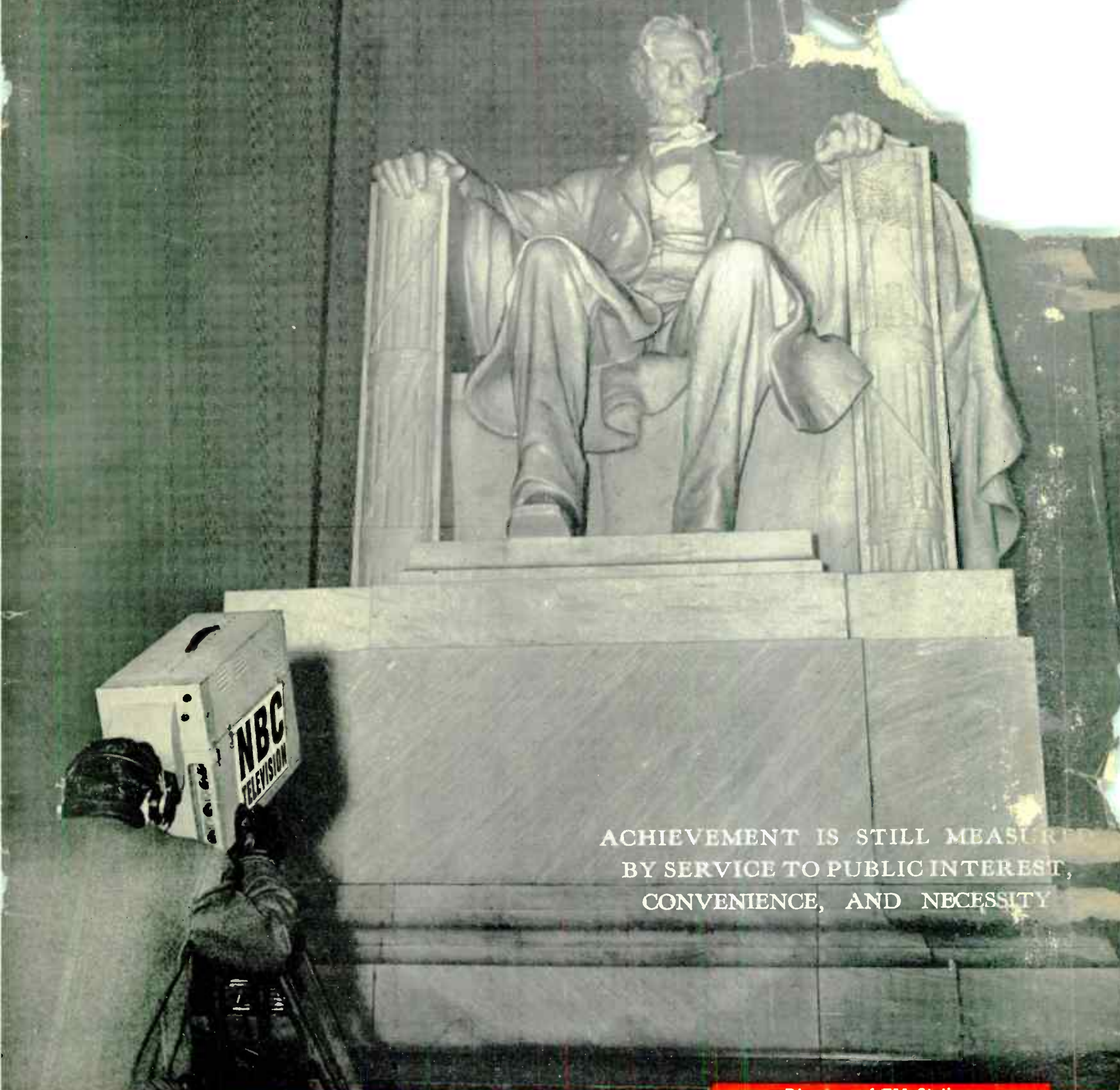
PRICE TWE

FM AND TELEVISION

MARCH 1946



ACHIEVEMENT IS STILL MEASURED BY SERVICE TO PUBLIC INTEREST, CONVENIENCE, AND NECESSITY

Directory of FM Stations

★ ★ Edited by Milton B. Sleeper ★ ★

HOW MYCALEX BUILDS BETTER PEACETIME PRODUCTS

As high frequency insulating standards become more exacting, the more apparent become the many advantages of MYCALEX over other types of materials . . . in building improved performance into electronic apparatus.

For 27 years MYCALEX has been known as "the most nearly perfect" insulation. Today *improved* MYCALEX demonstrates its superior properties wherever low loss factor and high dielectric strength are important . . . where resistance to arcing and high temperatures is desired . . . where imperviousness to oil and water must be virtually 100%.

New advancements in the molding of MYCALEX now make available the production of a wide variety of parts with metal inserts or electrodes molded in to create a positive seal.

It pays to become familiar with the physical and electrical properties of all three types of MYCALEX — MYCALEX 400, MYCALEX K and MYCALEX 410 (MOLDED). Our engineers invite your inquiries on all insulating problems.

SINCE 1919 MYCALEX THE INSULATOR
TRADE MARK REG U S PAT OFF

MYCALEX CORPORATION OF AMERICA

"Owners of 'MYCALEX' Patents"

Plant and General Offices, CLIFTON, N. J. *Executive Offices,* 30 ROCKEFELLER PLAZA, NEW YORK 20, N.Y.

FM

Synchronized
Western Electric

1 KWs

NOW IN PRODUCTION

DESIGNED by Bell Telephone Laboratories—built by Western Electric—this 1 KW assures you of a radiated signal truly representative of FM at its best!

The 1 KW will be followed in production by the 250 Watt, 3 KW, 10 KW and 50 KW transmitters.

Get in touch with your nearest Graybar Broadcast Equipment Specialist for assistance in planning your entire FM plant. Enter your order *now* at existing firm prices!

On Frequency

The Frequency Watchman holds your transmitter precisely on frequency.

Foremost among the operating problems of Frequency Modulation is control of the mean carrier frequency. The Watchman does it for you—constantly and accurately. How he does it is explained in a booklet—"The Frequency Watchman." A copy is being held for you. Write to Graybar Electric Company, 420 Lexington Ave., New York 17, N. Y.

Western Electric

Designed by
BELL TELEPHONE LABORATORIES

Distributed by Graybar

FM AND TELEVISION

FORMERLY: FM MAGAZINE and FM RADIO-ELECTRONICS

VOL. 6 | MARCH, 1946 | NO. 3

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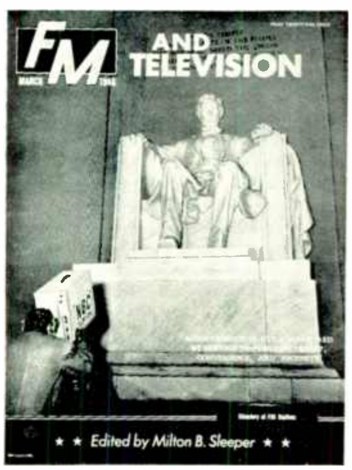


THE MONTH'S COVER

This very unusual photograph was taken at the time of the first demonstration of television transmission over A.T. & T.'s New York-Washington coaxial cable.

