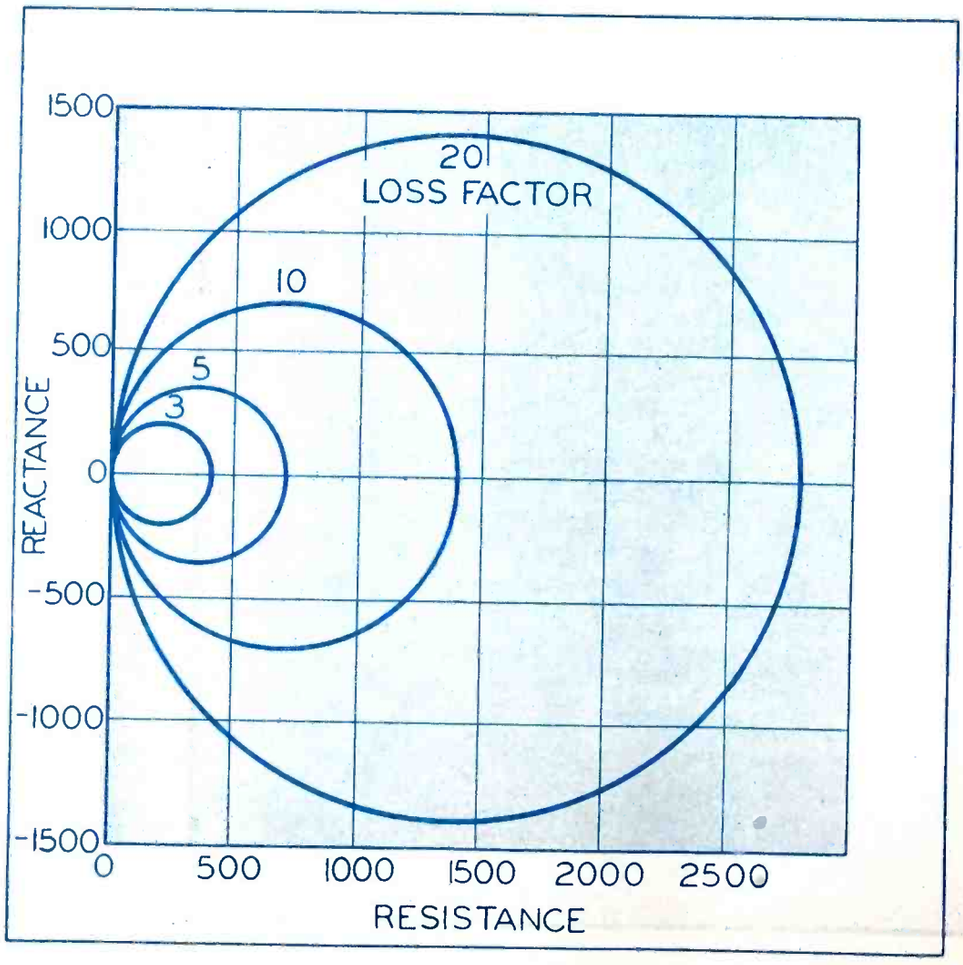
ADJUSTMENT OF TRANSMISSION LINE LOAD FOR MINIMUM LOSS

by

DR. VICTOR J. ANDREW

Victor J. Andrew Company





RADIO frequency transmission lines normally operate into a load impedance which is a pure resistance equal to the surge impedance of the line For lines over a quarter-wavelength long, this load gives substantially the minimum power loss in the line.

The engineer must decide what tolerance should be allowed, when adjusting for this normal load. He usually can calculate the normal line loss when using normal load, from the data supplied by the transmission line manufacturer. For any other load, this normal loss in decibels is multiplied by the factor

$$\frac{R^2 + X^2 + Z^2}{2RZ}$$

where R is the load resistance, X is the load reactance, and Z is the surge impedance of the line.

Load Impedance at U-H-F

At ultra high frequencies, the engineer is unlikely to know the load im-

(*Continued on page* 101)

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Figures 1 (top) and 2 (bottom)

Loss factor graphs, wherein each circle shows the range of the resistance and reactance in the termination of a 70-ohm transmission line, without increasing normal line loss by more than the factor indicated on the circle. These figures illustrate an alternate method of determining the loss factor, discussed numerically on page 101.

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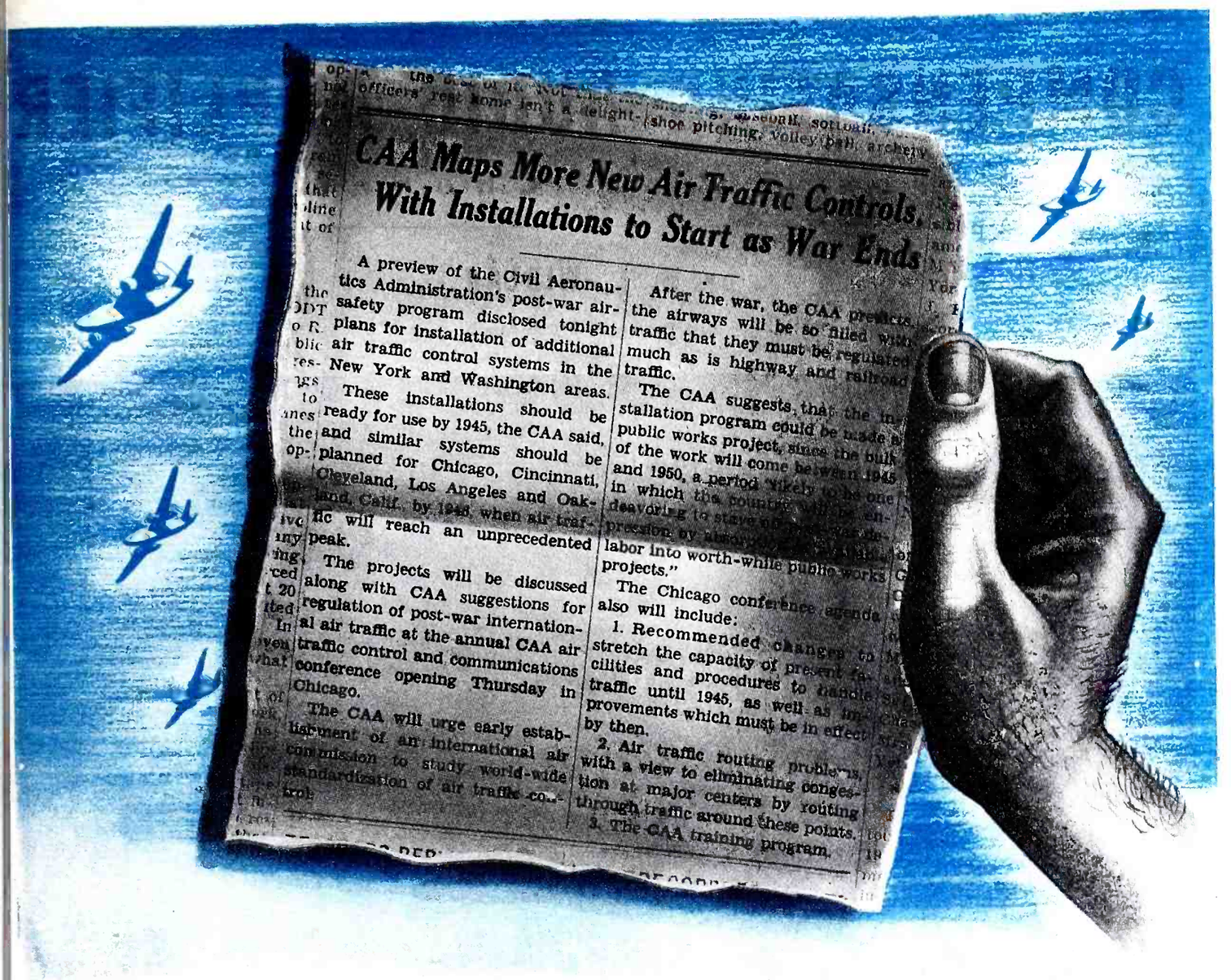
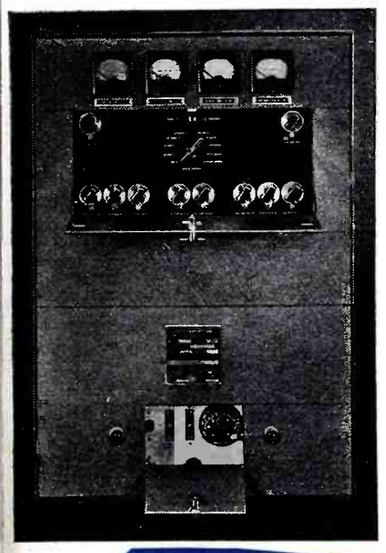


If the war should end tomorrow . . .



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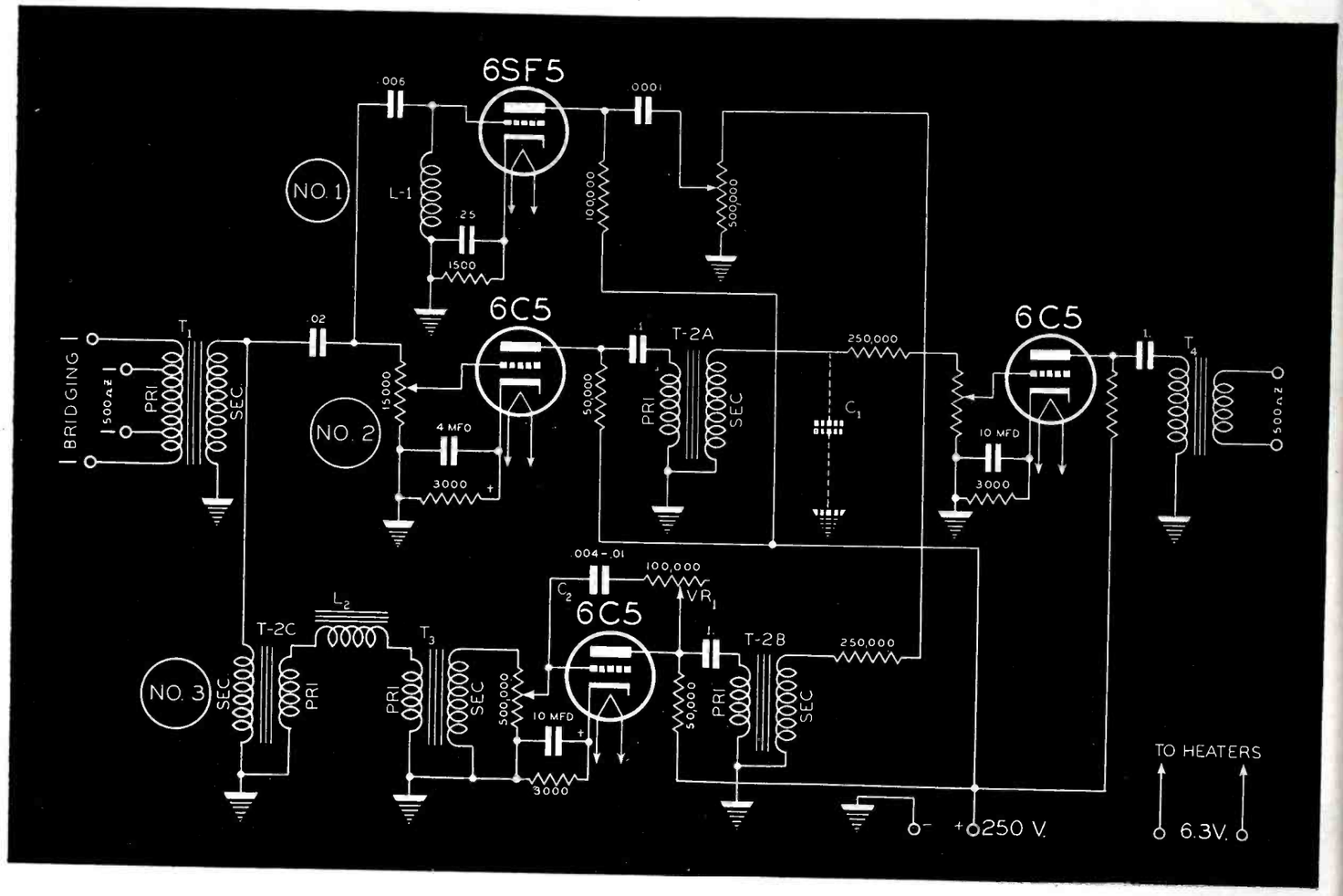


Figure 1

Circuit of the three-channel compensating audio amplifier. T_1 is the bridging or line-to-grid input transformer. T-2 (A, B and C) are 3 to 1 ratio interstage a-f transformers; T_3, a 6 to 1 ratio interstage a-f transformer, and T_4, a plate-to-line output transformer. L_1 is a 30-henry filter choke with core removed, and L_2 is a 30-henry filter choke, intact.

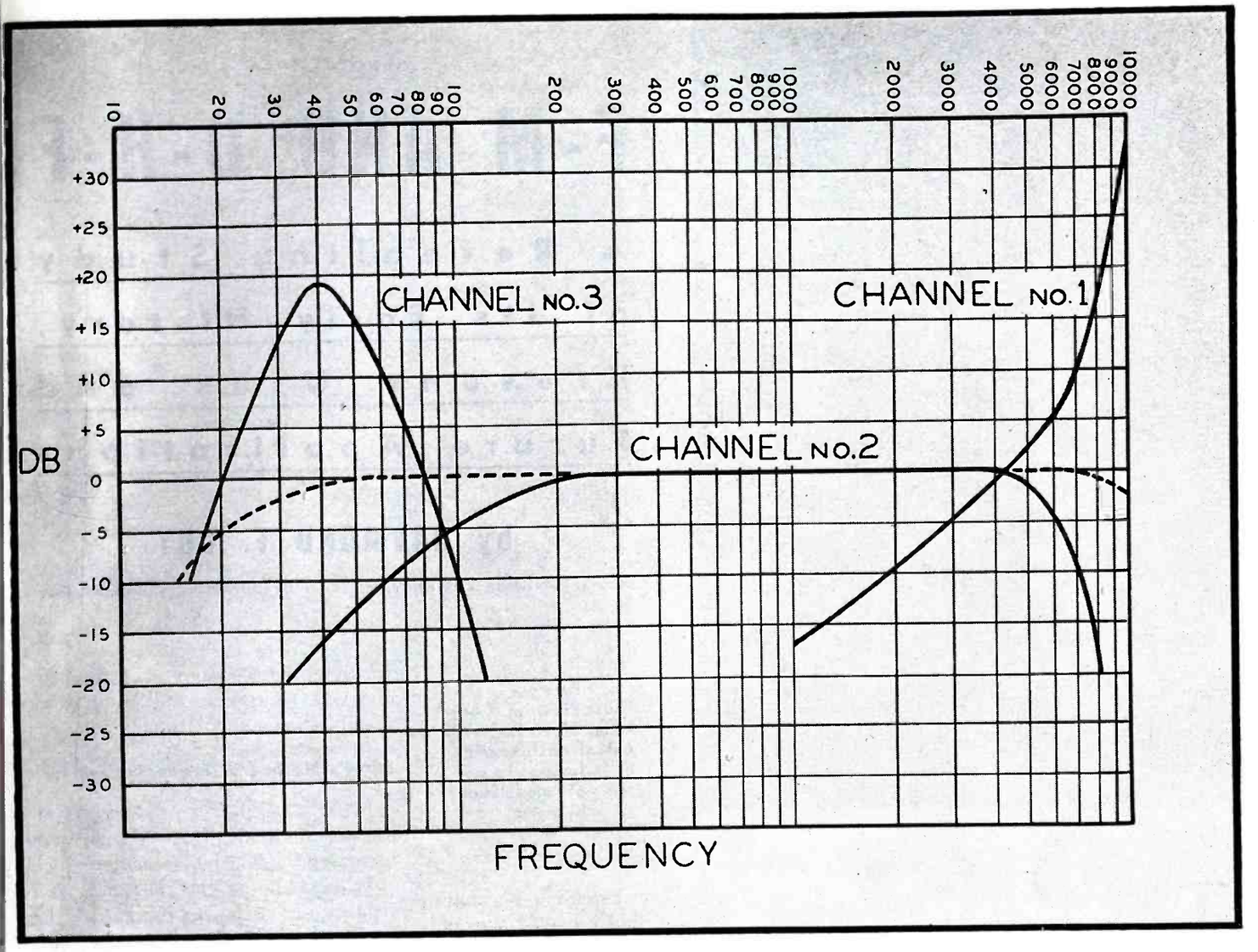
IN many applications of broadcasting, disc-recording and sound-film reproduction, an electronic equalizer proves valuable to compensate for losses in high- or low-frequency response.

As an example, in the broadcasting of football games from a remote city, it has become common practice on non-network or two- or three-station tie-ups, to obtain a class *D* medium grade wire facility to link the radio station with the point of origin. The class *D* line usually provides good intelligibility. However its high- and low-frequency performance is not as effective as the higher quality wire circuits ordinarily used in network broadcasting. On a great many occasions the writer has heard these class *D* facilities improved considerably by an *equalizer* inserted in the incoming circuit. This equalizer usually attenuated the middle range of 200 to 3000 cycles, by 1500 cycles or more. Of course, for each particular wire facility, there is a certain limit to the amount of correction or equalization that can be applied. Exceptionally quiet or noise-free class *D* circuits can be corrected so that they sound much the same as a high-quality network circuit, while on noisier circuits a compromise must be made to obtain maximum correction with a minimum of background noise.

In disc-recording, considerable progress has been made recently in extending the audio frequency range of recording and playback systems, with a general reduction in background noise.

If the disc is recorded with a boost at the low- and high-audio frequencies, the playback system can be equipped with a complementary low- and high-audio frequency filter. This will result in a reduction of rumble, and mechanical noise on the low end and a corresponding reduction of needle-scratch noise on the high end. The World Broadcasting System's vertically-cut recordings, and the NBC Orthacoustic records are excellent examples of this technique.

The same technique can be also suc-



cessfully applied to theatre sound-film reproducing systems, as well as to voice or music reinforcement systems that are deficient in high- or low-audio frequency response.

The Amplifier

A four-tube, compensating audio amplifier, that has given good results in the applications outlined above, is shown in Figure 1. It includes a high frequency channel, tuned by an inductance; a middle range, low gain channel; and a low frequency channel tuned by an iron core inductance and a degenerative feed back network. To provide phasing of the middle and low frequency channels in proper relation to the high frequency channel, the interstage transformers *T-2A* and *T-3B* have been included.

Channel 1

To avoid the *hangover* or *fringe* effect usually encountered in sharply tuned audio circuits, the first channel is tuned by an air core inductance to a broad resonance point at approximately 12 kc. No direct shunt capacity is used. There is, of course, the distributed capacity of the secondaries

Figure 2

Representative audio frequency response curves of the three channels and output stage. Output stage is indicated by dotted curve.

of transformers T_1 and *T-2C*, and the distributed capacity of L_1, that have a shunt effect.

Channel 2

The second channel has low gain, and uniform response between 200 and 5000 cycles. The high frequency limit can be adjusted by the selection of the correct value for C_1.

Channel 3

The resonance point of the third channel can be adjusted by means of C_2 and VR_1 to a point between 40 and 150 cycles. The inductance L_2 is necessary for removing audio frequency components above approximately 200 cycles. The transformer T-2C is connected in reverse. This provides a convenient means of coupling to the filter from the high impedance input terminal.

Input and Output Transformers

The input and output transformers T_1 and T_1 may be omitted if the three-channel amplifier is used in a high impedance application.

Response Curves

Representative audio frequency response curves of the three channels and the output stage are shown in Figure 2.

Phase Relationships

Care must be exercised to insure that the second and third channels are in proper phase relationship to each other and to the first channel. This can be done by the proper connection of the primary or secondary windings of T-2A and T-2B.

Filtering

Because of the increased low frequency response possible with the use of this amplifier, all preceding equipment must be sufficiently filtered and

(*Continued on page* 111)

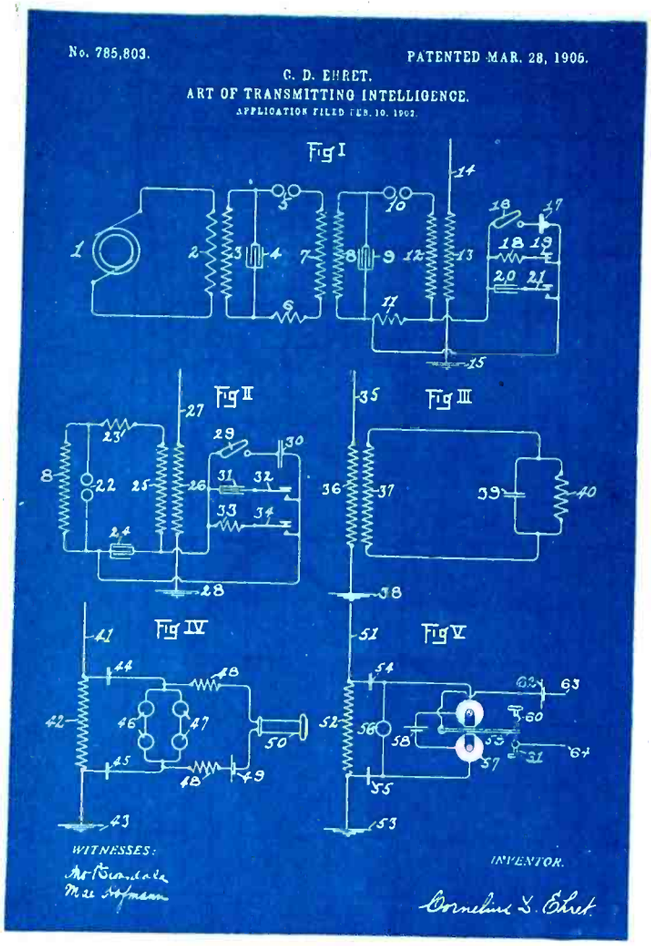


Figure 1
The patent of Cornelius Ehret, the first patent that specifically described a system of modulation by name.

F-M AND U-H-F

A Revealing Study of Its Early History, Present Uses and Future Applications

by RAYMOND F. GUY

Radio Facilities Engineer, National Broadcasting Company, Inc.

THERE is an old saying . . . "Build a better mouse-trap and the world will beat a path to your door." There is much truth in it. Frequency modulation is much superior to other methods of radio signaling, for numerous applications and its use is expanding and will continue to expand. However, f-m is old to the art. Although it was used in radio telegraphy 25 years ago, it was not until u-h-f services came into being that its natural field of application was found. The public, the radio layman and many engineers have heard and read of f-m but have not had the time, opportunity, interest or patience to inquire into its past, present and future. This writing is intended to present a perspective of the subject for such readers.

When F-M Began

In viewing the past of f-m, it is necessary to go back a few years to the time when the United States decided to purchase the physical equipment and the franchise of the French Panama Canal Company and build a Panama Canal. President Theodore Roosevelt had narrowly escaped the death which came to his Secret Service guard when his carriage was struck by one of the new electric trolley cars which were beginning to replace the cable cars on the streets of New York. The Brazilian aeronaut, Santos Dumont, had received a grand prize of 100,000 francs for his daring in piloting a pint-sized blimp completely around the Eiffel Tower and returning to earth, without breaking his neck. An unknown young man named Henry Ford had driven his super racer at the tremendous speed of 59 m-p-h in an effort to stimulate people to buy his new horseless carriages. The Wright brothers were as yet unheard of, because the Kitty Hawk flight was still of the future. Marconi only three months before, on December 12, 1901, had for the first time signaled by wireless from Poldhu, England to Signal Hill, Nova Scotia, and thus convinced the skeptics that there was something to this thing called wireless. These events fix the date when the first f-m patent application was filed.

Ehret's Patent

It was February 10, 1902 when Cornelius Ehret, of Philadelphia, filed a patent application covering the transmission and reception of code signals or speech by varying the frequency of the wireless waves, that is, f-m. So far as this writer has been able to discover, this was the first patent which specifically described any system of modulation by name, although the on-off keying of carrier waves for telegraphy had been used and was, of course, the simplest form of amplitude modulation.

Ehret's Method of Producing F-M

Ehret's method of producing f-m is the one used by many modern manufacturers of such equipment and consists of changing the reactance of resistance across a free oscillator. Figure 1 is a diagram of the transmitter and receiver in the Ehret patent. Inasmuch as the first three-electrode radio tube was many years in the future, Ehret at the time lacked a satisfactory means of producing continuous waves to be modulated. Later, when continuous wave generators were developed, frequency modulation was used for many years to key long wave telegraph transmitters because it was much simpler to change the frequency than to interrupt large amounts of r-f power.

Extracts of Ehret's Patents

Ehret's conception of transmission and reception of speech and other forms of signals was quite clear and is of sufficient interest to warrant quoting, in part, from the specifications of the first of his two patent applications of 1902.

"Be it known that I, Cornelius D. Ehret, a citizen of the United States, . . . have invented a new and useful Art of Transmitting Intelligence, of which the following is a specification.

"It comprises . . . a method of modifying and varying the frequency of the electroradiant energy in a manner corresponding and in accordance with the signal to be transmitted. (*Specified as speech or*

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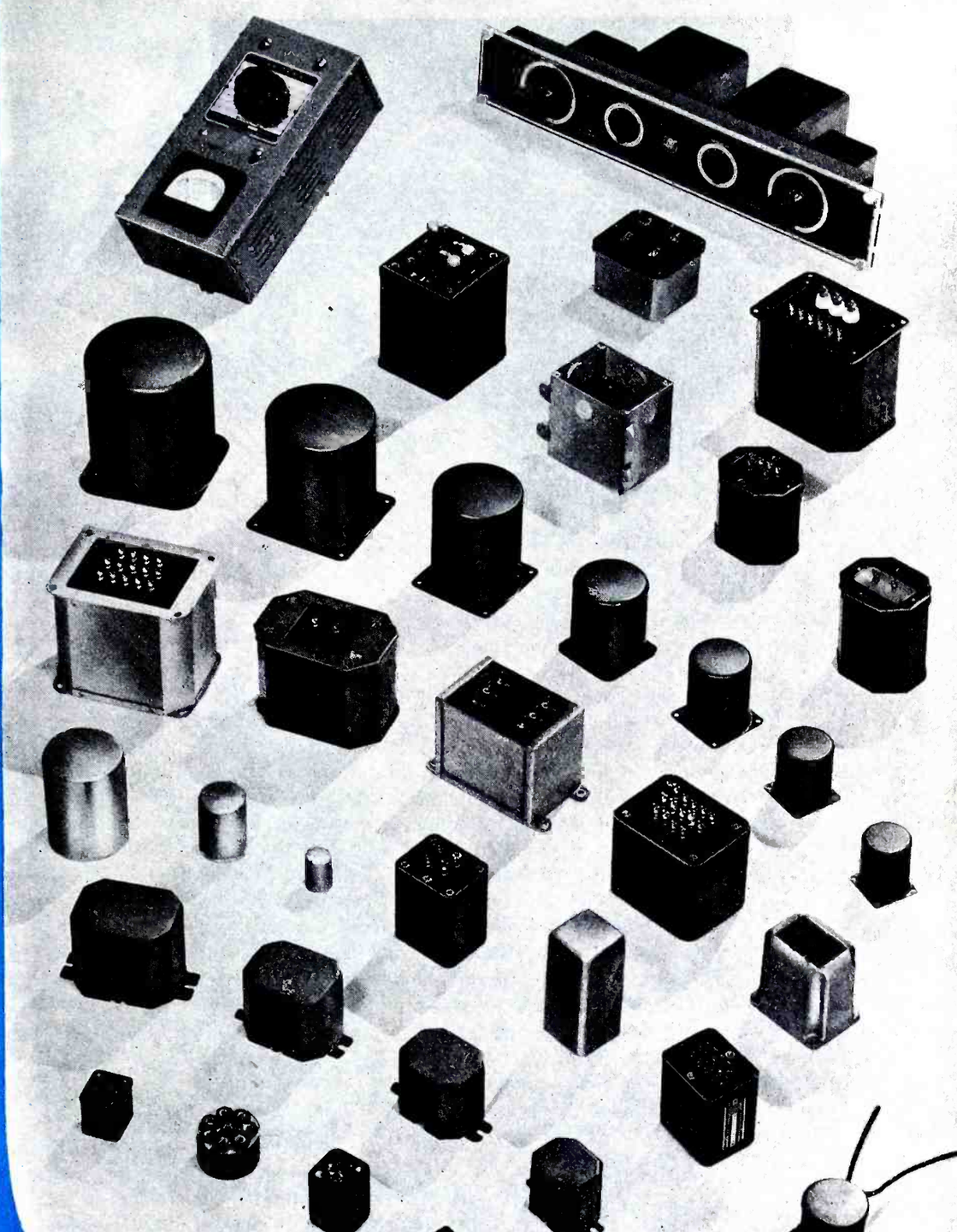

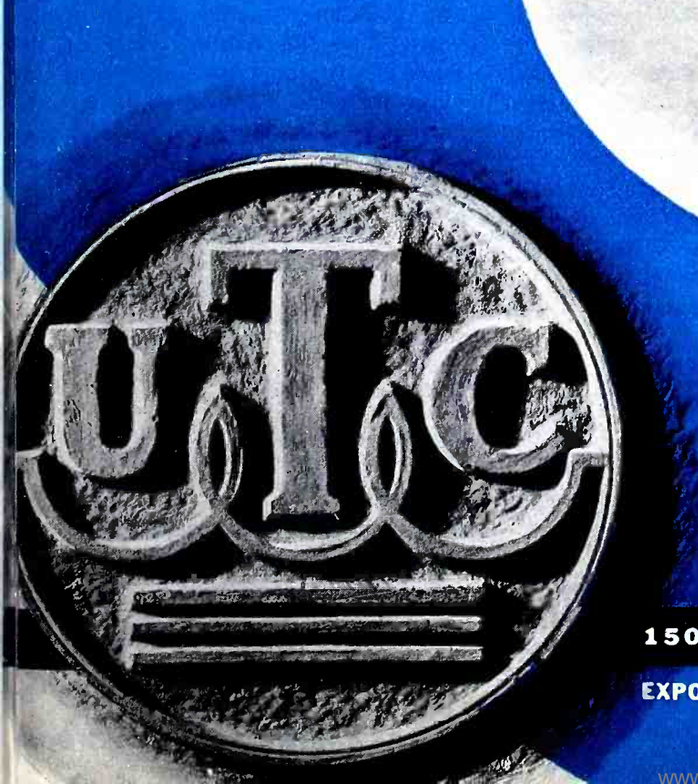

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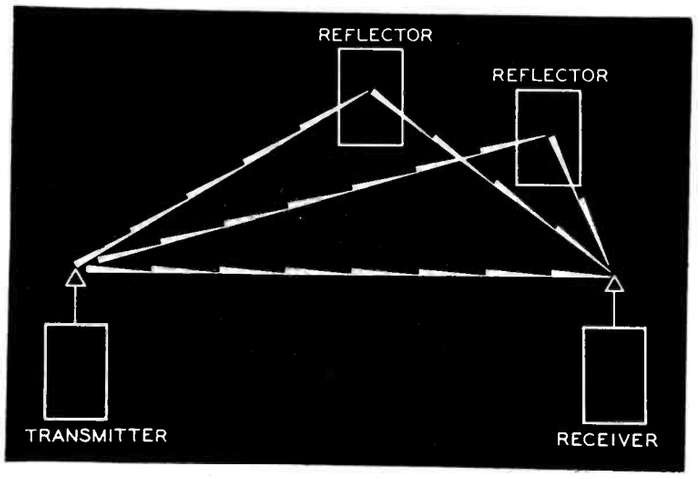

Figure 2

How multipath effects arise. The reflector may be Heavyside layers or large spaces, such as aircraft in flight, mountains or buildings.

telegraphic characters, audible or visible.)

"It comprises . . . a method of receiving the modified energy and causing the reproduction of speech and other signals by the effects of variations or changes in the frequency of the received energy.

"A charged electric circuit will . . . oscillate electrically. . . . The periodicity or frequency . . . is dependent upon . . . resistance, capacity or inductance. Changing the amount of L, C or R, or the amount of any combination of them will change the natural period of oscillation. . . . It is upon this principle that the hereinafter described system is based and in its essential feature comprises a system in which energy representing the message to be sent has its frequency varied or changed in accordance with the message.

"The inductance 11 is . . . shunted by a telephone transmitter . . . any variation of the resistance . . . changes the frequency.

"Operating one of the keys 19, 21 will . . . modify the frequency and speaking into transmitter 17 varies the frequency in accordance with the sound waves uttered by the speaker.

"The method does not depend upon increasing or diminishing the amount of energy transmitted . . ., my method depends for its operation upon the variation by and in accordance with speech waves of the frequency of the transmitted electroradiant energy waves which is the only characteristic of electroradiant energy which may be varied, in as much as mere quantity or magnitude of energy is not a property or characteristic.

"For the transmission through the natural media the frequency of the electrostatic and electromagnetic energies is very high, ranging from 100,000 cps to several millions. . . . The amounts of capacity resistance and inductance need be quite small, and therefore the variations of any one of these factors to even a moderate degree will greatly affect the periodicity of the circuit."

Claim 20 of Ehret's Patent

Claim 20 reads:

"The method of transmitting messages or signals which consists in continuously generating trains of waves of electroradiant energy of practically uniform frequency, modifying the frequency of said waves in accordance with the message or signal to be transmitted, and reproducing the message or signal to be transmitted, and reproducing the message or signal by the effect of the modification of the frequency of the received electroradiant energy."

Claim 21 of Ehret's Patent

Claim 21:

"The method of transmitting speech electrically, which consists in continuously generating trains of waves of electroradiant energy, said wave trains succeeding each other at a rate high as compared with the frequencies found in speech and said waves having practically uniform frequency, modifying the frequency of said waves by and in accordance with speech, and reproducing speech at a receiver by the effects of the modification of the frequency of the received electroradiant energy."

F-M Peculiarities

Entertainment by wire or radio was not to come for many years. Talking over wires was still a new and novel experience. But here was f-m forty-one years ago. Pre-emphasis and de-emphasis have been added and Armstrong has obtained a patent based on the degree of frequency modulation. But otherwise modern f-m is fundamentally as Ehret conceived it. Its satisfactory use for speech had to wait twelve years for the development of satisfactory methods of generating high frequency continuous waves. Its greatest field of application for serving mankind had to wait thirty-five years for the opening up of the ultra high frequency bands. Edwin H. Armstrong, in 1914, also patented and clearly and completely described the operation and application of vacuum tubes for generating continuous high frequency oscillations. In recent years, he has promoted the use of wide swing in f-m.

One may ask why, if f-m has been known for so many years, it wasn't placed to greater use. There are several reasons. Not the least of them is that f-m is most useful on high frequencies which have been harnessed only in recent years. RCA Communications' engineers tried it years ago over long distances on frequencies between 9,000 and 18,000 kc in a research program to determine its frequency propagation characteristics, its possible usefulness in the reduction of fading and the possibility of using two f-m receivers in a diversity receiving system. The tests were accomplished over twelve years ago and reported in 1936.* It was shown that f-m is much more distorted by the effects of long distance multipath transmission than is amplitude modulation.

The signals from a transmitter may arrive at a receiver over several different paths varying in the number of ricochets. Over the longest paths the delays may easily be as much as 2,000 microseconds representing an extra path length of nearly 400 miles. The two or more signals, each with its carrier constantly changing in frequency combine at random.

The frequency of the signal over one path may arrive at an instant when it is increasing while at the same instant the same signal over another path may arrive while its frequency is decreasing. Thus the carrier and side waves from two or more paths scissor across each other and produce in addition to beat tones, many others which are unrelated to the frequency of modulation and which are varying with a rapidity dependent upon the frequency deviation.

Distortion Problems

It may be easily seen that the distortion depends upon the difference in path lengths, the amount of frequency deviation, the relative amplitudes and the rate of change of deviation which means, of course, the audio frequency.

*Murry G. Crosby, *Frequency Modulation Propagation Characteristics*, Proc. IRE, pp. 898-913, Vol. 24, No. 6; June 1936.

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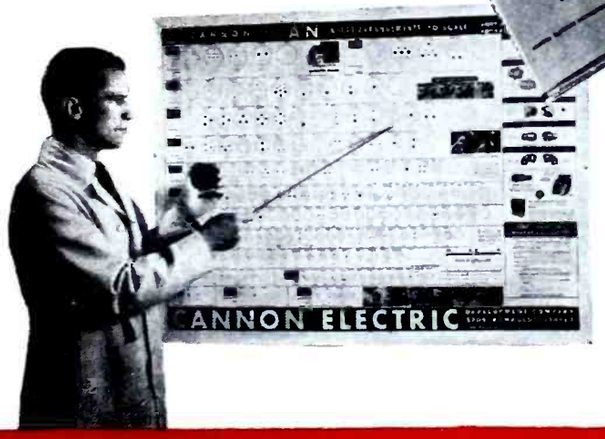

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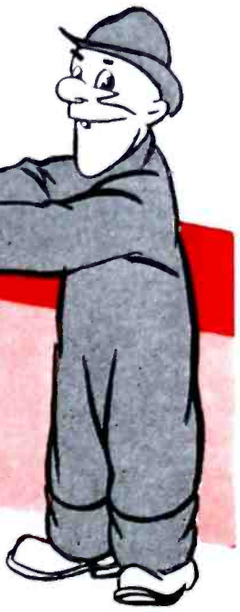
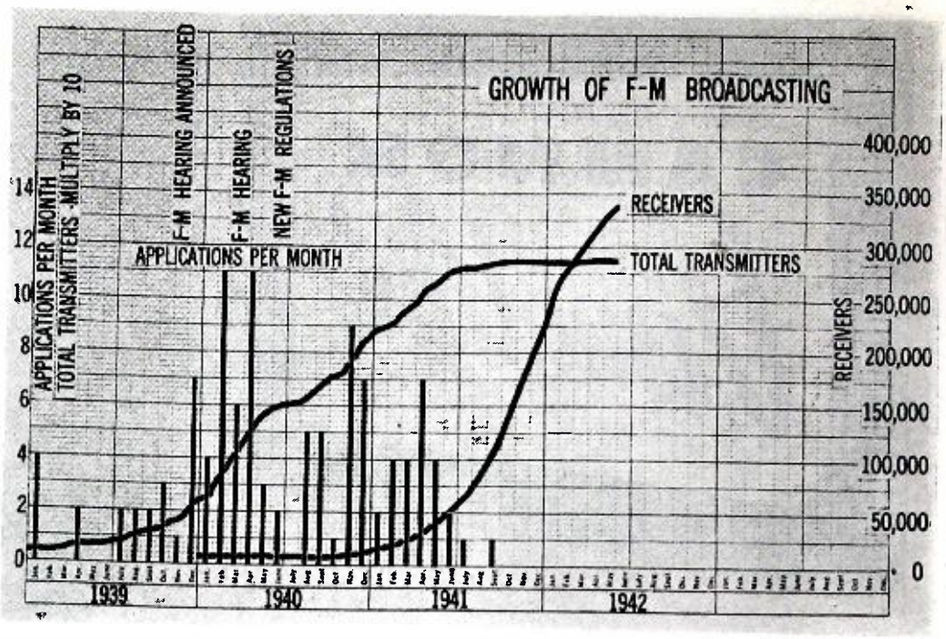


Short-Circuit Sammy is a genius at getting into trouble, but he raises some pretty good questions in the Cannon Plug training film. His pedagogical characteristics are confined to showing how not to do certain operations

Figure 3

This chart has been made from the author's records to show the growth of f-m broadcasting through 1939, 1940, 1941 and part of 1942. At the present time, according to this chart, the total number of f-m receivers are about 350,000.



The distortion is obviously greatest when the relative amplitudes are equal and all other factors are greatest.

The distortion caused by multipath transmission has been observed in f-m broadcasting where reflections result only from earth-bound objects such as buildings well within the high intensity primary service area. Its effects do not appear to be serious and except for unusual cases could and apparently do go unnoticed. More will be known about it. Amplitude modulation is much less subject to multipath distortion, as would be expected. Figure 2 shows how local multipath disturbances originate.

F-M Restrictions

The use of f-m was considered by the writer and many others in connection with standard broadcasting. The possibilities were not promising because of the limited band of frequencies available and the likelihood of multipath distortion. Vast areas of the United States depend entirely on night-time sky wave transmission from clear channel stations for their radio service. Frequency modulation appears to offer no advantage on the medium frequencies and, of course, cannot serve such listeners on the higher frequencies because of the semi-optical propagation characteristics of u-h-f waves. Hence, 40% of the geographical area of the United States depends, and will continue to depend, upon standard broadcasting clear channels. Frequency modulation cannot help them because they cannot support local stations.

F-M and Telegraphy

Frequency modulation was used in long wave telegraphy for many years before and after the last war but so far as speech and music were concerned it languished for about thirty-five years after its use for that purpose was conceived.

A good perspective on angular velocity modulation may be obtained by observing the number of patents issued through the years since this shows the amount of interest and activity in the subject.

F-M Patents

The tabulation shows the frequency and phase modulation patents issued year by year since the first ones were granted to Ehret in 1905, thirty-eight years ago. It is difficult to segregate the patents, which legitimately belong in this list, from others which pertain to the subject indirectly. However there are at least as many as are shown. Approximately 90% of those listed apply to Frequency Modulation and the remainder to phase modulation.

Year	Total
1905	2
1916	1
1917	3
1919	2
1921	1
1922	1
1923	1
1925	3
1926	4
1927	6
1928	6
1929	6
1930	1
1931	9
1932	16
1933	13
1934	10
1935	9
1936	17
1937	16
1938	15
1939	18
1940	24
1941	61
1942	122
To June 1st 1943	25
Total	392

About 400 patents have been issued on frequency or phase modulation. About 350 have been issued on frequency modulation alone. Frequency modulation research has gone on for over 33 years.

Seventeen years ago Wright and Smith were granted a patent on limiting, a most important feature in f-m. Numerous efficient discriminators and modulating circuits have been patented by various engineers for use in f-m systems.