We chose it as a cover picture because it seems to sum up, more eloquently than any words, the highest conception of coöperation between engineering and government in the service of public interest, convenience, and necessity.

Entered as second-class matter, August 22, 1945, at the Post Office, Great Barrington, Mass., under the Act of March 3, 1879. Additional entry at the Post Office, Concord, N. H. Printed in the U. S. A.

WHAT'S NEW THIS MONTH

1. After World War II
2. FM-AM Controversy

1. "Business errors grow through competitive conditions, and so long as there are enough inexperienced but vigorous executives who will not take the lessons of history, they, by their mistakes, can force the more prudent and historically learned into errors that become competitive necessities.

"Let's look at some of the mistakes of the 1920's.

"The first seems a little unreal right now when we are in a period of rising prices. But deflation will come, and with it a temptation to go into price selling which eventually leads to frenzied price-cutting. This soon loses its business value and becomes a kind of mania in itself.

"Another mania that is just as dangerous is that of volume for volume's sake. During the '20s, how many companies had to learn the hard way that there is a difference between mere volume and profitable volume?

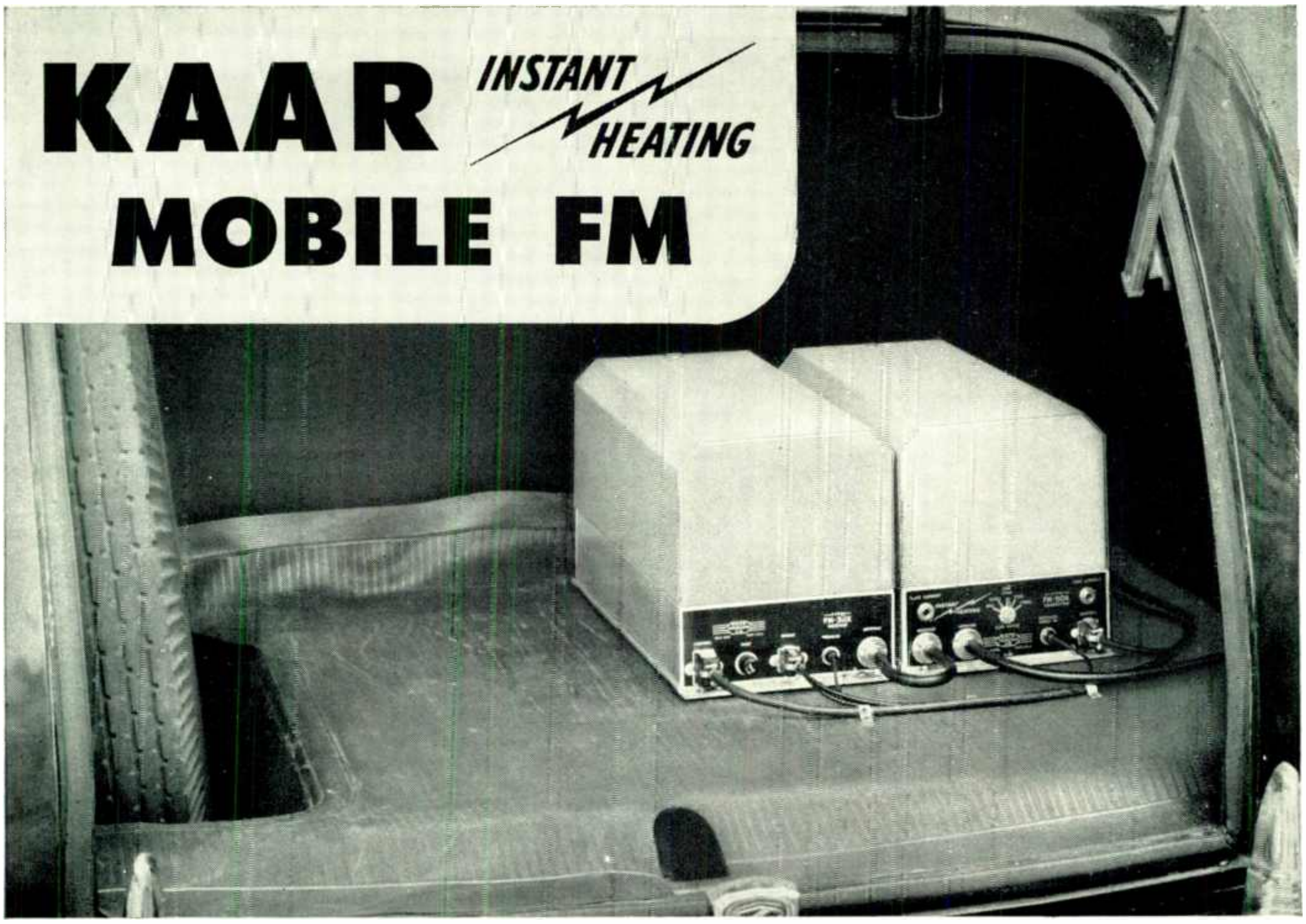
"Competition in service is another danger. No one denies the value to any business of offering to its customers extra services. But when service becomes a shibboleth and businesses attempt to compete on a service basis, each company offers more and more services until the cost of service is eating up the profits.

"Closely allied to mania for volume is the tendency to overload dealers. Over-enthusiastic sales managers and over-optimistic advertising men tend to forget that a sale is only consummated when the product reaches the ultimate consumer. They proceed, therefore, to load up dealers, and then are amazed when sales at the factory plunge downward because sales *from* the store are not in proportion to sales *to* the store.

"Competition in extending credit is another dangerous tendency in competitive markets. As dealers become stocked up with various lines, as the urge to get new dealers becomes more and more vital, there is a temptation to take on marginal or sub-marginal dealers. Credit men are asked to let down the bars. Eventually the sub-marginal dealers fail and the companies who used lax credit as a sales method find themselves in a worse case than had they used strict credit policies.

"Then there is the temptation to make too many models or too many variations

(CONTINUED ON PAGE 73)

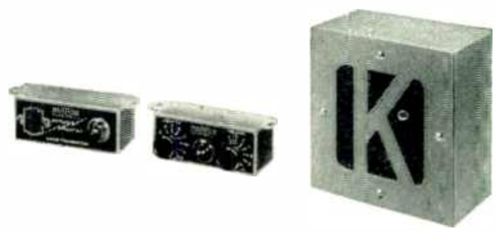


Now available! An FM Radiotelephone with a truly NATURAL voice quality!

New KAAR FM radiotelephones offer an improvement in tone quality which is suprising to anyone who has had previous experience with mobile FM equipment. The over-all audio frequency response through the KAAR transmitter and receiver is actually within plus or minus 5 decibels from 200 to 3500 cycles! (See graph below.) This results in vastly better voice quality, and greatly improved intelligibility. In fact, there is appreciable improvement even when the FM-39X receiver or one of the KAAR FM transmitters is employed in a composite installation.

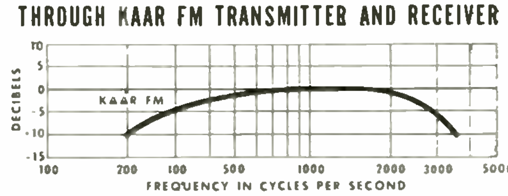
KAAR FM transmitters are equipped with instant-heating tubes, thus making it practical to operate these 50 and 100 watt units from the standard 6 volt ignition battery without changing the generator. Inasmuch as standby current is zero, in typical emergency service the KAAR FM-50X (50 watts) uses only 4% of the battery current required for conventional 30 watt transmitters. Battery drain for the KAAR FM-100X (100 watts) is comparably low.

For full information on new KAAR FM radiotelephones, write today for Bulletin No. 24A-46.



KAAR LOUD SPEAKER, remote controls for transmitter and receiver (illustrated above) and the famous Type 4-C push-to-talk microphone are among the accessories furnished with the equipment.

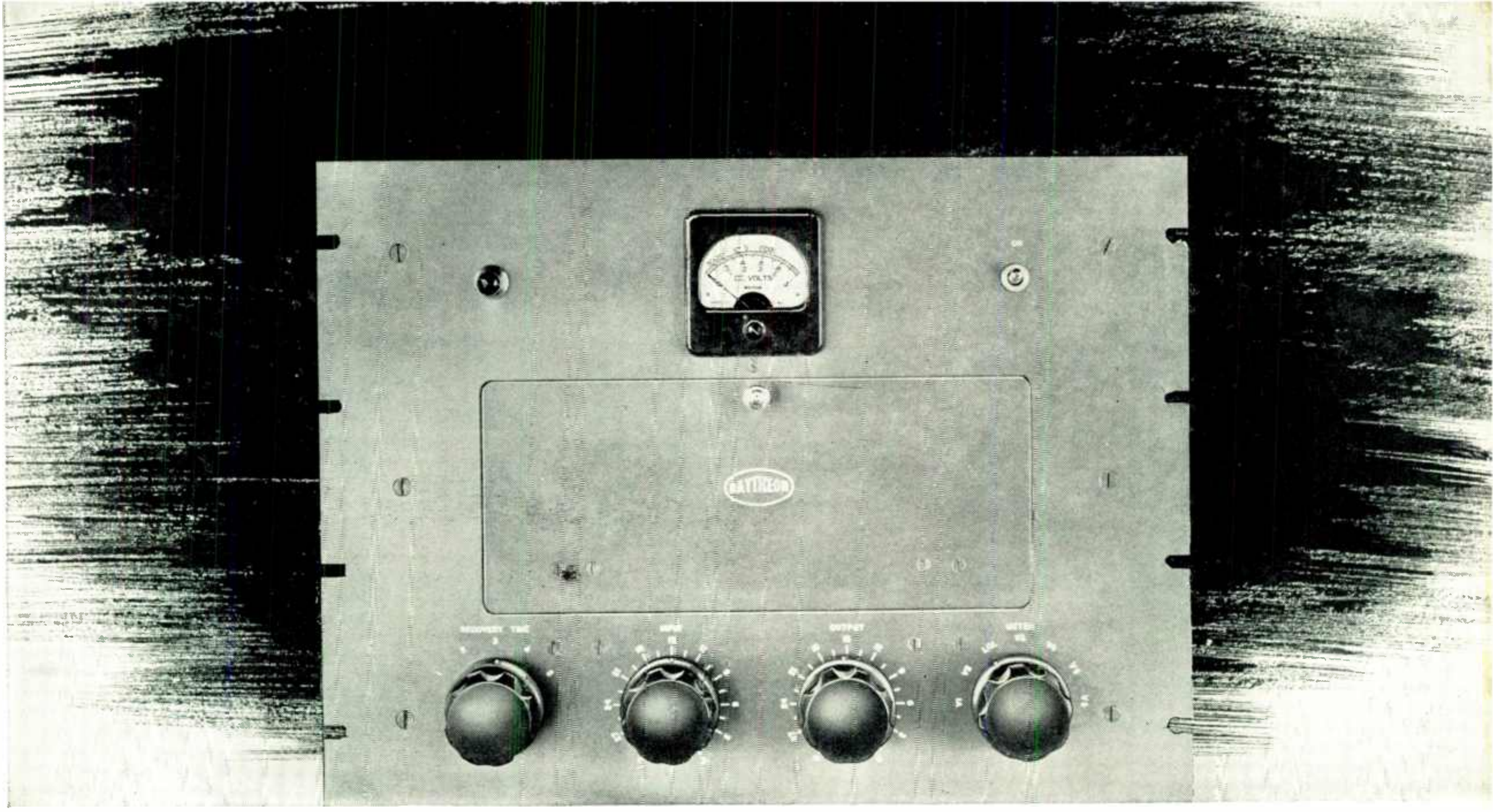
IMPROVED OVER-ALL FREQUENCY RESPONSE THROUGH KAAR FM TRANSMITTER AND RECEIVER



KAAR ENGINEERING CO.
PALO ALTO • CALIFORNIA

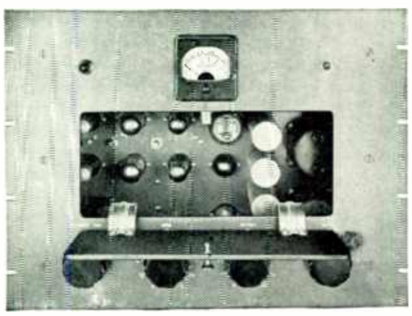
KAAR ENGINEERING CO.

ADVERTISERS INDEX

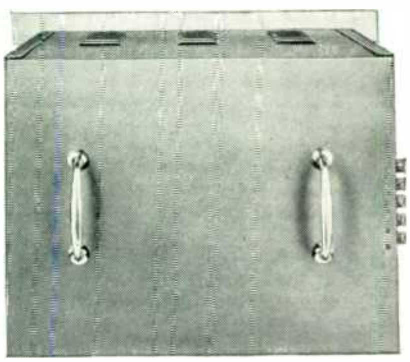


INCREASE COVERAGE . . . IMPROVE RECEPTION WITH

RAYTHEON'S VOLUME LIMITER!



Hinged front panel gives access to all components.



Back dust cover slides off to expose all wiring.

MAKE YOUR AIR-TIME more valuable by increasing the useful range of your signal and greatly improving reception. By more effectively using your present transmitter power, Raytheon's new Volume Limiter will raise your average percentage modulation without any audible increase in harmonic distortion.

Designed for use in high fidelity AM or FM speech input systems, this Limiter meets or exceeds all FCC requirements for FM transmission. Frequency response is from 30 to 15,000 cycles. Limiting action, independent of frequency response, prevents distortion and over-modulation. Variable recovery time, controlled by operator, assures proper recovery time for all types of programs. Separate input and output controls. Attenuators easily handle input variation from —40 DB to +20 DB. Meter, with rotary selector switch, checks plate current of critical tubes and shows exact amount of compression.

Actual engineering curves prove the following outstanding performance: compression ratio of 10 to 1, distortion less than 1%, noise level of 60 DB or better. Maximum output +23 DB.

Attractive modern styling, beautifully finished in medium metallic tan. Designed for mounting in standard relay rack or cabinet, front panel 19" x 14". Instant access to all components through hinged front panel. All wiring on vertical chassis is exposed, without removing unit from rack, by sliding off back dust cover.