Pre-emphasis of high frequencies was used by J. Weinberger and the writer 19 years ago at WJZ to approximately fit the sloping high frequency response of broadcast receivers. It was described in the *IRE Proceedings* of 1924. Pre-emphasis and de-emphasis also has been used in carrier wave telephony for noise reduction as described in the *Bell System Technical Journal* of April, 1934.

Present Status of F-M Broadcasting

Figure 3 has been made from the writer's records to show the growth of f-m broadcasting through 1939, 1940, 1941, and part of 1942, its growth period. It is of interest to note that the announcement in November 1939, of the "F-M hearings" stimulated a minor stampede of CP applications which were filed before or during the hearing. Following the issuance of the new f-m regulations in June 1940, a period was required to interpret certain of them and prepare applications. In the 6-months period centering on January 1940 there was another spurt after which new applications dropped off sharply in the 6 months preceding Pearl Harbor. The total f-m receiver sales in the nation are estimated at present at about 350,000, including all types. During the week of the final receiver tabulation shown on the chart fewer than 100 sets were sold by manufacturers. The rate of peace time re-

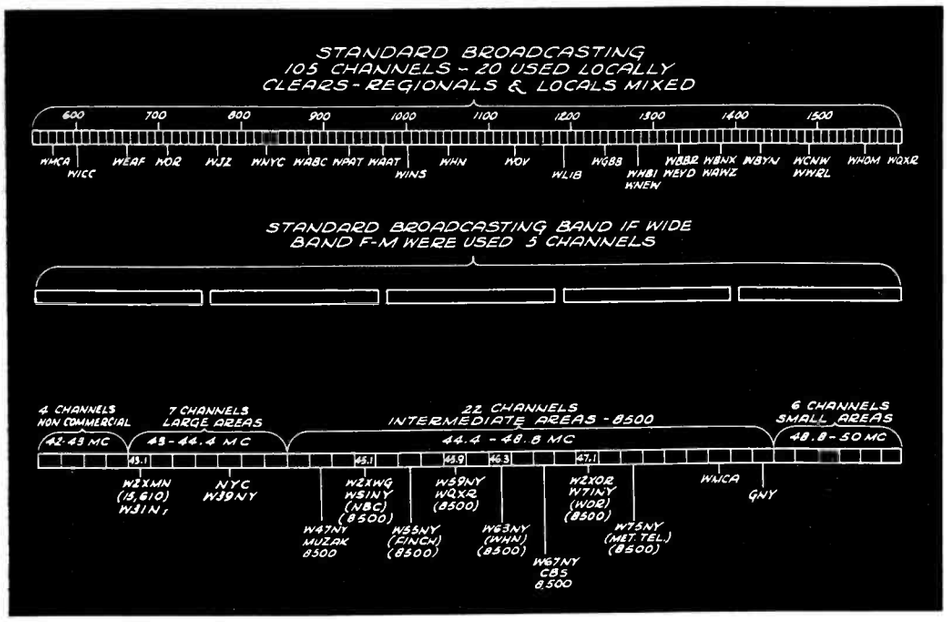


Figure 4

The frequency allocation problem in the New York area is graphically illustrated here. The upper scale shows the standard broadcast band assignment of stations, while the bottom scale shows the frequency assignments for the service of f-m broadcasting. It also illustrates the assignments to stations which are now operating or which have requested definite frequencies in the New York area.

ceiver sales was more indicative that f-m was *clicking*, than was the number of applicants seeking new construction permits, during the 6 months preceding Pearl Harbor.

F-M After the War

It appears certain that the sale of receivers with f-m bands will resume its upward trend after the war and that a potential f-m audience of significant size will result after several more years of peace time growth. At present f-m appeals to music lovers because the programs consist largely of recordings of classical and semi-classical music. This type of programming is natural in the absence of commercial programs. Frequency modulation broadcasting is not self sustaining and will not be until a great many more receivers are sold after the war.

Frequency Allocations in New York

A graphic picture of frequency allocations in the New York area is shown on Figure 4. The upper scale shows the standard broadcast band assignments of stations in the New York area. The bottom scale shows the frequency assignments for the service of f-m broadcasting and also shows the assignments to stations which are now operating or which have requested definite frequencies in the New York area. It will be noted that only two stations have been assigned frequencies in the group of channels earmarked for the largest areas, corresponding in a general way to the clear channel in standard broadcasting. The first four channels in the f-m group are set aside for non-commercial educational stations. The next seven channels extending from 43 to 44.4 megacycles are set aside for an area serving at least 15,000 square miles comprising primarily a large rural area and particularly that part of basic trade areas which cannot be served by stations assigned basic trade areas due to economic and technical limitations. This group is for stations which include in their service area a large rural area. The service in the area may include one or more principal city or cities.

Adjusting Allocations

The next group of twenty-two channels will have basic trade areas and a principal city. This group is for stations serving cities having a population greater than 25,000. All New York stations are assigned frequencies in this group except W39NY, the city of New York, and W31NY, owned by Major Armstrong. The next group of six channels extending from 48.8 to 50 megacycles is for an area comprising a limited trade area and a city. This group is for stations serving

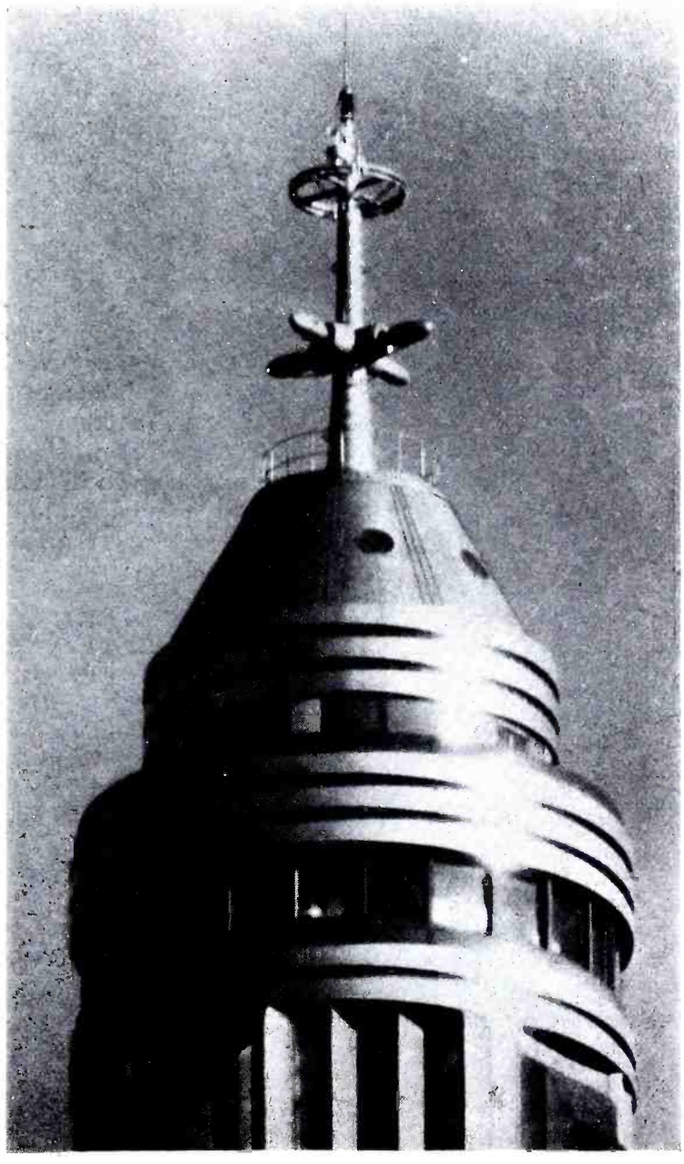


Figure 5

The WNBT-W2XWG antenna system on the Empire State building. The lower set of elements consists of a single turnstile group which radiates both television and radio broadcast signals. The circular antenna above is for the television sound channel. By an ingenious design, these antennae are decoupled to eliminate mutual effects. Additional coaxial filters decouple the feed systems and transmitters. The antennae were developed by engineers of RCA Communications.

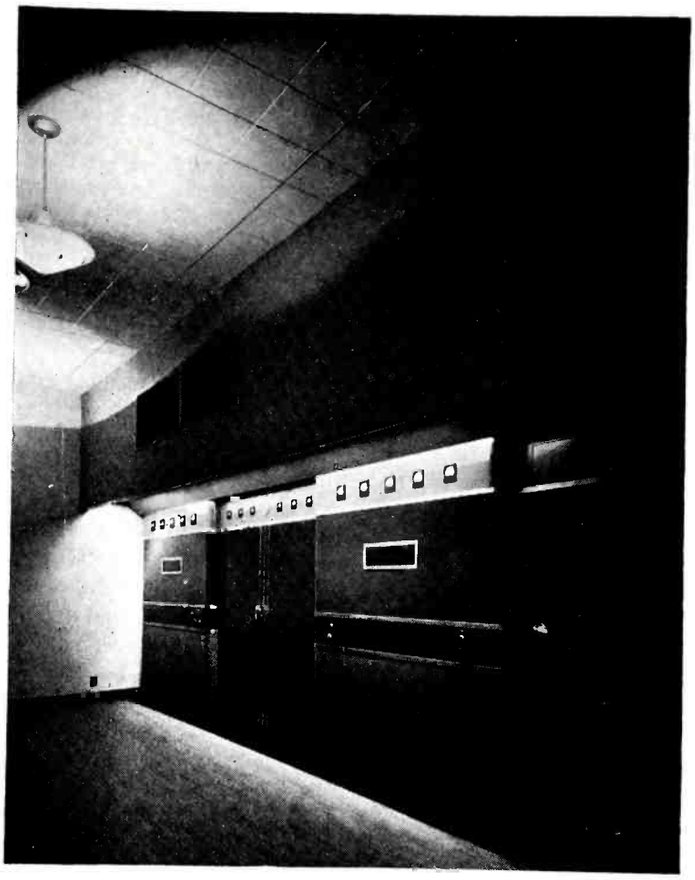


Figure 6

NBC's frequency modulation station W2XWG in the Empire State building, New York. This is an RCA 10-kilowatt transmitter operating now, however, on reduced power because of wartime tube shortages.

cities having a population of less than 25,000. However, applicants for a station in the latter group, to be located in a city having a population greater than 25,000 or adjacent to any metropolitan district having a population greater than one million may apply for 49.1, 49.5, 49.9 megacycles. It may be seen from the above that New York stations licensed to serve 8,500 square miles are limited to a radius of 52 miles. In the Chicago area stations are limited to 10,500 square miles representing a radius of 58 miles. In general, large cities like New York and Chicago are assigned authorized service areas of 8,000 to 11,000 square miles but in each city the areas must be substantially the same for all stations. Adjacent channels cannot be assigned in a given city because there would be objectionable interference between them. Therefore alternate channels are assigned in each area. In the large cities therefore only 11 channels are available for all f-m applicants.

F-M for Police

In the fields of police and other services where communications over semi-optical distances is required, and sky wave transmission is a detriment and nuisance, u-h-f transmission with frequency modulation is rapidly being adopted and this trend will certainly continue. It is in such services that f-m is in its natural medium. It is also finding use in public utility systems in communicating from point to point over the wire networks. Another interesting f-m application is its use by the Chicago Surface Lines[1] in two way communications to provide speedy control in emergencies.

Frequency modulation is being widely adopted on the ultra high frequencies for the police service. An audio frequency band of 3,000 cycles is used in connection with a deviation ratio of 5, resulting in a frequency swing of plus and minus 15 kc. This provides an excellent system of communicating over large areas and has the advantage of relatively narrow band width with little or no interference from long distances. Police systems which heretofore used frequencies adjacent to the standard broadcast band were greatly troubled by interference from distant stations at night.

NBC and F-M

NBC has been interested in f-m for many years. Its station in the Empire State building was the first in its area to be built and operated by a standard broadcast licensee. As soon as possible after the new FCC f-m standards were formulated, a new RCA transmitter of the maximum authorized power of 10 kw was installed. It is shown in Figures 5-6. It has operated from 3:00 to 11:00 p.m. daily except Thursdays and Fridays since its completion about the time of the FCC *freeze* order. A similar transmitter had been purchased for Chicago but it has subsequently been made available for and converted to the treatment of tools of war.

[1]Donald Phillips. COMMUNICATIONS, pp. 46, 47, 50, 90; July, 1943.

W2XWG Purpose

The original purpose of the W2XWG 1,000-watt station was to make a thorough-going field test of frequency modulation using the standards proposed for high frequency broadcasting. This field test was completed in time to make all of the data available to the FCC during the f-m hearing of March, 1940. It was widely published later.

The Master Control Room

The master control room in the Empire State plant contains the audio frequency equipment for both the f-m and television stations. In addition the same antenna is used for radiating the television signal and the f-m broadcasting signal. This is accomplished by the use of a specially designed antenna with a very wide pass band and impedance characteristic used in conjunction with a series of coaxial filters which provide one way circuits to the antenna, from the transmitters, without cross-talk or reaction.

F-M Station Listings

On pages 79, 84 and 85 appear two groups of f-m station listings that effectively illustrate the status of f-m today.

The first group of tabulations show the f-m broadcasting stations that are currently licensed and operating. In the second group appear the list of applicants for changes in authorizations or for reinstatements of applications originally filed and then canceled when new construction was stopped.

In the third group, presented below, we have an interesting list of the non-commercial educational stations.

In this non-commercial educational group, we find the Board of Education, City of Buffalo, N. Y., 42.9 mc; Board of Education, City of Chicago, Ill., 42.5 mc; Board of Education of the Memphis City Schools, Memphis, Tenn., 42.1 mc; Board of Education, City of New York, Brooklyn, N. Y., 42.1 mc; Board of Education of the San Francisco Unified School District, San Francisco, Calif., 42.1 mc; Cleveland City Board of Education, Cleveland, Ohio, 42.5 mc; San Diego Unified School District, San Diego, Calif., 42.3 mc; University of Illinois, Urbana, Ill., 42.9 mc, and University of Kentucky, Beattyville, Ky., 42.9 mc.

The Memphis and Urbana stations operate on 250 watts and the Beattyville station operates on 100 watts. All others use 1 kilowatt.

[See pages 79, 84 and 85 for station listings]

FROM HUNDREDS OF MILES AT SEA CAME

THE ALARM THAT SAVED MIDWAY!

Midway was ready when the Jap attempt to capture this strategic U. S. outpost came June 4 to 7, last year. Long before the Jap fleet of battleships, carriers, cruisers, destroyers and transports could bring their big guns into range—vigilant patrol planes with modern radio communications equipment had sounded the alarm. Many miles from Midway's shores American planes blasted their fleet...drove their survivors into a frantic homeward retreat.

REPEATEDLY it has been said—"this war is different". Yes, different because, on land, at sea and in the air, battles are being planned and fought with weapons never before available to our fighting men. Among these is the electronic tube. It is reassuring to know that no nation is making wider or better use of this great weapon of modern warfare than the U. S. A. To help serve the vast requirements of our Army and Navy National Union, for example, is producing electronic tubes on a scale far exceeding its pre-war peak. Yet, dramatic as are the achievements of electronics in war, there will be even more miraculous peace-time tasks for tubes to perform. National Union will be prepared to aid engineers and production men in applying the power of electronics to their special needs. To producers of war goods, this industrial electronics service of National Union engineers is now available.

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WOMEN IN INDUSTRY

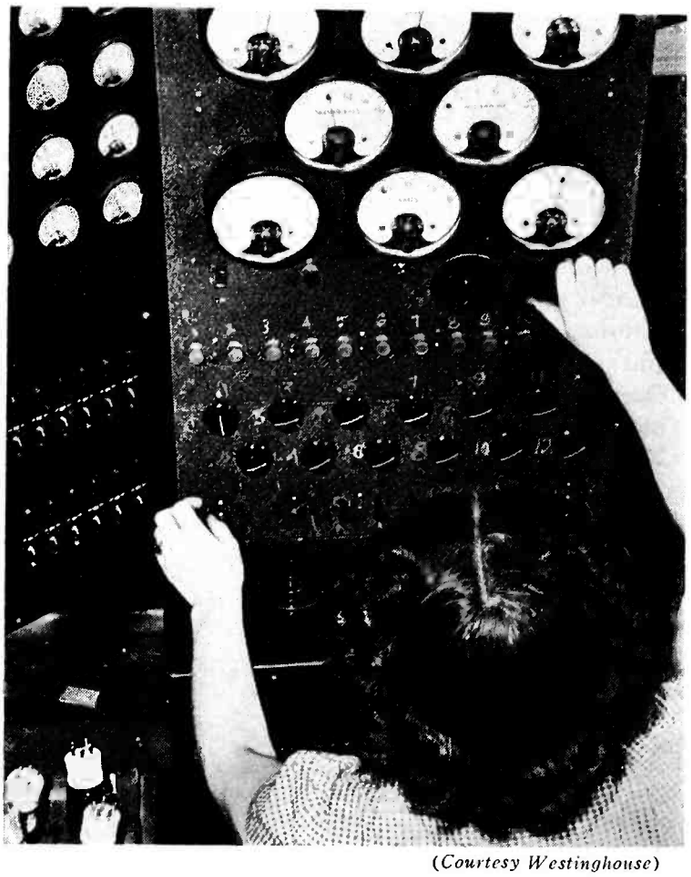
[See Cover and Page 2, This Issue]

(Courtesy General Electric)

Although women have been employed on tube production lines for many years, until recently their talents had been applied only to small part production. Rarely were they assigned to the use of large tools. Now, however, women can be found in many divisions of a tube plant, operating a variety of tools, large and small. Above we see, for instance, a girl with a husky production unit, exploding getter in radio tubes with high frequency.

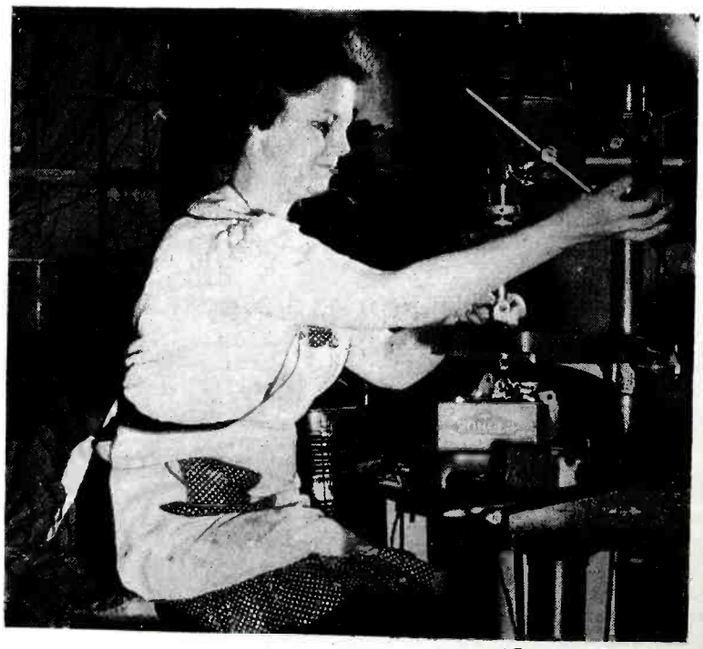
(Courtesy Westinghouse)

Large tube inspection also was formerly a man's job. Today, however, women have been assigned to this delicate and complicated task. The girl shown above is a graduate of a New York City college and is now a member of the engineering staff. She, like others in this and other plants, were given special courses at the plant. They have proved quite capable in their new posts.



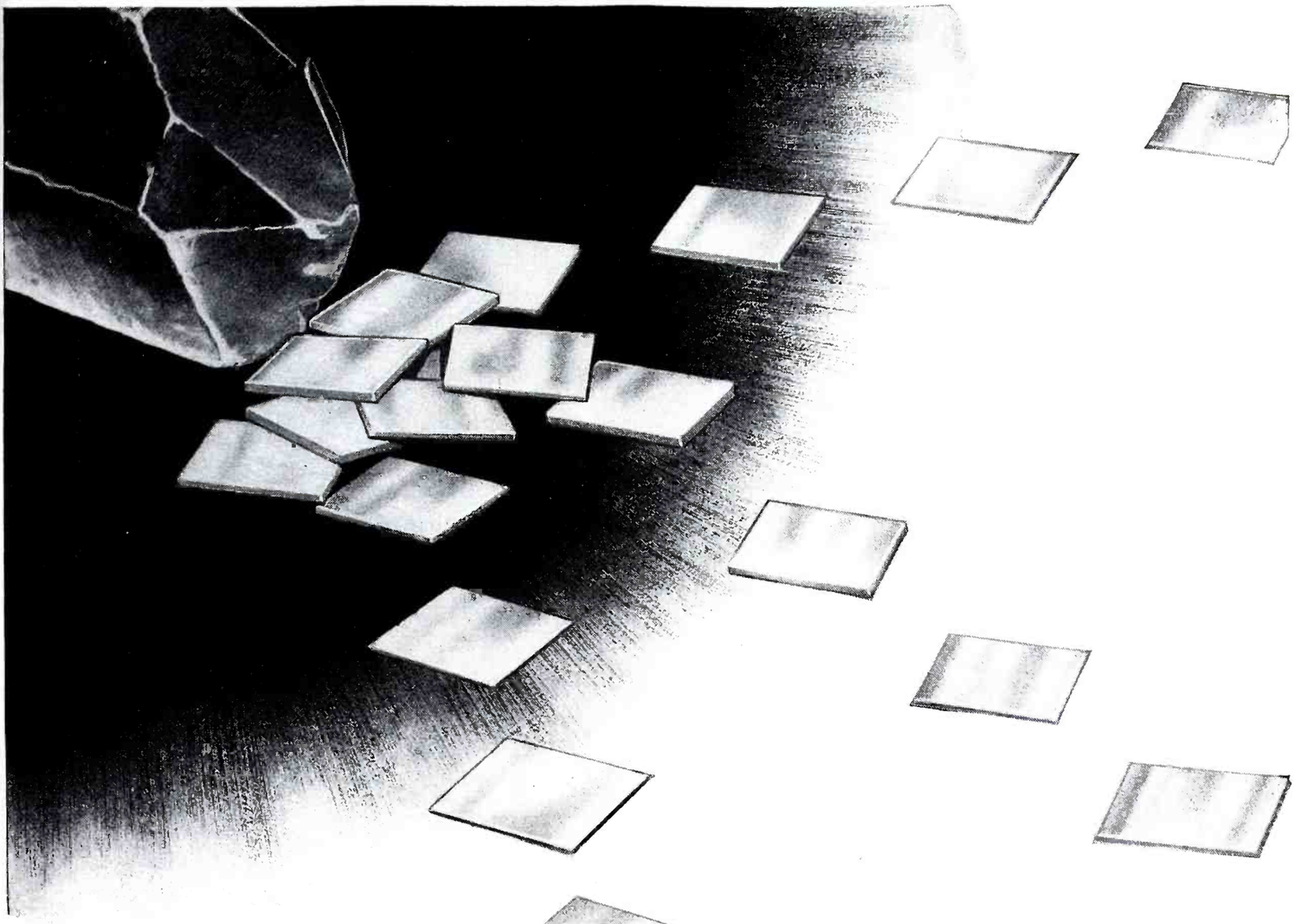
(Courtesy Westinghouse)

Tube testing has also been diverted to women's departments. Here we have a 51-control, 20-dial transmitting-tube tester under the guidance of a woman-member of the Westinghouse engineering division. With this device twelve or more transmitting tubes can be checked.



(Courtesy OEM)

Screw machine operations, strictly a man's task before, are now being handled very effectively by women, young and old.



KEYS TO TOMORROW

Locked within this crystal are keys to countless unexplored avenues of scientific and industrial knowledge. But it takes a consummate skill to release them. Such a skill is reflected in the scientific precision and craftsmanship which characterize oscillator plates and filter crystals by Philips. They have been proved worthy in their current service to Allied arms at war. They will be worthy of the task of helping open the doors upon a better tomorrow.

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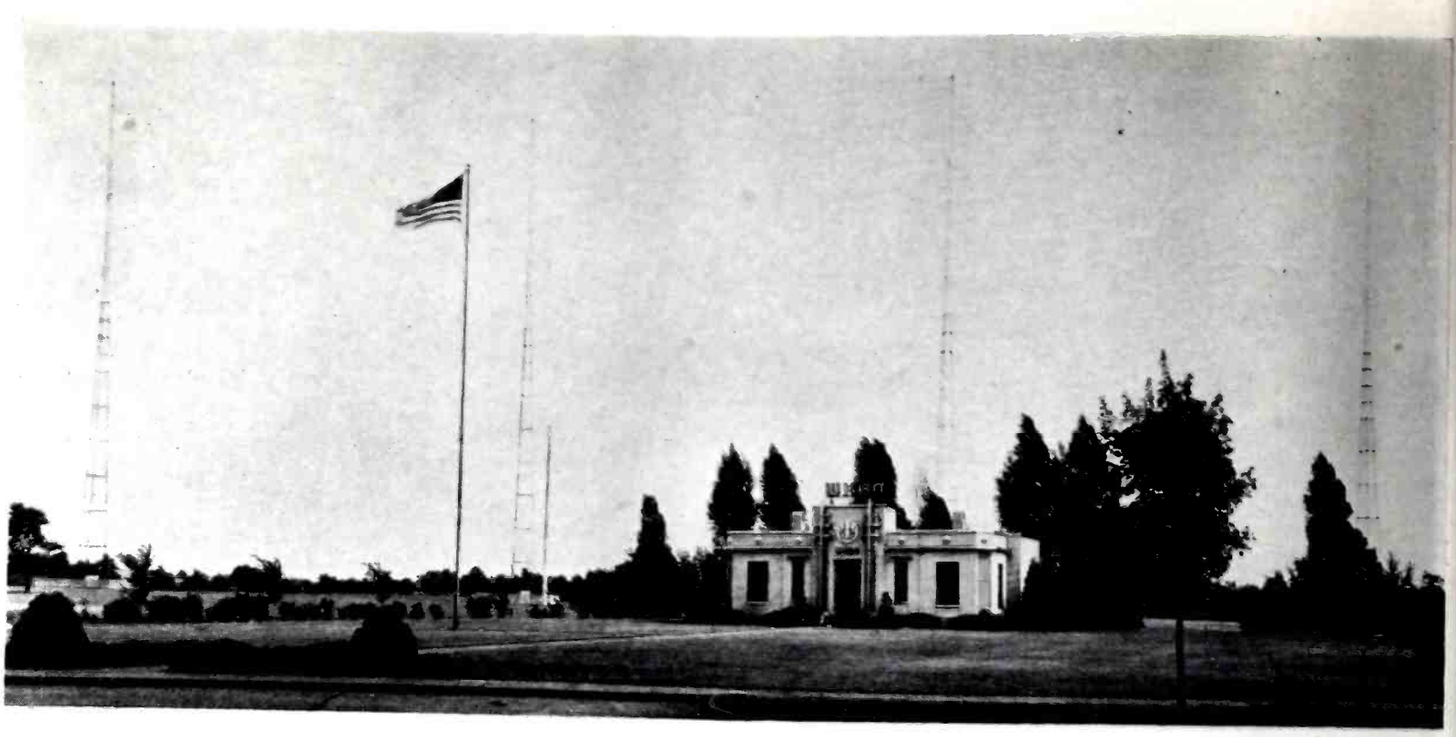


INSTALLING A TRANSMITTER

Under Wartime Conditions

by B. T. WILKENS
Chief Engineer, WKBN

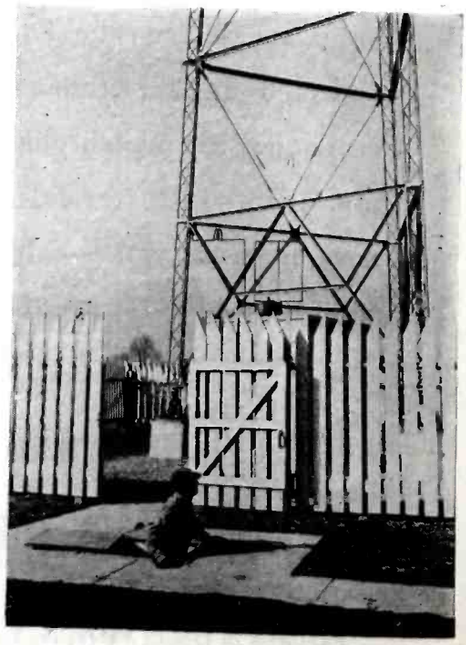
ON January 30, 1939, WKBN was granted an increase in power to 1 kw day and 500 watts night. Then on August 18, 1941, WKBN was authorized to operate full time. And on March 29, 1942, WKBN was granted authority to increase power to operate on 5 kw day and 5 kw directional night.

The first two grants did not affect the engineering department to any great extent except to add another man to the staff. The equipment was capable of handling the increase in power. With the third grant, however, growing pains were experienced. Ground and additional towers had to be purchased for the directional array; the necessary wire estimated and purchased, and of course a 5-kw transmitter was on the list, too.

The author during construction of the ducts. The openings or ducts may be seen inside the manhole between the bracing.

The transmitter building was designed previously for a 5-kw transmitter. Thus this part of the installation offered few difficulties. The interior of the transmitter room was renovated and a room built within a room, with the transmitter serving as the front of the inner room.

The transmitter was installed by the WKBN engineering staff. The interconnecting wiring between units was installed in a duct below the floor. All the wiring between the units at the old transmitter had to be removed from the conduit. For with the advent of the new transmitter, the conduit had become too small to hold the additional wiring. An interconnecting steel duct had to be installed. This worked out very well, for any conductor may be



Figures 1 (left) and 2 (right)

In Figure 1, we see the West Center tower and tuning house. The pickup loop for the phase monitor is mounted on top of the tuning house and loosely coupled to the feeder. At the top of the feeder, the lightning choke may be seen. Notice the lightning gap at the tower base. One gap is mounted on each leg. The wooden fence is a result of the war. Figure 2 shows the manhole at West Center tower. This manhole is 10 feet below the surface.

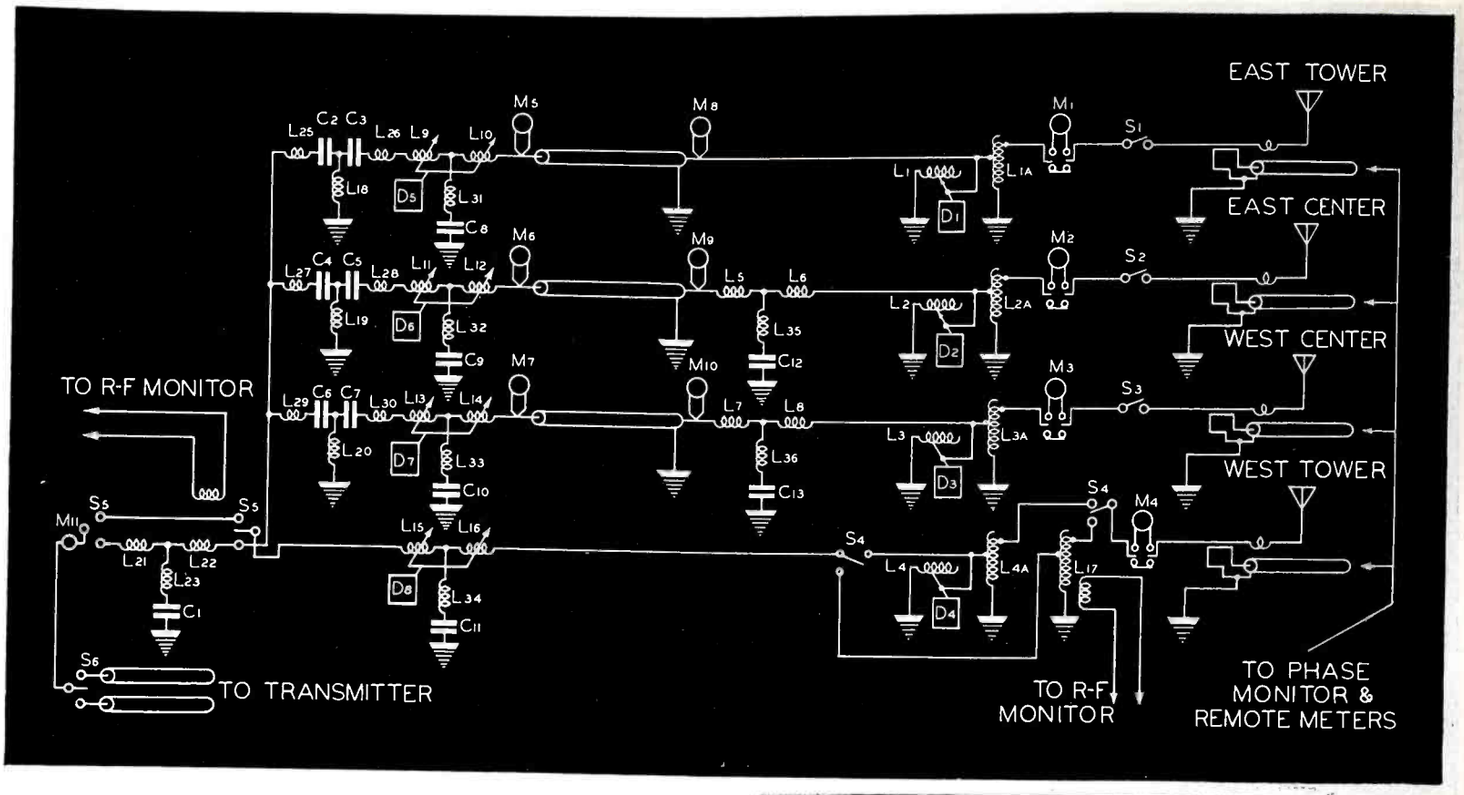


Figure 3
The WKBN directional array system.

examined or removed, or new wiring added, without removing all existing wiring necessary in conduit runs.

Remote controls for the transmitter are mounted in the control desk, lo-

Figure 6
The East wall, West tower. At left of picture are the three transmission lines for the West Center, East and East Center towers, respectively. At top left on the shelf is L_{32} and C_9, the shunt leg of the current network for the East Center element. At top center is the motor operated current network $L_{11, 12}$. Immediately below is the similar network for the East tower. Note the short lengths of transmission line at the extreme right of picture, which connect with the phasing networks located on the South wall. At right center are the shunt legs for the T networks above and below this shelf. Bottom network is for West Center tower.

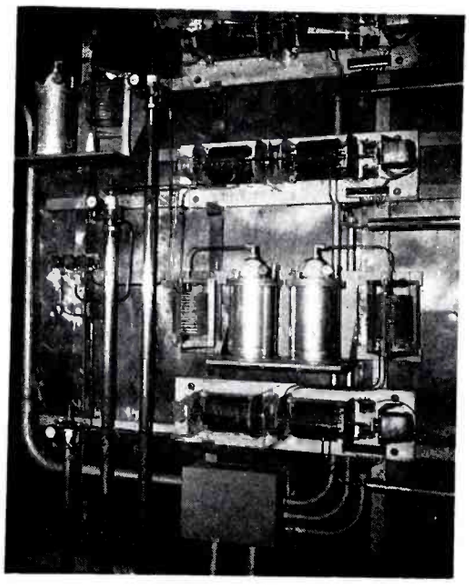


Figure 4
The West Center tuning house, North and West walls. On the North wall at the right of the picture is the T network ($L_{7, 8, 36}$, C_{13} in Figure 3). At the bottom center of the picture, the 1⅝" transmission line termination and M_{10} may be seen. At extreme left is the tower lighting choke and its associated bypass condensers. At top left is the feeder and entrance bushing. The flexible connection to S_3 is barely visible. To the right of the choke is the meter switch and M_3. Next to the switch is L_{3a}. L_3 is mounted immediately below L_{3a}, and the turn-counting device may be seen.

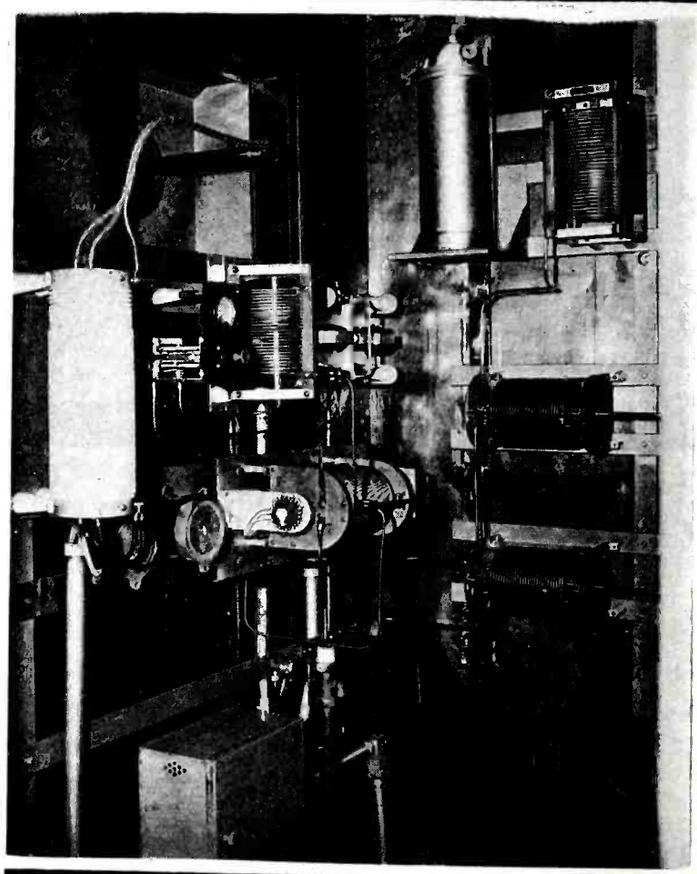
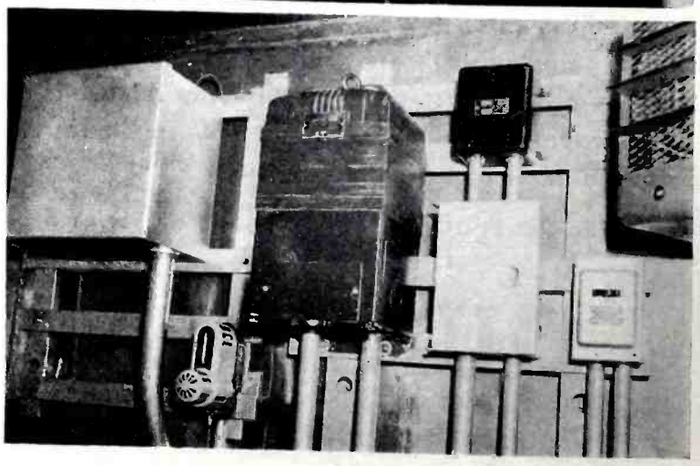


Figure 5
The West Center tuning house, East wall. At the top right is the electric heater and blower. Below is the disconnect switch and fuse box for all power and lighting circuits in this building. At the left of the heater is the mercury-type ten-ampere relay for flashing the top tower light. Below this relay is the tower lighting fuses.