No waiting—prompt delivery. Write for price and complete specifications.

RAYTHEON

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

***Broadcast Equipment Division*, 7517 North Clark Street, Chicago, Ill.**

DEVOTED TO RESEARCH AND MANUFACTURE FOR THE BROADCASTING INDUSTRY

ENGINEERING SALES

Sylvania: R. P. Almy has been named assistant general sales manager of the radio division, with Harold H. Rainier succeeding him as manager of distributor sales. Almy will be located at Emporium, while Rainier will be in Chicago.

RCA: Col. W. W. Watts, recently released from the Signal Corps, has joined the engineering products department as general sales manager. Before the war, he was Zenith vice president in charge of Wincharger Corp., and later radio and major electrical appliance mail order sales manager for Montgomery Ward.

Echophone: Wm. R. Whittaker Company, Los Angeles, will distribute Echophone receivers in southern California, under the direction of Whittaker sales manager Duane R. Larrabee.

Western Electric: Walter M. Reynolds, AT&T information manager since May, 1944, has been appointed W. E. publications manager, in charge of producing sales and instruction manuals, and preparation of displays, exhibits, and posters. He is succeeded at AT&T by R. I. Johannesen.

Kluge: New general manager in charge of sales and production for Kluge Electronics is Ray Reilly, west coast radio sales executive who is remembered as sales manager for the original Sonora Company.

General Radio: Ivan G. Easton has been appointed manager of G.R's. New York engineering and sales office, succeeding Martin A. Gilman who is now back with the sales engineering staff at Cambridge. At the Chicago office, Kipling Adams, formerly assistant manager of the service department, has succeeded Lucius E. Packard who resigned recently to embark on a manufacturing venture of his own.

Sylvania: Has transferred D. W. Gunn, of the radio tube division, from New York to the Cleveland office at 295 Union Commerce Building. He will work with equipment manufacturers in Michigan, Ohio, and Indiana.

Ward Leonard: Has opened a sales office in the Industrial Office Building, Newark 2. R. W. Yonasch, formerly of the home office sales engineering department, is in charge.

FOR UHF AND SHF DETECTION

SYLVANIA SILICON DIODES

FEATURES

- Low noise level.
- Rugged construction.
- Gold plated for low contact resistance.
- Low capacitance.
- Low inductance.
- No heater.
- High conversion efficiency.
- Hermetically sealed.

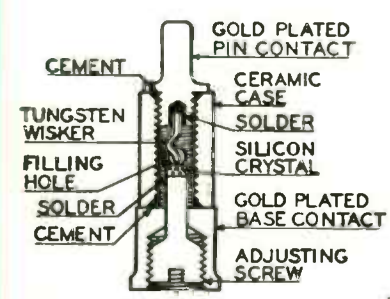
Resistant to shock and vibration . . . functioning over a wide range of ambient temperatures . . . Sylvania Silicion Diodes offer exceptionally interesting potentialities.

They are especially effective as converters and rectifiers for ultra and super high frequencies. They have found one of their most important applications as first detectors in microwave receivers.

Asymmetrical characteristics make these Silicon Diodes useful in low voltage applications. On reversal of current direction, instant high blocking action results.

Sylvania Silicon Diodes are available in many types. Three popular types are:

1N21B	Recommended for 3,000 mc. operation
1N23B	Recommended for 10,000 mc. operation
1N26	Recommended for 25,000 mc. operation



Sectional view of the Sylvania Silicon Diode, showing component parts.

For lower frequencies and higher voltages and currents, the Sylvania Gx metal Crystal Diode, Type 1N34, is recommended.

Investigate the potentialities of these new circuit elements pioneered by Sylvania Electric. Your inquiries are invited.

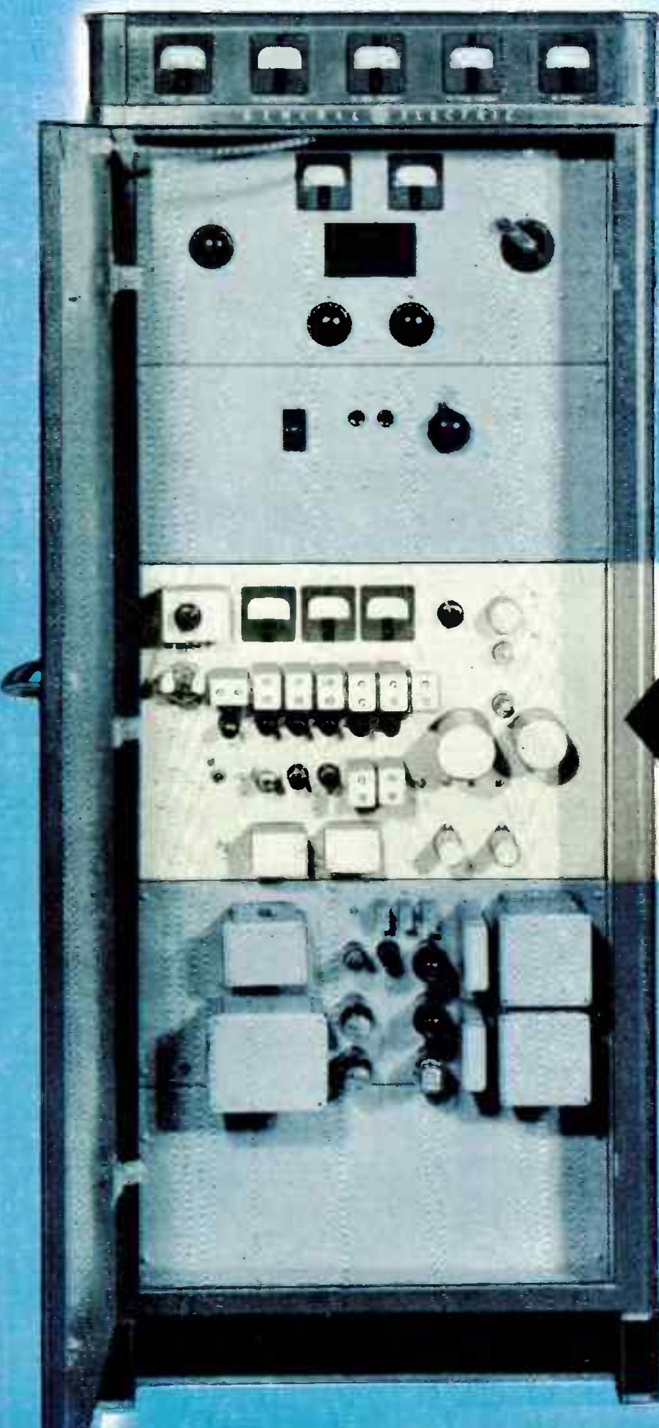
SYLVANIA ELECTRIC

Electronics Division . . . 500 Fifth Avenue, New York 18, N. Y.

MAKERS OF ELECTRONIC DEVICES; RADIO TUBES; CATHODE RAY TUBES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS

New G-E **250 WATT**

THE TRANSMITTER



FRONT VIEW

THE NEW G-E PHASITRON MODULATOR

This is the *simple* all-electronic modulation system which uses only 10 receiving-type tubes. The heart of this system is the G-E Phasitron. This tube, with its wide phase shift, allows a frequency multiplication of only 432 to produce a ± 75-kc swing at the output frequency. Frequency conversions are unnecessary, thereby eliminating spurious responses. Important, too, is direct single-crystal control—*independent of modulation.*

Have you placed

STUDIO AND STATION EQUIPMENT • TRANSMITTERS

GENERAL ELECTRIC

160-E3-6814

FIRST AND GREATEST NAME IN ELECTRONICS

FM TRANSMITTER

WITH THE *PHASITRON* CIRCUIT

• Simple Design

Only 9 r f circuits and 10 r-f tubes from crystal to output frequency. Direct crystal control with *one* crystal. Minimum number of components and controls.

• Easy-to-Get-At

Vertical chassis construction. Full length front and rear doors. Plenty of room to work in.

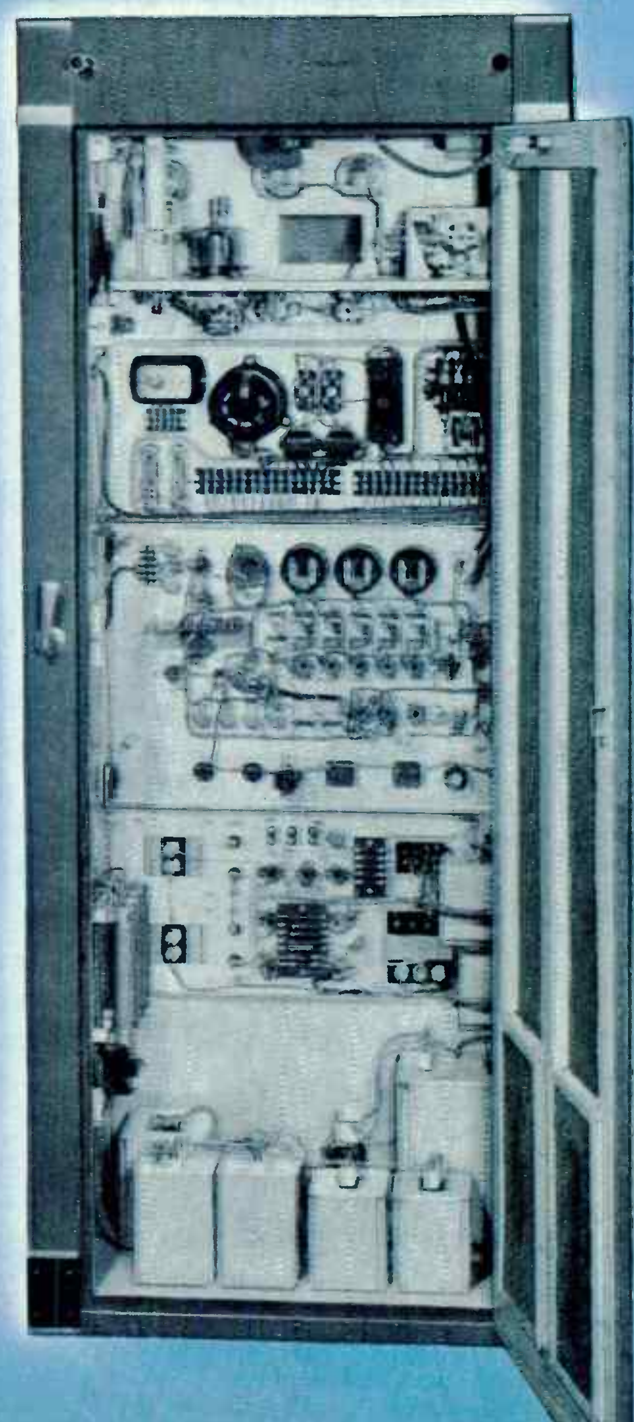
• Basic Unit For Any Power

Your transmitter today—your exciter tomorrow. Allows increase in power with no equipment obsolescence. Simplified inter-unit connections.

• Lower Price

your order yet?

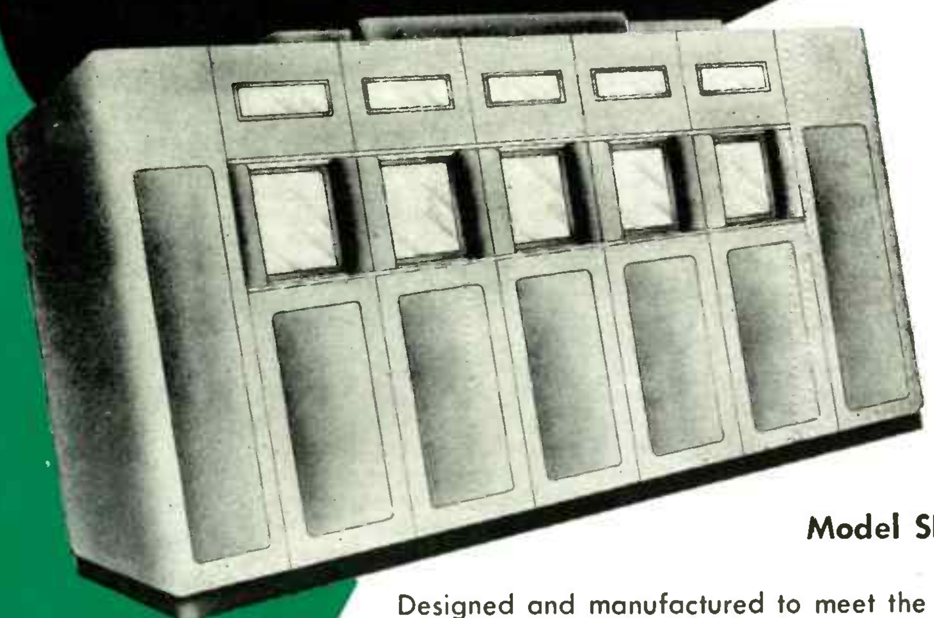
For information on this outstanding transmitter and the complete line of G-E FM broadcast equipment, call your G-E broadcast sales engineer, or write: *Electronics Department, General Electric Company, Schenectady 5. N. Y.*



REAR VIEW

ANTENNAS • ELECTRONIC TUBES • HOME RECEIVERS

FM • TELEVISION • AM *See G.E. for all three!*



BIRD MODEL 63-A WATTMETER AND WIDE-BAND LINE TERMINATION

For Output Measurement

VHF-UHF

10 TO 1500 MEGACYCLES

Developed and proven under stress of war, this instrument is especially suited to equipment having 50-ohm coaxial transmission circuits. Solving the dual problem of power measurement and line termination, this constant impedance instrument supplies meter readings thru thermocouples while dissipating the r-f energy in an ingenious artificial antenna. Power range 1 to 500 watts.

NOW READY FOR PEACETIME USES!

COAXWITCH

A SELECTOR SWITCH FOR COAXIAL CIRCUITS

This new switch was developed for airborne radar antenna switching. A 50-ohm device, it maintains a constant characteristic impedance. To retain LOW standing wave ratios and secure maximum transfer of r-f energy, specify "Coaxwitch". Available now, in two models; Model 74 for single coaxial circuits; Model 72-2 for handling two coaxial circuits simultaneously.