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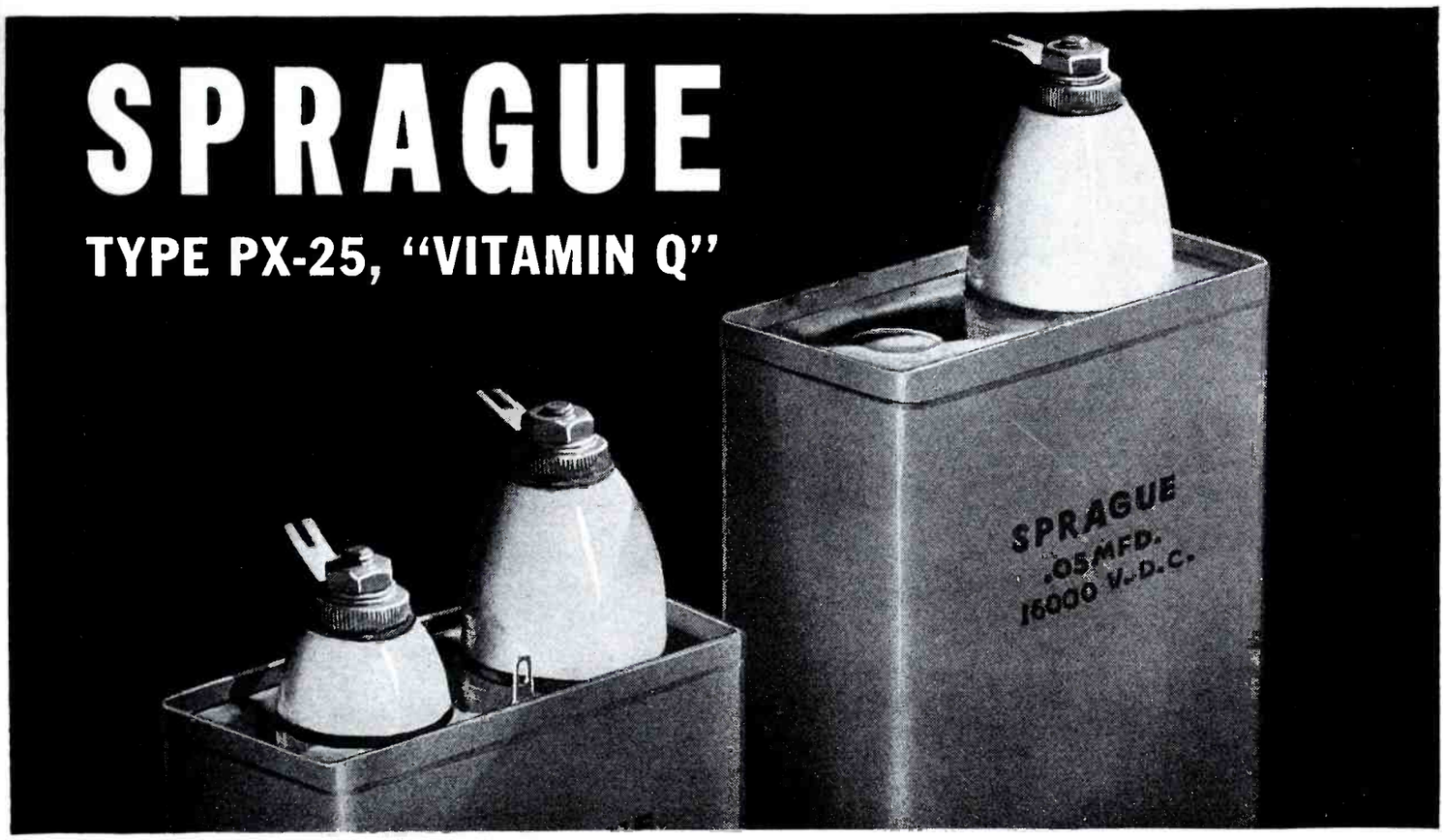

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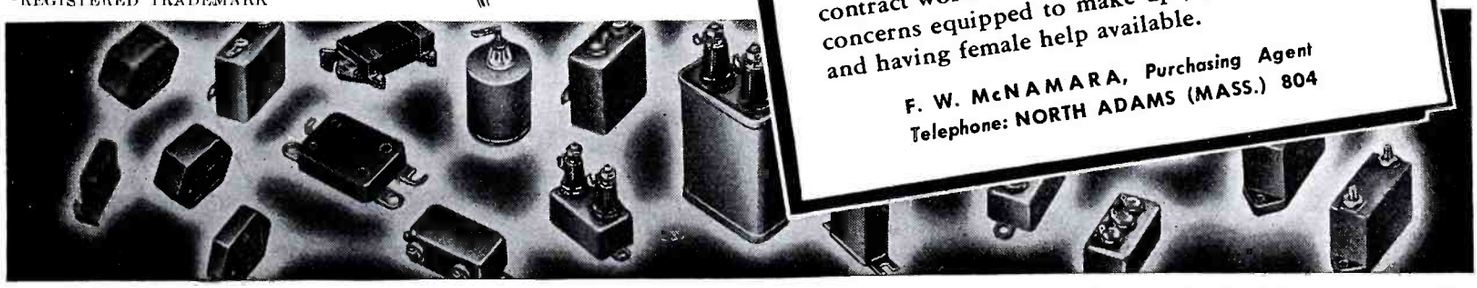


MANUFACTURERS OF A COMPLETE LINE OF RADIO and INDUSTRIAL CAPACITORS and KOOLOHM RESISTORS

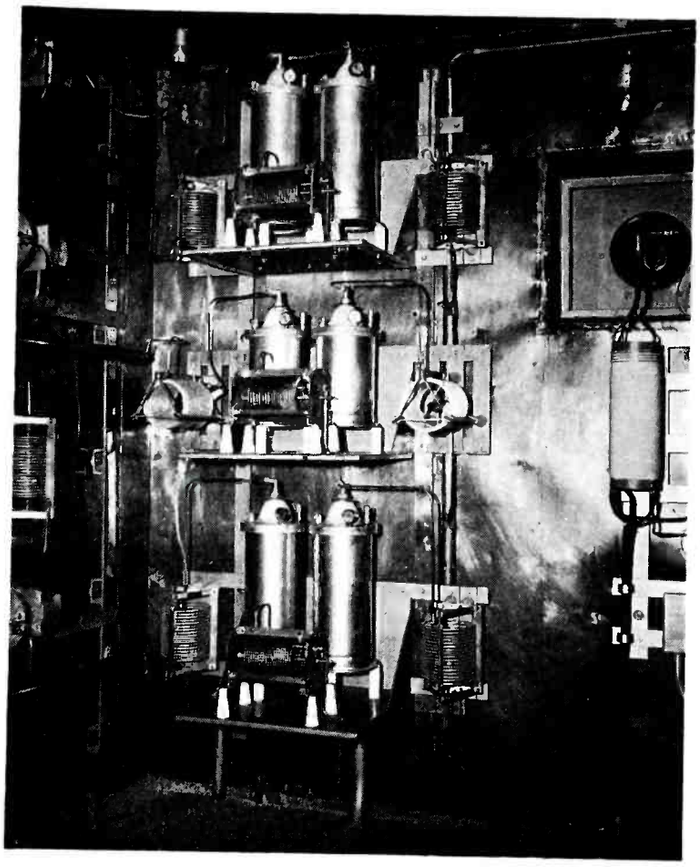


Figure 7

The South wall, West tower. At top left, protruding from the ceiling, is the pipe stub which mounts the pickup loop above the roof and carries the transmission line from same into building. This may be seen looping down to the East wall. At left of picture are the transmission lines between the current and phasing networks referred to in Figure 6. The condensers and inductances mounted on shelves and extending from the floor to the ceiling are the phasing networks and connect to the common point through the transmission line shown at the right of these networks, behind the inductances. At extreme right is the lighting choke and feeder to the West tower.

cated in front of the transmitter. Incidentally, this was also designed and built by the WKBN engineering staff. The control desk also houses control equipment for the emergency studio at the transmitter building. This desk is made of birch, finished natural, to harmonize with the interior fittings. The panels of the control desk are steel, painted and engraved to match the transmitter.

Wartime Problems

In normal times the construction of a directional system would not present any unusual problems, but with shortages, priorities, etc., a real problem prevailed.

We had to secure the necessary acreage adjacent to the present holdings, to erect the three additional elements required for the directional array. And three 344′ wide base, self-supporting towers were also required. As it was necessary to insulate the original shunt-excited radiator, as well as the three additional radiators, compression type insulators were purchased. A far-sighted purchase several years previous, assured enough copper wire for the entire ground system, but large quantities of underground cable, lead cable, conduit, fibre duct, and other material, were still required. In addition, we needed elaborate phasing and motor operated current networks and their associated control panels. Fortunately our orders were filled, and it wasn't long before the transmitter building walls started to bulge.

1⅝" Concentric Lines Used

Prior to the 5-kw grant, 2,100 feet of 1⅝" concentric transmission line and all fittings had been purchased, to replace the two 1" lines feeding the shunt radiator from the transmitter building, some 800′ distant. This purchase, we soon learned, was a wise investment. Priorities prevented the carrying out of our original transmission line plan. Thus the large concentric line was used to feed the three additional elements from the dividing network located at the tuning house at the base of the original radiator (West tower).

Due to our location, which adjoins a fine residential district on the southern edge of town, it was imperative to bury all interconnecting wires,

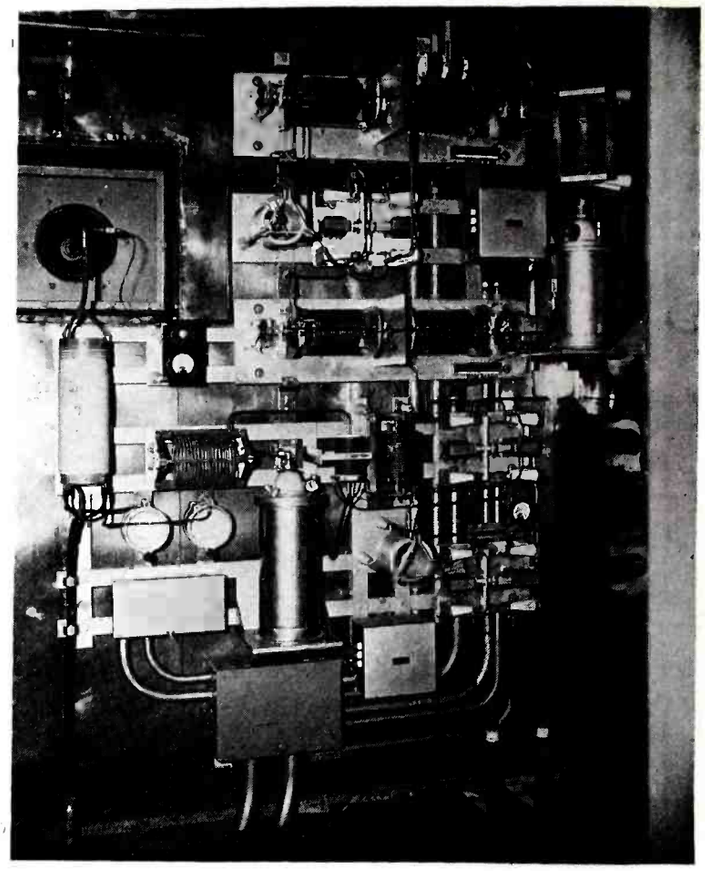
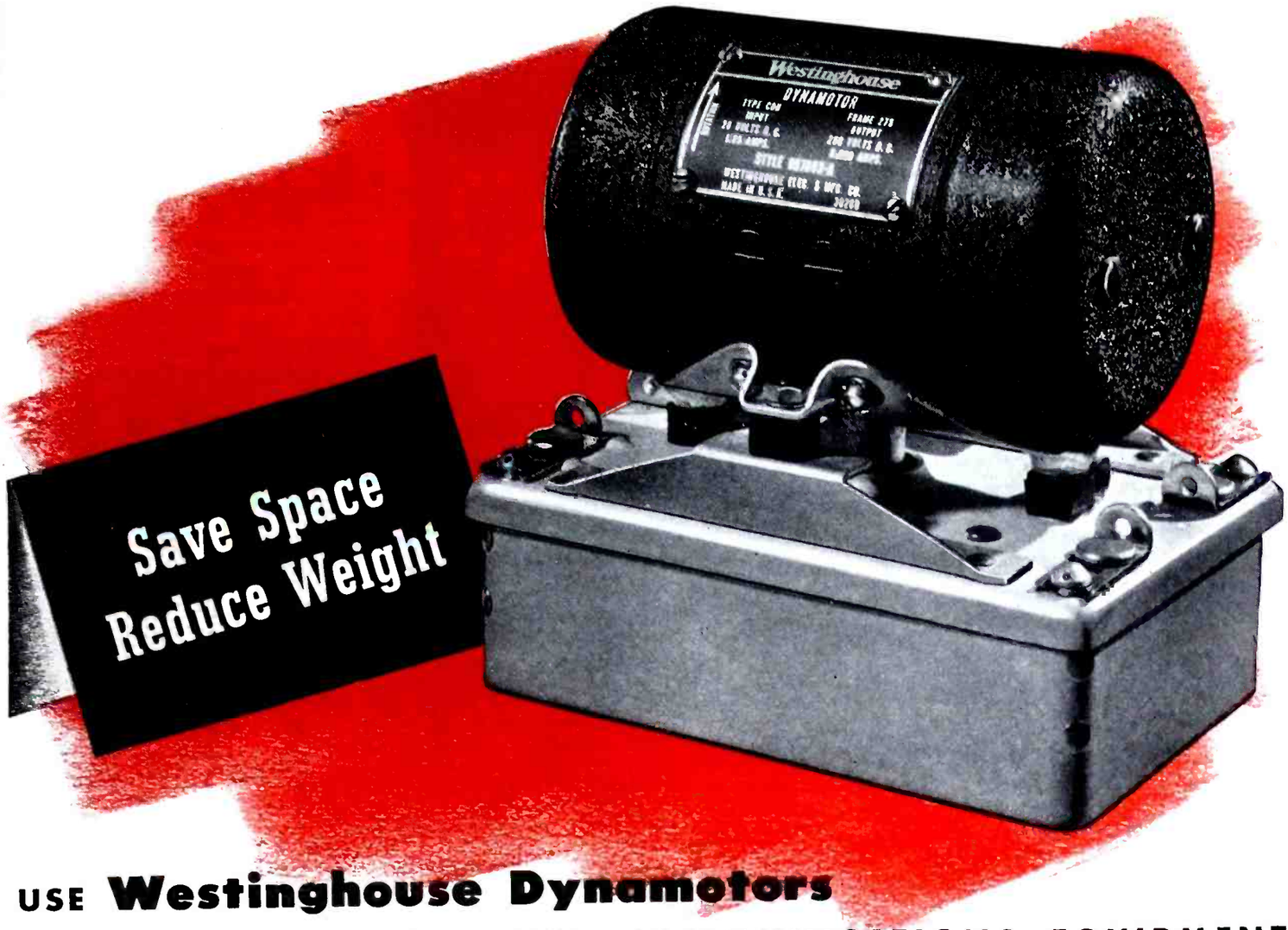


Figure 8

Another view of the South wall, West tower. Extending across top of picture is the transmission line connecting all elements to the common point. This line drops down to switch 5 (Figure 3) at right of picture. (The right angle concentric line fittings were made by the WKBN staff.) At top right are L_1 (directional) and L_{17} (day) inductances for the West tower. Note pickup coil for r-f monitor and transmitter protective circuit above the right inductance. Inductance at left below, beside insulator window, is L_{1a} (directional, part of the L network). The r-f switch beside L_{1a} is S_4 and is used to change inductances L_{17} and L_{4a} mounted above it, when changing from day to night. The box at right of switch houses the rectifier associated with the pickup coil for the r-f monitor. Inductance and condenser at extreme right top is L_{34}, C_{11}. The motor-operated inductances in center are $L_{15, 16}$ of the West Center T network. Note grounding straps connected at bottom left of motor-operated inductance mounts. At left center is M_4 and meter switch. The two switches at bottom right are S_5 and S_6, from top to bottom. The meter, between these switches, is M_{11}, the line current meter. The pickup coil for the line current or common point meter is coupled to L_{22}, both of which are shown at the left of S_5. The inductance directly below L_{22} is the other series inductor, L_{21}, comprising the T network, which is switched in and out for day and night operation. The pressure condenser at bottom center and the inductance at top left of this condenser are the shunt leg L_{23}, C_1 of the foregoing T network. Below L_{23} may be seen the bypass condensers across the lighting choke. The box beside the condenser houses several relays used for transferring audio and protective circuits for the day and night operation. At the lower right corner of the picture protruding from the manhole cover are the two transmission lines between the transmitter and this tuning house.



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cables, etc. All power circuits, telephone circuits, etc., were fed underground to the transmitter building from utility terminations, nearly 1,000 feet away. The power cable was terminated in a vault built into the basement of the transmitter building. This vault houses the primary fuses, an oil disconnect switch and the step-down transformers, as well as the plate transformer for the transmitter.

Between the transmitter building and the main tuning house, located at the west tower, five 3″ steel conduits were used to carry power, telephone, control, communication, lighting circuits, phase-monitor pickup circuits, remote-antennae ammeter circuits, spares, and two 1″ concentric transmission lines.

Concrete Manholes

The long run to the tuning house was broken at four points by concrete manholes, for inspection, maintenance and ease of installation. Between the main tuning house and the three additional towers, a 3″ fibre duct, set in concrete, was installed.

Having learned from experience that small manholes built into the original installation were too small for practical purposes, two 6′ x 6′ x 7′ manholes were incorporated in the underground construction of the directional array, to provide plenty of room for installation and maintenance. Incidentally, they would make excellent air raid shelters.

Buildings At Base of Towers

At the base of each tower, a brick building was erected to house the tuning units, flasher relay, isolation transformer, and power circuits. Each building is individually heated by an electric fan and heater unit, thermostatically controlled. The buildings were copper lined, and a copper-ground screen built into the concrete floor. The entire shielding is tied-in to the ground array. At the base of each tower leg, a rod was driven 9 feet below the concrete mat, and tied into the ground system. A copper ground screen 48-feet square was placed under each tower on the surface of the ground, and covered with 4″ of crushed limestone to prevent vegetation.

Ground System

The ground system for the West (original) tower consists of 270 radials approximately 400 feet in length. The ground systems for each of the three additional elements consists of 180 radials, 150-feet long. The ground wires were plowed in with a special attachment developed by the WKBN engineering staff, which was mounted on a tractor equipped with vacuum lift.

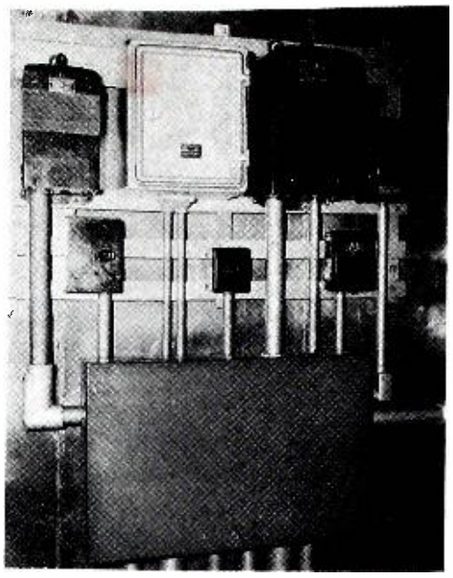

Figure 9

At the West wall, West tower. Across the top, from left to right, are the isolation transformer for West tower lights; master flasher which operates the individual mercury relays located at each tower tuning house; 7.5 kva transformer for power and lighting used in all tuning houses, and main disconnect for 110/220 power and lighting service. In the next row, from left to right, are the West tower lighting fuses; mercury relay for West tower top light flashing, and main switch for tower lighting circuit operated by the photoelectric cell relay.

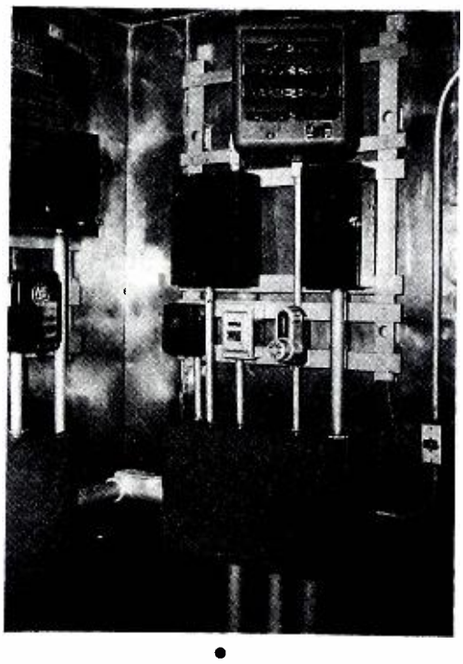

Figure 10

The North wall, West tower. Heating unit is at top center, with its thermostatic control directly below. To bottom left of unit are the relays controlled by the photoelectric cell. To bottom right of heating unit is a box, mounting relays for controlling 220-volt directional switching relays. These relays are operated from low voltage carried in telephone cable. The two boxes at left center and below the photo electric cell relay cabinet are—at left, emergency tower light control relay which may be operated by a switch on control desk at transmitter, should the photocell fail, and at right, the disconnect switch for building power and lighting circuits.

The WKBN engineering department had to engage in building operations, for it was impossible to find a contractor who would assume responsibility of this exact construction job. Tower foundations were laid out, holes dug, forms built, and concrete poured before winter set in. This gave the concrete plinths a chance to harden or cure sufficiently, and to settle if they would, before any towers were mounted. It also provided a further wedge with which to speed up delivery of the towers. Throughout the winter of 1941-1942 construction was maintained. The main tuning house at the base of the West tower was built under a tent, and to prevent the concrete and mortar from freezing, a salamander was used. In the spring of 1942, as soon as it was possible to work the ground, construction was started upon the additional buildings, one at the base of each tower site. As each of these buildings required some means of connection with the main underground system, it was necessary to excavate and build forms for a 4′ x 4′ x 5′ manhole under each building. This provided easy access to the duct system.

Fibre Ducts

During the tower erection period, the channels for the ducts were opened, and some of the fibre ducts placed in position. The ducts are 3″ fibre and are laid in concrete on approximately 8″ centers. Construction continued on the ducts all summer and fall. Grading following completed work as fast as possible so the fall rains could settle the backfill. Concrete sidewalks were laid when the weather permitted, which, when completed made it possible to work in all kinds of weather. Ground radials were buried in the fall, but not until after much delay because of bad weather and inability to secure the services of a tractor. Ground screens were laid down, as the snow began to fly, and the radials tied in. As fast as a section of screen was completed, it was covered to a depth of four inches with crushed limestone.

Outside Work Completed Xmas, 1942

All of the outside work was completed before Christmas 1942 and attention was centered upon the mounting and wiring of the dividing and tuning networks, and associated equipment. The work of building three concentric transmission lines was started, and a tent was erected to protect these lines from the elements. But for one thing, everything was completed and ready for the initial adjust-

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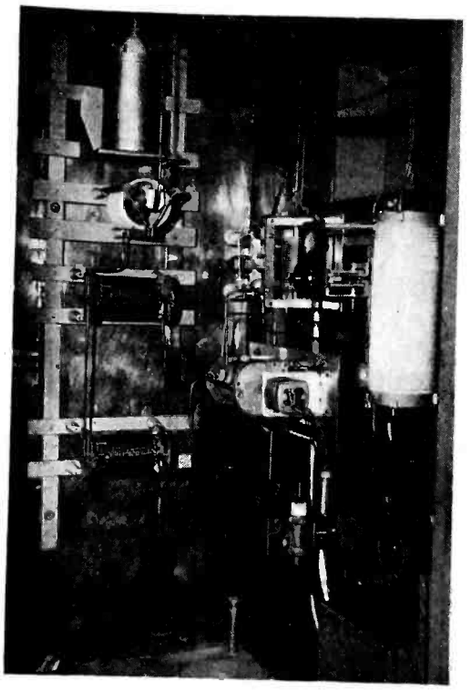
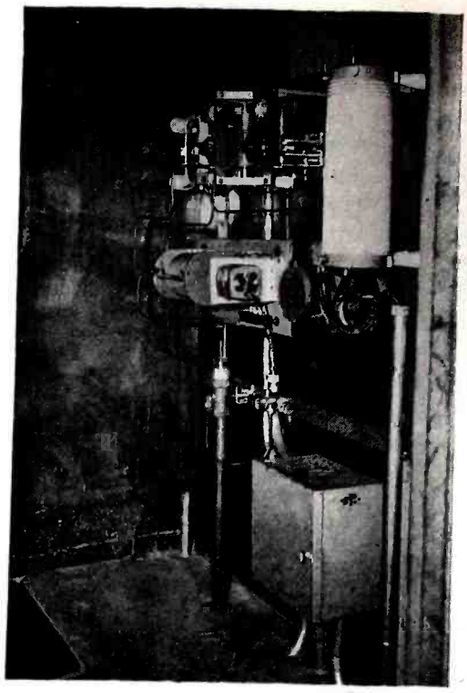




Figures 11 (left), 12 (right) and 13 (top) Figure 11 shows the East Center tuning house. At left from top to bottom is the T network C_{13}, L_{86}, $L_{7,8}$ used to artificially extend the length of the transmission line. At bottom right, the transmission line termination and meter M_9 may be seen. In the center of picture is the switch which disconnects the element during daytime operation. The L network, meter and meter switch and lighting choke and associated condensers are also shown.

Figure 12 shows the East tuning house. Note the small amount of equipment required for tuning the East tower. Both the East Center and East tuning houses have the same equipment layout. Note the copper lining in all buildings.

In Figure 13 is the new 5-kw transmitter. Note the indirect fluorescent lighting above the transmitter front. Behind the door, at left of transmitter, are the phase monitor, remote antennae meters and the directional switches. The control desk is at bottom right of picture. Audio equipment racks, not shown, are at left front. Floor is rose and brown asphalt tile over a hardwood floor. At top center of picture, skylight edge just shows. Ceiling of transmitter room is treated with gypsum tile.

ments by February 1, 1943. As it was impossible to obtain a suitable phase monitor, and the connecting transmission line and pickup loops, it became necessary to design and build suitable equipment, and to find a substitute for the transmission line. In Figure 14 appears one of the three sections of the phase monitors adapted. This phase monitor has one feature which made it desirable. An r-f milliammeter may be inserted in series with the transmission line from the pickup loop. If proper care is exercised this meter can be calibrated to read antenna current of the particular tower to which the loop is coupled. The calibration will hold over a considerable period of time.

Phase Monitor Mounting

The phase monitor was mounted in a rack at the transmitter building. All lines from the pick-up loops were extended to the same length to avoid any phase shift due to different length lines. The design of the directional system was based on the use of concentric or unbalanced transmission lines, having a characteristic impedance of 60 to 80 ohms.

Placement of Elements

Figure 15 shows the placement of the elements, at the extremities of a parallelogram, with the East and West elements spaced 852 feet and lying on a line bearing 66.9° true. The East Center and West Center elements are spaced 302 feet and lie on a line bearing 85.9° true.

Reactance Reversals Avoided

The West tower in the array is the original tower and is used as the reference element for the phase monitor. The transmission line to the East tower is approximately ½ wavelength in length. No line is used at the West tower. The transmission lines to the West Center and the East Center towers are electrically extended to approximately ½ wavelength. This was done to avoid reversals in signs of reactance at the sending end of the transmission lines, which, when the lines are connected in parallel, may cause the common-point impedance to have

(*Continued on page* 110)

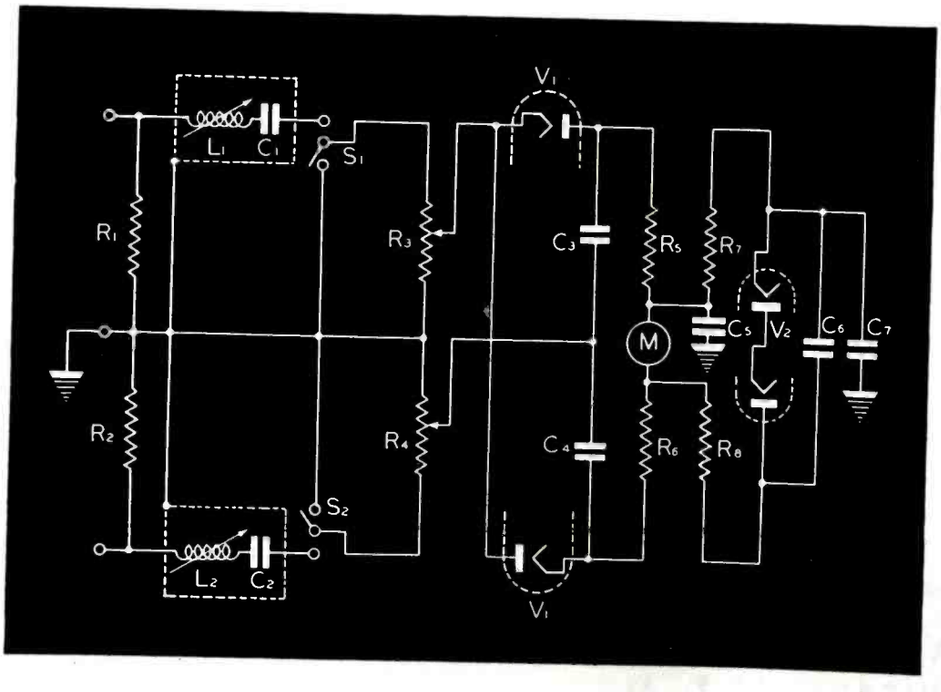


Figure 14

One of three identical sections of the phase monitor, that had to be built because of the scarcity of commercial units. With this monitor, a r-f milliammeter, inserted in series with the transmission line from the pickup loop, can be calibrated to read antenna current of the particular tower to which the loop is coupled.

what price Star-Gazing?

To dream and plan realistically for the future is both good and necessary. However, to indulge in Star-Gazing through the wrong end of the telescope is an extravagance which no industry can afford. RADIO can point with pride to its achievements and its miraculous progress made under the impetus and emergency of war. But to promise that the miracles of Radar and other Electronic development will be ready for delivery on V-Day . . . is to damage an otherwise glorious record.

THE FUTURE IS BRIGHT . . .

BUT LET'S KEEP OUR EYE ON THE BALL!

Our number one job right now is the production of Radio Communications Equipment and Radar for the armed services. These are weapons which will help win the war. The application of new Electronic knowledge to peacetime radio production will, of necessity, be a gradual and evolutionary process. Your number one mass market immediately after the war will be radio and phonograph sales, and you *can* bet on *this*—it's going to be a "whale" of a market!

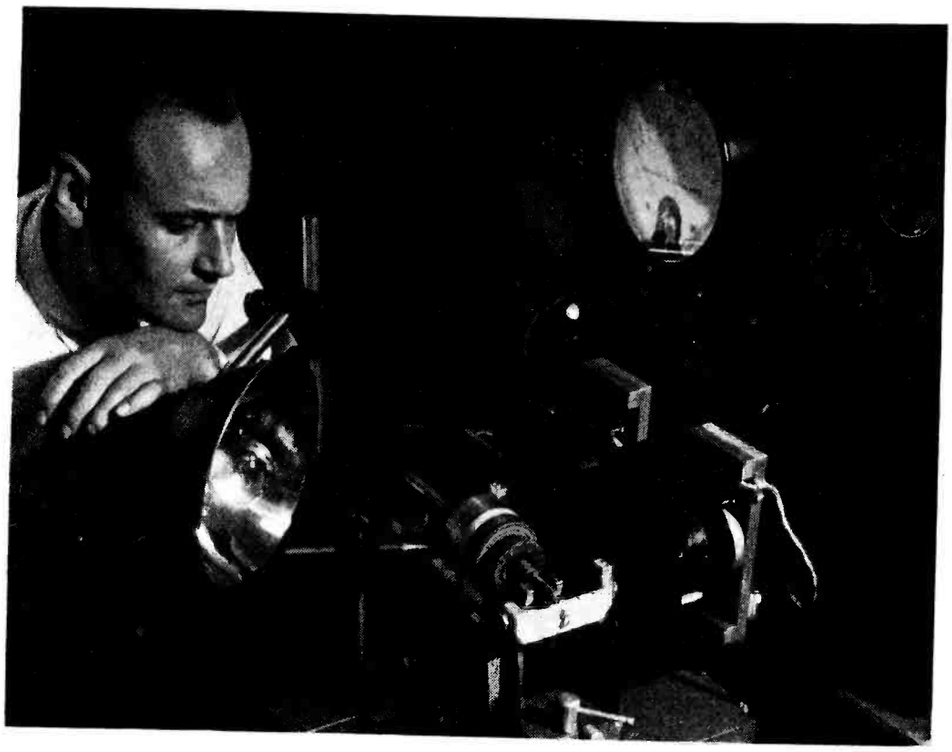
ARMY E NAVY

For the development and production of Radio Communications Equipment for our armed forces, the Motorola organization was awarded the Army-Navy "E" with added Star for continued excellence of performance. Motorola is proud of the part it has been privileged to play in the speeding of Victory.

You May Expect Big Things from Motorola. We can't say when but we *can* say . . . no one will be ready sooner!

Motorola RADIO
FOR CAR & HOME
GALVIN MANUFACTURING CORPORATION · CHICAGO

PRODUCTION AIDS



The stroboscope has proved itself a very useful tool in the plant. It has provided the solution to many intricate production problems.

At the left we see the stroboscope used in a very unique way; to check up on motor balance. With the aid of the stroboscope, the operator can see a spot on the revolving rotor that is out of balance and can read that amount directly on a meter.

The *dynetric balancing method* is used in conjunction with the stroboscope here to afford judgment of the correct balance. With dynetric balancing, it is possible to determine the exact location and the amount of corrective mass required to eliminate vibration. According to tests made, it has been possible to measure unbalanced vibration of as small as twenty-five millionths of an inch, in as quickly as 45 seconds.

(*Courtesy Westinghouse*)

SETTING up and adjusting a standard optical system, with its maze of metal clamps and rods, has been considerably simplified by the use of a method using alnico, made into magnets and inserted into the base of the standards.

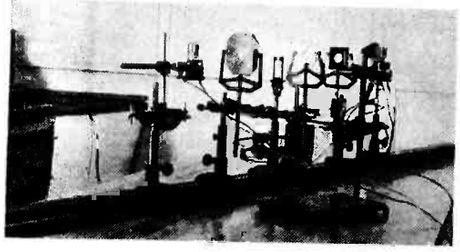
Developed by N. F. Barnes

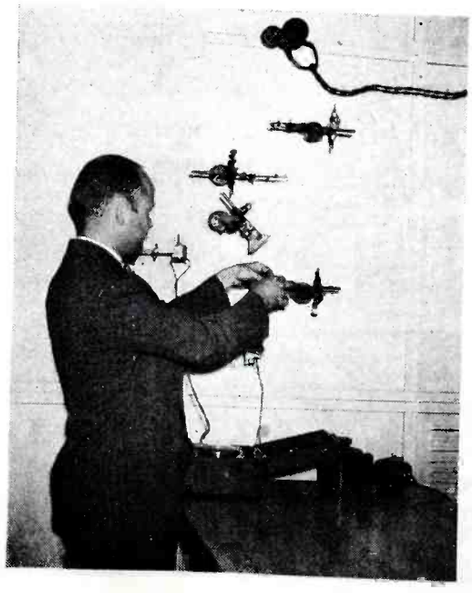
This new method was devised by Norman F. Barnes of General Electric's laboratory in Schenectady. All that is required is a metal top to the table on which the system is placed and metal walls, if a vertical system is desired.

Alnico magnets are not only among the most powerful but once magnetized they stay so.

"Getting the proper dimensional adjustments with the old type optical system was often a tedious job," according to Mr. Barnes. "The slightest little movement would throw the entire system out of adjustment and this often occurred when you attempted to tighten a holding screw on one of the standards. And if you required a vertical system, it was a real job to get the various lenses into proper line by clamping them onto wooden or metal uprights. With the alnico standards, it's no trouble at all. The standards stick wherever you place them."

Below and at right we have the old and new optical adjustment system. In the view below, appears the usual optical system employed with its metal runway and maze of clamps and rods that are required to make the necessary adjustments. Note how the ringstand is clamped to prevent it from moving when adjustments are made on a phototube. At right, we see Norman F. Barnes, with the new system, using but a few parts.



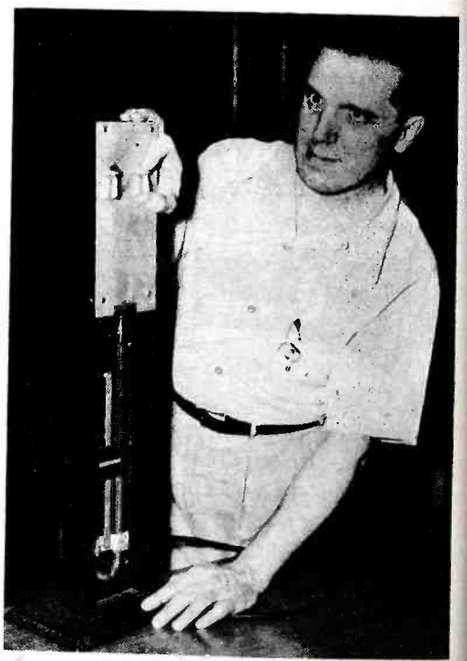


Lab Engineer Wins WPB Award

Francis E. Pratt, instrument laboratory engineer, Stromberg-Carlson Company, Rochester, N. Y., has won the War Production Board's certificate of individual merit.

Pratt's contribution consists of a differential pressure gauge that is said to provide the testing of aircraft communication units 32 times faster than heretofore.

(*Continued on page* 81)



Francis E. Pratt and his differential pressure gauge used to speed up tests on aircraft communication parts.

Your boat will have a 'phone!

After the war...

. . . the two-way radiotelephone will be employed by American industry as a convenience, a safeguard and a business requirement. This modern method of communication has many proven applications in the following fields:

Aviation	Railroading
Marine	Public Utilities
Police Patrol	Fire Fighting
Trucking	Engineering
Mining	

If you think you may be able to employ two-way radiotelephone communication in your field, we would be pleased to discuss your problem without cost or obligation. We have nothing to sell since our entire output has been placed at the disposal of the United Nations all over the world!

•

Requests for information and literature from responsible parties may be addressed to Jefferson-Travis Radio Manufacturing Corporation, 380 Second Avenue, New York.

YES, sir—when peace comes any water-faring craft from an ocean liner to a runabout can have two-way radiotelephone equipment for the pleasure, convenience and safety that it spells. The amazing wartime development of this unusual form of communication gives definite promise it will be used in scores of ways in the social and industrial life of the nation after the war.

As pioneers in the field of two-way radiotelephone equipment it gives us satisfaction to know that our entire output is effectively serving the United Nations in every sphere of conflict and hastening the day when Jefferson-Travis again will be making this equipment for you and your peacetime purposes in Tomorrow's World!

JEFFERSON-TRAVIS

RADIOTELEPHONE EQUIPMENT

NEW YORK • WASHINGTON • BOSTON

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President — RCA BUILDING, 30 Rockefeller Plaza, New York, N. Y. — GEORGE H. CLARK, Secretary

Personals

FROM Leroy Brenmmer, formerly very active as our Los Angeles chapter secretary, has come an interesting note, describing his present activities.

He says, "Just a line to let you know that the Japs haven't got me yet. I got off the *President Monroe,* for a couple trips off, after being on her for nearly two years. And I have returned up to Alaska for the salmon fishing season, where I am engineer-supervisor in charge of four radiotelephone and telegraph coast stations, plus the installations of ten boats. You will recall that I was up here in 1941 also.

"It has been a good year for fish. I will probably rejoin my ship after a vacation down in sunny California, and will try to run back to little old New York while I am at it.

"Since Pearl Harbor, I have had many exciting moments making over a dozen trips down to the southwest Pacific. Have gone through plenty of action, and have been awarded both the New Zealand and Australian *Merchant Navy Medal of Honors,* plus a personal citation from MacArthur.

"Manage to keep track of the gang via the pages of COMMUNICATIONS."

IT is with profound sorrow that we have learned of the death of Walter V. Russ, manager of the Marine department of Mackay Radio and Telegraph Company. He was but 43 years. His many friends will miss him.

For the Record

AS might be expected of a membership which is constantly shifting, from ship to shift and to shore, the records of our secretary might be listed as the *Book of Multiple Addresses.* In an attempt to clear this up, at least to date, a questionnaire is being mailed to each member, at each of his addresses. Do *your* part when you receive this.

During the WOR broadcast, Ted McElroy offered to send his code chart to schools, free of charge. Shown with the chart are, left to right: William McGonigle, J. R. Poppele, Francis Horne, Major General J. O. Mauborgne (Ret.), Ted McElroy, and Lothar Shnitkin, a scholarship winner.

At the recent Marconi Memorial Scholarship broadcast over WOR. Left to right: Francis H. Horne, one of the winners, Ted McElroy, and William McGonigle

Copies of the 1943 Yearbook are still available, at cost (fifty cents). As a premium, each subscriber will receive free a copy of the 1943 supplement. This is a new departure. It gives full details of the 1943 Cruise. Previously we have had to wait for an entire year before getting this story. Write to the Secretary, room 3535, 30 Rockefeller Plaza, and include money order or check.

So that our Association may be effectively represented each month in these pages, members are urged to send in stories of themselves or their work — and frequently! Something more than a mere record of assignments is desired. Make it a special story of some event of the past or present; a meeting of the "clan" here or there. Write something that YOU would like to read if the other fellow wrote it. Your president, and your secretary, toil every month to tell VWOA's story, and always succeed, but it is not just what we want. We would like to get down to earth and tell stories of what our members are doing and where they are. To achieve this aim, YOU must tell US. Send manuscripts to the secretary.

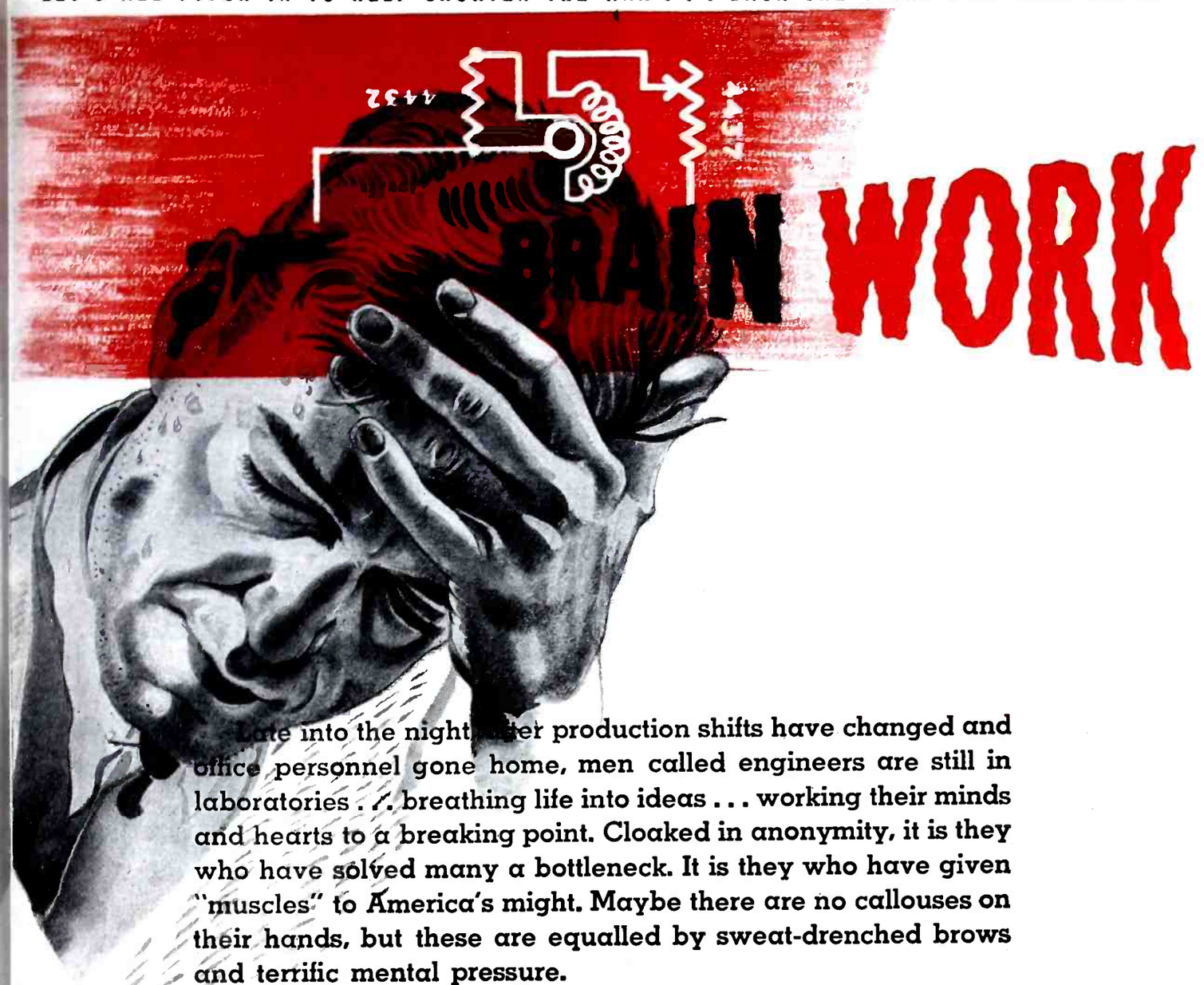
How We Began

"AS I listened to the three broadcasts at our last Cruise," commented Bill Fitzpatrick, our Memory Log friend, recently, "my mind went back to our first *babbling broadcast* over WRNY, early in 1925, the year when the nebulus which later became VWOA first came into sight. From the stammering of a bunch of excited operators to the measured words of Admirals and Brigadier Generals, is quite an advance for eighteen years.