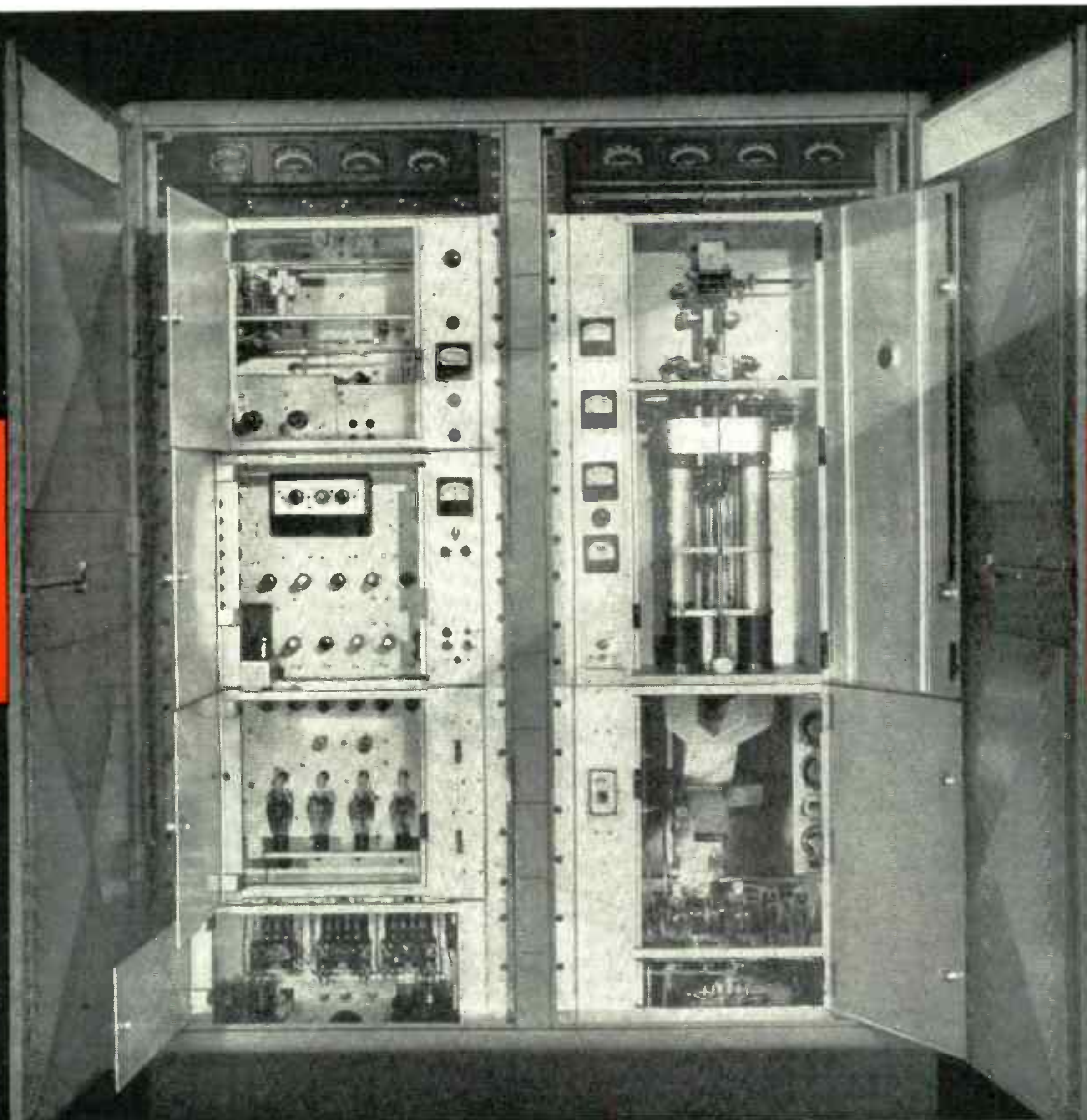
Write for Catalog Pages

BIRD ELECTRONIC CORPORATION

FORMERLY BIRD ENGINEERING COMPANY

Instrumentation for Coaxial Transmission

1800 EAST 38th STREET • CLEVELAND 14, OHIO

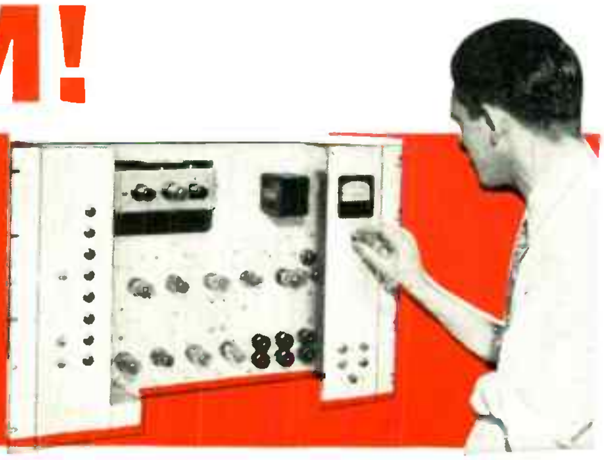


HERE'S THE

BIG NEWS

IN FM!

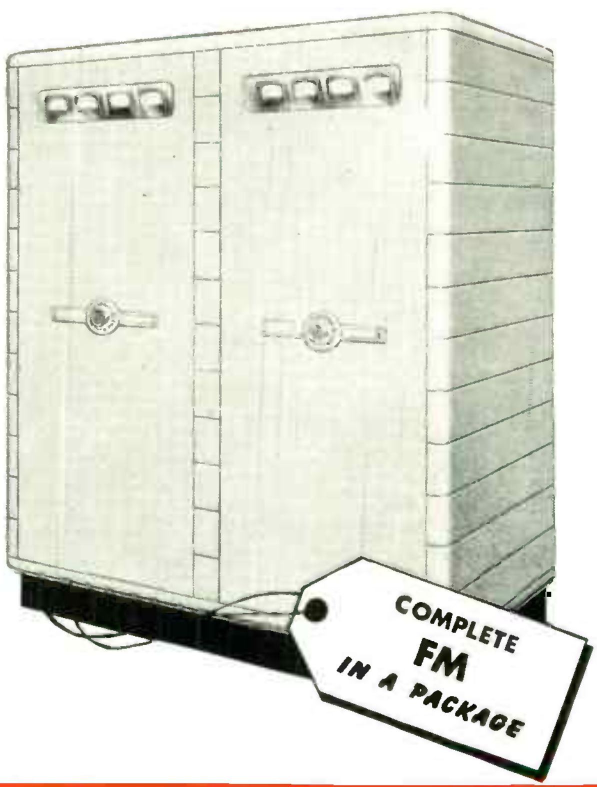
. . . it's FEDERAL's new "FREQUEMATIC"* MODULATOR



1—3—10 and 50 KILOWATT FM RADIO EQUIPMENT

The "FREQUEMATIC" Modulator takes its place as part of the complete "package" of FM broadcasting equipment offered by Federal. From one source, you get every piece of broadcasting gear to set up operation *now* . . . from studio equipment to transmitting tower . . . all precision-engineered, all matched, all of highest quality. No more piecemeal assembly of components, and uncertainties of divided responsibility. Federal assumes full responsibility for delivery and *installation* of a complete FM Broadcasting System. For complete details, write: Federal Telephone and Radio Corporation, Newark 1, New Jersey.