"But the thought which struck me with greatest force, as celebrity after celebrity was introduced, and as medals were presented freely, was that one man, present at the time, who really

(*Continued on page* 100)

LET'S ALL PITCH IN TO HELP SHORTEN THE WAR . . . BACK THE THIRD WAR LOAN DRIVE



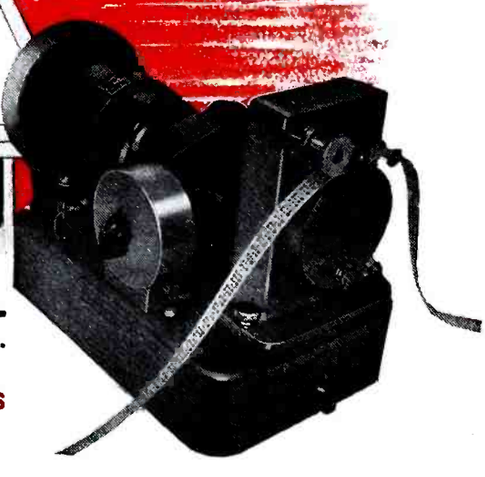
BRAIN WORK

Late into the night, after production shifts have changed and office personnel gone home, men called engineers are still in laboratories . . . breathing life into ideas . . . working their minds and hearts to a breaking point. Cloaked in anonymity, it is they who have solved many a bottleneck. It is they who have given "muscles" to America's might. Maybe there are no callouses on their hands, but these are equalled by sweat-drenched brows and terrific mental pressure.

Such are the engineers of McElroy, too . . . forever probing new and unfamiliar corridors of electronic progress. Out of their work tonight will come another advancement in the art of wireless telegraphy. Out of their work tonight will come industrial developments for a world of tomorrow.

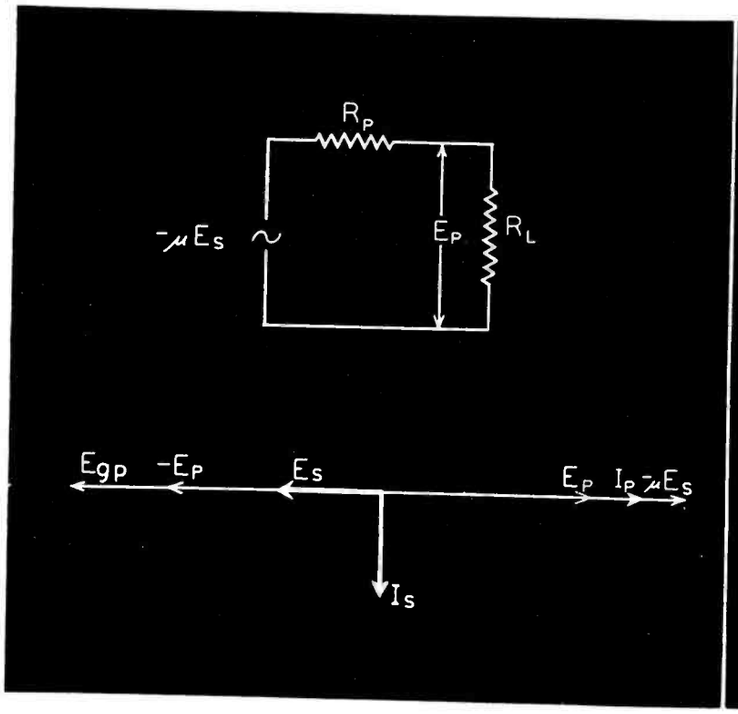
TED McELROY AND HIS STAFF
ARE CREATIVE ENGINEERS

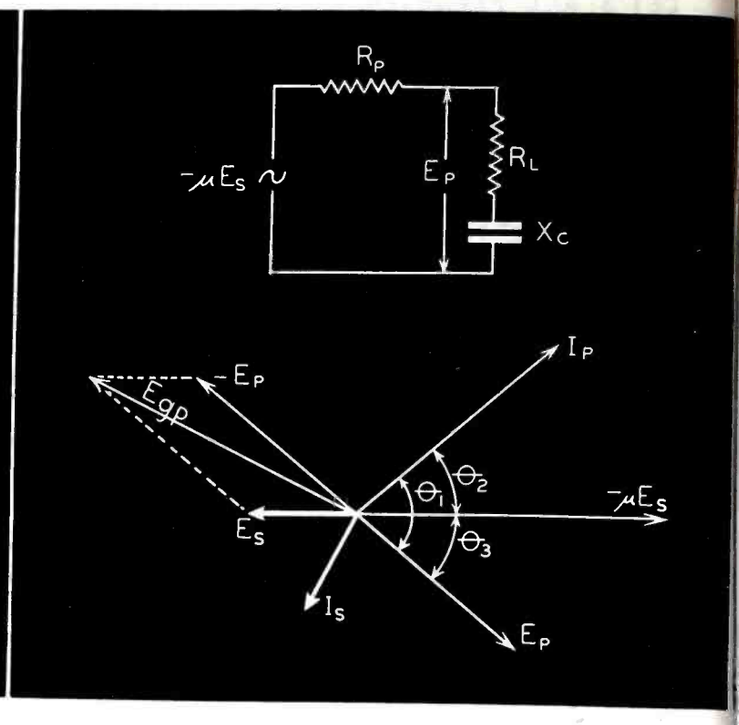
WE NEVER COPY...NEVER IMITATE
WE CREATE . . . DESIGN . . . BUILD
PLEASE FEEL FREE TO CALL UPON US
WHENEVER WE CAN BE OF SERVICE



McElroy MANUFACTURING CORP.
82 BROOKLINE AVE., BOSTON, MASS.

WORLD'S LARGEST MANUFACTURER OF AUTOMATIC RADIO TELEGRAPH APPARATUS





Figures 1 (left) and 2 (right)

In Figure 1 appears the equivalent circuit and vector diagram of a vacuum tube amplifier that is operated at a frequency low enough to make the transit time of the plate current electrons unimportant. In Figure 2 we see an equivalent circuit and vector diagram if the load impedance has a component that is a capacity reactance.

THE INPUT ADMITTANCE OF VACUUM TUBES

by PAUL K. HUDSON

Assistant Professor Electrical Engineering

University of Idaho

IT is possible for the input conductance (the real part of the complex admittance) of a vacuum tube amplifier to be positive, negative, or zero. The significant factors that determine the input conductance are: (*a*)—load impedance; (*b*)—physical construction of the tube, and (*c*)—frequency.

Input Conductance Factor

If the input conductance of a vacuum tube amplifier is negative, power flows from the plate circuit to the grid circuit and the tube may oscillate. It then has little value as an amplifier. Also, if the input conductance of a vacuum tube oscillator is positive, power flows from the grid circuit to the plate circuit and it may stop oscillating. There are other harmful effects of the input conductance of vacuum tubes[1, 2, 3].

Use of Vector Diagrams

The physical explanation for the real component of input admittance can be found by the use of vector diagrams of the currents and voltages in the tubes. A component of the input current is used in charging the capacitance of the grid and plate. This current I_s flows as a result of the voltage E_{gp} across these elements. The voltage E_{gp} is the difference between the grid signal voltage E_s and the a-c voltage E_p developed across the load impedance.

(*Continued on page* 102)

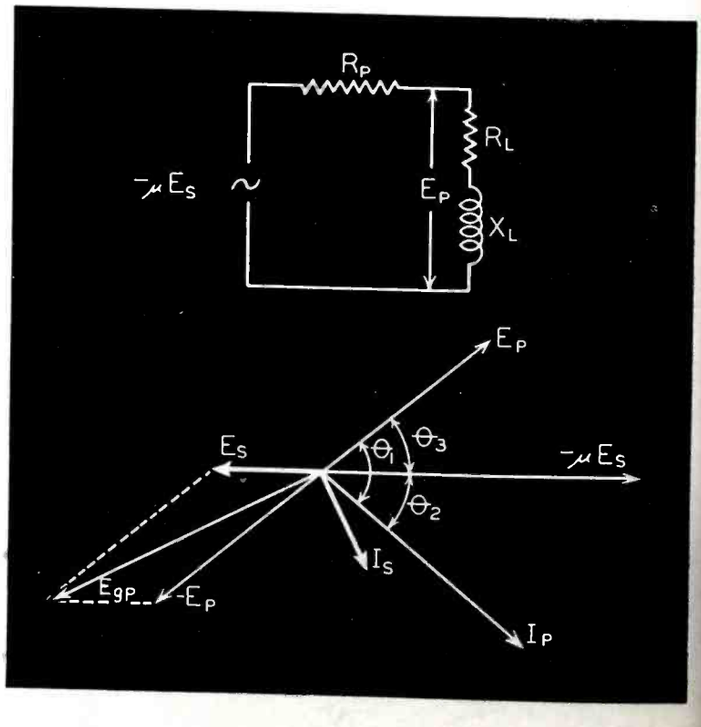


Figure 3

If the load impedance has a component that is an inductive reactance, the equivalent circuit and vector diagram shown here is the result. It will be noted that E_p is shown leading I_p by the phase angle θ_1 of the load impedance and $-\mu E_s$ leads I_p by the angle θ_2 of the entire circuit. The voltage E_{gp} is the vector difference between E_s and E_p.

OIL IMPREGNATED

(ACTUAL SIZE 13/16 SQUARE)

To Meet the Higher Temperature Requirements of Your Present and Future Equipment

The molded paper capacitors, supplied by *Micamold* for a number of years, have been wax impregnated. Now we have added a comprehensive line of oil impregnated capacitors which are being widely used in radio and electrical equipment. Of these, the types 336 and 337 are the same size as the familiar postage-stamp mica capacitors.

We will be glad to acquaint you with the complete line of *Micamold* Capacitors. Perhaps you are now working on a project where a *special* molded paper capacitor can be designed to fit in with your requirements. Can we help you? Communicate with us.

Remember, there's a MICAMOLD CAPACITOR for all communications and electronic applications

RECEIVING AND TRANSMITTING MICA CAPACITORS • MOLDED PAPER CAPACITORS • DRY ELECTROLYTIC CAPACITORS
OIL IMPREGNATED PAPER CAPACITORS • MOLDED WIRE WOUND RESISTORS

MICAMOLD RADIO CORPORATION

1087 FLUSHING AVENUE — BROOKLYN 6, N. Y.

BACK THE ATTACK — GET BEHIND THE THIRD VICTORY WAR LOAN DRIVE.

D U A L —

For Mobile and Fixed Operation

by ART H. MEYERSON

New York Fire Department Radio Laboratory

Figure 1

Receiver mounted in car. The vibrator unit is mounted in the motor compartment, and the speaker is in the center grille. Directly under the grill is the on-off switch.

THE functional design of a receiver built for a specific need may sometimes lead to new applications of basic radio principles that are not immediately apparent. The equipment, dual-channel receivers, to be discussed has served that purpose.

Need for Dual Channel Units

The dual-channel receivers were originally designed to fill a particular need in the communication system of the New York Fire Department. Previous to its use, two separate receivers had been installed in those mobile units that required communication facilities with both the police and fire departments. A band-switching receiver was inadequate since both units had to be *on receive* most of the time. For example, one mobile fire unit, which makes long runs, uses the police channel to determine if any police units are responding to police calls along the route of travel. This avoids accidents, which may occur due to the siren of a fire car masking the siren of a police car.

Separate R-F Stages

It was therefore decided to consolidate those components of the two receivers common to both. The block diagram, Figure 5, shows the layout of the new unit.

This receiver utilizes two separate r-f stages tuned to their respective frequencies, 2.45 mc for police, and 1.63 mc for fire. These in turn, feed two triode-hexode converters, with the triode portions joined in a push-pull crystal oscillator operating on a frequency of 2.04 mc (Fig. 3). The output of the converters is fed into an i-f stage tuned to 410 kc, the difference between either signal and the oscillator, and then through a diode detector, squelch and audio system. A single antenna may be used, utilizing the circuit shown in Figure 4.

Push-Pull Oscillator

One advantage of the type of con-

CHANNEL RECEIVERS

Figure 2

Front view of the a-c/d-c house receiver mounted in a cabinet. When the switch in the center is in the neutral position, both police and fire signals are received. The left and right positions are respectively for either police or fire signal reception. The two panel lights, which are colored red for fire signals and green for police signals, operate concurrently with the signal.

verter circuit used, aside from stability and reduction of the number of circuit components, is the elimination of second harmonic cross-talk, through the use of a push-pull oscillator.

Fixed-Station Receiver Design

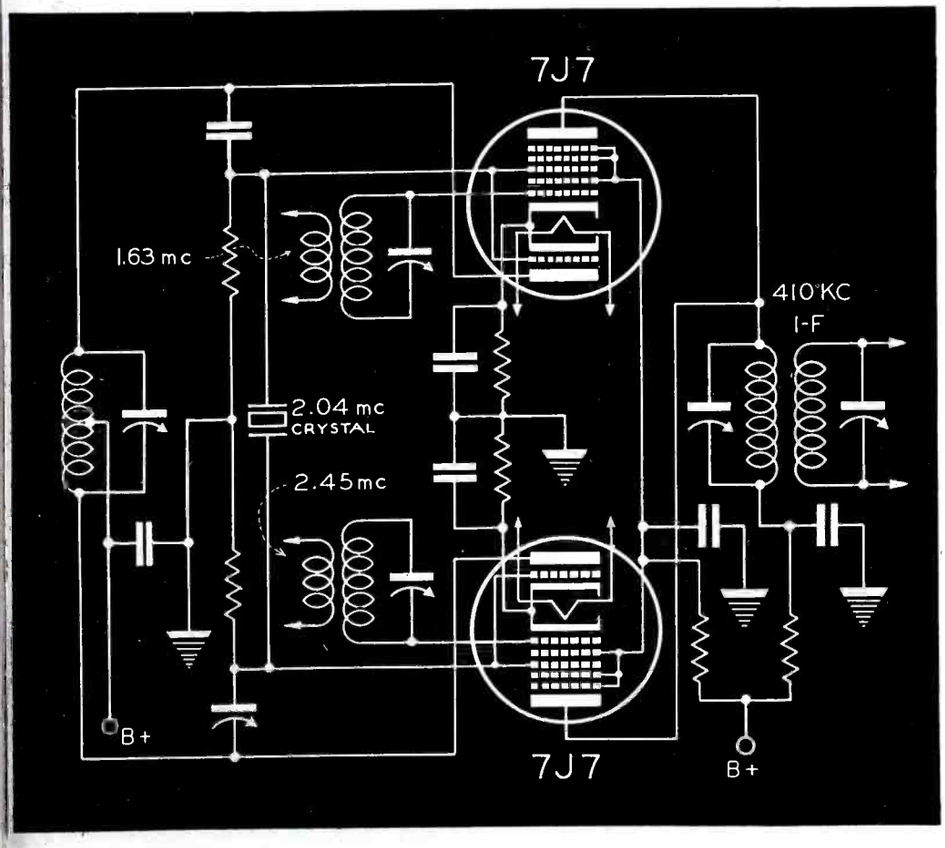
A similar type of construction was used in the design of an a-c/d-c dual-channel receiver for use at fixed stations (Figure 2). Since these receivers are not subjected to the hard service that mobile units experience, it was decided to forego crystal control to reduce expense.

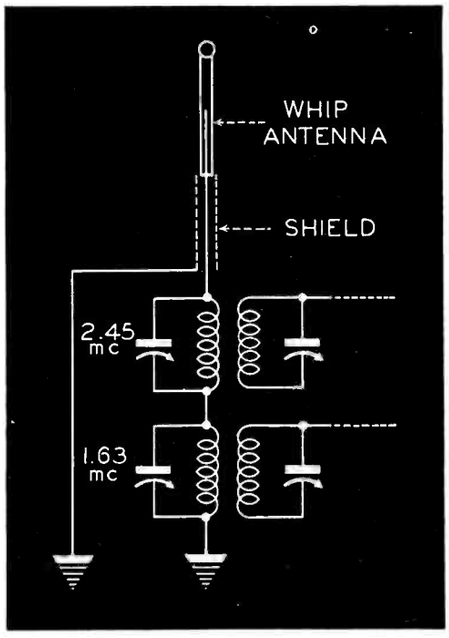
Unique Pilot Light System

Two pilot lights, one green to indicate the police channel, the other red to indicate the fire channel, operate in conjunction with a three-position panel switch to indicate the channel or channels being received. In its neutral position both channels are received simultaneously. Throwing the switch to the left or to the right cuts out either channel by removing the plate and screen voltages from one of the r-f stages.

Squelch Control Mounting

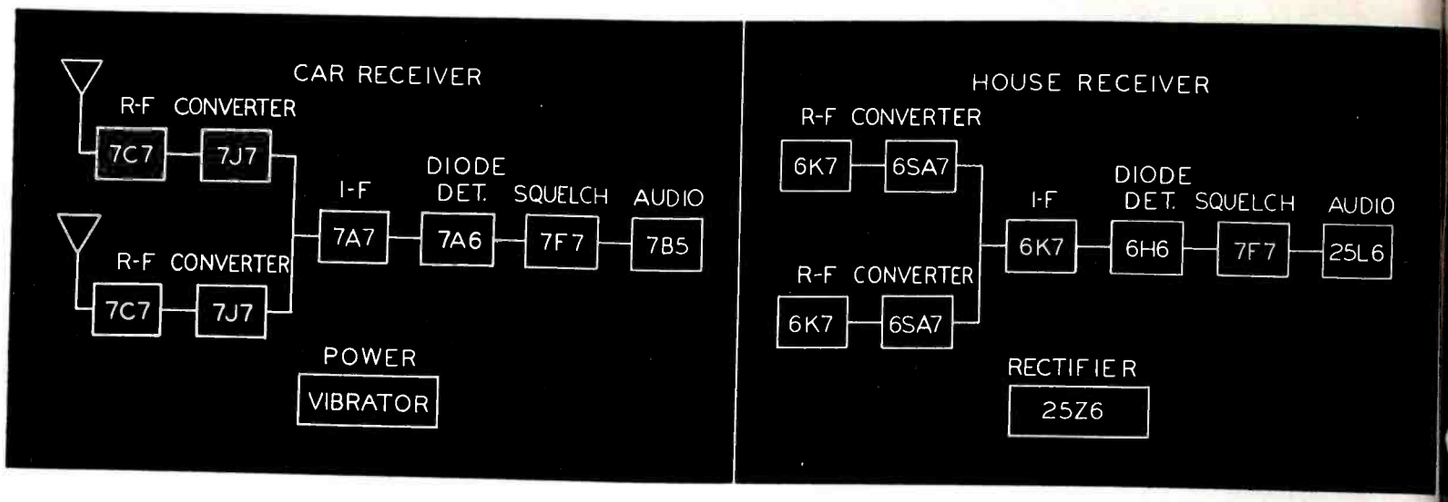
The squelch control is mounted close to its associated circuit to reduce wiring, and brought out to the front panel by means of a short length of auto cable. In the fixed receiver, since receiving conditions are static, the squelch control has been moved from the front panel to the side of the





Figures 3 (left) and 4 (above)

Figure 3 illustrates the two separate i-f stages used. They are tuned to their respective frequencies, in the dual channel receiver. Either a dual antenna or a single antenna, shown in Figure 4, can be used.



chassis to prevent oversetting by operators.

Dual Message Reception

No special problems were encountered in the design of either receiver. Standard parts and practices were used in their construction. However, filtering of all voltage feed circuits was necessary to reduce inter-circuit feedback and cross-talk. When both stations go on the air simultaneously, both messages may be received, since they are repeated.

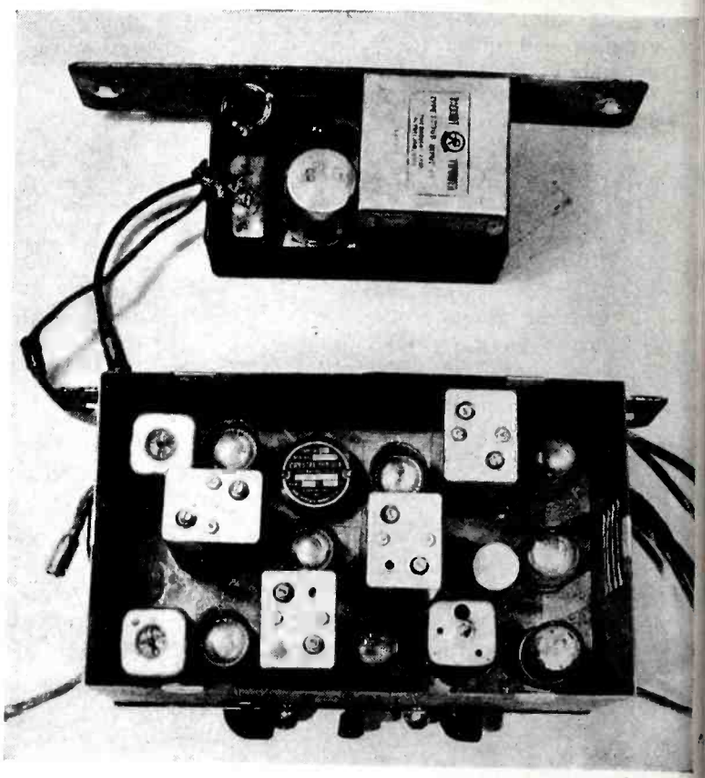
Other Uses for System

The satisfactory results experienced with this receiver has suggested a similar use for the same principle, in conjunction with duplex communication systems, involving fixed and mo

(*Continued on page* 103)

Figures 5 (top) and 6 (right)

At top, a block diagram of the car and house-receiver tube setup. Note that the power supply, in one instance, is battery, and in the other, house current. At right is the top view of the car receiver with the vibrator used for 6-volt application. Note the compact layout and convenient location of the crystal.



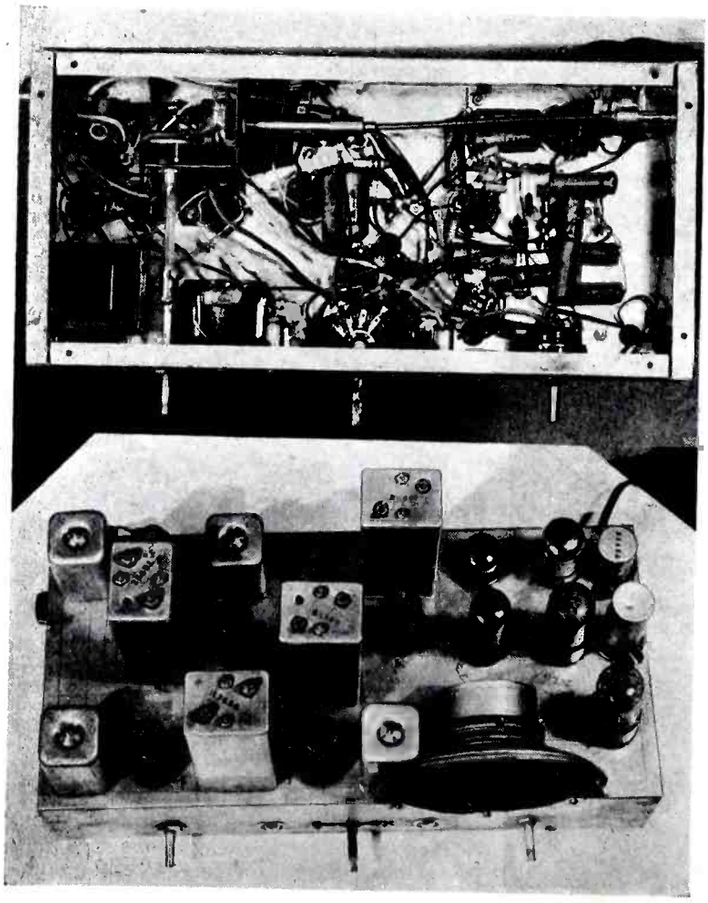
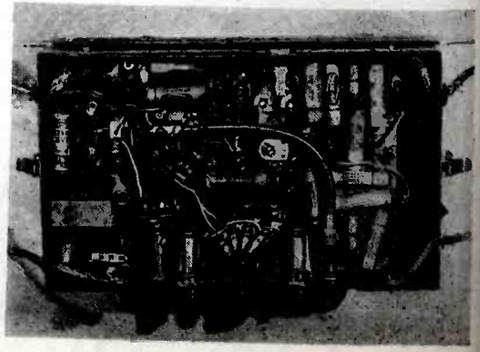


Figure 7

Bottom and top views of the a-c/d-c line house receiver. The squelch control, which was formerly adjusted from the front, has been moved to the side to provide fixed adjustment. This particular mode of physical design was employed since receiving conditions are static here and it isn't necessary to continually adjust the control. The squelch control is mounted, of course, close to its associated circuit to avoid any possibility of losses.

Figure 8 (below)

An underside view of the car receiver. Note the ceramic compensating unit in the center that is used to balance the crystal oscillator. In this model the squelch control is operated by a cable, to affect short lead lengths. A phone jack in the rear of the receiver chassis is connected to the cathode of the i-f tube to provide easy alignment in the car.



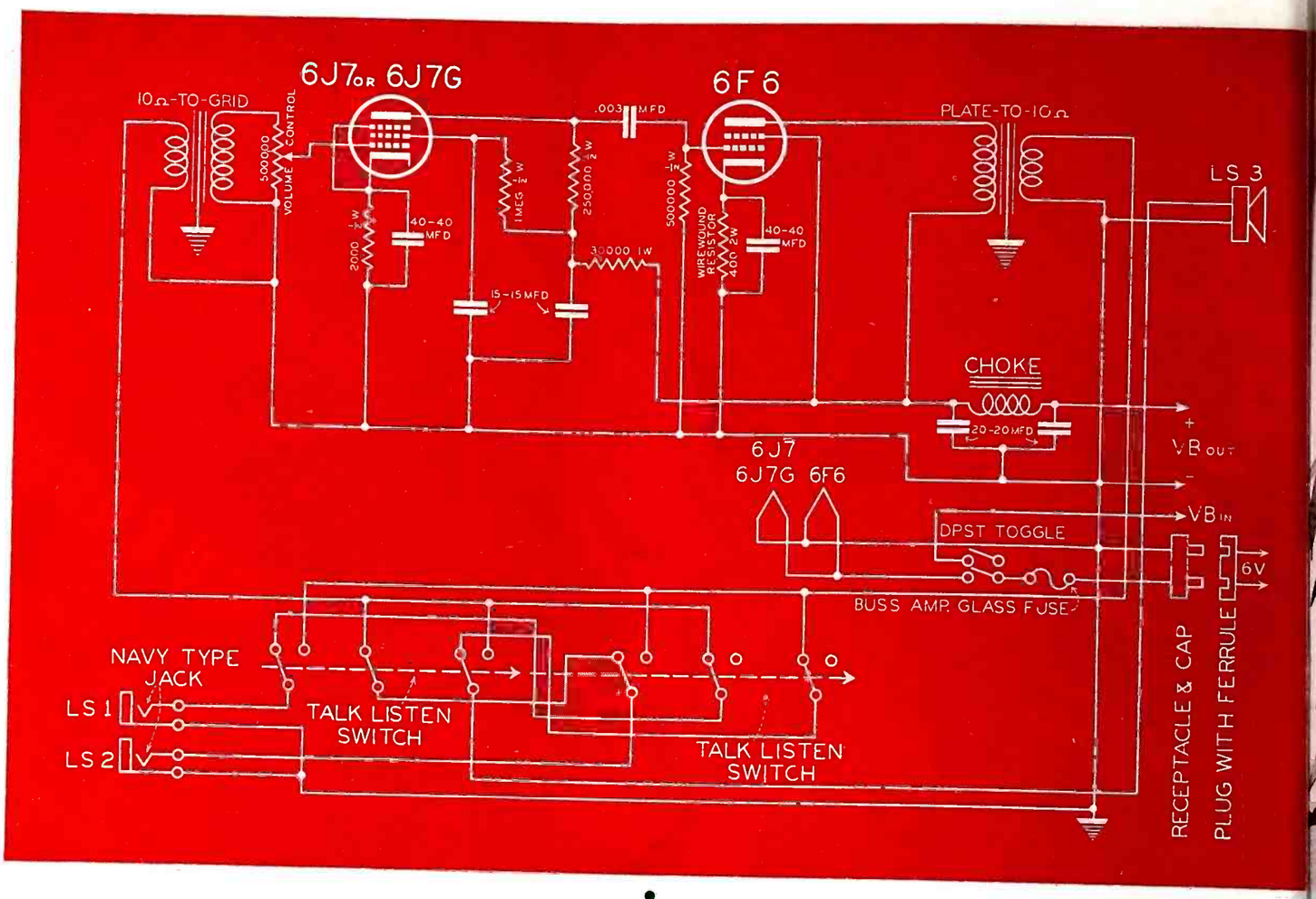


Figure 1
Two-station, resistance-capacitive coupled amplifier, for divers.

PORTABLE COMMUNICATION SYSTEM

For Divers

by **DANIEL W. GELLERUP**
Technical Supervisor, WTMJ-W55M*

TO provide the rapid establishment of two-way communications between a diver's tender station on the surface, and one to two divers, a portable diving amplifier, weighing approximately only twenty-five pounds, was recently developed. Speech pick-up and reproduction in all cases are obtained on the reproducers, these units being used both in their normal capacity and as microphones. The system is normally set up for transmission of speech from all connected divers to the tender. Switching facilities are provided on the control panel to select and talk to any one diver from the surface station. Volume control is also provided to make more intelligible the speech as picked up under varying pressure conditions.

The amplifier is housed in a heavy

Figure 2
Daniel W. Gellerup and the compact two-way diving amplifier.

[*On Leave*]

(*Continued on page* 104)

Voice communications on every front...

Whether by radio or land wire telephone, a voice command gets the job done with clarity and speed.

Available from stock, 1700U series microphone. Single button carbon type, push-to-talk switch, etc. For trainers, intercommunication and general transmitter service.

UNIVERSAL microphones are playing a vital part in voice communications of all the Armed Forces . . . being the first instrument through which a command is given. Care must be taken that the electronic patterns of the voice are held true for the many electrical circuits through which they must later pass. UNIVERSAL microphones with their precise workmanship are carrying the message through in all forms of voice communication whether from a tank, ship or aeroplane. UNIVERSAL products meet all U. S. Army Signal Corps Laboratory tests. Standardization of parts, inspection, and workmanship of high order combined with the best of material, make UNIVERSAL'S microphones and accessories outstanding in every application.

U. S. Army Signal Corps and U. S. Navy plugs and jacks are offered as voice communication components to manufacturers of transmitters and sound equipment for the Armed Forces. Catalog No. 830 contains complete details.

UNIVERSAL MICROPHONE CO. LTD.

INGLEWOOD, CALIFORNIA

FOREIGN DIVISION, 301 CLAY ST., SAN FRANCISCO 11, CALIF. • CANADIAN DIVISION, 560 KING ST. W., TORONTO 2, ONTARIO

SYNTHETIC REVERBERATION

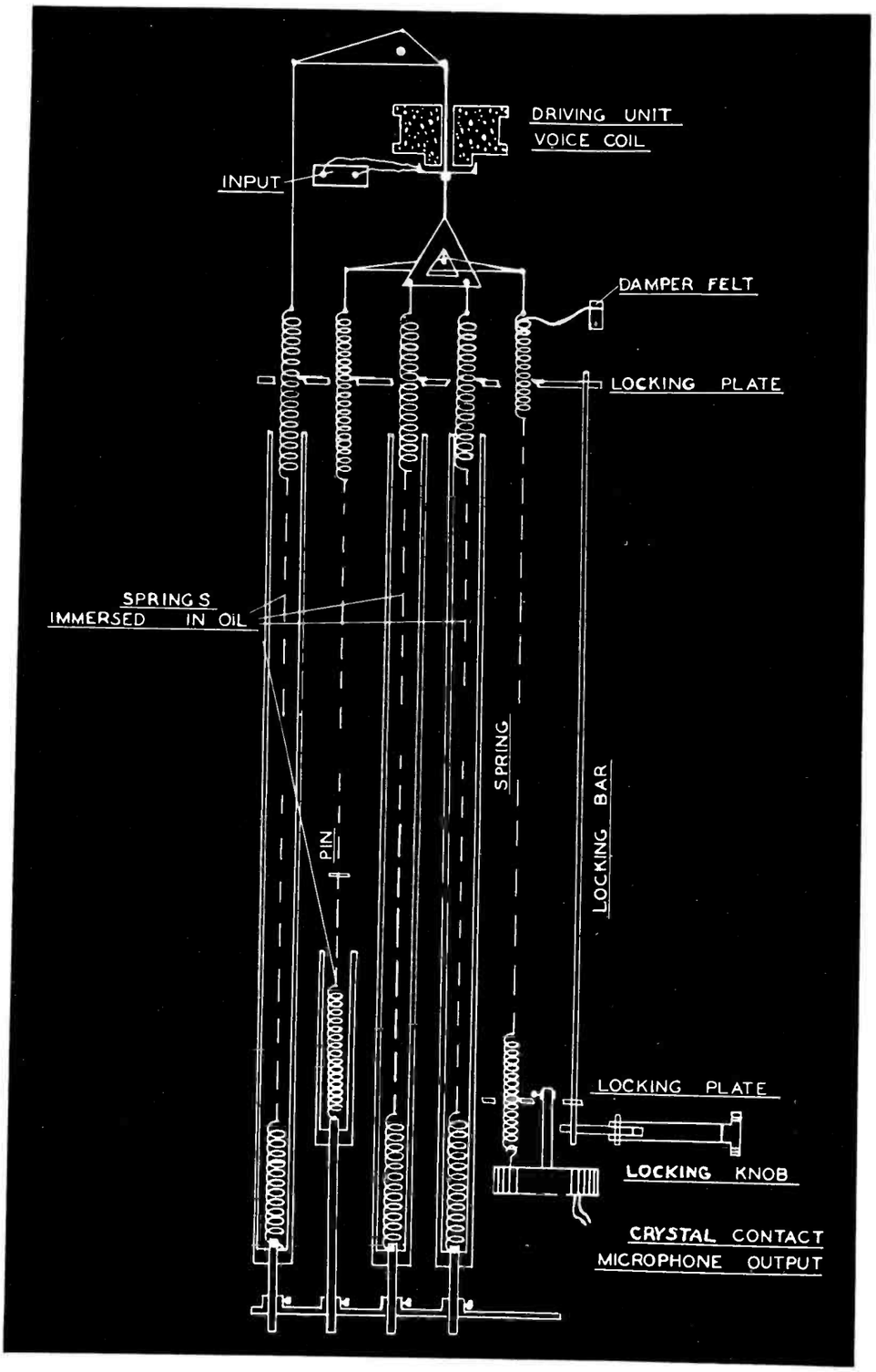


Figure 1

The unit used to provide synthetic reverberation. It is known as a reverberstat and is approximately 4 feet long, 6 inches wide and 3 inches deep. A variety of acoustical effects are available with this unique device.

by **JOHN K. HILLIARD**

Altec Lansing Corporation

SEVERAL methods have been made available for adding synthetic reverberation to broadcast programs, transcriptions and sound motion pictures. Until recently reverberation chambers, reverberation pipes, staggered pickups from recorded sound, and the time delay of phosphorescence effects have been used.

Now, in addition to these methods, a device known as a reverberstat has been made available for this purpose.

Basic Unit Is P-M

This unit consists essentially of a small permanent-magnet loud speaker voice-coil mechanism, actuating a rocker arm to which several sets of springs are attached. These, in turn, set into vibration a small crystal microphone. (A cross section is shown in Figure 1.) The springs are surrounded in tubes of oil of varying length which provide damping for the springs. The time of reverberation is controlled by the dimensions of the springs and the oil damping.

Crystal Microphone Used

The vibrations on a crystal microphone set up small electrical currents which are amplified and combined with the original signal to give the desired effect.

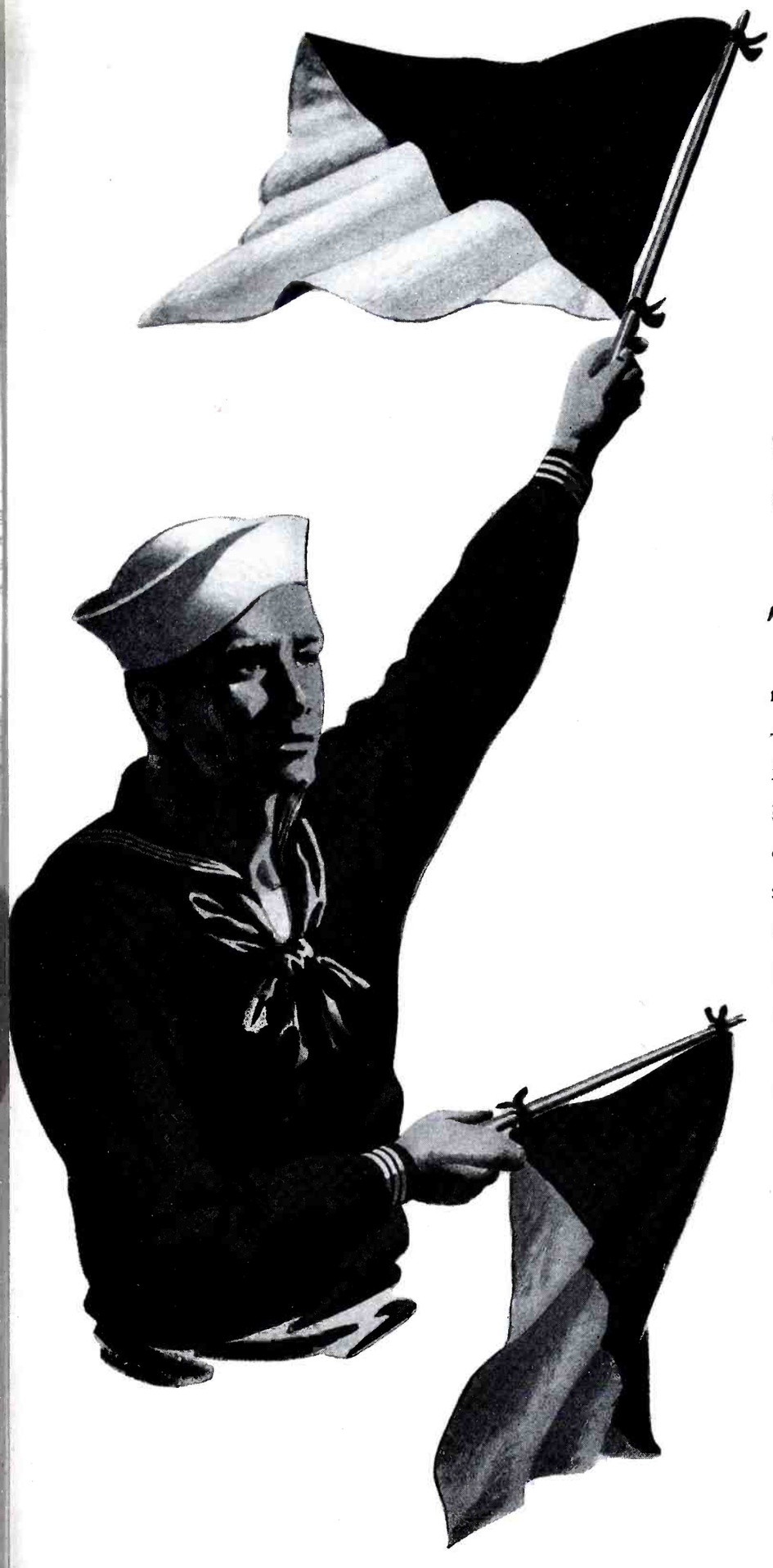
Compact Size

The device is made into a small compact unit approximately 4 feet long, six inches wide, and three inches deep. It can be mounted in an acoustically insulated box so that outside mechanical and acoustic noises do not interfere with its operation. It does not occupy appreciable space in terms of a reverberation chamber, and for this reason it has been practical and economical to place these units in as many places as there are individual demands. In motion picture studio work, as many as four reverberstats are used in a single dubbing or re-recording operation. Each reverberstat may be adjusted to have different damping and as a result give individually different acoustical reverbations. By means of electrical networks controlling either the input or output of the reverberstat, the quality of acoustic reverberation may be controlled over an extended range.

Frequent Variation Provided

If it is desirable to re-enforce the original sound in such a manner that the sound appears to originate in a dungeon or cavern, the low frequency reverberation is emphasized greatly. If it is desirable to have a speaker appear to come from a public address system which has a certain amount of

(*Continued on page* 108)



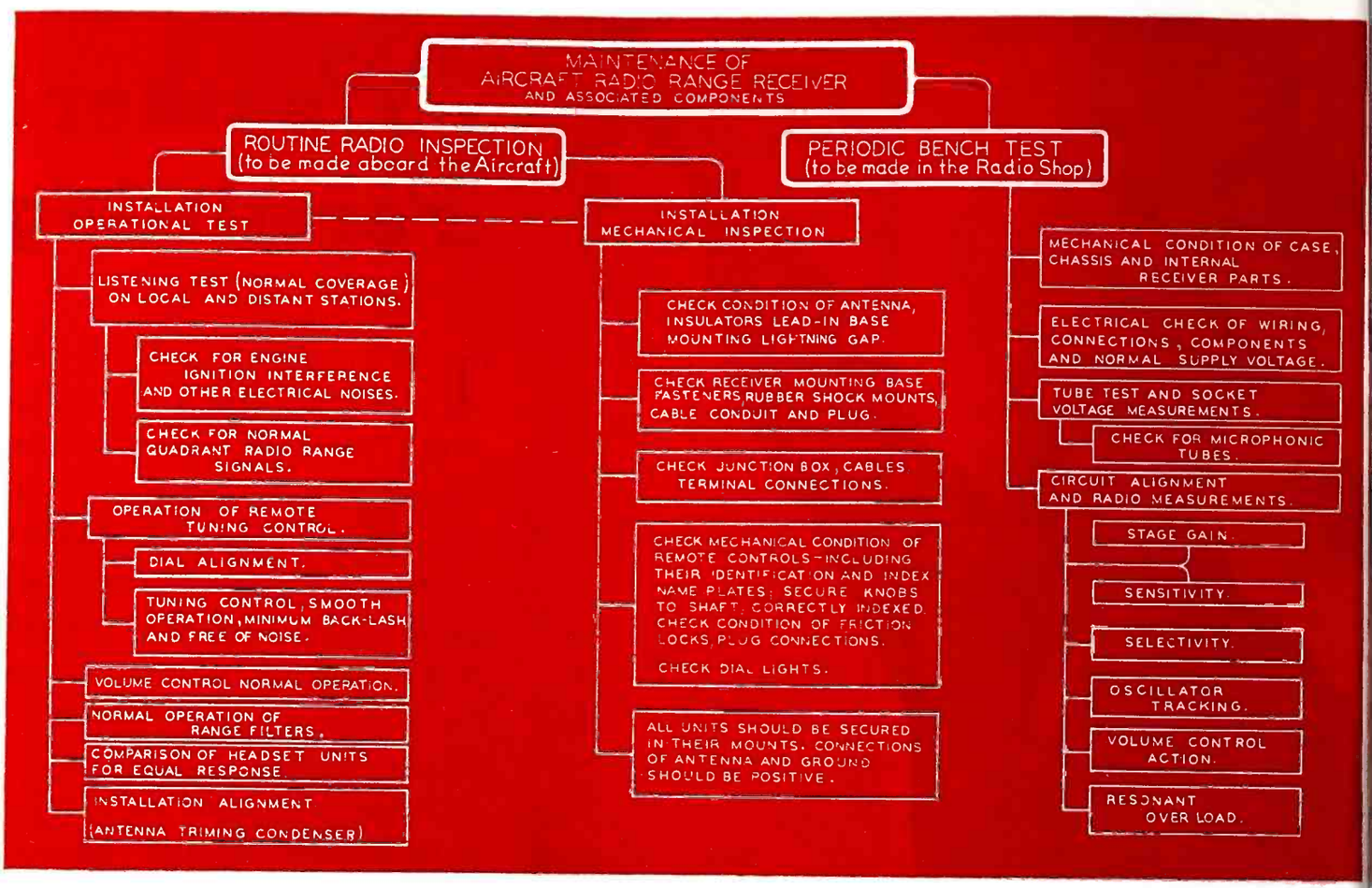
Weather Permitting

THE effective range of the time-honored wig-wag system of flag signalling is limited by weather conditions — is reduced to zero during heavy rains, fog, or at night. The effects of natural interference are felt, too, even in radio communication, when static from unshielded ignition and secondary electrical circuits interrupt reception. Breeze Radio Ignition Shielding, a product of years of Breeze design and manufacture, makes it possible to overcome this evil, and insures static-free and dependable transmission and reception of messages. Produced in many sizes to designers' specifications, this Shielding is in use today on aircraft, tanks, and PT boats of the U. S. Army, Navy, and Air Forces. Used in conjunction with Breeze Flexible Conduit and Fittings, assemblies can be fabricated to meet the requirements of any shielding problem.

Breeze CORPORATIONS INC. BREEZE MARK NEWARK, NEW JERSEY

AIRCRAFT RADIO MAINTENANCE

by CHARLES W. McKEE
Supervisor of Aircraft Radio, Eastern Air Lines, Inc.



IN aircraft communications, maintenance has an extremely vital role, for flight efficiency depends on maintenance proficiency.

Maintenance and Repair

Maintenance is not to be confused with repair. Maintenance is that technique used to hold or keep in a particular state. As applied to aircraft, maintenance means the keeping of equipment in such condition to render normal performance. And in the consummation of this requirement it is mandatory that consideration be given certain irregularities that are aggravated by adverse conditions encountered during normal flight. Briefly these adverse effects include vibration, temperature and pressure variations, and humidity.

Normal performance, free of interruption, during each flight period of service is of utmost importance for any type of equipment. This feature is emphasized in aircraft work.

Training Aircraft Radio Technicians

In training aircraft radio technicians, there are two basic considerations. The first involves the thorough knowledge of the basic principles of radio theory. The second concerns the specialized requirements of aircraft radio. This includes familiarization with the purposes and services of the equipment.

Aptitude

The development of an *aptitude* for the specialized vocation of aircraft radio maintenance assumes an important position in training. Learning by working the equipment, under the guidance of experienced technicians, can provide most of the training for attainment of aptitude. This can be accomplished by an assimilation of knowledge in the school shop with the use of a *mock-up*, or by actual maintenance work. The latter is an essential to a certain degree.

Aircraft Radio Test Procedure

In determining the condition of an aircraft radio system, a procedure affording the answer to certain questions, must be followed. The questions or problems involved are . . . Is the performance normal? If not, what are the symptoms? Then, what is the cause, and further, what are the proper corrective measures that must be taken?

To secure answers to the above questions, we must have a maintenance procedure, whereby the condition of the radio station may be determined. We must then acquaint the technician with the use of this information to provide for normal radio performance. Broadly classified, there are three

POOR COMMUNICATIONS COST 2000 LIVES

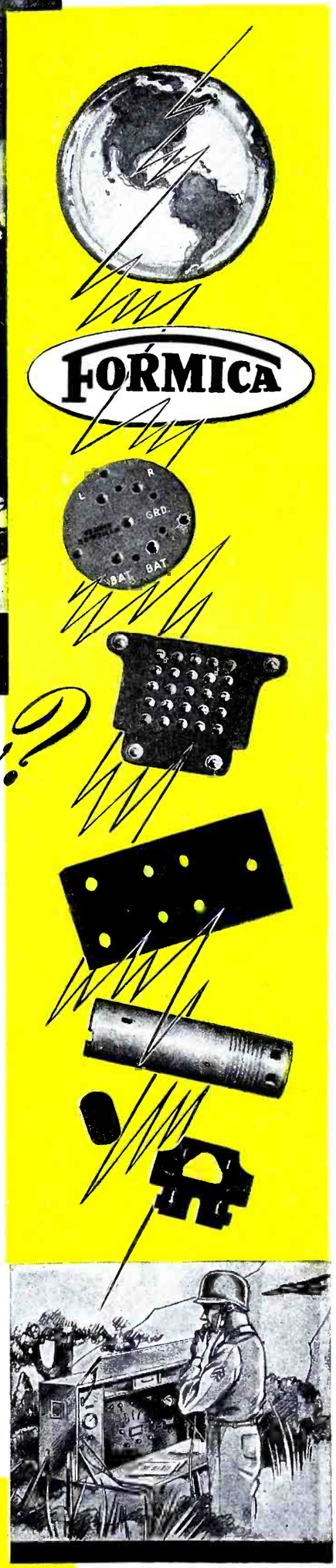
What about Ours Today?

THE unnecessary war of 1812 was declared two days after Lord Castlereagh announced in England that the "Orders in Council" (which caused the quarrel) would be repealed — but the Congress of 1812 didn't get the news in time.

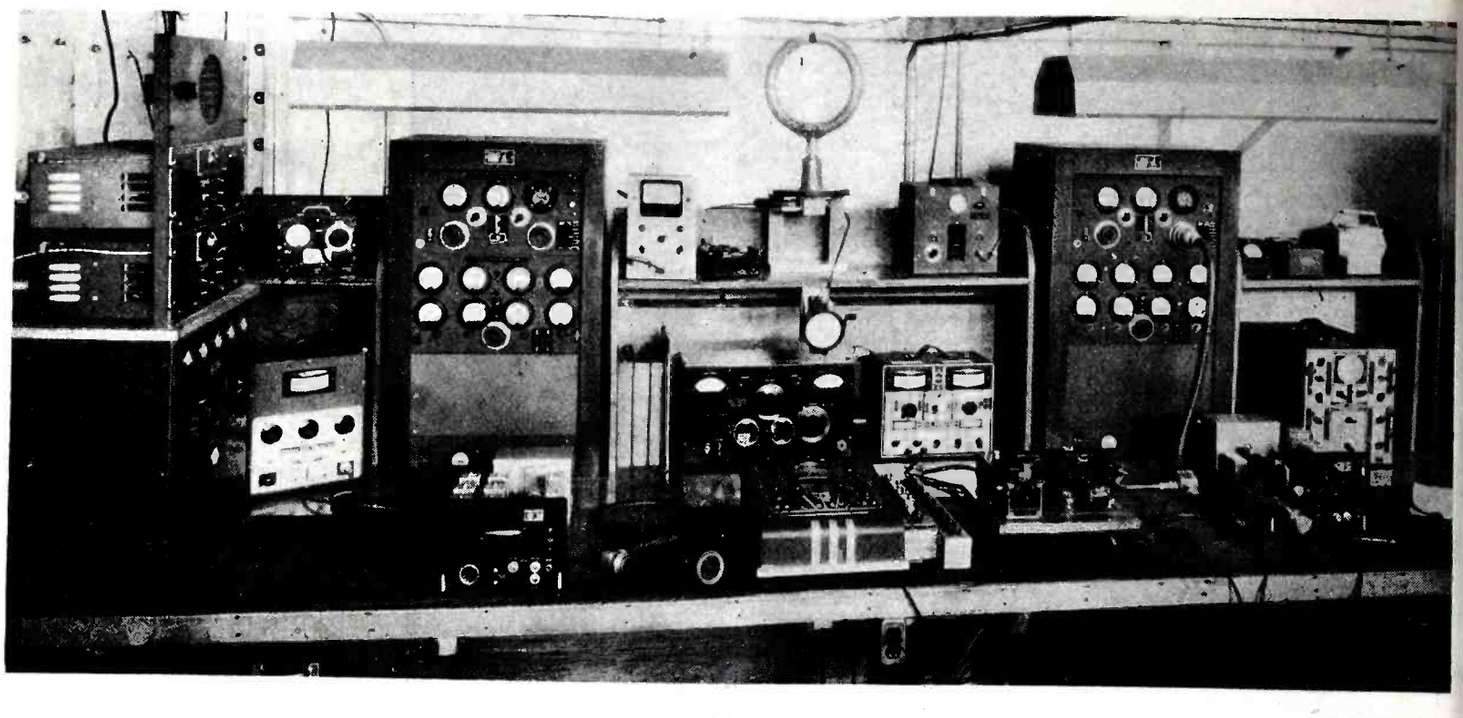
The final battle of New Orleans, costing 2,000 lives, was fought fifteen days after peace was signed at Ghent — but the armies hadn't heard the news.

Today news, propaganda, and battle orders can girdle the globe in a second if communications equipment is functioning perfectly.

Radio parts made of Formica help civil and military communications function perfectly because of Formica's excellent insulating qualities at radio and audio frequencies. In addition, Formica is light, strong, tough, moisture resistant, and readily machined. A material possessing such properties will have many new uses in the close knit world of tomorrow, some uses in your product no doubt.



THE FORMICA INSULATION COMPANY
4635 Spring Grove Avenue, Cincinnati, Ohio



An aircraft radio shop test bench. The rack and panel cabinets contain input power regulators, metering circuits and controls. In testing units, circuits and conditions that duplicate those of an actual aircraft installation are employed for the receiver under special test.

sources of information that we may use to ascertain the condition of the aircraft radio system. Briefly these sources are:

(*1*)—Reference to pilot's (or radio operator's) equipment log for a report of recent radio performance comments. This report will indicate whether radio trouble was experienced during flight.

(*2*)—A further determination of the status of the equipment performance is possible by making a complete operational check of the aircraft radio system.

(*3*)—A thorough mechanical inspection of the radio installation will give much desirable information.

With due consideration given to the above factors during a routine check of the radio system supplemented by a thorough investigation and observation, it will be possible to locate irregularities. It will also be possible to find those conditions that would, if not corrected, contribute to a radio failure at some later date. It must be remembered that in many cases a radio failure is the result of a neglected irregularity (apparently of a very trifling nature at the beginning) which later developed to be a major defect. From this, it can be readily seen that maintenance is rightfully defined as the work involved to keep all parts in condition, so that the equipment will perform, without interruption, the services for which it was designed. To accomplish this, it is imperative that the technician be familiar with circuit functions and normal performance. Thorough investigations are essential. The technician must not *jump to conclusions.*

Almost anyone can repair a broken part of the installation or equipment after it has failed. Real ingenuity, however, is a mandatory requirement to correct possible defects and to maintain the radio system with the fewest possible irregularities.

Classification of Performance

The pilot's report of radio performance broadly fits into two classifications:

(*1*)—Mechanical—electrical.

(*2*)—Abnormal operation.

Usually, the mechanical-electrical reported troubles' corrections are of an obvious nature. They include broken parts, such as broken headset cords, blown fuses, loose cable connector plugs, broken bonds, loose apparatus mounts, broken or loose antenna leads, defective meters, also conditions like low battery voltage, or ignition interference, etc.

Abnormal operation, for sake of clarity for discussion, may be divided into three general parts:

(*1*)—Radio conditions.

(*2*)—Incorrect use of the radio equipment operational controls.

(*3*)—Malfunctioning of the equipment.

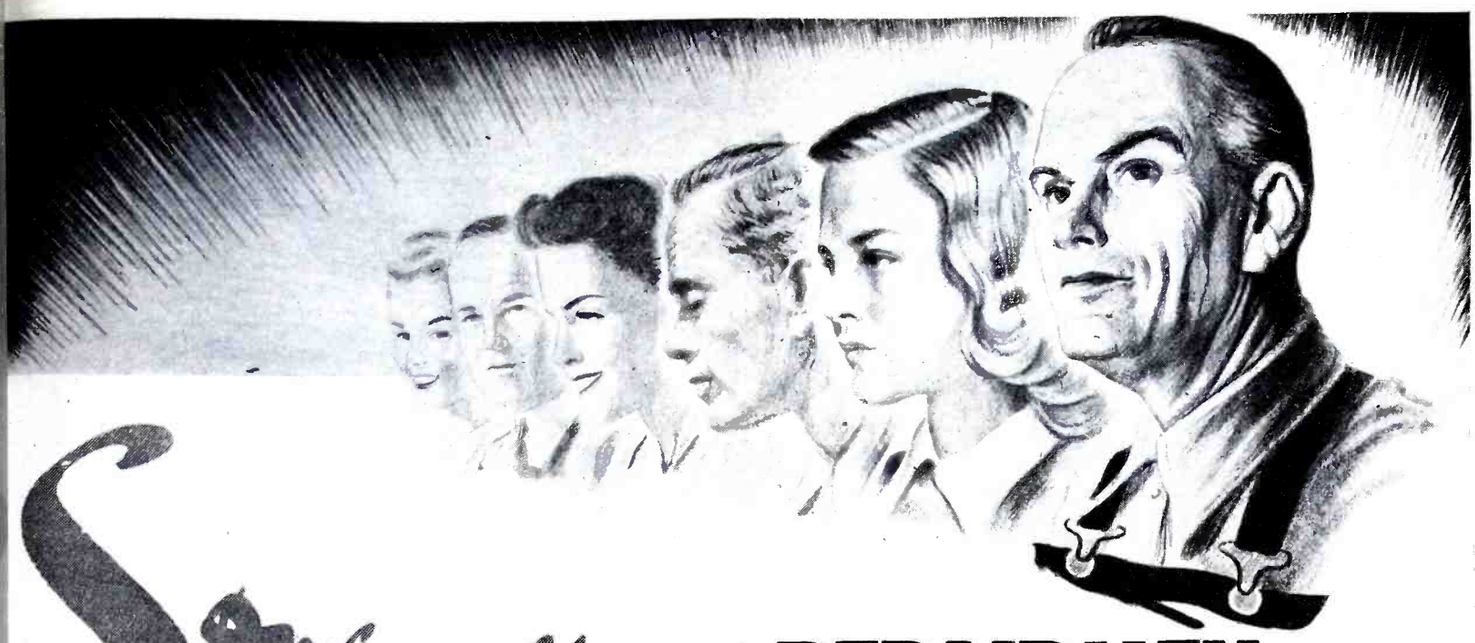
Radio Conditions

It is easy to jump to the conclusion that since the pilot said that the communications equipment was *good only for short range,* or that the radio compass gave *erroneous bearings,* the trouble was due to static, skip or night effect. In some cases it is true that these or other uncontrollable factors are the causes for poor performance. But we cannot be definite about the cause until a thorough investigation has been made. It is not plausible to assume this cause even when you know that poor radio conditions do exist. Because it is possible for a combination of adverse radio conditions and a radio system defect to exist simultaneously.

Operational Control Use

The incorrect use of operational controls is not a common condition. Pilots who are familiar with the operation of the radio and new pilots who have been well schooled in the use of the radio, usually know the controls. However, at some time or another, he can be expected to encounter this kind of trouble. It is difficult to make a decision as to a fault in this category. In order to cope with this type of trouble, it is necessary to make a study of the possible misuse of the controls and to learn of the associated symptoms.

Malfunctioning of the equipment of a radio system where the trouble could be in one of several units is one problem that requires careful consideration. Sometimes the cause is very obvious, while in some instances the cause is not at first apparent. Much



Some were { REPAIRMEN . . . STENOGRAPHERS

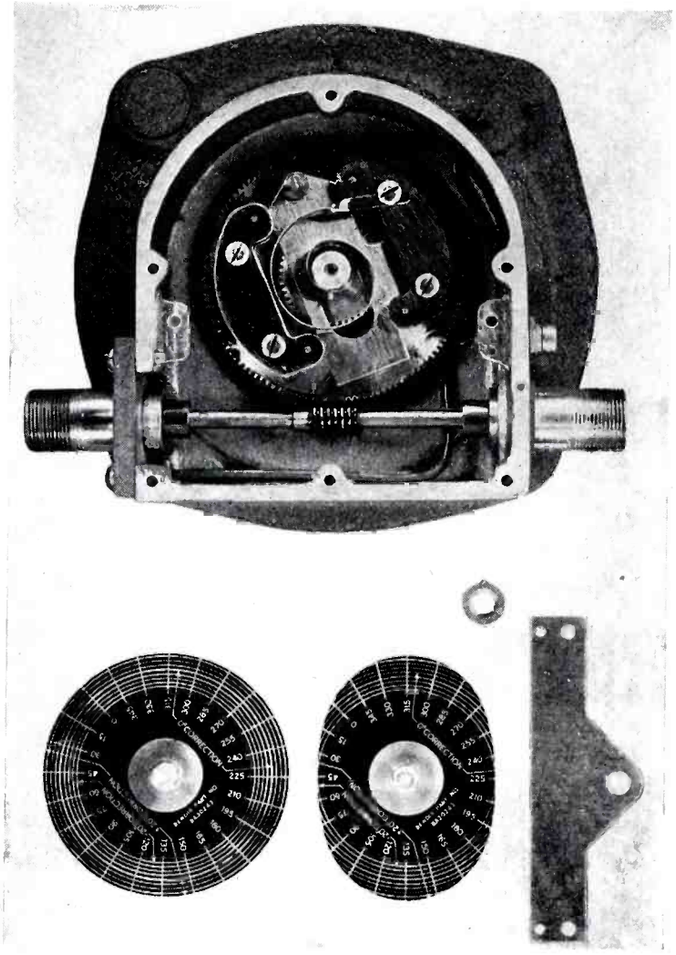
. . . and some have been with us for a good many years. Now they form a solid battlefront behind the fighting front. Thanks to these men and women, the Kenyon Transformer Co. is building not only more transformers . . . something which, in view of the excellence of our product, we thought was impossible.

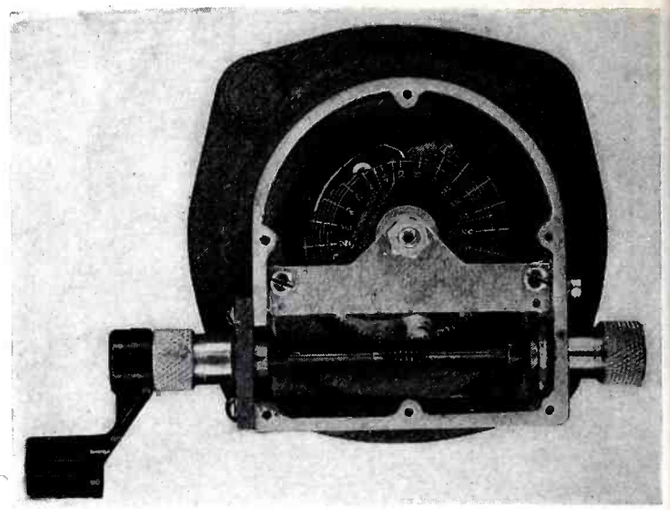
Valiant People . . . their hands are tough, their eyes are sharp, and their minds are determined. And, when day is done, you will find them at a Red Cross blood bank, or tending a Victory Garden, or collecting scrap-metal—doing just what America expects us all to do in this monumental struggle for human rights and dignity.

THE MARK OF EXCELLENCE

Your War Bonds help the war effort— buy more!

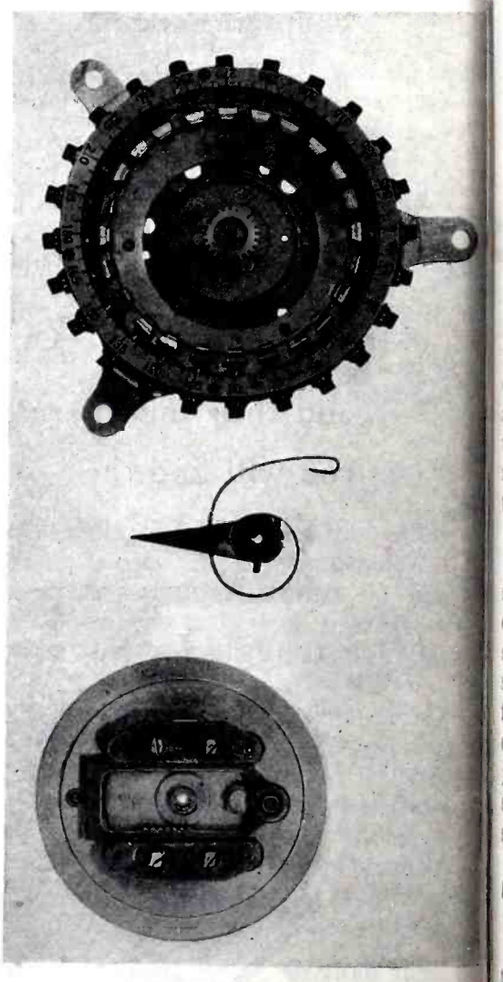
KENYON TRANSFORMER CO., Inc. 840 BARRY STREET NEW YORK, U. S. A.





Units used in compass work require careful maintenance. These units are very delicate and must be inspected regularly with care.

At left, is a view of a disc type corrector unit showing the rachet and roller used in a compass. A cut and uncut disc is shown below the unit. These discs are quite interesting. For, on them are marked the polar coordinates with radial lines at 15° intervals. A disc so graduated is of great assistance in determining the layout for cutting the contour of the cam in accordance with a correction curve.



A view of an adjustable steel tape type corrector unit that is also used in compass work. The adjustable feature is obtained by using a circular steel tape supported at 15° intervals by adjustment screws.

can be accomplished by using the method of *process of elimination*. This involves changing each unit of the equipment involved, piece by piece, and noting the results after each change.

A good rule to follow when diagnosing a defect in the radio system is first to examine for all of the simple causes . . . What is the trouble? Is power delivered from the input supply? Is the fuse open? If so, is the short circuit or cause of excessive current still present?

Typical Case Histories

In the following examples no reference will be made to those of an obvious nature. Some of these examples are isolated cases, but are good from the illustrative point of view.

Example 1—From test, it appeared that one of two microphones (each were plugged into their respective jack boxes) was weak. After replacing the microphone that appeared to be the weak one, with one that was known to be normal, it also checked as a weak unit. The cause of this was due to an accidental parallel operation of the microphones. The microphone that tested normal in the circuit was the one that caused the trouble. This was due to the switch being jammed in the *make* position. When the good microphone switch was closed, both microphones were actually connected parallel in the circuit.

Example 2—This example refers to a control switch that is connected in the circuit of a relay coil. Several such installations were delivered from the factory. On only one plane the pilot reported that he received an electric shock when he used this *control* switch. Investigation showed that this switch had its metal push button connected to the high side of the line. The switches on all other installations had the enclosed center contact connected to the high side and the button switch terminal to ground. In this reported case of trouble, the pilot was receiving the *inductive surge* of the 12-volt operated relay coil.

Example 3—Abnormal relay operation is not always due to the adjustment of the spring tension or armature gap. An actual occurrence is related.

A relay failed to release when the energizing circuit switch was opened. Investigation showed that the relay adjustments were correct. Further investigation showed that the relay control circuit wiring had a low resistance path to ground. In this case leakage through the insulation of the wire was not enough to close the relay,

but the current was sufficient to hold the relay closed after each operation sequence until vibration interfered. The circuit design dictated that the relay be of a low current type and that the control switch be located in the return side of the circuit. The correction was made by use of a better grade of insulated wire.

Example 4—During the time that a certain type transmitter (equipped with a ventilating fan—was being used, a scent of burning insulation was apparent. The first indication was that it was from the transmitter. Further investigation showed that it was the dynamotor (located adjacent to the transmitter) that was overheated. The belief that the odor came from the transmitter was due to the transmitter ventilating fan source of input air, which was near the dynamotor. If the first deduction had been considered final, the transmitter would have been changed and the failing dynamotor would not have been replaced.

Example 5—In this case we find a phenomenon that was caused by a high resistance connection (corrosion) in an antenna *lead-in* connection that was a part of the antenna used with a low frequency receiver. The symptoms were that this low frequency receiver would operate for a short interval only, after a transmission on the h-f two-way system. Apparently, a contiguity of the circuit occurred through the corroded connection. Conduction was effected by the inducted r-f from the h-f transmitter. The trouble was remedied by cleaning the corrosion from the connection. Loose corroded connections especially those in an audio circuit sometimes result in a rectifying action. A good soldered connection is a remedy to preclude this type of defect.

Example 6—A shorted jack or headset level control resulted in a short circuit of the receiver output that is selected by that particular selector switch. The symptom here was confusing. All audio lines for each receiver output ran parallel through each jack box; thus the audio that is shorted will change as the defective selector switch position is changed.

Listening Test

In some installations, it is possible that one receiver will introduce noise into another receiver. The check should include a listening test on the other receiver while the subject receiver is operating.

It is also good practice to check the operation of the equipment from each control position using the headset and microphone that is assigned to that station.

Whenever a unit is opened or adjusted subsequent to the *check-out* operational test, the equipment involved should be given a *reoperational check.*

It is not mandatory that one follows any one certain prescribed procedure of the several possible ones that could be used in making a routine radio inspection. It is an advantage that one routine system be selected and used methodically. For it will be of benefit in preventing possible omission of certain checks. It must be remembered that when this routine procedure is set up, a logical order should be arranged.

Operational Checks

A brief illustration will be of value in making this point clear. Suppose an operation check is being made in a radio beacon receiver. A listening check shows that the receiver is operating. This alone is not enough because there are other vital operating characteristics that must be checked. They include:

(*1*)—The receiver tuning dial reading. Is it within alignment tolerance of the assigned frequency of the station to which the receiver is tuned?

(*2*)—Is the remote tuning control shaft operation smooth? Does it introduce a noise in the receiver?

(*3*)—Does the receiver volume control give adequate control on strong as well as medium weak stations? The action of control must be smooth and free from sudden volume changes. For correct beam flying procedure, normal volume control action is equal in importance to the observation of the course signal.

(*4*)—Normal course signal characteristics must be checked too. This can be done by referring to the radio range chart. Ground location with reference to the station will show that you should receive a certain course signal. It may be an *A, N* or *on course* as the case may be.

Safety Precautions

Your work is as safe as you make it; conversely, it is as much a hazard as you make it. A few precautions are given for guidance.

The radio equipment should not be operated while the plane is being gassed or when gas lines are open or when someone may accidentally contact the antenna, etc.

Even when the propeller is not in motion, one should not walk within the propeller line. People have been shot by a supposedly empty gun.

There should be no tampering with the landing gear retracting controls, cowl flap controls, or other controls and particularly those with which you are not familiar.

It is wise to observe various conditions that could, if not properly considered, present a hazard. For example, on one type of plane, which has been on jacks, the extended struts do not recede immediately when jacks are removed. You can avoid placing yourself in a *pinned-in* position because when the plane settles, it will move as much as 18 inches.

Accidental short circuits while working on the equipment, should be avoided. When doing mechanical work on the unit, it is good practice to first open the input power line. At all times necessary precaution should be exercised to avoid accidental contact with high voltage circuits.

Design Changes

When assigned to maintenance work, it is a good policy *not* to make design changes. To do so may lead to unforeseen difficulties. Suppose we refer to a practical example.

BFO Design Problem

In a certain type of automatic radio compass, a *beat frequency oscillator* was used primarily to receive c-w signals in order to identify them for radio bearing purposes. The operator at times found it desirable to use this compass receiver for c-w communications. Due to low bfo ejection voltage, the signal received was not fully modulated. It was a simple matter to make a design change and obtain a larger ejection voltage. This idea might appear logical until we find that the automatic compass with bfo operating and the receiver, tuned slightly off zero, beat with the signal (about 48 cycles). This extra source of 48 cycles could then take over from the governing 48-cycle oscillator and give a bearing of 30 to 40 degrees in error. We can see that the designer had a reason for using a low value of beat frequency oscillator ejection voltage.

Six-Volt Tubes in Duplex Functions

We have another example where a 6-volt filament type tube was used as an oscillator for the alternate purpose of transmitter-oscillator and receiver-hetrodyne oscillator. The radio designer used a series filament resistor with this 6-volt tube across a 12-volt supply line. The oscillator-tube filament could have been connected series with another 6-volt tube of same current value, thereby saving a resistor and the apparently unnecessary power

(*Continued on page* 103)

NEWS BRIEFS OF THE MONTH...

APCO CONVENTION

The tenth annual National Convention of the Associated Police Communications Officers will be held at the Hotel Loraine, Madison, Wisconsin, on August 30, 31, September 1 and 2. Featured during this War Communications Conference will be talks on priorities, civilian defense, police activities, and 118 mc and the WERS. Trips will be made to the U. S. Naval Training School at the University of Wisconsin and the Truax Field, Army Air Force Radio School.

* * *

MAJOR FALKNOR'S POST GOES TO BELOUNGY

James Beloungy, who for the past year has been in charge of the vacuum tube rebuilding plant of Freeland & Olschner, in New Orleans, has been named chief engineer of the CBS Central Division. He succeeds Major Frank B. Falknor, now in the Army.

* * *

NEW TRADE MARK FOR NORTH AMERICAN PHILIPS

A new trade mark *Norelco,* has been announced by North American Philips Company, Inc., Dobbs Ferry, N. Y. It will be applied to products handled by the Industrial Electronics Division, 419 Fourth Avenue, New York.

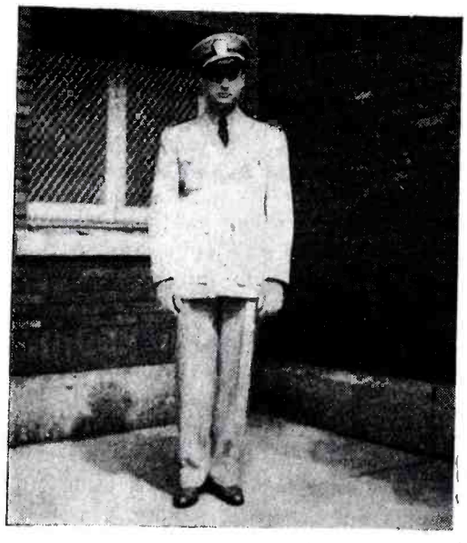
These products will include electronic temperature indicators; direct reading frequency meters; searchray (industrial and research X-ray) apparatus, and X-ray quartz crystal analysis apparatus.

The trademark will also cover cathode ray tubes; transmitter, amplifier and rectifier tubes; quartz oscillator plates; fine wire of all drawable metals (bare, plated and enameled), and diamond dies, all of which will continue to be handled direct from the Dobbs Ferry plant.

* * *

K. C. PRINCE WITH NAVY

Kenneth C. Prince, Chicago attorney, who has served as executive secretary of the Sales Managers Club, Western Group (now Association of Electronic Parts and Equipment Manufacturers), for nine years, has been commissioned Lieutenant (j.g.) in the United States Naval Reserve.



Lieutenant (j.g.) Kenneth C. Prince

MICA-KINKS

I am just a little guy,
They call me Mike O'Denser,
They sell me now for a price
That's handsome high and fancy.

I wish I wasn't quite so high,
So I can rest in peace,
In a stock bin or a radio,
To do as I damn please.

The guy they call "Priority",
Is watching like a hawk,
You can't go here! You can't go there!
Not even for a walk.

The engineers are crazy,
They get me all agog,
They like to see me grow a tail
Instead of just a lug.

I'm being checked and counted,
Until I'm good and sore,
'Cause I have a "Capacity"
For so much and no more.

But I am glad to do my share,
To fight for our nation,
And rather proud of the fact
That I am "tops" for the duration.

Ralph Berkman
Lafayette Radio Corporation
Chicago, Illinois

* * *

WHITE STAR FOR RADIO RECEPTOR "E" FLAG

Radio Receptor Company, Inc., 251 West 19th Street, New York City, has won a white star for their Army-Navy "E" flag.

Radio Receptor has been engaged in manufacturing ground-to-air radio navigational communications, airport traffic control equipment, and other electronic devices since 1922.

Ludwig Arnson is president of Radio Receptor Company, Inc.

Ludwig Arnson, president of Radio Receptor Company, Inc.

RADIO WIRE RELIEF

Radio jobbers have been told by the WPB that they may apply for relief on Form PD-470 (WPB-1161) listing frozen stocks of copper wire mill products by amounts, sizes and types which cannot be sold in accordance with CMP regulation 4. In the event an application should be approved by WPB, copper wire sold under such authorization cannot be replaced in stock.

* * *

CORDERMAN JOINS W. E.

Roy C. Corderman, formerly assistant chief of the OWI Bureau of Communications Facilities, is now with the radio division of Western Electric, 120 Broadway, New York. Mr. Corderman has been on leave from A. T. & T. since December 1, 1941. He will continue with war work in the government contract section of Western Electric.

* * *

LOYD A. BRIGGS WINS V-P POST WITH RCA COMMUNICATIONS

Loyd A. Briggs, general superintendent, of RCA Communications, Inc., has been promoted to vice president and general superintendent.

Mr. Briggs is former European communications manager of RCAC in London.

* * *

ROSENBAUM, WFIL PRESIDENT, NOW LIEUTENANT COLONEL

Samuel R. Rosenbaum, president of WFIL and vice president of Albert M. Greenfield & Co., has been appointed to the rank of Lieutenant Colonel, United States Army Special Reserve, for service in the Division of Military Government of Occupied Territories.

Roger W. Clipp has been named executive vice president to exercise full executive powers as president during Mr. Rosenbaum's absence.

* * *

LAFAYETTE RADIO EXPANDS SCHOOL DIVISION

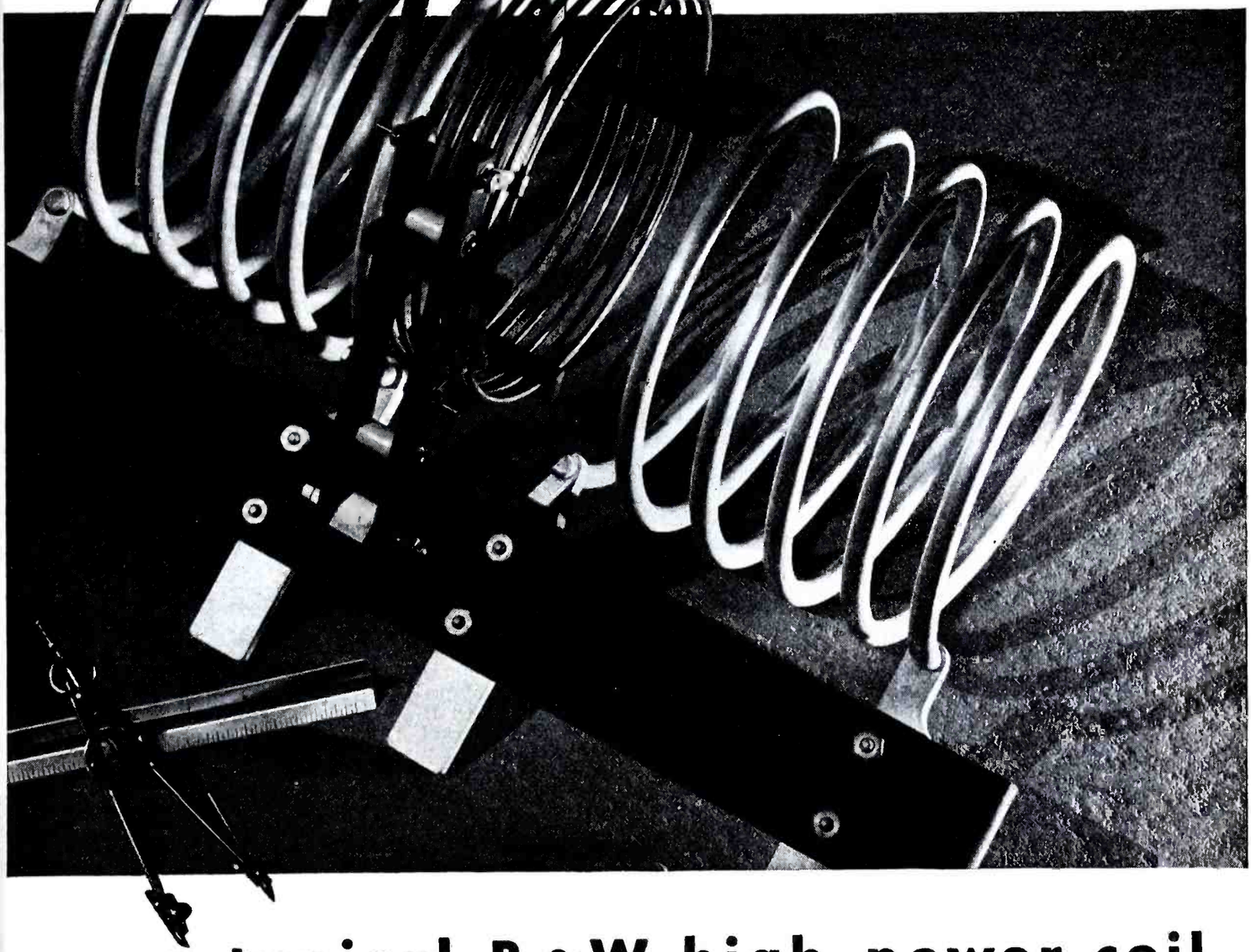
The Schools Division of Lafayette Radio Corporation, Chicago, Ill., headed by Arthur J. Rattray, has recently been enlarged and expanded. This department was established to give consultation service to schools and colleges on radio training programs and engineering problems.

A new brochure on radio training kits

(*Continued on page* 82)

Arthur J. Rattray, head of the Schools Division, Lafayette Radio Corporation.

10 KW!



...a typical B & W high-power coil

Over 10" in diameter by 20" long, and designed for 10 KW. service, this variable-link final amplifier, plate coil, is a good example of B & W engineering at work on the job of matching modern inductor requirements. B & W Inductors of this general type are available in all standard frequency ranges. Coils are bolted in place, and may be switched for band-changing with a minimum of time and effort. Connections are silver-soldered, and all metal parts, including coils, are heavily silver-plated. Coils in the unit illustrated are of ⅝ copper tubing. Other B & W Air Inductors of this type utilize tubing as large as 1".

FAST DELIVERIES on all B & W Air Inductor types are assured by our greatly expanded facilities, and straight-line production on most smaller types. Engineering data on any type upon request.

BARKER & WILLIAMSON, 235 Fairfield Ave., Upper Darby, Pa.

Air Inductors

"BABIES AND JUNIORS" *(25 to 75 watts)*

STANDARD TYPES *(100 watts to 1 KW.)*

SPECIAL HIGH-POWER TYPES *(to 10 KW. and above)*

B&W

TURRETS — BAND HOPPERS — SWINGING LINK ASSEMBLIES, ETC.

SPECIAL RADIO AND ELECTRONIC EQUIPMENT ASSEMBLIES

Variable Air Condensers

(Integral neutralizing types)

MANUFACTURERS OF QUALITY ELECTRONIC COMPONENTS FOR OVER A DECADE

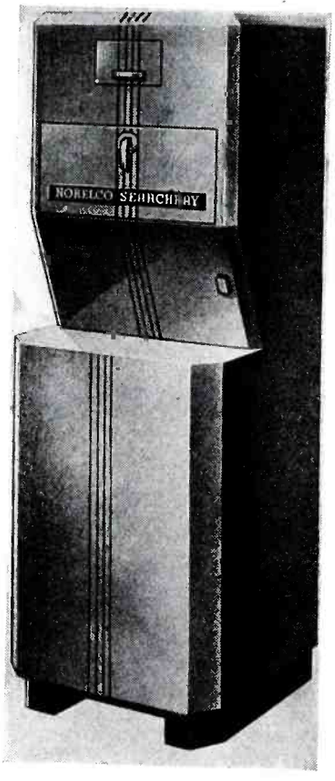
THE INDUSTRY OFFERS

SEARCHRAY INSPECTION UNIT

A Searchray for X-ray inspection of small parts, moulds, castings of light alloys, ceramics, plastics and rubber; packaged food products; assemblies, semi-finished and finished products, is now being marketed by the Industrial Electronics Division of North American Philips Company, Inc., 419 Fourth Avenue, N. Y. City. The object under inspection can be instantly seen fluoroscopically through an eye-level eye-piece.

Safety for the operator is assured by a rayproof, shockproof housing with full automatic electric interlocks which interrupt the circuit while the compartment door is open.

Searchray is supplied with accessories which permit radiographic examination covering a maximum area of 11"x14" using standard 12"x14" X-ray film or paper. The article compartment is 21" long x 18" deep x 9" high. The fluoroscopic screen measures 12"x16" with 8½"x11½" being the maximum area observable at any one time. Approximately 69" high x 26½" wide x 24" deep, and weighs approximately 425 lbs.