*Trade Mark



Telephone and Radio Corporation

Newark 1, New Jersey

Export Distributor:
International Standard Electric Corporation

AN IT&T ASSOCIATE

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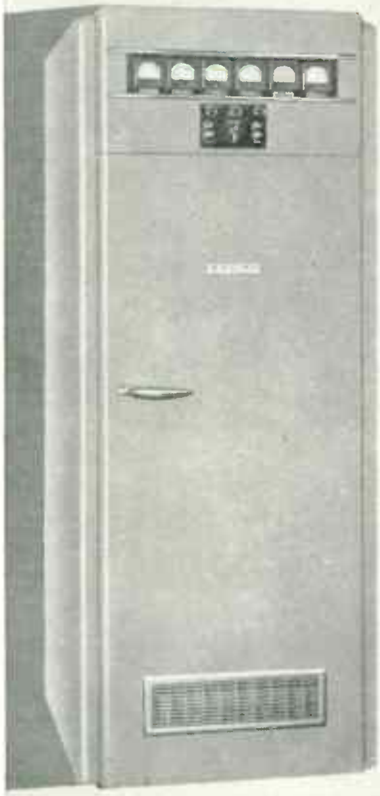
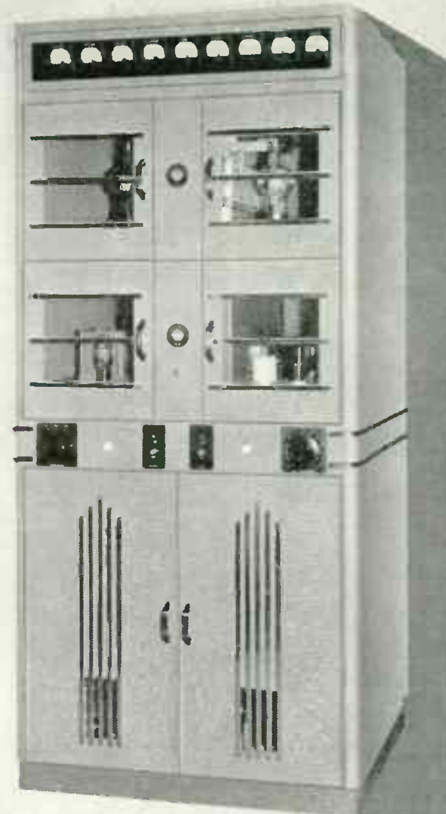


FM and AM Broadcasting

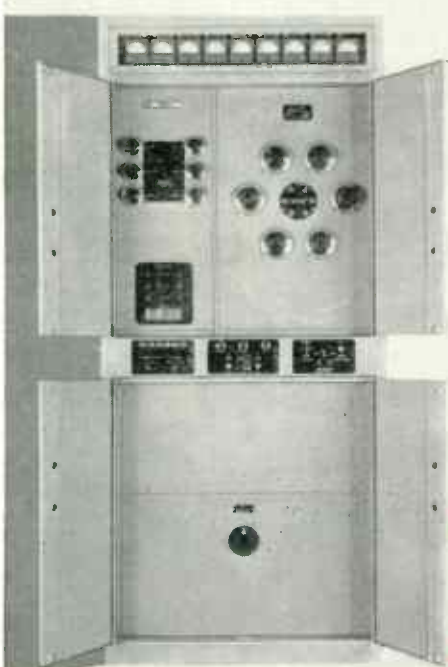
TEMCO will deliver *within 30 to 60 days* equipment for any of the following services:

- FM and AM BROADCASTING
- AVIATION and MARINE
- POLICE - FIRE - FORESTRY and PUBLIC UTILITY
- POINT - TO - POINT COMMERCIAL
- AMATEUR and CITIZEN

Send us your requirements for IMMEDIATE action



Police - Fire - Forestry and Public Utility



Point - to - Point Commercial

Amateur and Citizen

Aviation and Marine

TEMCO

RADIO COMMUNICATION EQUIPMENT

TRANSMITTER EQUIPMENT MFG. CO., INC.

345 Hudson Street, New York 14, N. Y.

BROOKLYN *or* BANGKOK

Around the corner or around the world...

Finch Facsimile (Telefax) means high-speed and completely accurate communication — *in writing*.

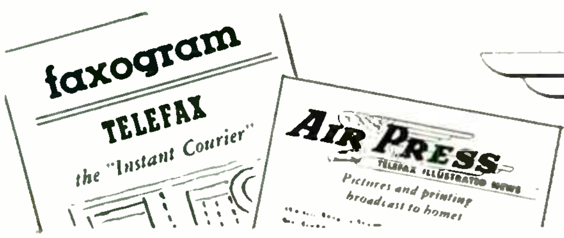
Every word written, every diagram drawn, every photograph printed on paper up to 8½" x 11" can be transcribed electrically to sensitized paper as far as radio or wire will reach, in from two to four minutes!

Due to the number of words and the detail of pictures that can be shown in a sheet this size, "Faxograms" constitute the world's fastest as well as most flexible and accurate system.

And the Finch "Air-Press"—broadcasting all kinds of printed matter, with illustrations, offers unlimited fields for progress in publishing, entertainment and education by radio.

Write for description of Finch Patents contributing to Finch World leadership in Facsimile.