* * *

RECORD-MARKER

A record-marking method, the *Spot-O-Graph,* to provide individual timing of sound effects and music, has been marketed by Heroservice, 45 West 45th Street, New York City.

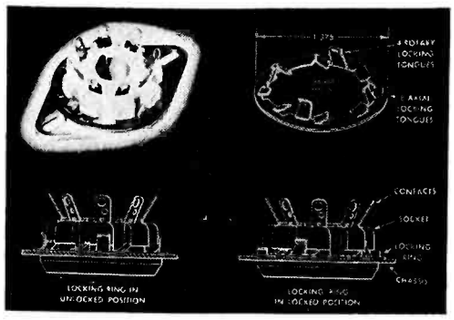
It is in the form of an ordinary record, but with a cone-shaped partition down the center, on each side of which there is a minutely graded scale, so that the needle can fit exactly in the right spot.

Spot-O-Graph records come in 10", 12" and 16" sizes.

LOCKING RING FOR SOCKETS

A locking ring for use with sockets has been developed and patented by the A. W. Franklin Manufacturing Company, 175 Varick Street, New York City.

The Franklin locking ring fits between the chassis and the component to be locked; a simple tool is placed over the component and a ⅛ turn to the right securely locks the component to the chassis; a further ⅛ turn does the unlocking.

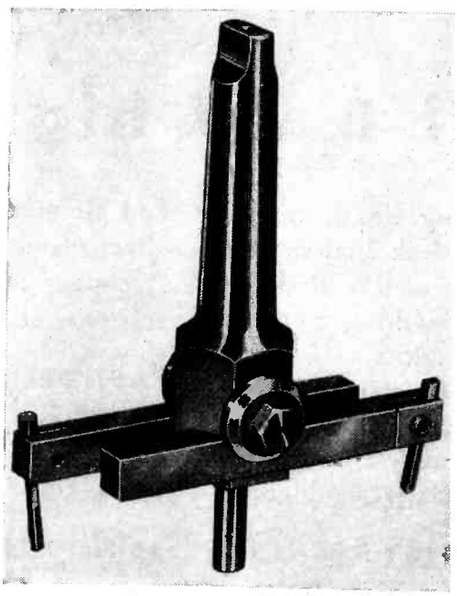


* * *

ADJUSTABLE FLY CUTTER

A fly cutter for cutting holes or discs in metals of thicknesses up to one inch, including boiler plate, stainless steel, cast iron, plastics, and other "problem" materials, is now available from Robert H. Clark Company, 3424 Sunset Boulevard, Los Angeles 26, California.

The tool is obtainable with straight or tapered shank and covers expansions of 4" to 10" in diameter, including all decimal or fractional intermediate sizes.



* * *

HIGH-ALTITUDE GENERATOR BRUSHES

Generator brushes for airplane use at altitudes above 30,000 feet have been developed by the Stackpole Carbon Company, St. Marys, Penn.

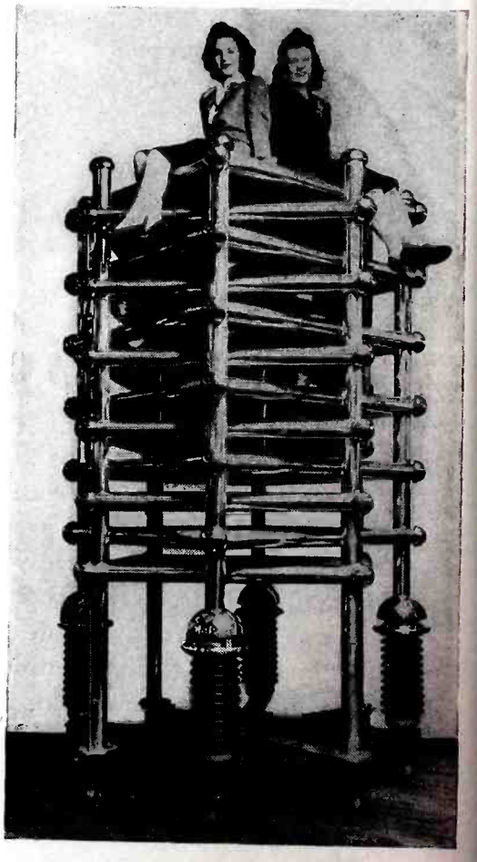
These brushes are treated with a special process developed by the Westinghouse Electric & Mfg. Company.

GIANT CONDENSER USES NON-CRITICAL MATERIALS

A 200,000-volt, 2500-mmfd air condenser using non-critical materials has been constructed in a Newark plant of the Federal Telephone and Radio Corporation. It is employed in the company's high-powered transmitter laboratories as a phantom antenna capacitor.

Condensers of this type were formerly manufactured from aluminum and about half a ton of metal would ordinarily have been used for a capacitor of this size. In its present state, it consists of twelve hollow plates of 10-gauge sheet steel, each 3⅓" in overall thickness. The plates are seventy-six inches square, welded together on the sides. The plates were first copper-plated and then nickel-plated and given a high polish. Plating was to improve conduction and efficiency. The highly polished balls at either end of each hollow plate are actually shields. Their job is to prevent electricity from being dissipated into the air at the high voltages used. The supporting insulators shown were designed for 400,000 volts dry flashover.

The entire assembly stands over ten feet high and weighs over 2,000 pounds.



JONES PLUGS AND SOCKETS

A new series of multi-contact plugs and sockets have been designed by Howard B. Jones, 2460 W. George Street, Chicago 18, Illinois. This new line is known as the 2400 series and is interchangeable with the present 400 series.

The plug and socket bodies are of BM120 formula bakelite moulded accord-

(*Continued on page* 94)

CARRIER CURRENT TRANSMISSION

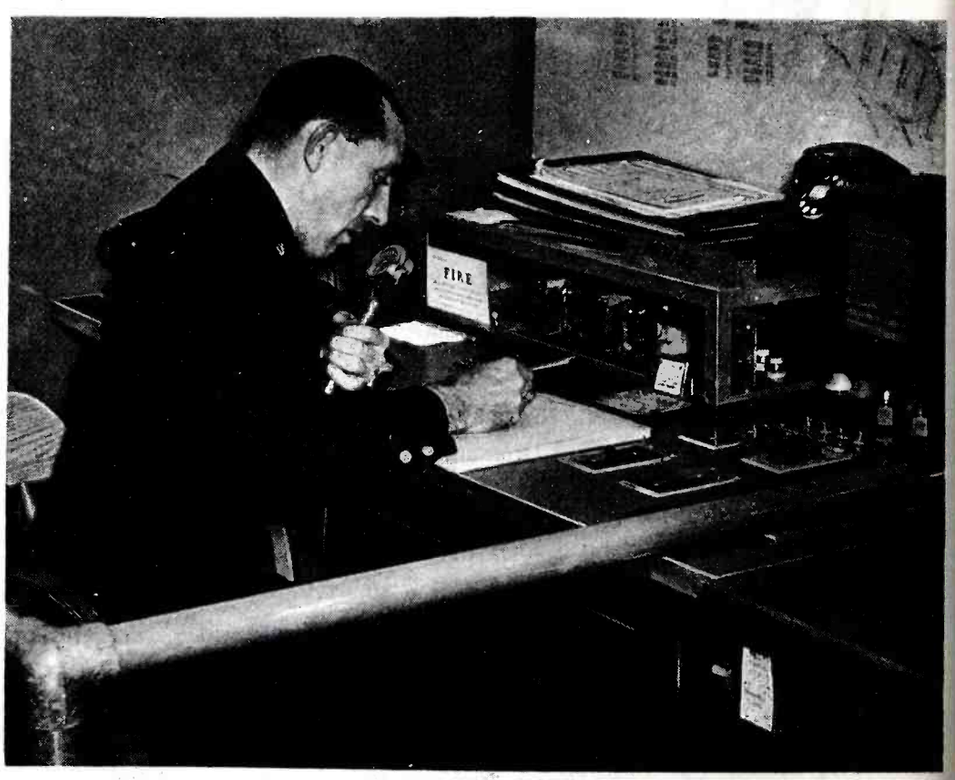
(Continued from page 15)

Figures 6 (left) and 7 (below)

In Figure 6, Harry Lyon at a typical carrier current transmission installation. At extreme right appears a 150-kc carrier current transmitter. In this installation are also a 114-mc space transmitter and the necessary receivers for both carrier current and space reception. In Figure 7, is shown an interesting carrier current installation atop a mountain. The two switches in front on the right hand side of the desk are for remote control. The left hand switch is for the a-c power supply to the transmitter. The right hand switch controls the plate supply to the oscillator. At the microphone is Richard Moore, who operates this particular installation.

as to an antenna and feeder system, can seldom be obtained because of the varying impedance of the power line. Capacity is necessary in the matching circuit for two reasons. First, it is necessary to keep the 60-cycle power out of the transmitter. Second, we must match the transmitter to the line impedance, which is generally highly capacitive. The residential load is usually of a resistive nature, because of the lamp load. This is generally more capacitive than inductive. In commercial areas, with heavy motor loads, the circuit would tend to be of a highly inductive nature. To effect a match to these different type loads, the coupling coil is furnished with matching taps. And the capacity is varied by trial and error method. Generally, capacitors of from .01 to .04 mfd will prove satisfactory.

To measure the radio frequency inputs to the line, an r-f ammeter inserted in series with the circuit can be used.



Substation Problems

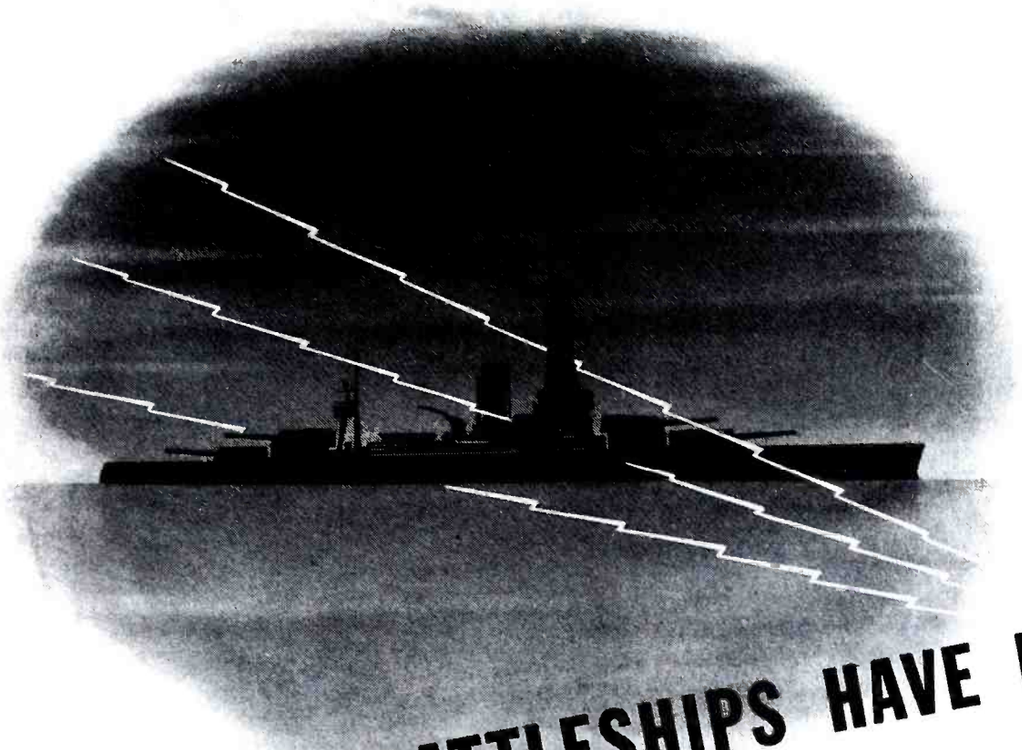
Sub-stations in the distribution system present additional problems, such as: (1)—Segregated buses. (2)—Shunt loads. (3)—Feeder distribution from the station. If the transmitter is feeding into a feeder of one bus in the segregated buses, losses occur in the power transformer. And due to short lengths of the buses, even though one bus may be above the other, the loss in inductive coupling from one length to the other is high.

Transfer of energy is dependent on the signal passing through the power transformer. We thus arrive at the problem of shunt losses. The larger the transformer, the greater the capacitive reactance, therefore causing a greater loss of the signal to ground. Also the voltage regulators on the feeders add additional loads to ground. In spite of this, a percentage of the signal will pass beyond the sub-station. In tests, signals have been found to pass through three sub-stations of fairly high capacity. Beyond this, the signal falls off rapidly into the normal line noise, thus becoming inaudible.

Tuned Isolating Circuits

Where the transmitted signal enters one bus and leaves the sub-station on another, the outgoing signal will be

(Continued on page 106)



THICKSKINNED BATTLESHIPS HAVE NERVES!

Beneath their many inches of armor-plate, Uncle Sam's battlewagons are as finely co-ordinated as champion boxers . . . instantly responsive to commands. A network of nerves . . . the lines of electric communication . . . runs through the ship. The command, "Battle Stations!" is electric . . . *literally.*

To keep these nerves alive with energy is one of the war jobs now being done by Stancor Transformers. When peace is won, American industry will enter a new age of electronics . . . the transformation of electric power to build and serve a happier world. Stancor engineers are preparing, by foresighted research, to serve the needs of peace after victory.

STANCOR

STANDARD TRANSFORMER CORPORATION - 1500 NORTH HALSTED STREET - CHICAGO

ANTENNA ARRAY DESIGN

(*Continued from page 21*)

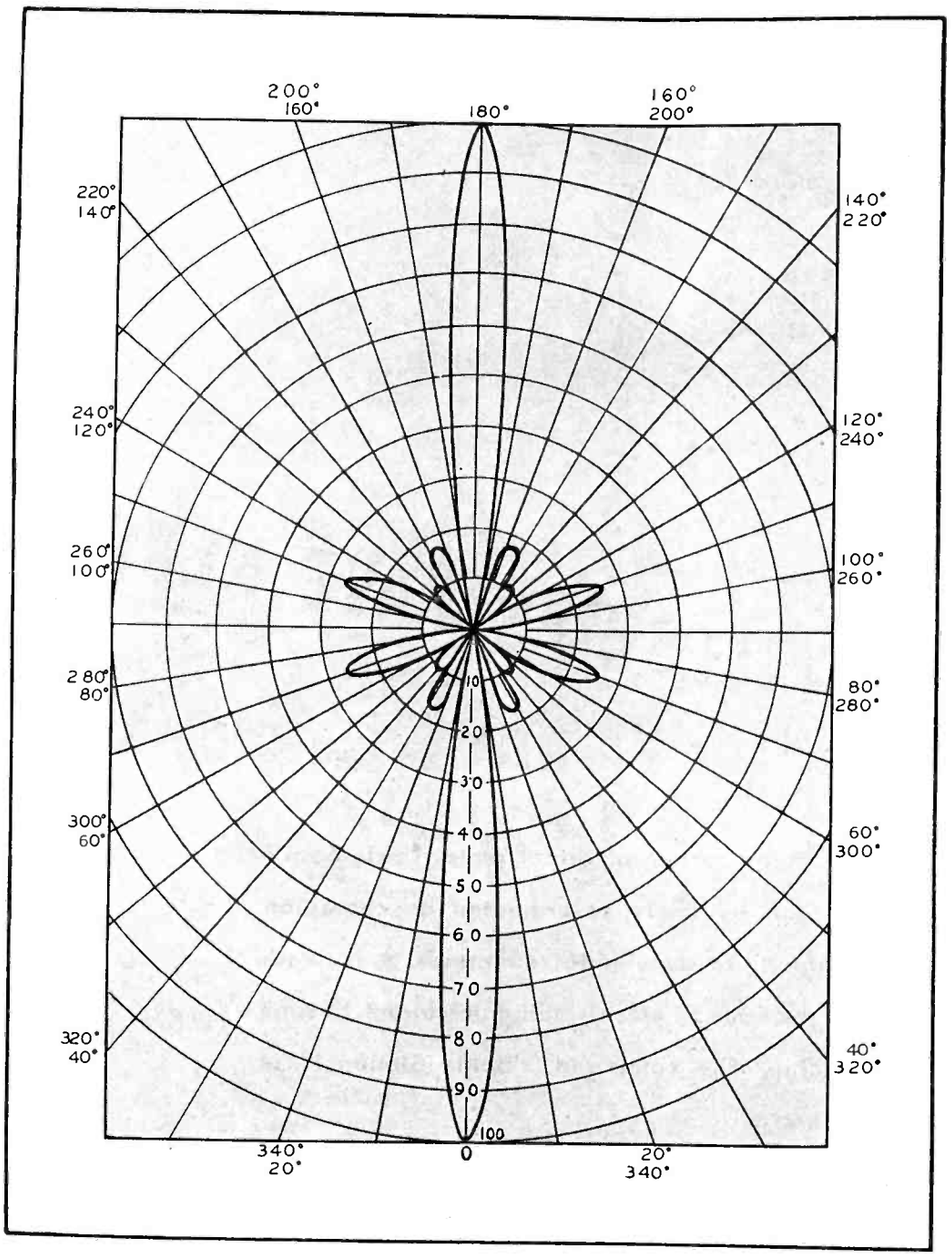


Figure 14

Here we have an illustration of example 2 using three pair of antennae.

design of antenna arrays.

Practical Application

The practical application of the foregoing theory is done using the following steps:

(1)—Plot ε versus θ for the desired pattern.

(2)—Decide on a value of s_1. A good value to choose is about 150°.

(3)—Replot ε of step *1* versus $(s_1 \sin \theta)$. This is done by picking various values of θ, calculating $(s_1 \sin \theta)$ and obtaining the value of ε at that value of θ from the diagram of step 1. It is best to plot this curve from $-s_1°$ to $+ s_1°$ of the $(s_1 \sin \theta)$ coordinate.

(4)—Extend the curve obtained in step *3* arbitrarily to the part where $(s_1 \sin \theta)$ is equal to $+ 180°$ and $(s_1 \sin \theta)$ is equal to $- 180°$. This should be done with the thought of keeping the harmonic content of the wave of step *3* as low as possible.

(5)—Now any method of Fourier analysis can be used to analyze the wave obtained in step *4*. The d-c component will give the value of E_0. The fundamental component will give the voltage necessary for E_1 and the harmonics will give the voltages necessary for E_2, E_3, E_4, etc. It should be kept in mind that these are all proportional voltages.

(6)—If the pattern is not symmetrical about the origin, it will be necessary to employ both the cosine and sine functions. This means that the same pair of antennae will have to be fed with a certain voltage in phase and another pair of voltages 180° out of phase. The voltage in each antennae may be added vectorially and each antenna fed individually with the result. The relationship between any pair of voltages fed to antennae will be determined by the result of the Fourier analysis.

(7)—In order to obtain the exact pattern of step *1*, it will be necessary to use an infinite number of antennae. However, the exact number of antennae necessary can be obtained by plotting patterns of the result of step *5*, using only a finite number of antennae. The number of antennae actually used will be determined finally by how closely it is desired to actually obtain the pattern of step *1*.

Example 1

In Figure 8 is shown a pattern which was needed in a special case where it was necessary to have the null very sharp with a great deal of power right off the null point. It is also desirable to have no other nulls than those perpendicular to the array. Figure 8 was replotted in rectangular coordinates as shown in Figure 9, where $(150 \sin \theta)$ is used as the abscissa. Figure 9 is very close to a perfect sawtooth whose Fourier analysis yields equation *14*.

$$\varepsilon = E \sin (150 \sin \theta) + \frac{E}{2} \sin (300 \sin \theta) + \ldots + \frac{E}{n} \sin (n\, 150\, \theta) \qquad (14)$$

This means that the d-c component is zero or that the center antenna will have no voltage in it and may be left out. The first pair of antennae will be spaced 150° to each side of the center, and fed 180° out of phase with one another with a voltage E. The second pair will be spaced 300° to each side of the center and fed in the same phase relationship as the first pair with one half E, the voltage on the first pair. The n'th pair will be spaced n times 150° to each side of the center and fed with one-n'th the voltage E. In order to show the effect of using different numbers of harmonics a few patterns were calculated. With three pairs of antennae,

(*Continued on page 78*)

ANTENNA ARRAY DESIGN

(*Continued from page 76*)

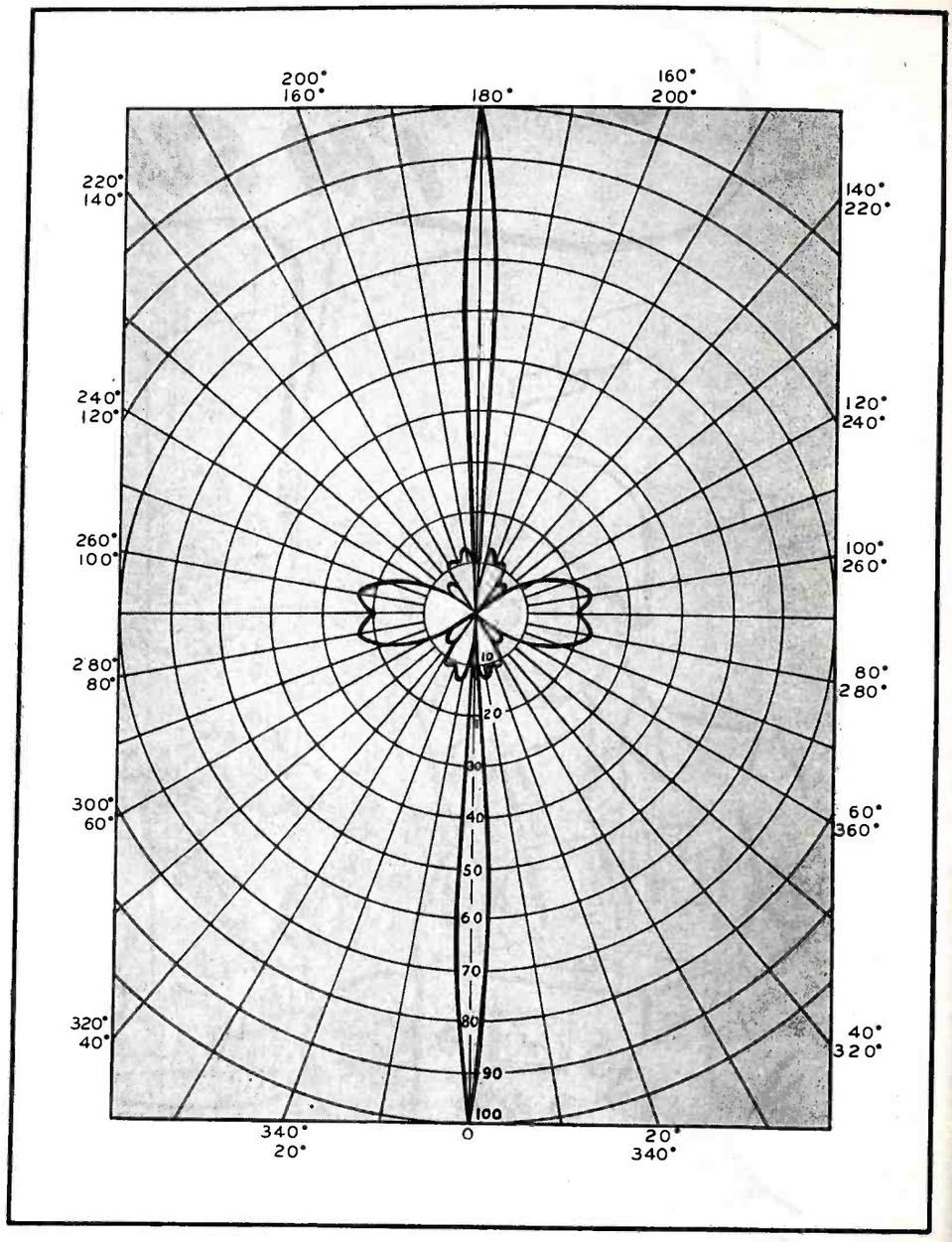


Figure 15

Illustration of example 2 using four pair of antennae. Note that this provides a much sharper lobe, but it still has minor lobes. The minor lobes, however, are at right angles to the antenna array and can be reduced very considerably by making the array out of a dipole antenna that would only radiate a minor amount to the sides.

Figure 10 was obtained. If six pairs of antennae are used, we have the pattern of Figure 11. Figure 11 is closer to the desired pattern of Figure 8. However, six pairs of antennae means twelve antennae stretched over a space of 1800°, which is quite a large array. The more antennae that are used the closer the finished pattern would approach the desired pattern of Figure 8.

Example 2

In this case a pattern shown in Figure 12 is desired. This is a very sharp lobe perpendicular to the antenna array. Replotting Figure 12 in rectangular coordinates with (150 sin θ) as the abscissa, we obtain Figure 13. The analysis is simplified if we put a negative pulse at $-180°$ and $+180°$ as shown. When the wave of Figure 13 is analyzed by means of any convenient Fourier analysis, equation *15* is obtained.

$$\varepsilon = E\cos(150\sin\theta) + E\cos(450\sin\theta) + \ldots + E\cos[(2n-1)\,150\sin\theta] \qquad (15)$$

Summation of Odd Cosine Terms Sharp Lobes

It can be seen that we have here a summation of odd cosine terms. Using three harmonics, the first, third and fifth, the diagram shown in Figure 14 results. In this case all of the antennae are fed with equal power as shown by equation *15* and they are all fed in phase. This gives a very sharp major lobe but includes a number of minor lobes. Using four pairs of antennae, we secure the pattern shown in Figure 15. This gives a much sharper major lobe, but still contains large minor lobes. The minor lobes, however, are at right angles to the antenna array and can be reduced very considerably by making the array out of dipole antennae that would only radiate a minor amount to the sides. The effects of six pairs of antennae have also been studied. Such an arrangement provided an extremely sharp lobe, but still contained a noticeable secondary lobe at 20°.

Rotation of Patterns

A very interesting example can be illustrated by calculating a number of patterns wherein the sharp lobe is rotated through a large angle. Thus it is possible with the use of stationary antennae to rotate a sharp lobe electronically. It must be remembered, however, that the pattern will be symmetrical about the 90°—270° line, and there will be a second lobe existing there. By the proper combination of different sets of antennae, it seems possible to have a single maximum lobe which can be shifted through practically any angle. However, the array will be extremely complicated and the results would not seem to warrant the extensive equipment required. It is also possible to rotate a null point in a similar manner, but again a second null point would exist, which is also symmetrical about the 90°—270° line.

Conclusion

Fourier analysis can be applied to obtain specified antenna patterns. The examples shown here were confined to cosine and sine functions. A combination of sine and cosine terms can be used if any occasion should arise. It would mean, however, that each antenna would have to be supplied with a different amount of power and in that manner be individually controlled.

Credits

My thanks to J. Kaplan for his help in calculating some of the patterns.

COMMERCIAL AND EXPERIMENTAL F-M BROADCAST LICENSES WITH PERMANENT OR TEMPORARY FACILITIES

[*See Raymond Guy paper, pp.* 30, 32, 34, 35, 36]

Freq. (MC)	Call Letters	Licensee	Location	Coverage Specified Sq. Miles	Remarks
43.1	W31NY	Edwin H. Armstrong	Alpine, N. J.	15,610	Commercial
43.9	W39NY	City of New York	New York, N. Y.	3,889	Commercial with temporary facilities
44.7	W47NY	Muzak Radio Broadcasting Station, Inc.	New York, N. Y.	8,500	Commercial with temporary facilities
45.1	W2XWG	National Broadcasting Co., Inc.	New York, N. Y.	1,000-W (Power)	Experimental, class 2
45.9	W59NY	Interstate Broadcasting Co., Inc.	New York, N. Y.	8,500	Commercial with temporary facilities
46.3	W63NY	Marcus Loew	New York, N. Y. (T-Cliffside Park, N. J.)	8,500	Commercial with temporary facilities
46.7	W67NY	Columbia Broadcasting System, Inc.	New York, N. Y.	8,500	Commercial with temporary facilities
47.1	W71NY	Bamberger Broadcasting Service, Inc.	New York, N. Y.	8,500	Commercial with temporary facilities
47.5	W75NY	Metropolitan Television Co.	New York, N. Y.	8,500	Commercial with temporary facilities
44.9	W49PH	Pennsylvania Broadcasting Co.	Philadelphia, Pa.	9,300	Commercial with temporary facilities
45.3	W53PH	WFIL Broadcasting Co., Inc.	Philadelphia, Pa.	9,300	Commercial
45.7	W57PH	Westinghouse	Philadelphia, Pa.	9,300	Commercial with temporary facilities
46.9	W69PH	WCAU Broadcasting Co.	Philadelphia, Pa.	9,300	Commercial with temporary facilities
47.3	W73PH	William Penn Broadcasting Corp.	Philadelphia, Pa.	9,300	Commercial with temporary facilities
45.1	W51C	Zenith Radio Corp.	Chicago, Ill.	10,800	Commercial
45.9	W59C	WGN, Inc.	Chicago, Ill. (T-Schaumberg)	10,800	Commercial with temporary facilities
46.7	W67C	Columbia Broadcasting System, Inc.	Chicago, Ill.	10,800	Commercial with temporary facilities
47.5	W75C	Moody Bible Institute	Chicago, Ill. (T-Addison)	10,950	Commercial with temporary facilities
43.9	W39B	Yankee Network	Boston, Mass. (T-Mt. Washington, N. H.)	31,000	Commercial with temporary facilities
44.3	W43B	Yankee Network	Boston, Mass. (T-Paxton)	19,000	Commercial
46.7	W67B	Westinghouse	Boston, Mass. (T-Hull)	6,700	Commercial with temporary facilities
44.5	W45D	Evening News	Detroit, Mich.	6,828	Commercial with temporary facilities
44.9	W49D	John Lord Booth	Detroit, Mich.	6,800	Construction permit. Operating experimentally under special authority
44.7	W47P	WWSW, Inc.	Pittsburgh, Pa.	8,400	Commercial
47.5	W75P	Westinghouse	Pittsburgh, Pa.	8,400	Commercial with temporary facilities
43.2	W3XO	Jansky-Bailey	Washington, D. C.	100-W (Power)	Experimental
44.5	K45LA	Don Lee Broadcasting System	Los Angeles, Calif.	6,944	Commercial with temporary facilities
45.1	W51R	Stromberg-Carlson	Rochester, N. Y.	3,200	Commercial
44.9	K49KC	Commercial Radio Equipment Co.	Kansas City, Mo.	4,400	Commercial with temporary facilities
46.5	W9XER	Midland Broadcasting Co., Inc.	Kansas City, Mo.	1,500	Developmental broadcast station with authority to operate experimentally
44.7	W47A	Capitol Broadcasting Co., Inc.	Schenectady, N. Y.	6,589	Commercial with temporary facilities

(*Continued on page* 84)

BOOK TALK . . .

Reviews of the Latest Technical Literature

ORGANIC CHEMISTRY SIMPLIFIED

By Rudolph Macy, Ph.D., Chemist Chemical Warfare Service, formerly Ass't Professor of Chemistry, University of Maine . . . 431 pp. . . . Brooklyn, New York: Chemical Publishing Co., Inc. . . . $3.75

This book has been prepared for those interested in the study of organic chemistry, in the classroom, or in the home. An interesting approach to the application of chemical properties has been prepared by Dr. Macy. For instance, the first part treats of the position of the carbon atom in chemistry. This part is divided into eight chapters, covering the nature of organic chemistry and including a discussion of north and south poles.

The second part covers the architecture of carbon compounds analyzing such phases as methane and structure theory, carbon chains and rings, paraffins, olefines and acetylenes, and the geography of the benzene ring.

The third part covers a classification of carbon compounds with a discussion of alcohols, phenols, ethers, sulphur, phosphorus, etc.

In the concluding part of the book, many special topics in organic chemistry are discussed. These include the role of isoprene in nature, dyes, isotopic chemistry and giant molecules.

The communications engineer will find this book very helpful as a guide in development work. There are many puzzling problems involving a more than passing acquaintance with chemistry, that come up frequently in radio design work. This volume has the answer to many of these problems.

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QUARTZ CRYSTAL APPLICATIONS

By W P. Mason . . . 46 pp. . . . New York: The Bell System Technical Journal, July, 1943, American Telephone and Telegraph Co. . . . $.50

Student and engineer should read this paper. It is one of a series that has been appearing and will continue to appear in the journal, from time to time.

In this particular presentation, Mr. Mason discusses the early history of piezoelectricity and its applications, theory of piezoelectric materials, electrical impedance and law dissipation in crystals, as well as the modes of motion and crystal orientation to produce low temperature coefficient crystals.

An appendix in the paper covers Voigt's elastic and piezoelectric relations and their application to the determination of low temperature coefficient crystals. Analyzed in this discussion are the mathematical expressions for piezoelectric relations, values of the elastic and piezoelectric constants, derivation of equivalent circuit, of crystal, and the use of Voigt's relations in locating regions of low temperature coefficient crystals for simple modes of motion.

Throughout the paper appear effective illustrations in the form of charts, diagrams and photographs. The illustrations include Nicholson's oscillator circuit, the various quartz crystal cuts in relation to the natural crystal and the relationship of *AT* and *DT* low temperature coefficient crystals.

In this issue of the journal also appears a crystal paper by W. L. Bond, covering the methods for specifying quartz crystal orientation and their determination by optical means.

In this thirty-nine-page paper, Mr. Bond analyzes the subject of quartz and its axes; natural face orientation; flat lay cutting; *Z* section or vertical cutting; polarized light as applied to crystals; polarizers and analyzers; plane of polarization rotation, and immersion fluids.

In the appendix appears data on ring eccentricity correction.

• • •

RADIO ENGINEERS' HANDOOK

By Frederick E. Terman, Sc.D., Professor of Electrical Engineering and Executive Head, Electrical Engineering Dep't., Stanford Univ. (absent on leave); Director, Radio Research Laboratory, Havard University . . . 1019 pp. . . . New York: McGraw-Hill Book Co. Inc. . . . $6.00

This long awaited book is one of the most comprehensive reference guides ever published. Approximately 2,000 published technical articles were reviewed during the preparation of the book to assure thoroughness.

Sturdy analyses of subjects ranging from simple resonant circuits to microwave tubes are the result of the careful treatment given.

There are thirteen sections to the book. In the first section appear a variety of tables that will be more than welcome by every engineer.

The second section covers circuit elements, and discusses such phases as inductance and capacity effects associated with resistors and resistor behavior at high frequencies, self inductance of straight conductors, mutual inductance and coefficient of coupling, air-cored coils, magnetic cores, dielectrics, etc.

In the third section is covered circuit theory. An analysis of series resonance, coupling effects, transmission lines, networks, attenuators, wave guides and resonators appears here.

The fourth section is devoted to vacuum tubes. The physical properties of electrons and ions are discussed in a most complete way. Included in this chapter are data on amplification factors and miscellaneous types of tubes. Electron optics and cathode-ray tubes are featured topics in this chapter, too.

Vacuum tube amplifiers form the basis of discussion of section five. All types of amplifiers are explained with suitable charts and diagrams as illustrations. Filter coupling networks for improving the characteristic of power amplifiers are shown, too. The various types of video frequency amplifiers, heretofore a neglected phase of analysis, has been given considerable treatment in this book.

In section six, we have a description of various types of oscillators of both mechanical and electronic construction.

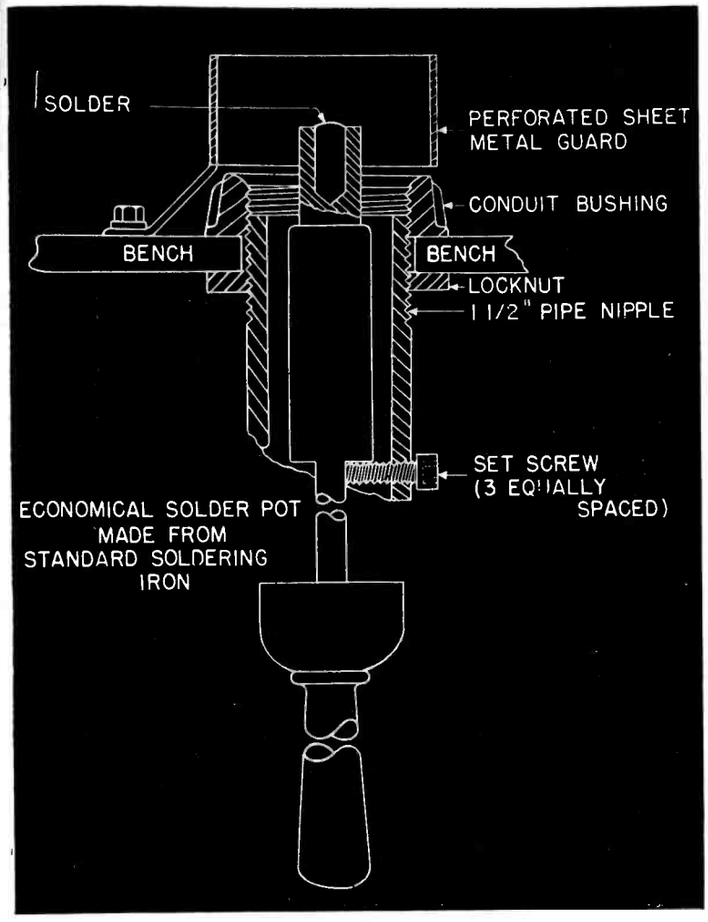
Modulation and demodulation is the subject of section seven. In section eight is an analysis of power supply systems; section nine covers radio transmission and receivers; section ten provides a study of propagation of radio waves; section eleven discusses antennas; section twelve discusses radio aids to navigation and section thirteen covers measurements.

An extensive bibliography has been prepared for this book. There are

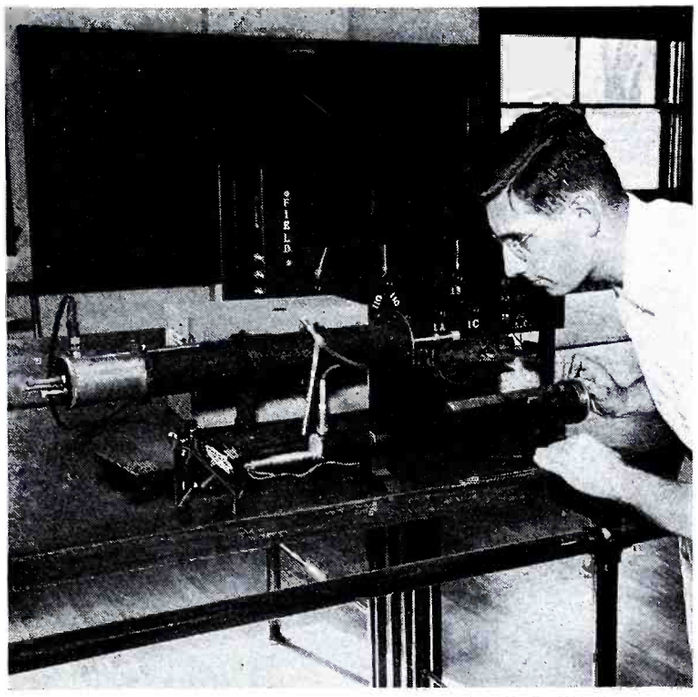
(*Continued on page* 111)

PRODUCTION AIDS

[Continued from page 50]



An improvised solder pot developed by R. H. Bainbridge, a G. E. foreman, to facilitate the production of small instrument-type motors. A perforated sheet metal guard encircles the exposed tip, permitting free circulation of air about the top, eliminating the possibility of solder overheating. It also assures complete operational safety.



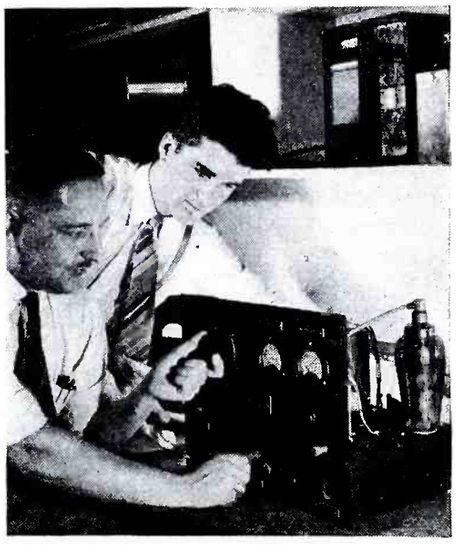
(Photo by W. R. Wildhagen)

Ultra high frequencies are used extensively today in receiver and transmitter work. Many special measurement devices have had to be designed to attain maximum efficiency on production lines. Above we see a unit used to measure the wavelength of an ultra high frequency oscillator. This device was built in the electrical engineering laboratories of the University of Illinois.

A typical p-a system used to entertain workers in government and commercial plants to improve morale and increase production. Systems cover not only interior but exterior locations. The amplifier is used also as a means of disseminating vital information to the workers. In addition it also serves as an emergency information service.
(Courtesy OEM)

Below, F. W. Williamson, noted phonograph-needle designer, with a photomicrographic unit that measures angular deflection of needles. The lesser the angular deflection, the less the distortion and the better the tone quality. Thus, through this medium of analysis, it is entirely possible to improve needle design, and its corresponding production.

Youth is playing a major role on the production front today. Plants are giving courses of instruction on production aids. Below we see a recent college graduate, James E. Zimmerman, currently a member of the Westinghouse Research Laboratories Graduate Study Course, obtaining instructions from Dr. W. E. Shoupp.
(Courtesy Westinghouse)



NEWS BRIEFS

(Continued from page 70)

with schematic diagrams, radio parts catalog, etc., is now available.

* * *

KELLOGG WARTIME HELPS

A 12-page booklet *75 Ways for Telephone Folks to Help Win the War* has been released by the Kellogg Switchboard and Supply Company, 6550 South Cicero Avenue, Chicago, Ill.

In the book are seventy-five tips on maintenance of telephone equipment.

Copies are available gratis.

* * *

AIRCRAFT ACCESSORIES BUYS PHONETTE COMPANY CONTROL

A controlling interest in The Phonette Company of America, Los Angeles, has been acquired by Aircraft Accessories Corporation, Kansas City, Kansas.

Phonette will be operated as a subsidiary, under the supervision and direction of the electronics division of Aircraft Accessories, according to Randolph C. Walker, president.

The Phonette Company of America was formerly engaged in the development, manufacture and sale of the *Phonette*, a music vending device invented by W. S. Farrell, its president.

Officers and directors of The Phonette Company now are: Randolph C. Walker, chairman of the board; W. S. Farrell, president and director; C. N. Kimball, vice president and director; Ray Eller, secretary-treasurer and director, and C. F. Skinner, director.

* * *

UNIVERSAL PLUG-JACK CATALOG

A four-page loose leaf edition of catalog 830, describing Army and Navy plugs and jacks, has been issued by Universal Microphone Company, Inglewood, Calif.

Besides plugs and jacks, the illustrated catalog includes descriptions of prongs, cord clamps, jack inserts and shells for both jacks and plugs.

* * *

FABRICATED PIPE BULLETIN

A 64-page illustrated book discussing a variety of fabricated piping and uses has been issued by the Flori Pipe Company, St. Louis, Missouri.

* * *

GERBER SALES TO REPRESENT UNIVERSAL

The Gerber Sales Company, Boston, Mass., has been appointed New England factory representative for the Universal Microphone Co., Inglewood, Calif.

* * *

SNAP-ACTION MIDGET SWITCH CATALOG

A 10-page loose-leaf file size catalog describing snap-action midget switches has been released by the Acro Electric Company, 1305 Superior Ave., Cleveland, Ohio. Included are engineering data on construction embodying the rolling spring principle. Ten types with complete ratings and blueprint drawings are illustrated and described.

* * *

SPEED NUT BULLETIN

A 20-page illustrated catalog showing 50 new Speed Nut and Speed Clip applications has been issued by Tinnerman Products, Inc., Fulton Road, Cleveland, Ohio. Listed are maximum load limits for Speed Nuts of all sizes. Illustrated are retainer rings, Speed Nut strips, latching nuts, cable clips, anchor nuts, angle bracket Speed Nuts, conduit clamps, harness clamps, pulley brackets, junction box cover clips, fairlead guide blocks, nuts for inspection doors, hat sections and switches and Speed Nuts for plywood.

* * *

W. B. GILLEN IN NEW G. E. POST

W. B. Gillen has been named manager of manufacturing of the tube division of the General Electric Electronics Department. Mr. Gillen will be responsible for all G. E. tube manufacturing activities at Buffalo, Cleveland, Lynn and Schenectady. For the present he will make his headquarters at Nela Park, Cleveland.

* * *

IMPREGNATION DATA

A 4-page illustrated bulletin, 431-W, on *dag* colloidal graphite for impregnation and surface coatings has just been released by the Acheson Colloids Corporation of Port Huron, Michigan.

In this bulletin is a detailed discussion of the impregnating capacity of colloidal graphite dispersions and the application and results of impregnation and surface coating of colloidal graphite for various industrial products. It includes the reasons for colloidalization of graphite for this purpose and notes on the methods used to impregnate materials.

* * *

FORMED SHEET LAMINATED PLASTICS TO BECOME POPULAR

According to specialists at Formica Insulation Company, Cincinnati, *formed sheet* plastics will be a popular post-war material.

In *forming* plastics, the finished laminated sheet is heated and then bent immediately into shape to make curved or formed parts; the designed shapes hav-

ing retention qualities that are said to be fixed, stable and permanent.

The sheet to be formed is heated by placing in an oven, immersed in a hot liquid or radiated by infra red. This process takes about one minute. When hot, the sheet is placed immediately in a wooden form and bent to shape.

The shapening process requires only a few minutes until it is set. Then the finished piece is removed from the form.

Most recent advances in the *formed* process is in production of materials with the ability to be drawn into compound curves. Sheet is now made in a canvas grade which can be molded into cup or otherwise *drawn* shape. Even spinning has been accomplished.

The *formed* process is in contrast to the older molding method of producing shapes. In the conventional pre-war method one piece was molded at a time, utilizing a costly machined steel mold. By the new method sheets are pressed in multiple presses where 80 large sheets can be made in one cure. Those cured sheets are then cut into desired shape and formed by the newer, simpler method.

* * *

BUREAU OF STANDARDS STANDARD FREQUENCY BROADCAST SERVICE

The National Bureau of Standards standard frequency broadcasts service from WWV has been improved and extended. A new transmitting station has been built. 10-kilowatt transmitters installed, and additional frequencies and voice announcements added. The services include: (1)—standard radio frequencies; (2)—standard time intervals accurately synchronized with basic time signals; (3)—standard audio frequencies, and (4)—standard musical pitch, 440 cycles per second, corresponding to A above middle C.

The service is continuous at all times day and night. The standard radio frequencies are: 5 megacycles per second, broadcast continuously; 10 megacycles per second, broadcast continuously, and 15 megacycles per second, broadcast continuously in the daytime only.

All the radio frequencies carry two audio frequencies at the same time, 440 cycles per second and 4,000 cycles per second; the former is the standard musical pitch and the latter is a useful standard audio frequency. In addition there is a pulse every second, heard as a faint tick each second when listening to the broadcast. The pulses last 0.005 second; they may be used for accurate time signals, and their one-second spacing provides an accurate time interval for purposes of physical measurements.

The audio frequencies are interrupted precisely on the hour and each five minutes thereafter; after an interval of precisely one minute they are resumed. This one-minute interval is provided in order to give the station announcement and to afford an interval for the checking of radio-frequency measurements free from the presence of the audio frequencies. The announcement is the station call letters (WWV) in telegraphic code (dots and dashes) except at the hour and half-hour, when the announcement is given by voice.

The accuracy of all the frequencies, radio and audio, as transmitted, is better than a part in 10,000,000. Transmission effects in the medium (Doppler effect, etc.) may result in slight fluctuations in

(Continued on page 86)

COMMERCIAL AND EXPERIMENTAL F-M BROADCAST LICENSES WITH PERMANENT OR TEMPORARY FACILITIES

[*Continued from page 79*]

Freq. (MC)	Call Letters	Licensee	Location	Coverage Specified Sq. Miles	Remarks
48.1	W81SP	Westinghouse Radio Stations, Inc.	Springfield, Mass.	2,380	———
48.5	W85A	General Electric	Schenectady, N. Y. (T-New Scotland, N. Y.)	6,600	Commercial
45.3	W53H	Traveler's Broadcasting Service	Hartford, Conn. (T-Avon)	6,100	Commercial
46.5	W65H	WDRC, Inc.	Hartford, Conn. (T-Meridan)	6,100	Commercial with temporary facilities
43.0	W9XYH	Head of the Lakes Broadcasting Co.	Superior, Wisc.	1,000-W (Power)	Class 2 experimental
43.2	W8XFM	The Crosley Co.	Cincinnati, Ohio	1,000-W (Power)	Class 2 experimental
43.4	WIXTG	Worcester-Telegram	Worcester, Mass. (T-Holden, Mass.)	1,000-W (Power)	Class 2 experimental. Application commercial permit pending
44.1	W41MM	Gordon Gray	Winston-Salem, N. C. (T-Clingman's Peak)	69,400	Commercial with temporary facilities
44.5	W45V	Evansville on the Air, Inc.	Evansville, Ind.	8,397	Commercial
44.5	W45BR	Baton Rouge Broadcasting Co., Inc.	Baton Rouge, La.	8,100	Commercial
44.5	W45CM	WBNS, Inc.	Columbus, Ohio	12,400	Commercial with temporary facilities
44.7	W47NV	National Life & Accident Insurance Co., Inc.	Nashville, Tenn. (T-Franklin)	16,000	Commercial
44.9	W49FW	Westinghouse	Fort Wayne, Ind.	6,100	Commercial with temporary facilities
44.9	W49BN	Wylie B. Jones Advertising Agency	Binghamton, N. Y.	6,500	Commercial
45.5	W55M	The Journal Co.	Milwaukee, Wis. (T-Richfield)	8,540	Commercial
47.1	W71SB	South Bend Tribune	South Bend, Ind.	7,100	Commercial with temporary facilities

APPLICATIONS FOR CONSTRUCTION PERMITS OR REINSTATEMENT

45.5	W55NY	Wm. G. H. Finch	New York, N. Y.	8,500	———
43.9	W39NY	Frequency Broadcasting Corp.	Brooklyn, N. Y.	9,318	———
45.1	W51NY	National Broadcasting Co., Inc.	New York, N. Y.	8,500	Construction permit
——	———	News Syndicate Co., Inc.	New York, N. Y.	8,500	Construction permit application
48.3	———	WBNX Broadcasting Co., Inc.	New York, N. Y.	8,730	Construction permit application
48.3	W83NY	WMCA, Inc.	New York, N. Y.	8,550	Construction permit application
48.7	W87NY	Greater New York Broadcasting Corp.	New York, N. Y.	8,500	Construction permit application
——	———	Debbs Memorial Radio Fund, Inc.	New York, N. Y.	8,600	Construction permit application
44.7	W47C	WJJD, Inc.	Chicago, Ill.	10,800	Construction permit
46.3	W63C	National Broadcasting Co.	Chicago, Ill.	10,800	Construction permit
47.9	W79C	Oak Park Realty & Amusement Co.	Chicago, Ill.	10,800	Construction permit
——	———	Globe-Democrat Publishing Co.	St. Louis, Mo.	13,083	Construction permit application
45.1	K51L	St. Louis University	St. Louis, Mo.	13,000	Construction permit
45.5	K55L	The Pulitzer Publishing Co.	St. Louis, Mo.	13,391	Construcition permit application
46.5	W65PH	Seaboard Radio Broadcasting Corp.	Philadelphia, Pa.	9,300	Hearing for extension of time postponed

Freq. (MC)	Call Letters	Licensee	Location	Coverage Specified Sq. Miles	Remarks
46.1	W61PH	Gibraltor Service Corp.	Philadelphia, Pa.	9,318	
47.7	W77PH	WDAS Broadcasting Station, Inc.	Philadelphia, Pa.	9,300	
45.3	———	Constitution Publishing Company	Atlanta, Ga.	7,380	
45.3	W53D	WJR, the Goodwill Station	Detroit, Mich.	6,800	
——	———	James F. Hopkins, Inc.	Detroit, Mich.	6,790	
47.3	W73D	King Trendle	Detroit, Mich.	6,750	
44.5	———	Head of the Lakes Broadcasting Co.	Superior, Wisc.	2,754	For change of experimental station to commercial status
44.7	———	Globe Democrat	St. Louis, Mo.	13,083	
44.7	———	Star Times	St. Louis, Mo.	12,480	
45.9	K59L	Columbia Broadcasting System	St. Louis, Mo.	13,000	
43.5	———	Don Lee Broadcasting System	San Francisco, Calif. (T-Berkley)	18,050	
———	———	Columbia Broadcasting System	Boston, Mass.	20,200	
——	———	Radio Voice of New Hampshire, Inc.	Manchester, N. H. (T-Mt. Shaw)	31,630	
44.1	———	Sun Company of San Bernardino	San Bernardino, Calif.	17,101	
45.1	K51AM	Amarillo Broadcasting Corp.	Amarillo, Texas	5,600	Construction permit forfeited. Applicant filed new application
——	W51SL	American Broadcasting Corp. of Kentucky	Lexington, Ky.	6,298	
——	———	WOKO, Inc.	Albany, Inc.	7,164	
45.3	———	Indianapolis Broadcasting, Inc.	Indianapolis, Ind.	13,200	Construction permit application
45.7	———	Courier-Journal & Louisville, Times Co.	Louisville, Ky.	13,200	Construction permit application
45.9	W59BM	The Baltimore Radio Show, Inc.	Baltimore, Md.	5,500	Construction permit
46.1	———	Ashland Broadcasting Co.	Ashland, Ky.	4,160	Construction permit application
46.3	W63SY	Central New York Broadcasting Corp.	Syracuse, N. Y. (T-Pompey, N.Y.)	6,800	Construction permit
46.5	———	Houston Printing Corp.	Houston, Texas	10,500	Construction permit
46.5	W65H	WDRC, Inc.	Hartford, Conn. (T-Meridan)	6,100	Licensed station. Application to change frequency to 43,500 kc, coverage to 13,944 square miles and to increase transmitter power
46.5	———	Hawley Broadcasting Co.	Reading, Pa.	4,275	Construction permit application
46.7	———	Piedmont Publishing Co.	Winston-Salem, N. C.	4,600	Construction permit application
47.1	W71RF	Rockford Broadcasters, Inc.	Rockford, Ill.	3,900	Construction permit
48.5	———	The Outlet Co.	Providence, R. I.	7,520	Construction permit application
——	———	United Broadcasting Co.	Cleveland, Ohio	8,420	Construction permit application
49.1	W91NJ	New Jersey Broadcasting Corp.	Jersey City, N. J. (T-near Bloomfield)	6,200	Construction permit
49.9	———	Mercer Broadcasting Co.	Trenton, N. J.	3,200	Construction permit application
44.7	W47R	WHEC, Inc.	Rochester, N. Y.	2,318	Construction permit in suspense, No. 79
46.5	———	Pittsburgh Radio Supply House	Pittsburgh, Pa.	8,400	
47.1	———	Evening Star Broadcasting Co.	Washington, D. C.	5,600	
43.7	K37LA	Earl Anthony	Los Angeles, Calif.	34,000	
45.7	———	Earl Anthony and Sons	New Bedford, Mass.	1,787	
46.9	W69GR	King Trendle	Grand Rapids, Mich.	5,300	
47.1	———	Portland Broadcasting System	Portland, Me.	3,980	
48.1	———	Federated Publications, Inc.	Battle Creek, Mich.	4,100	

***NOTE:** The letter "T" appearing before a station location enclosed in parenthesis represents the transmitter location.*

NEWS BRIEFS

(*Continued from page* 83)

the audio frequencies as received at a particular place; the average frequency received is however as accurate as that transmitted. The time interval marked by the pulse every second is accurate to 0.000 01 second. The 1-minuate, 4-minute, and 5-minute intervals, synchronized with the seconds pulses and marked by the beginning and ending of the periods when the audio frequencies are off, are accurate to a part in 10,000,000. The beginnings of the periods when the audio frequencies are off, are so synchronized with the basic time service of the U. S. Naval Observatory that they mark accurately the hour and the successive 5-minute periods.

Of the radio frequencies on the air at a given time, the lowest provides service to short distances, and the highest to great distances. For example, during a winter-day, good service is given on 5 megacycles at distances from 0 to about 1000 miles, 10 megacycles from about 600 to 3000 miles, and 15 megacycles from about 1000 to 6000 miles. Except for a certain period at night, within a few hundred miles of the station, reliable reception is in general possible at all times.

Information on how to receive and utilize the service is given in the Bureau's Letter Circular, *Methods of Using Standard Frequencies Broadcast by Radio,* obtainable on request.

* * *

LEVEL RECORDER BULLETIN

A six-page brochure describing a graphic level recorder and its applications has been released by the Sound Apparatus Co., 150 West 46th St., New York City. Included in the bulletin are data on audio frequency response measurements.

* * *

FRAUMAN OF SHURE NOW IN AIR CORPS

Burt Frauman, formerly with the sales engineering department of Shure Bros., Chicago, Illinois, is now in the Army Air Corps as an aviation cadet.

* * *

NEW INTERPOLATION TABLES

Complete 5-point tables of lagrangean interpolation coefficients, that were originally issued in June, 1941, for private distribution in the War Department, have just been released for public reference, according to the Journal of Mathematics and Physics published by M.I.T.

Copies of these tables are available from the Marchant Calculating Machine Company, Oakland, California, free of charge, by members of any recognized mathematical, scientific, or engineering societies or by members of the faculties of public institutions and public libraries. To others who may wish to secure this material, the price is 15c. In requesting these data, ask for publication MM-228.

* * *

ELECTRONIC PRIMER

A four-page leaflet describing the fundamentals of electronics has been released by General Electric, Schenectady, N. Y..

* * *

GILMORE RETIRES FROM W. E.

Harry B. Gilmore, secretary of the Western Electric Company for the past 41 years, has retired. Norman R. Frame, assistant secretary, was elected secretary to succeed Mr. Gilmore.

* * *

PHILCO APPOINTS P. M. CRAIG CHIEF ENGINEER

Palmer M. Craig, for the past two years chief engineer in charge of radar and radio communications equipment development, has been named chief engineer of the radio division of Philco Corporation.

Mr. Craig joined the Philco Research Laboratories in 1933 as a radio engineer.

* * *

J. H. FOUNTAIN APPOINTED PUBLICITY MANAGER OF SPERRY

J. H. (Joe) Fountain has been appointed publicity manager in the public information department of Sperry Gyroscope Company.

Mr. Fountain will also perform certain assigned duties as special assistant to the vice president for sales of Sperry.

* * *

CANNON RACK AND PANEL CONNECTOR DATA

A 28-page bulletin describing Cannon type DP rack and panel electrical connectors has just been released by Cannon Electrical Development Company, 3209 Humboldt Street, Los Angeles 31, Calif.

The bulletin includes descriptions, applications, illustrations, sketches and tabular data on types DP-D, DP-B, DP-R and nine other DP types used in a variety of applications in radio and instrument installations in aircraft, tanks, electrical pipe organs, etc.

For copies, write the factory.

* * *

MACKAY MARINE DIVISION APPOINTS E. H. PRICE MANAGER

E. H. Price is now manager of the marine division of the Mackay Radio and

Telegraph Company. This office was formerly held by Walter V. Russ, who died recently.

James T. Chatterton, former district manager of the Washington, D. C. office, succeeds Mr. Price as commercial manager, with headquarters in New York City.

* * *

WPB ISSUES DEFECTIVE PART AMENDMENT

An amendment, (3), to Limitation Order L-265, issued by the WPB says that used, defective, exhausted or condemned parts for electronic equipment that cannot be disposed of by producers or suppliers, for salvage, must be destroyed within sixty days. This action was taken to prevent such defective parts from getting back into trade channels.

* * *

G. E. PLASTICS PLANT WINS "E"

The Pittsfield works of the plastics divisions of General Electric has been awarded the Army-Navy E.

Brigadier General Guy H. Drewry presented the flag. William H. Milton, manager of the division, accepted the flag.

* * *

SOLAR MOVES OFFICES

The executive and sales offices of the Solar Manufacturing Corporation have been moved to 285 Madison Avenue, New York City. Solar factories are located in Bayonne, N. J., West New York, N. J., and Chicago, Ill.

* * *

KAAR AND NEVIN WIN G. E. PROMOTIONS

I. J. Kaar and G. W. Nevin have been appointed managers of the receiver and tube divisions, respectively, of General Electric's Electronics Department. The receiver division is located at Bridgeport,

(*Continued on page* 88)

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THEY'RE RECEIVER TESTERS

Engineers at a General Electric plant about to enter a chamber to test war radio equipment at temperatures as low as 100 degrees below zero. The cold surpasses that encountered by Arctic-bound ships or planes flying in high altitudes.

NEWS BRIEFS

(*Continued from page 87*)

Conn., while the tube division is located in Schenectady.

Mr. Kaar formerly was managing engineer of the receiver division.

Mr. Nevin formerly was chairman of the management committee of the tube division of the Electronics department.

* * *

BLIND MAN TOP PRODUCER

Clarence McPherson, blind finisher of crystals in the Aircraft Accessories Corporation, Kansas City, Kansas, was top producer on three different days recently, according to figures just announced.

* * *

R. J. CORDINER NOW ASS'T TO G. E. PRESIDENT

Ralph J. Cordiner has been appointed assistant to the president of G. E. Mr. Cordiner, who resigned in June as vice chairman of the War Production Board, was formerly president of Schick, Inc., of Stamford, Conn., prior to which he was manager of the G. E. appliance and merchandise department.

* * *

UNITED ELECTRONICS WINS "E"

The United Electronics Company, Newark, N. J., have won the Army-Navy "E" award for excellence in production. Ceremonies were held at the Essex House, Newark.

* * *

GOLD STAR FOR FEDERAL TEL. "M" PENNANT

A gold star has been added to the *M* pennant of Federal Telephone and Radio Corporation.

The Martime Commission *M* pennant and Victory Fleet flag were awarded previously to Federal for outstanding performance in the development and production of radio equipment for ships of the Liberty and Victory fleets.

* * *

CERAMIC CONDENSER CHART DATA

A loose leaf data sheet describing ceramic condensers of ¾" and 15/16" diameter style, has been released by the Erie Resistor Corporation, Erie, Pennsylvania. These types, which are known as the 160 and 170 respectively, are rated at 500 volts d-c working and 500 to 1500 volts d-c working. Standard tolerance on temperature coefficient for both models is said to be ±60 parts per million or ±15%, whichever is greater. Any desired capacity tolerance may be specified in smaller

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SHURE EQUIPMENT AT CASABLANCA

Jack Berman, sales manager, Shure Brothers, Chicago, Ill., displaying a photograph of historical value. It pictures General Mark W. Clark and General Nogues witnessing the ceremonies when American fighting materials were turned over to the French. Encircled in the photo is part of this fighting equipment—a boxed Shure microphone.

than ±3 mmf or ±1%, whichever is greater.

* * *

MICO INSTRUMENT MOVES

The Mico Instrument Company has removed its offices and factory from 10 Arrow Street to 80 Trowbridge Street, Cambridge, Mass.

* * *

WHEATSTONE BRIDGE CENTENARY

The one-hundredth birthday of the Wheatstone bridge was celebrated on June 15, in London. One hundred years ago Sir Charles Wheatstone presented his famous Bakerian lecture describing the now famous Wheatstone bridge network.

* * *

WBS SOLD TO DECCA

The World Broadcasting System has been purchased by Decca Records, Inc. Percy L. Deutsch, president of WBS, will continue in the same capacity.

* * *

DR. L. G. HECTOR WITH WPB AS CONSULTANT

Dr. L. Grant Hector, chief engineer of National Union Radio Corporation, Newark, New Jersey, has been appointed production consultant on miniature tubes in the Radio Division of the War Production Board.

Dr. Hector has requested representatives of the miniature tube manufacturers to study particular problems. One such group consists of circuit application engineers, under the chairmanship of Walter Jones of Sylvania Electric Products. Inc., Emporium, Pa.

* * *

NATIONAL FOREIGN TRADE CONVENTION FOR NEW YORK

The thirtieth National Foreign Trade Convention of the National Foreign Trade Council will be held in the Hotel Pennsylvania, New York City, October 25, 26 and 27.

* * *

THYRATRON TUBE DATA

In the latest issue of the DuMont Oscillographer, Melvin B. Kline discusses the replacement of gas triodes or thyratron tubes, for use in sweep oscillator service.

* * *

ELECTRONIC TUBES PRIMER

A 24-page nontechnical book, *How Electronic Tubes Work,* has been issued by the General Electric Electronics Department. It is designed primarily for industrial engineers. Illustrated with 117 sketches and photographs. The eight basic types of industrial electronic tubes and their uses are described.

The book (GEA-4116) is available free on request to Dept. 6-215, Publicity Divi-

(*Continued on page* 90)

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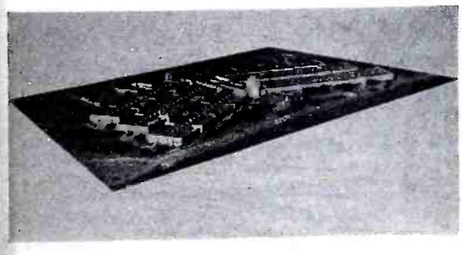
NEW FEDERAL RADIO PLANT



Layout of the new plant of the Federal Telephone and Radio Corporation being built in northern New Jersey. The first unit in this project is expected to be completed by October 1, 1943.

NEWS BRIEFS

(*Continued from page 89*)

sions, General Electric Company, Schenectady, New York.

* * *

JOHN COWLES RETURNS TO STATION ACTIVITY

John Cowles, special assistant to E. R. Stettinius, Jr., Lend-Lease administrator, has left this post to return to his former position as president of the Minneapolis Star-Journal and Tribune and co-owner of stations KSO and KRNT.

* * *

G. R. NOISE DATA

The concluding portions of the discussion on noise, parts XII and XIII, appear in the July issue of the General Radio Experimenter.

Analyzed in this issue are vibration and the uses of the vibration analyzer.

* * *

POWER MEASUREMENT LAMP DATA

Technical data sheets describing a series of PM (power measurement) lamps has been released by the radio division of Sylvania Electric Products, Inc.

Essentially the lamps consist of two identical filaments, one of which may be employed as a load on equipment being tested, while the other side is lighted from a known source of power. When the brilliance of the two filaments is the same, the r-f power into one filament is essentially the same as the d-c power in the other filament, thus affording a means of measuring r-f power. At the present time six lamps are included in the series, which cover a range of from 10 watts to 50 milliwatts. Under certain conditions this range may be extended to 25 watts.

* * *

C. G. STOLL CELEBRATES 40 YEARS WITH W. E.

Clarence G. Stoll, president of the Western Electric Company, recently celebrated his fortieth anniversary with that organization.

Mr. Stoll joined Western Electric as a student apprentice in its Clinton Street Shop in Chicago, after graduating from Pennsylvania State College in 1903. After a succession of promotions in the manufacturing department, he became vice president in 1926 and was elected to the presidency in 1940.

He was in charge of the company's factory at Antwerp, Belgium, in the World War year of 1914.

* * *

CANNON WINS "E"

The Cannon Electric Development Company, Los Angeles, has been awarded the Army-Navy "E" for excellence of war production.

* * *

RCA PROMOTES TEEGARDEN

L. W. Teegarden has been named assistant general sales manager of the RCA Victor Division of the Radio Corporation of America.

In his new capacity, Mr. Teegarden will have direct supervision over the selling, distributing and warehousing of all RCA products. In addition, the company's four regional directors in the Eastern,

Central, Western and Southern territories will report to him.

* * *

SCOPHONY APPOINTS DR. ROSENTHAL

Dr. A. H. Rosenthal has been appointed director of research and development of Scophony Corporation of America, according to an announcement today by Arthur Levey, president of Scophony.

Dr. Rosenthal has been connected with Scophony Ltd. of London for several years and contributed some of the more important Scophony inventions. In his present position he will head a group of engineers engaged in research and development of fundamental inventions, not only in television, but also in electronics, including various applications of supersonics.

* * *

NBC SUMMER COURSE COMPLETED AT NWU

The 134 students who entered the classes of the second NBC-Northwestern University Summer Radio Institute have graduated. Most of them have already been assigned to radio stations scattered from Vermont to Texas and from Florida to Oregon.

The six-weeks course in which educators of Northwestern University and top personnel of NBC's Central Division studios in Chicago participated, covered radio production, announcing, programming, news writing, studio engineering and public service. Albert Crews, chairman of the radio department of the NWU School of Speech and Judith Waller, director of public service for NBC's Central Division acted as co-directors of the Institute.

* * *

RMA PLANS BROAD STUDY OF POST WAR PROBLEMS

RMA will undertake studies of the industry's post war problems on a broad scale. A special RMA Committee on Post War Planning has been organized by president P. V. Galvin.

The chairman of the new special RMA committee is R. C. Cosgrove, vice president and general manager of the Crosley Corporation. The following are on the committee: W. R. G. Baker, General Electric Company, Bridgeport, Conn.; M. F. Balcom, Sylvania Electric Products, Inc., Emporium, Pa.; John Ballan-

(*Continued on page 92*)

NEWS BRIEFS

(*Continued from page* 91)

tyne, Philco Corporation, Philadelphia, Pa.; H. C. Bonfig, RCA Victor Division, Camden, N. J.; Walter Evans, Westinghouse Elec. & Mfg. Co., Baltimore, Md.; A. H. Gardner, Colonial Radio Corporation, Buffalo, N. Y.; Leslie F. Muter, The Muter Company, Chicago, Illinois; J. J. Nance, Zenith Radio Corporation, Chicago, Illinois; E. A. Nicholas, Farnsworth Television & Radio Corp., Ft. Wayne, Ind.; Ross D. Siragusa, Continental Radio & Television Corp., Chicago, Ill.; Ray F. Sparrow, P. R. Mallory & Co., Inc., Indianapolis, Ind., and A. S. Wells, Wells-Gardner & Co., Chicago, Illinois.

Wide jurisdiction in the field of post war planning, including reconversion of the industry to civilian production and also immediate problems relating to war contracts and their termination, has been given to the committee. Its work on industry economic problems will be correlated with that of the technical planning agency now being organized by RMA and the Institute of Radio Engineers.

The committee is authorized to organize subcommittees or panels and to deal with such subjects as . . . liason planning with government and industry agencies, reconversion to civilian production, public relations (promotion and advertising), distribution problems, war contract termination, war inventory disposal, government plants problems, reemployment and labor relations, market analysis (research), patents and licensing, and export markets.

* * *

DUMONT REFERENCE MANUAL

A 100-page loose leaf manual on cathode-ray tubes and instruments has been issued by Allen B. Du Mont Laboratories, Inc., Passaic, New Jersey.

Covered in this reference guide are oscillograph design considerations, amplifiers, intensity modulations, characteristic frequency and phase determinations, Du Mont specialty products, etc.

* * *

STUART HEADS WESTINGHOUSE LAMP DIVISION

Ralph C. Stuart has been appointed manager of the lamp division of the Westinghouse Electric and Manufacturing Company, with headquarters in Bloomfield, New Jersey.

Mr. Stuart has been with the Westinghouse Electric and Manufacturing Company and the Canadian Westinghouse Company for 25 years. He will have charge of all activities of the lamp division, including sales, illumination engineering, district office activities of the lamp division, as well as manufacturing and engineering in the Division's five plants in New Jersey and West Virginia.

* * *

ZENDER SERVING WPB

Ray Zender, chief engineer and sales manager of Lenz Electric Mfg. Co., Chicago, Ill., has been appointed wire consultant to the Radio and Radar section of the War Production Board.

* * *

F. J. BRABAND JOINS BELMONT

Frank J. Braband, retired division marshal of the Chicago Fire Department

has been appointed fire marshal at Belmont Radio Corporation, Chicago, Ill.

* * *

RMA PARTS GROUP ORGANIZED

For consideration and action on problems of each of the major group of RMA parts manufacturers, sectional organization of ten parts groups has been completed by chairman Ray F. Sparrow of the parts division.

The ten sections and their respective chairmen are:

Capacitor section, S. I. Cole, Aerovox Corporation, New Bedford, Mass.; Coil section, Monte Cohen, The F. W. Sickles Co., Springfield, Mass.; Fixed Resistor section, D. S. W. Kelley, Allen-Bradley Company, Milwaukee, Wis.; Instrument section, R. L. Triplett, Readrite Meter Works, Bluffton, Ohio; Socket section, Hugh H. Eby, Hugh H. Eby, Inc., Philadelphia, Pa.; Switch section, H. E. Osmun, Centralab, Milwaukee, Wis.; Transformer section, George Blackburn, Chicago Transformer Corp., Chicago, Ill.; Variable Condenser section, Wm. J. May, Radio Condenser Company, Camden, N. J.; Variable Resistor section, J. H. Stackpole, Stackpole Carbon Company, St. Marys, Pa., and Wire section, R. G. Zender, Lenz Electric Manufacturing Co., Chicago, Ill.

* * *

ELECTRONIC COMPONENTS REMAIN IN "B" CLASSIFICATION

All electronic components now classified as *B* items under CMP procedure are being continued in such classifications despite the wide discussion of future CMP changes, according to Ray C. Ellis of WPB.

Revision of the *B* list has been under consideration by WPB and the armed services. There may be some changes in *B* classification of a few end products, but none in electronic components. Mr. Ellis also stated that no future radical change in procedure would be made without consultation with the industry, some of whom would have been concerned over the published reports that the *B* list was to be greatly reduced or possibly eliminated entirely.

* * *

MAINTENANCE HANDBOOK

An 88-page book covering the maintenance of motors and generators has been released by the Ideal Commutator Dresser Company, 1041 Park Avenue, Sycamore, Illinois. No charge for copies.

* * *

COLE ON RMA EXECUTIVE GROUP

S. I. Cole, Aerovox president, elected to RMA executive committee.

THE INDUSTRY OFFERS . . . —

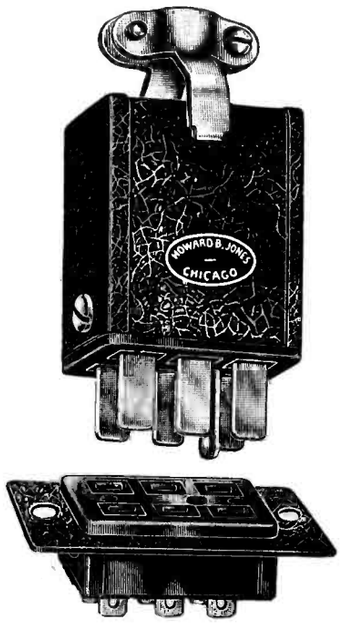
(*Continued from page 72*)

ing to Navy specifications 17P4. Sizes range as follows: 2, 4, 6, 8, 10 and 12 contacts and are furnished with either a shallow bracket for flush mounting, deep bracket for recessed mounting or with metal cap with or without cable clamps. As both the plug and socket bodies are of identical size, they are interchangeable with either cap or bracket.

A new type of socket contact has been developed. Four individual flexing surfaces make contact with each plug prong. Due to the design, each segment makes positive contact over practically its entire surface providing increased contact area and smoother action. Projections on all four sides of the socket contact lock it into position when forced into the contact pocket.

Both the plug and socket contacts are mounted into recessed pockets. Barriers surrounding the contacts are said to increase the contact to contact and contact to ground distance, thereby increasing the voltage rating.

The socket contacts are of phosphor bronze, silver plated. Plug contacts are of brass, ¼"x1/16" silverplated.

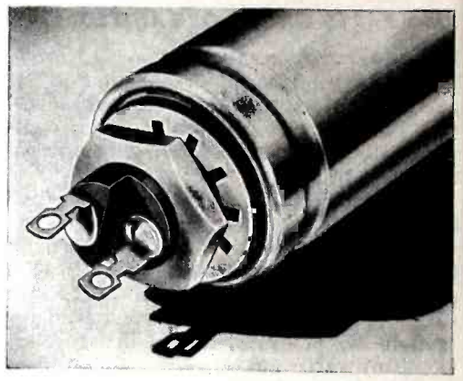


* * *

TWO-TERMINAL COMPACT OIL CAPACITOR

The inverted screw mounting Aerovox type 10 oil capacitor has been improved with a double-terminal. Heretofore this capacitor had a single insulated terminal and grounded can, although when screw-mounted on a metal chassis it could be fully insulated by an insulating washer.

The new double-terminal feature means that both terminal lugs are insulated from the *floating* can and no insulating washer is required. These capacitors, made by Aerovox Corporation, New Bedford, Mass., are said to be hermetically sealed, accomplished by the use of the new one-piece molded bakelite terminal assembly. The capacitors, available on high priorities only, are filled with either hyvol vegetable oil or mineral oil, rated up to 4.0 mfd at 600 v. d-c and to .5 mfd at 1500 v. d-c. The can, similar in design and dimensions to the usual inverted-screw-mounting metal-can electrolytics, is of aluminum or an approved substitute.



* * *

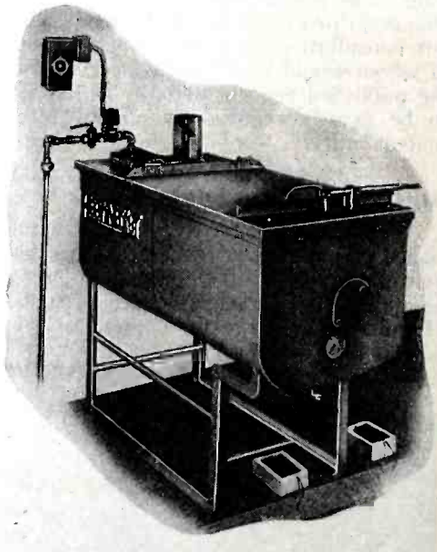
MELTING KETTLES

For electrical compound melting, Aeroil Burner Company, West New York, N. J., have produced Heet-Master kettles.

They are equipped with a removeable immersion tube heating unit. Temperature control is available with an electro magnetic valve and thermostat with a range of 150° to 550° F. A special draw-off valve for filling of transformers, batteries, condensers and other electrical equipment is provided. This valve, controlled by lever action outside and on top of the Heet-Master, is poppet-actioned, non-drip, and opens inside the kettle at the hottest spot located over the *working set back* of the kettle skids.

A hand-control rod or foot pedal can be attached by extension arm for convenient operation. Four valve reducers are furnished with the Heet-Master to reduce the stream of melted compound to ¾" ½", ⅜" and ¼" as desired. The valve itself provides a 1" opening.

Kettles are available in three sizes, 5, 10 and 25 gallons.



* * *

HALLICRAFTERS COMMUNICATIONS UNIT SCR-299

The Signal Corps SCR-299 mobile radio communications unit, developed by Signal Corps technicians cooperating with civilian engineers, and produced by Hallicrafters, Inc., has recently seen action on many fronts, according to data just released.

In the system will be found the familiar HT-4 450-watt unit with the necessary military changes. The complete mobile unit also includes standard Signal Corps

BC-342 and BC-312 receivers and type PE-95 gasoline-driven generator.

During the landing of our large convoy in Africa, the SCR-299 operated on five networks, including circuits from Oran to England, Casablanca, Gibraltar, Algiers and Accra.

* * *

DURAKOOL ADJUSTABLE ELECTRONIC TIME RELAY

Adjustable electronic time relays, hermetically sealed, have been developed by Durakool, Inc., 1010 N. Main Street, Elkhart, Indiana.

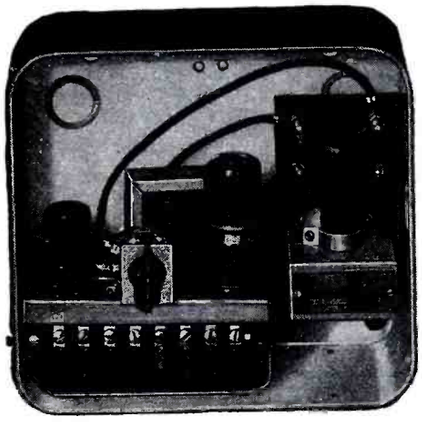
The principle of operation is electronic. The load is carried by a quick-acting Durakool mercury relay.

The only moving part is a fast operating steel encased plunger working in a hydrogen pressure atmosphere displacing the mercury and said to be capable of millions of operations.

Time setttings are continuously variable within the range and may be adjusted to precisely the required operating point.

Standard models cover time ranges from .05 to 0.5, 0.10 to 10, and 1.0 to 100 seconds respectively. Special models can be produced up to 5 minutes.

Contact capacities are available up to 75 amperes, either normally open or norcally closed.



* * *

DOUBLE ELECTRODE SPOT WELDER

Two types of a duplex jaw spot welder have been recently introduced by the Eisler Engineering Co., Newark, New Jersey. They are resistance welding machines, designed for welding of light gauge sheet and wire.

Each unit consists of two independent small welding machines built together with one transformer and a rheostat for finer heat adjustment. It is available as a welder equipped with rocker arm, and with a vertical press arrangement. Both are foot operated by means of two treadles and chains and made in sizes from ½ to 3 kva. The transformer used in both types has five secondary tap con-

(*Continued on page* 96)

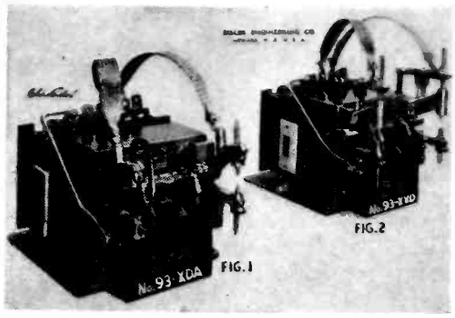
THE INDUSTRY OFFERS . . . —

(*Continued from page 95*)

nections providing five different heat positions.

The machines are built for single phase a-c of 110, 220 or 440 volts, 25 to 40, 50 and 60 cycles.

The welders are said to be especially qualified for welding of radio tubes, incandescent lamps, intricate optical and jewelry parts, etc.



* * *

DRY-DISC RECEIVER

Rectifier units, for up to 1500 watts using dry-disc type of element and insulated secondary winding, have been announced by McColpin Christie Corporation, 4920 S. Figueroa Street, Los Angeles, Calif.

Output control of the unit, known as the *M* series Rectodyne, is adjustable by means of a tap changing switch operated by a knob on the front panel. In addition to this, a dual voltage permits doubling the d-c ampere capacity at half voltage by means of a series-parallel switch. Direct current voltages of 6, 12, 24, 32, 48, 64, 96, 128 and 144 volts are obtainable.

Single phase and 3-phase models are available, and the 3-phase units can be had with a filter for testing radio apparatus.

In addition to the stationary model illustrated, a portable model, mounted on 8" rubber-tired wheels and furnished with a handle, can also be obtained. The size of the models is 13"x13"x19".

* * *

RIVET GUN KIT

A rivet gun kit to aid field service and repair men in heading up Cherry Blind Rivets, is now available from Cherry Rivet Company, 239 Winston Street, Los Angeles, Calif. The G-10 hand gun is included in the kit, which permits servicing operations where air power is not available.

The principal feature of the kit is its complete complement of pulling heads and

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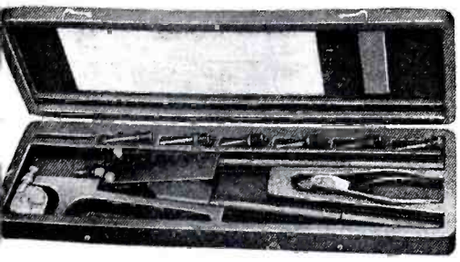
other convenient accessories for the G-10 hand gun.

The kit also contains a right angle adapter for use in inaccessible places that cannot be reached through a straight pull in line with the axis of gun head. Six interchangeable pulling heads are also included for sizes 1/8", 5/32" and 3/16" standard diameter rivets, one each for countersunk and brazier type head in all sizes.

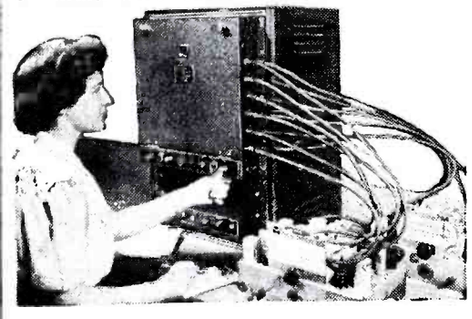
The case measures 23½"x7¼"x2 3/16".



* * *

HIGH SPEED CIRCUIT TESTER

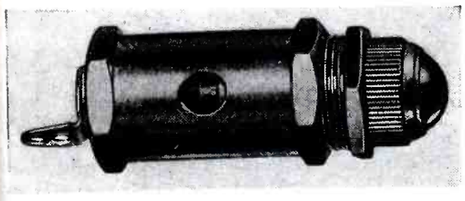
An automatic high-speed mass production tester, Rotobridge, has been produced by Communications Measurements Laboratory, 116 Greenwich St., New York. With the Rotobridge it is said to be possible to attain Wheatstone bridge precision while testing circuits at a rate of one circuit per second. Rotobridge designers and manufacturers also have available a model which permits testing of multi-wire cable harnesses.



* * *

GOTHARD PILOT LIGHTS

A series of pilot lights for grounded pilot light panels have been developed by Gothard Manufacturing Company, 1300 N. Ninth Street, Springfield, Ill. Bulb change is accomplished from the front of the panel without disturbing body mounting or wiring. The bulb automatically comes out when the jewel holder is unscrewed. Bayonet socket lamps (long or round) may be used. It is well ventilated. Available with either faceted or plain jewels.



* * *

SHOCK-PROOF RELAYS

Small, compact general purpose relays, said to be able to withstand shocks and vibration, have been developed by Potter and Brumfield Manufacturing Company, Princeton, Indiana.

The relays, known as the SP series, have a carefully balanced armature that is said to operate equally well in any

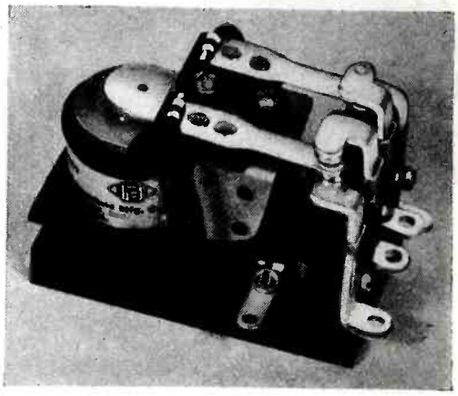
(*Continued on page* 98)

THE INDUSTRY OFFERS . . .—

(*Continued from page 97*)

position. The unit construction of the bakelite molded base and stationary contact support eliminates the use of screws and rivets. All steel parts are heavily cadmium plated.

Moving contact springs are tinned or silver plated. Available in both a-c and d-c types. Will carry a non-induction load of 5 amperes at 110 volts 60 cycles. Average size 2⅜" long, 1⅝" high, 1 1/12" wide. Special voltages available on order.



* * *

25-KW REVOLVING ARMATURE TYPE A-C GENERATOR

A 25-kw generator has been announced by the Kato Engineering Company, Mankato, Minn. It is known as the model 55 and has a rated capacity of 25 kw at 80% power factor, single phase, or 30 kw at 80% power factor, three phase. This unit is 38 17/32" long by 24½" wide x 25¾" high and weighs approximately 1375 lbs.

The generator is of the revolving armature type, separately excited, six pole, 1200 rpm with damper windings.

Available in all standard voltages and special voltages, either straight 110, 220 or 440 volts single phase or 115/230 or 220/440, four ring, single phase. Also available for straight 110, 220 or 440, three wire, three phase or 120/208, four wire, three phase. Inherent voltage regulation, approximately 10% between no load and full load with 3% speed change.

Designed for direct attachment to engine bell housing. Also available as an independent generator with standard shaft extension.

The standard exciter voltage is 125 volts. Exciter is of two pole laminated inter-pole design. Can be furnished for either direction rotation. All leads brought out externally.

* * *

ELECTRONIC DESK FOR CATHODE-RAY PRODUCTION

To expedite cathode-ray tube production Allen B. Du Mont Laboratories, Inc., Passaic, N. J., have developed an *electronic desk*. For routine production checkup, these units are operated by girls, but engineers too use them in checking up the characteristics of new tubes and experimental runs.

The *electronic desk* is a steel cabinet in the form of a modified flat-top desk. An inclined platform supports the cathode-ray tubes which are plugged into their respective receptacles at the rear. Directly beneath the inclined platform or

shelf is a battery of meters covering all required readings. Directly in front is the writing space, and beneath a drawer for paper, forms, pencils and so on. On either side of the writing space are more meters. Where the desk drawers would be there are switches and controls for the power supply which forms part of the test position and which provides all required voltages for a wide array of cathode-ray tube types.

The operator can check for brilliance, focus, deflection, leakage resistance and other characteristics.

* * *

PORTABLE METAL-COATING (PLATING) PROCESS

A metal-coating process to expedite application of the heavier silver coatings now specified on many government projects, for bus bars, lugs and other parts of electrical equipment has been developed by Rapid Electroplating Process, Inc., 1414 South Wabash Avenue, Chicago, Illinois. It can also be used for plating, replating or touching up rust and corrosion resistant coatings of other metals, on production lines or in the field. Available in silver, cadmium, tin, copper, zinc, nickel and gold.

Plating current for small jobs can be obtained from dry batteries, storage battery or any convenient source supplying direct current at 3 to 6 volts.

Standard applicators are available in three sizes. Special applicators can be made to order to facilitate work in very close quarters, or for special requirements on production lines.

The *rapid plating rectifier* can be connected to any 110-120 volt, 50-60 cycle ac circuit, and will supply current for up to three applicators, or, operators.

* * *

VERTICAL, HIGH-SPEED, HOLLOW-SHAFT SYNCHRONOUS MOTORS

A new line of vertical high-speed, hollow-shaft synchronous motors has been announced by the motor division of General Electric. Furnished in ratings from 100 to 1000 hp, and in speeds from 514 to 1800 rpm, these motors are especially desirable for pumping applications where a large volume of fluid is handled, such as in ordnance and synthetic rubber plants.

For protection, these motors have a dripproof enclosure. They are streamlined throughout.

The frames of these motors are of cast-iron construction, which provides strength to withstand the high-thrust loads often encountered in pump applications.

The motors can be furnished with non-reverse ratchets to prevent reversal of pump rotation at shutdown or on starting. They are also available in solid-shaft construction.

VWOA NEWS

(*Continued from page* 52)

deserved the most recognition, was barely mentioned. He never became president of the Association and thereby acquired a brass marine clock. He was never presented with a medal, nor is he even a courtesy Life Member. Yet in the spring of 1925 *he* was the Veteran Wireless Operators Association all by himself! And that man was Pete Podell.

"Something happened to Pete that spring. He struck upon the idea of an association of old-time wireless men. He was one himself. There were many others and he felt that they ought to get together and talk over old times now and then. He contacted Jimmie Maresca, another old time operator, then chief engineer of Hugo Gernsback's station WRNY atop the Hotel Roosevelt, New York City. The two then came to see me, explaining their idea, and asking me to join them.

"The idea seemed good to me, after I had been assured that nothing but fraternalism and old-timer reunions would be the basis of any meetings. With this decided, two other potential members were contacted. They were Sam Schneider, who later became our *perpetual treasurer,* and Gilson Willets, director of station WRNY.

"The first meeting of our proposed association was held in the control room of WRNY. Mr. Gernsback had been told about the idea by his station manager. He thought that it would not be a bad idea to give us some publicity. Thus we were introduced to the microphone and given fifteen minutes of unrehearsed time on the air. Each of us told about the desirability of old-time wireless men keeping in touch with each other. Apparently people listened to that broadcast, and either directly or indirectly wireless operators all over the city learned of the plan. For when we held our second meeting, about two weeks later, on October 15, 1925, in the foyer of the Hotel Roosevelt, over fifty men attended. Incidentally, in our first broadcast, Gilson Willets was the first to speak. He thus holds the enviable position of VWOA's first representative *on the air.*"

In continuing his recollections of the earlier days, Bill Fitzpatrick recalled that most stations then were on top of hotels. Beside WRNY, there was one on top of the Waldorf-Astoria with E. N. Pickerill as manager. Atop the Congress in Chicago, our late brother Baskerville established the

(*Continued on page* 111)

TRANSMISSION LINES

(*Continued from page 26*)

pedance, but can measure the *standing wave ratio,* which is the ratio of maximum to minimum voltage (or current) at different points along the line. Calling this ratio K, the factor for multiplying normal loss is

$$\frac{K^2 + 1}{2K}$$

To illustrate the use of this factor, let us consider a 1,000-watt transmitter operating on 2 megacycles, using a 200-foot transmission line of the 7/8" gas filled type, which has 70-ohms impedance and a normal loss of 0.1 db (23 watts). The engineer decides to make adjustments to keep the loss down to 0.13 db (30 watts). Then

$$\frac{0.13}{0.10} = \frac{R^2 + X^2 + 70^2}{140\,R}$$

Examining this equation, we see that R may vary between 33 and 149 ohms, or X may vary between -54 and $+54$ ohms. If both R and X vary from normal values, the tolerances are slightly smaller.

Solving for the standing wave ratio K, a maximum value of 2.1 is found permissible.

At ultra high frequencies, transmission line losses are much greater, and correspondingly better adjustment of the line load is justified.

There are several factors, other than power loss, which determine a satisfactory line load, and often another factor requires much closer adjustment than is required to minimize loss.

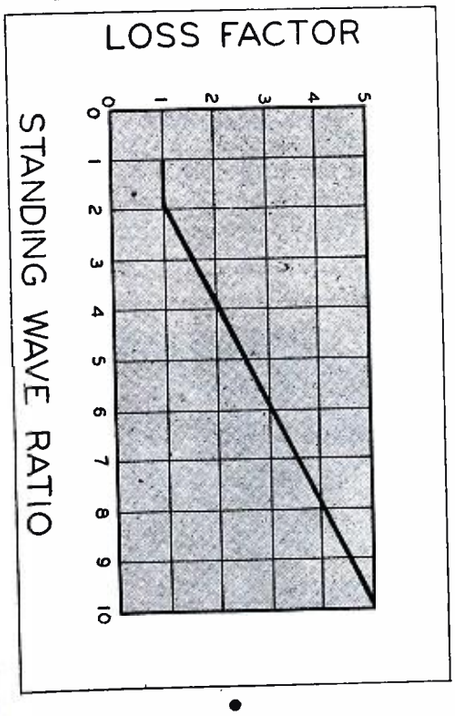


Figure 3

Loss factor (increase in loss over loss of normally terminated line) as a function of standing wave ratio (ratio of maximum to minimum voltage or current along the line).

INPUT ADMITTANCE OF VACUUM TUBES

(*Continued from page* 54)

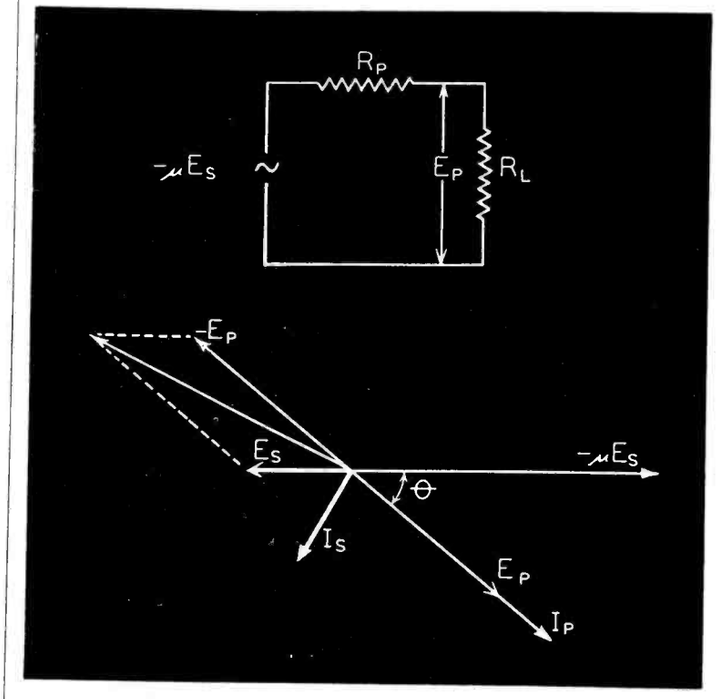


Figure 4

If the load impedance is assumed to be a pure resistance but frequency E_s is raised to such a high value that the period of E_s is approximately equal to the time of flight of an electron through the tube, we have the equivalent circuit and vector diagram shown here.

Figure 1 shows the equivalent circuit and vector diagram of a vacuum tube amplifier that is operating at a frequency low enough to make the transit time of the plate current electrons unimportant. The load impedance is a pure resistance. The load voltage E_p, the plate current I_p, and the equivalent grid voltage $-\mu E_g$ are all in phase because the load impedance is a resistance. The voltage E_{gp} across the grid and plate is the vector difference between the signal voltage E_s and the load voltage E_p. In this case E_{gp} is equal to the algebraic sum of E_s and $-E_p$. The voltage E_{gp} causes the current I_s to flow, and I_s leads E_{gp} by 90° because it is a charging current. Also, I_s leads E_s by 90° and therefore there is no component of I_s in phase with E_s. This means that there is an infinite resistance shunted across the grid and cathode, and the conductance is zero.

Capacitive Reactance

If the load impedance has a component that is a capacitive reactance, the equivalent circuit and vector diagram is shown in Figure 2. I_p is shown leading $-\mu E_s$ by the phase angle θ_2 of the entire circuit. I_p leads E_p by the phase angle θ_1 of the load

(*Continued on page* 108)

DUAL-CHANNEL RECEIVERS

(Continued from page 58)

bile stations. The regular procedure calls for the mobile units to use one channel for communication to the fixed station and another for intercommunication between mobile units. This necessitates calling the fixed station to notify a mobile unit it is wanted on the other channel. The use of a dual-channel receiver would obviate this, and keep all mobile units in constant touch not only with the fixed station, but with each other. This system, of course, could only be used when the two channels are close enough in frequency to permit a reasonable I-f frequency.

Although, as previously stated, the original purpose of the receiver was the reduction of components for mobile use, it is expected that the method outlined in the previous paragraph will be put to use in the future expansion of the mobile system of the Fire Department.

AIRCRAFT MAINTENANCE

(Continued from page 69)

dissipation. The designer used the oscillator-tube filament and resistor scheme because one of two filaments are more apt to fail than one filament. Such an oscillator failure would affect both transmitter and receiver.

Investigate Before Redesigning

At one time or another a good idea for a design change will be conceived either through the analytic way or because of necessity to provide adequate service to remedy an inherent defect. These ideas should not be neglected, because progress depends on good and usable new developments. However, for the reason given and for the sake of standardization, design changes should not be made, without a complete investigation and consideration as to the possible degradation of the equipment.

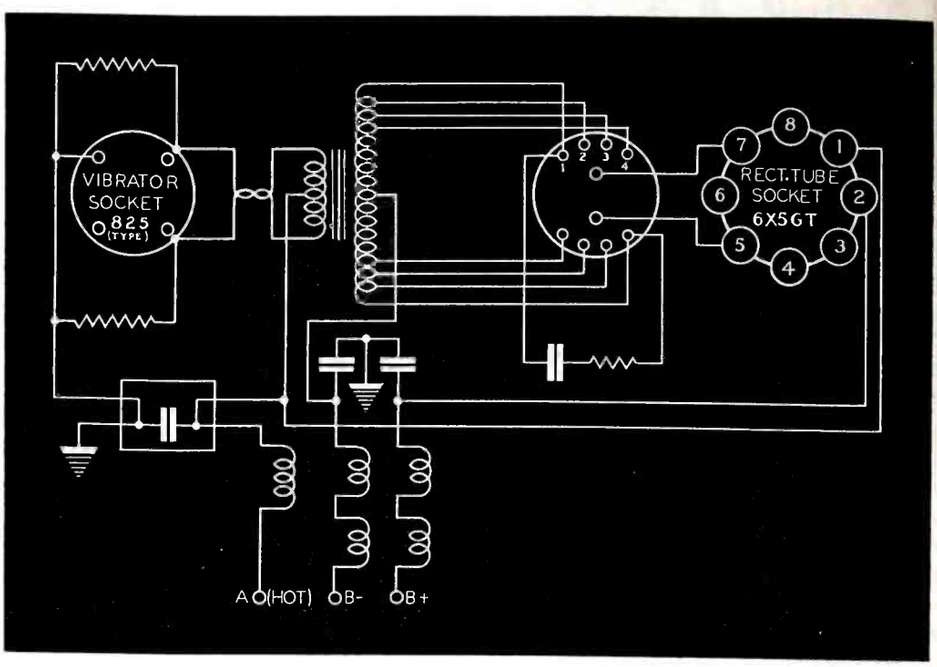


Figure 3
The vibrator unit used with the two-station diving amplifier.

DIVING COMMUNICATION SYSTEM

(*Continued from page* 60)

formed steel case plated and painted to resist corrosion. On the front of this case is located the control panel on which are the manual controls. The amplifier itself is mounted on a chassis of special design which is fastened to the bakelite control panel. This panel, in turn, is secured to the cabinet, making the whole assembly splash-proof.

Connection to the two divers' cables is made through two receptacles along the bottom of the rear of the amplifier cabinet. These receptacles are of special design to accommodate a standard diving equipment plug. The plugs are so polarized and connected as to prevent the insertion of any plug in the wrong receptacle. Caps for all receptacles are provided for their protection when not in use.

The tender's speaker unit is of the direct radiator type. This is mounted in the front panel. A protective screen is provided for the front of the reproducer to protect it against mechanical damage.

Divers' Reproducers

The divers' reproducers, which mount in the diving helmets, consist of small permanent magnet driver units with a suitable mounting bracket and protective grille. These speakers have an impregnated fibre cone.

Amplifier Circuit

The amplifier consists essentially of a resistance-capacitance coupled circuit using one type 6J7 functioning as a voltage amplifier. The second of these stages is coupled to a 6F6 in the output stage. The input is coupled to the voice circuits through an input transformer. The output is coupled to the voice circuits by means of a suitable output transformer.

6-Volt D-C Power Supply

The power supply from which the amplifier is designed to operate is a 6-volt d-c source. A vibrator type of voltage converter is used to secure the necessary plate voltage. This converter is supplied as a unit mounted on the chassis. Incorporated in this unit is a self-driven vibrator, one 0Z4 or 6X5 rectifier, a transformer, and the necessary filter chokes and condensers to remove the high transient voltages developed by the rapid switching of the battery current by the vibrator.

Heater operation is obtained by connecting the vacuum tubes in a parallel circuit. The power supply is fused and is controlled on the amplifier control panel by means of an *on-off* power switch.

Control Circuits

Manually adjusted controls for this system are located on the control panel. These consist of one volume control, two switches for controlling the direction of transmission, and the power switch. The volume control is

(*Continued on page* 108)

HOW TO MAINTAIN CAPACITORS

THE maintenance required on power-capacitor installations is so small its importance is often overlooked entirely. The first inspection of operating voltage and temperature should be made 8 to 24 hours after energizing the capacitor bank. The voltage of the system near the capacitor location should be checked during the first light-load period to ascertain whether overvoltage is present. Any changes in circuit connections, which may increase voltage levels, warrant a re-check of operating conditions. A regular inspection should be made four times a year or oftener, depending upon the severity of operating conditions, giving attention to operating voltage, temperature, fuses, and possible mechanical damage. Capacitor bushings and busbar supports, subject to accumulation of dust or foreign materials, should be cleaned periodically, the intervals depending on the severity of dust conditions.

Because of their extremely high internal resistance, capacitors may retain a charge for days after they are disconnected from the circuit, if no discharge circuit is provided. Most power-factor-improvement capacitor units have internal resistors connected directly between their terminals to automatically discharge the capacitor. Separate discharge coils are sometimes used with large banks. However, before touching any terminal or bus connection it is recommended that the capacitor be disconnnected from the circuit and then discharged by short circuiting the terminals and at the same time, temporarily grounding them to the case or supporting rack. A T-shaped conductor insulated by a stick of wood, provides a convenient and safe means of discharging a capacitor unit.

For capacitors installed in industrial plants, the National Electrical Code requires that the discharge device reduce the residual charge to 50 volts or less in one minute, whereas discharge resistors in pole-type capacitors for electric-service companies, not covered by the Code, usually are designed to discharge to 50 volts in five minutes.

Potential transformers may serve as discharge devices, but, if connected through fuses, the fuses must be capable of carrying the discharge current without melting.

Capacitors supply reactive current through the reactance of the circuit. Thus the operating voltage at the point of the capacitor installation is increased. Therefore, capacitors are more

(*Continued on page* 107)

CARRIER CURRENT TRANSMISSION

(*Continued from page* 74)

weaker. This is due to coupling and shunt losses.

Gain of power into the distribution system is possible by using tuned isolating circuits. These consist of a circuit tuned to the transmitter frequency, and inserted between the meter and the house load, with the transmitter output connected to the meter side of the unit. Where two-wire service is brought into the residence, only one coil is necessary. In three-wire systems, two tuned units are used.

Isolating Circuits

These isolating circuits prevent losses caused by residence shunt load, thus providing much greater output into the distribution system. Due to increased coupling, three-wire systems afford a higher transfer of energy, as well as reduced radiation.

Where isolating circuits are used, the receiver will also have to be connected to the meter side of the isolating units. Incidentally tests have indicated that losses, due to the presence of the electric meter, have been less than is generally assumed.

When higher power transmitters are used, the isolating units prevent flickering of the residence lights.

Coupling Methods

In Figure 2, appear methods of coupling a transmitter to the power line. At (*a*), is a two-wire 115-volt service, without isolating units. At (*b*), we have a three-wire 115-230-volt service, without isolating units. In (*c*) and (*d*), appear these two and three-wire services, with isolating units. In the two-wire service, it will be noticed that only one capacitor is used in the matching impedance, whereas in the three-wire circuit, two capacitors are used. These capacitors should be preferably mica. Due to the low impedance circuit, the voltage rating of the condenser should be high enough to tolerate the line voltage. The coils in the isolating unit should have sufficient current carrying capacity to carry the resident load. The reactance of the unit at 60 cycles should be low

(*Continued on page* 107)

CAPACITOR MAINTENANCE

(*Continued from page* 105)

likely to operate on overvoltage than other equipments which absorb or require current and cause a voltage drop in the line.

Recognizing this factor, the voltage rating and permissible operating overvoltage of capacitors are higher than those established for some other devices, such as induction motors. Standards have been established to permit 10-per-cent overvoltage for short periods on capacitors rated 2400 volts and above, and to permit 15 per cent temporary overvoltage for ratings of 230, 460, and 575 volts. Permissible overvoltage, as an average over any 24-hour period, is 5 per cent for all ratings. The average operating voltages are subject to the limitation that the maximum permissible operating kva which may include harmonic kva, must not exceed 135 per cent of the kva rating.

[*Information, Courtesy General Electric*]

CARRIER CURRENT TRANSMISSION

(*Continued from page* 106)

enough so as not to cause noticeable line voltage drop.

Receiver Conversion

Superheterodyne receivers were converted to operate from approximately 100 kc to 200 kc, for these experiments.

In Figure 2, (*a*) and (*b*), we have two methods of coupling receivers to the power line.

The Maryland Installation

A system for communications over power lines using the 150 and 160 kc ranges has been introduced in Maryland. A 150-kc transmitter in one town, maintains contact with another transmitter in another town over ten miles of power line, providing reliable two-way communication twenty-four hours a day. Receivers are located in nine other towns, covering an area of 100-square miles. Transmitters for the other nine locations are now under construction.

A-M Used

Throughout this system, a-m has been used. For equipment with a minimum of parts could be used, and in addition, the use of a-m has proved very satisfactory. This does not mean that it isn't possible to use f-m. It's adaptability has been considered.

[*To Be Continued*]

INPUT ADMITTANCE OF VACUUM TUBES

(*Continued from page* 102)

impedance. E_{gp} is equal to the vector difference between E_s and E_p. Also, $E_{gp} = E_s - E_p \angle 180° - \theta_3$. The current I_s will again lead E_{gp} by 90°, but it now has a component in phase with E_s. Therefore, the input conductance will be some positive value.

Inductive Reactance

If the load impedance has a component that is an inductive reactance, we have the equivalent circuit and vector diagram shown in Figure 3. E_p is shown leading I_p by the phase angle θ_1 of the load impedance, and $-\mu E_s$ leads I_p by the phase angle θ_2 of the entire circuit. The voltage E_{gp} is the vector difference between E_s and E_p, i.e.: $E_{gp} = E_s - E_p \angle 180° + \theta_3$. Of course I_s leads E_{gp} by 90° as usual, but it now has a component that is 180° out of phase with E_s. Therefore the input conductance is negative.

Pure Resistance

Finally, if the load impedance is again assumed to be a pure resistance, but the frequency of E_s is raised to such a high value that the period of E_s is approximately equal to the time of flight of an electron through the tube, then we have the equivalent circuit and vector diagram shown in Figure 4. When the frequency of E_s is high, the transit time of the electrons causes the plate current I_p and the load voltage E_p to lag the equivalent voltage $-\mu E_s$ by the angle θ. The voltage E_{gp} is found in the usual manner, and I_s leads E_{gp} by 90°. The vector I_s is shown to have a component in phase with E_s and therefore the input conductance is positive. The positive input conductance that results from the transit time of the electrons is an important factor in the design of high frequency vacuum tubes.

In the foregoing discussion, the grid current that results from positive grid operation or stray capacities other than the grid-plate capacity has been disregarded.

[1]Terman, F. E., *Radio Engineering,* McGraw Hill Co.; pp. 231.
[2]Brainerd, J. G., *Ultra High Frequency Techniques,* D. Van Nostrand Co., pp. 295.
[3]Everitt, W. L., *Communication Egineering,* McGraw Hill Co., pp. 506.

DIVING AMPLIFIER

(*Continued from page* 104)

provided so as to obtain the correct level at either the tender's or the divers' reproducers. The two, two-position switches, one for each diver, provide means for transferring the divers' reproducers from input to output and the tender's reproducer from output to input. These switches are so connected that the normal, or unoperated position provides speech transmission from all connected divers to the tender's reproducer. The power switch provides means for turning on or off the power supply to the amplifier while it is still connected ready for use. This must be turned to the *on* position in order to apply the proper operating voltages to the amplifier components.

SYNTHETIC REVERBERATION

(*Continued from page* 62)

ring and sharp echoes, the middle high frequencies are added using as long a time of delay as possible. Another condition such as being close to a public speaker in a large auditorium is obtained by adding a limited amount of both low and high frequency reverberated energy.

Warble Tone Measurement

The response characteristic of the unit cannot be conveniently measured by a steady tone because of the standing waves due to reverberation. It has been found necessary to measure its characteristic by means of warble tones similar to the method used in measuring loud speakers and microphones.

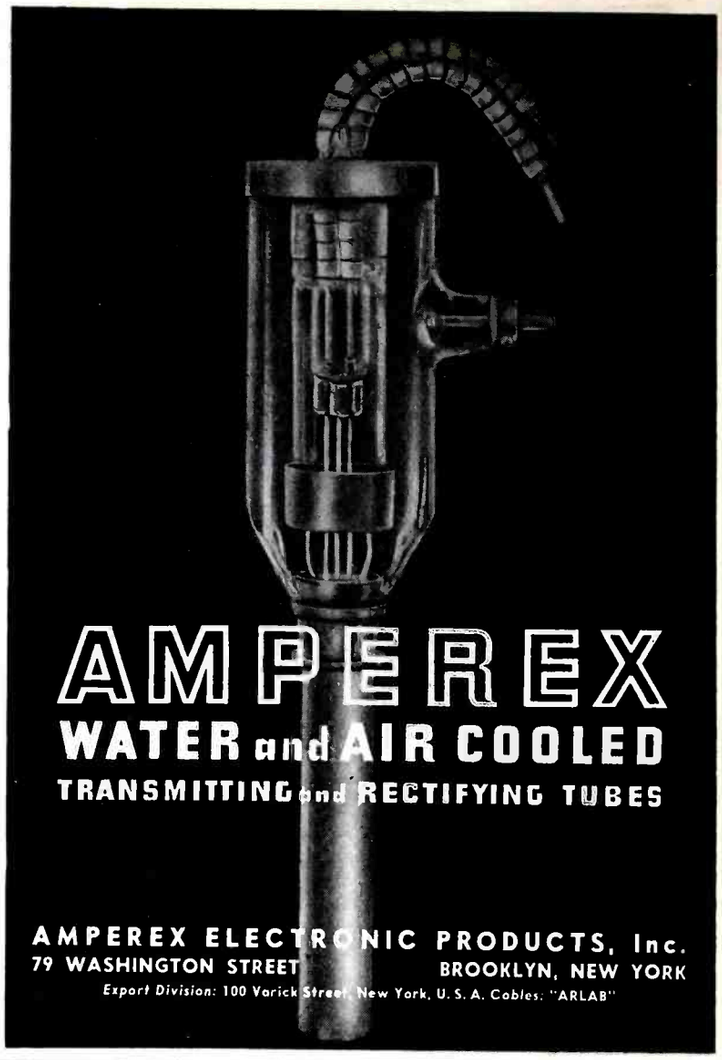
Extensive Use of Unit

At the present time, because of its compactness and simplicity, broadcasting and motion picture studios are using a large number of these devices to produce the effects of reverberation so often heard.

★ ★ ★

BUY UNITED STATES WAR SAVINGS STAMPS AND BONDS FOR VICTORY

★ ★ ★



WARTIME TRANSMITTER INSTALLATION

(*Continued from page* 48)

undesirable values at the sideband frequencies.

Non-directional Operation

For daytime non-directional operation the West tower is used. During this period the unused elements are open-circuited, tuning inductors for the West element are changed, the *T* network at the input to the system is removed, and the pickup monitor which operates the *carrier-off* relay for the transmitter (a protective device) is changed from the common point to the West tower. All this is accomplished by relays operated by a single push button located at the transmitter building.

L Networks Used

The tuning system has been complicated somewhat by an attempt to provide a control of the current amplitude for each element, that is as independent as practicable, from other controls. For each element an *L* network has been provided with one inductor, motor operated. Independent control of relative phase relationships is provided by a 90° *T* network for each element, located at the West element turning house. Each of these networks is motor driven. The remote-operated motor controls, with controls and position indicators both in the transmitter house and the West element coupling house, vary the positions of the taps and the current amplitudes.

Power in East Element

The power in the East Center element flows in a reverse direction, for which provision has been made in the circuit arrangement.

Credits

Howard E. Condella of the staff mounted all the tuning house equipment. Two of the staff who participated in the new transmitter project are now in the armed services. They are John Cherpak, CRM, USNR and Thomas A. Price RM2C, USN. Wrathall & McNary were the consulting engineers.

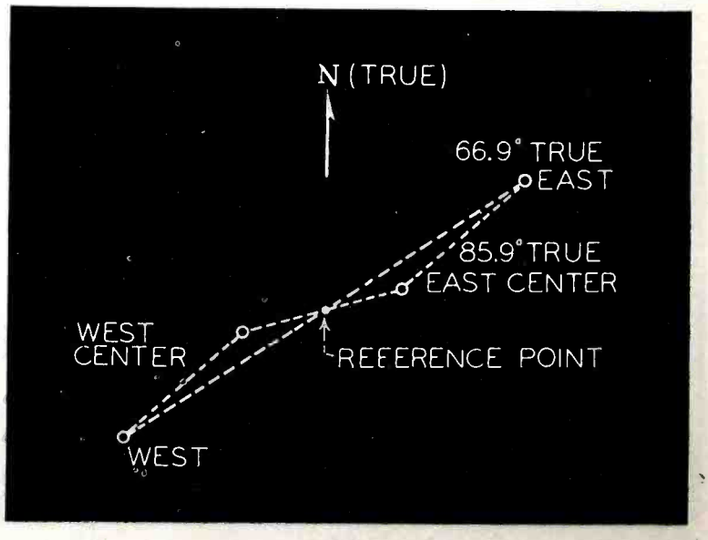


Figure 15

Placement of elements for directional array. The distance between East and West towers is 852 feet, and between East Center and West Center is 302 feet.

BOOK TALK

(*Continued from page* 80)

about 1,500 footnote references to published manuscripts throughout this volume.

This book is a *must* for every engineer and communications executive.

• • •

PRIMER ON RADIO

Prepared by Electronics Dept., General Electric . . . 68 pp. . . . Bridgeport, Connecticut: General Electric Co. . . . $.25

This book is the outgrowth of a training course in radio, prepared for those in nontechnical positions. The scope of the material is broad, with mathematical and fundamental theory held to a minimum. It is an interesting presentation for the beginner who is interested in learning about the fundamentals of radio.

• • •

TELEVISION MANUAL

By F. J. Camm . . . 224 pp. . . . New York: Chemical Publishing Company . . . $2.50.

Another fundamental book, covering, however, the subject in a semi-technical British style. The material is presented in a review form in a rather simple manner.

As a reference book for the primary science library, this book can be recommended. However, in view of the rather broad treatment of the subject, engineers and professionals will find little new of interest to them.

The dictionary of television terms, which is a feature of this manual, is also quite primary in its coverage, serving to give a rather popular explanation of the various topics.

THREE-CHANNEL AMPLIFIER

(*Continued from page* 29)

free of hum. The amplifier should not be used in low-level applications, because of the possibility of inductive pickup in L_2 and the associated transformers. This unit has been used successfully when connected to a source, between minus 10 db and plus 8 db.

Precautions

Precautions should also be taken to avoid capacity or electrostatic coupling between high-level output circuits and the input to the amplifier. The greatly increased gain possible at the high frequencies makes this warning necessary.

VWOA NEWS

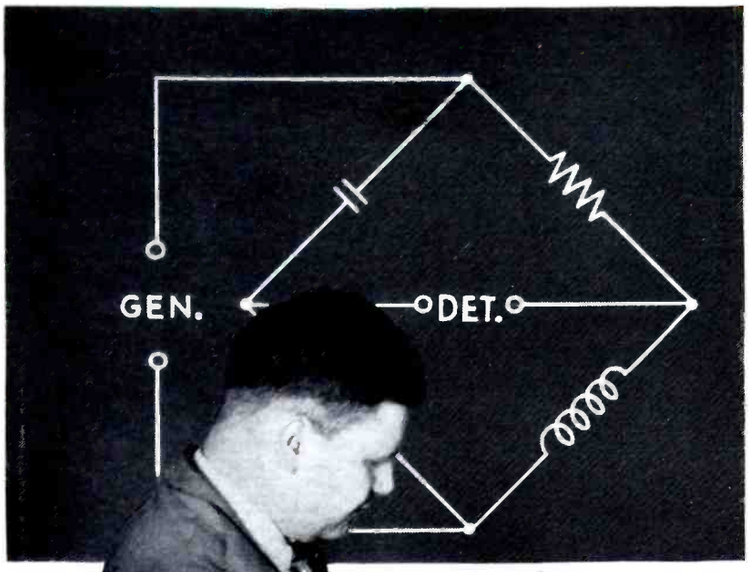
(*Continued from page* 100)

first radio-communication system between Chicago and New York, Bill recalled. He then mentioned the New Orleans coast station on the roof of the Grunwald (now the Roosevelt) hotel where Arthur A. Isbell was once manager. The exclusive Plaza Hotel had a station too, with E. E. Bucher in charge.

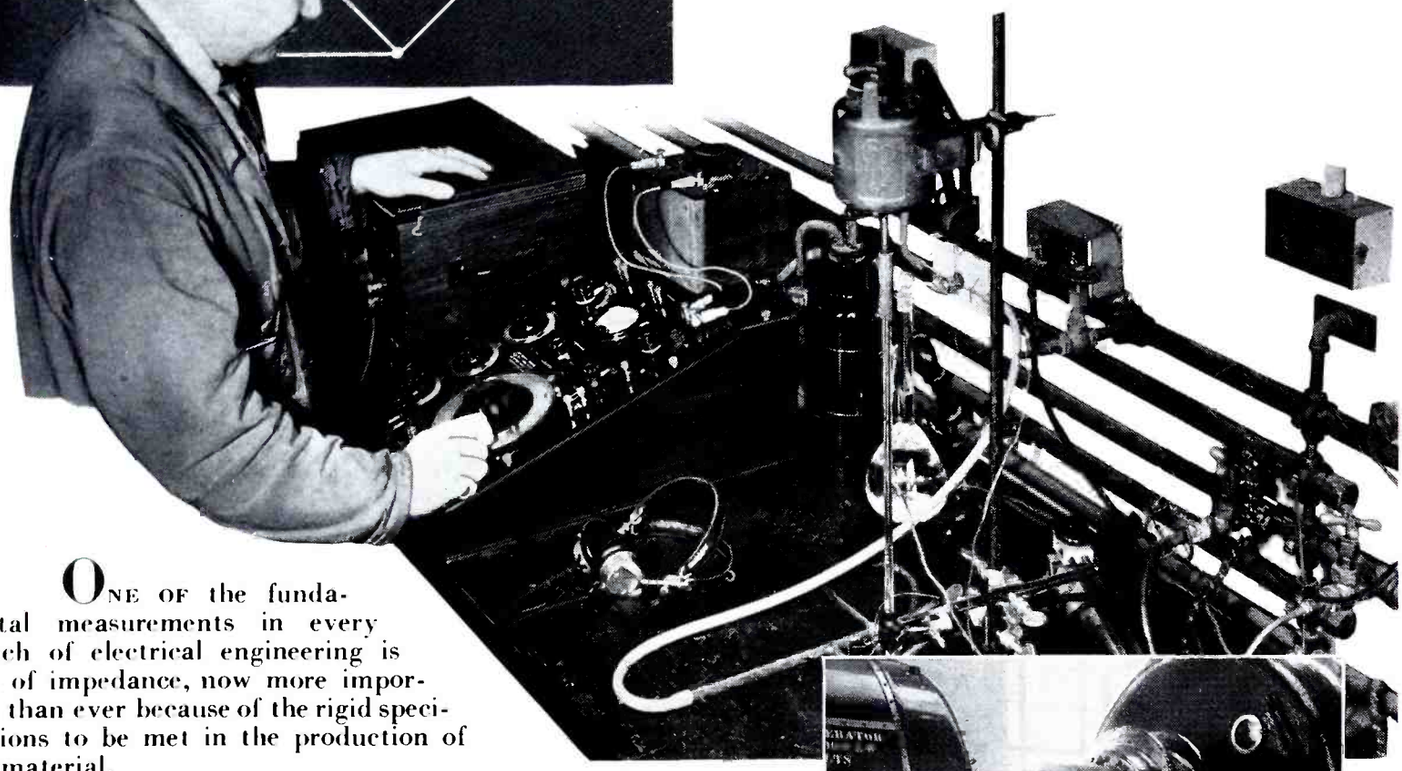
Speakers on First Program

Bill's notes of the speakers of that evening of Oct. 15, 1925, are of interest. Present were . . . J. R. Poppele, now chief engineer of Mutual Broadcasting and station WOR; L. J. Michaels, now a lieutenant of the New York Police; J. A. Bossen, now traffic manager of Mackay Radio; Fred Klingenschmitt, who was elected vice president and later master of ceremonies of the first *cruise;* Frank Orth, now with Columbia Broadcasting; Aaron Barbalate, with RCA Communications; Ben Lazarus; Henry Horneij; F. F. Webb, in whose offices the play of J. F. J. Maher for VWOA's second broadcast was well rehearsed; George McEwan of the old SV station; Axel Berg, now in government service, and R. W. Young.

COMMUNICATIONS — AUGUST, 1943 — ADVERTISERS

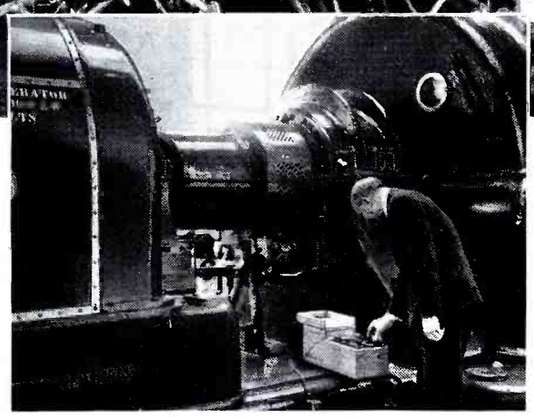


Impedance bridges



One of the fundamental measurements in every branch of electrical engineering is that of impedance, now more important than ever because of the rigid specifications to be met in the production of war material.

In circuits with lumped constants the accepted means of impedance measurement is comparison by a null method, using an a-c adaptation of the Wheatstone bridge. Impedance bridges have been a General Radio specialty for nearly 25 years. A program of continuous research into methods, circuits, and circuit components has led to increasingly better designs and more useful instruments. For measuring both the reactive and resistive components of impedance at all the important frequencies between 60 cycles and 60 megacycles, there is a General Radio bridge to do the job.



Measuring insulation resistance on generator.

Because all our facilities are devoted to war projects, these impedance bridges are at present available only for war work.

ARMY (E) NAVY

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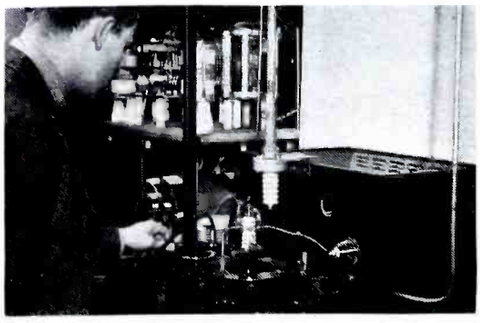
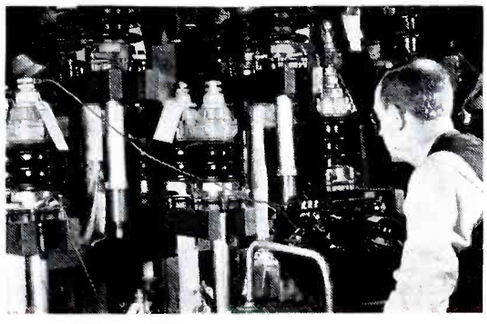
Radio frequency bridge in broadcasting station.



Capacitance test bridge measuring transformer bushings.



Capacitance bridge and oil cell.