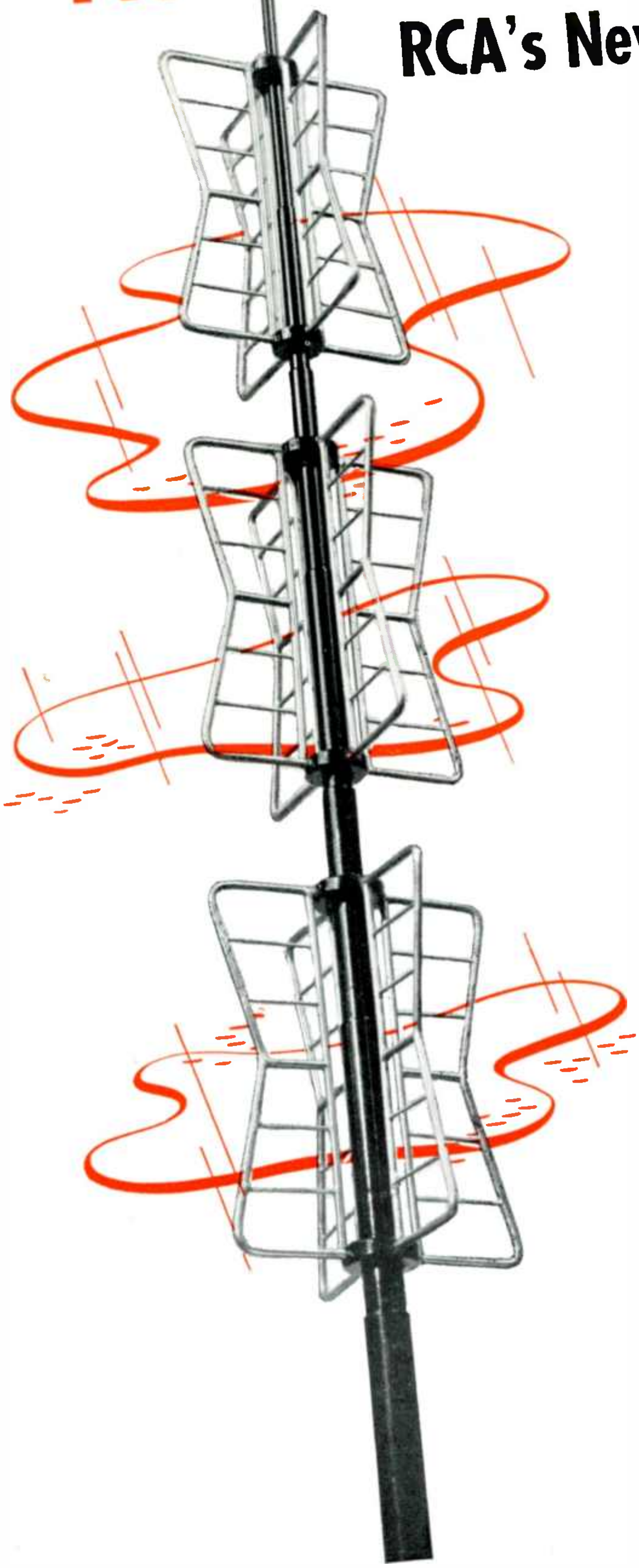
FINCH Telecommunications Inc.
PASSAIC, N. J., U. S. A.
NEW YORK OFFICE: 10 EAST 40 ST.



self-synchronizing
finch facsimile

THE SUPER TURNSTILE—

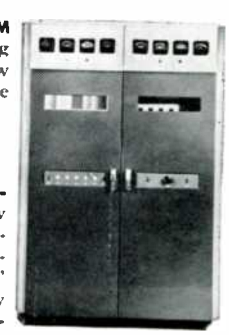
RCA's New, Wide-band, High-gain



- Extremely broad frequency characteristics
- High gain (approximate power gain: 1.25, 2.5, and 4 for one-, two-, or three-section antennas)
- Lower transmitter power for a given coverage
- One size operates at any frequency from 88 to 108 mc
- Handles up to 20 kw—which can be increased very simply by substitution of larger feed line
- Easy and inexpensive to install—single-pole mounting
- Fewer feed points and end seals
- Pretuned at factory
- No field adjustments required
- A standardized, "packaged" item—comes complete
- Entire structure can be grounded
- Circular field pattern (easily modified for FM to "figure-8" or in-between patterns)
- Withstands high-wind conditions and ice
- Two FM transmitters can be diplexed into a single antenna
- Both sound and picture television transmitters can be diplexed into a single antenna

RCA'S NEW LINE OF FM

←The 250-watt FM exciter featuring new circuits, new tubes, and a new type of construction.



The 1-kw FM transmitter. Note how RCA's "add-an-amplifier" design results in "single-unit" appearance for any power size. →

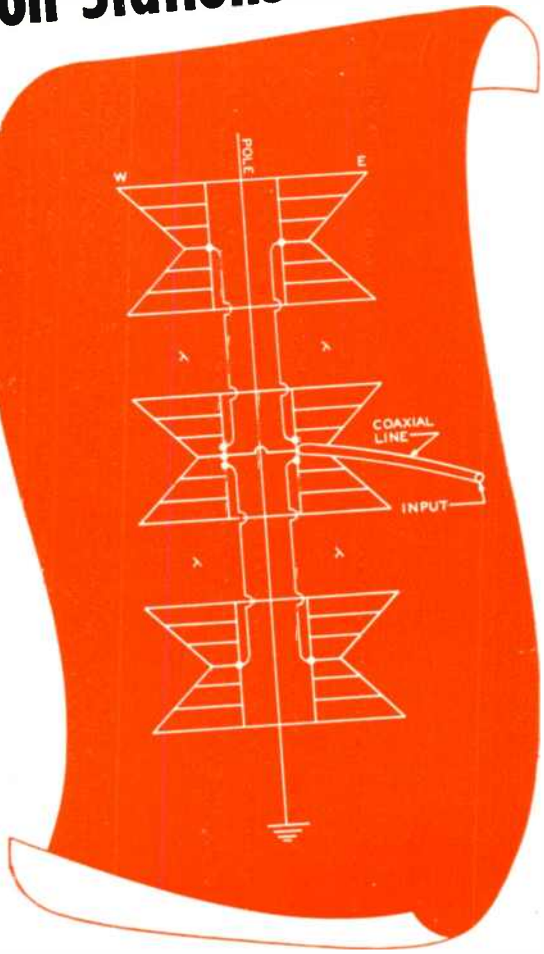
Antenna for FM and Television Stations

This new RCA antenna, we believe, is a real step forward in the art of FM and Television Broadcasting.

Its most notable feature is the use of bat-wing-shaped "current-sheet" radiators in place of the dipole arms of prewar turnstiles.

The chief effect of the "current-sheets" is to broaden the antenna's operating characteristic so that the impedance reflected on the transmission line is almost equal to that of the line itself over a frequency range of 20 per cent—nearly twice the entire FM band! Hence, there are no tricky field adjustments to worry about.

Write today for a copy of our new leaflet which fully explains how this unique antenna works, and why it assures you the long list of advantages summarized at the left. Radio Corporation of America, Dept. 35-C, Broadcast Equipment Section, Camden, N. J.



The West-East current sheets showing the transmission-line connections. The sheets are fed in push-pull. For television, the connections are made as shown here, i.e., the outer conductor of the coaxial line is attached to the one sheet and the inner conductor to the other sheet. For FM, separate coaxial lines feed the two sheets of each dipole. The North-South radiators (not shown) are fed in a similar manner, but with a 90-degree phase displacement.

BROADCAST AND TELEVISION EQUIPMENT

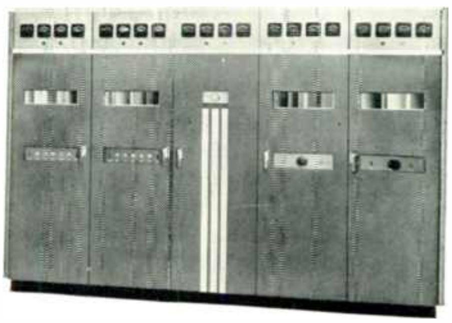
RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DIVISION, CAMDEN, N. J.

TRANSMITTERS FEATURING "DIRECT FM" AND "GROUNDED GRID"

← **The 3-kw FM transmitter.** A new hollow base frame on all ratings provides space for inter-unit wiring. No under-floor conduits required.

The 10-kw FM transmitter. Controls for all ratings centralized on flush-mounted strips accessible through centers of doors. (25- and 50-kw ratings will also be available.) →



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THE RADIO INDUSTRY NEEDS THE FCC'S HELP

Commission's Failure to Implement Radio Industry's Postwar Expansion Has Been Costly to Labor and Management

BY MILTON B. SLEEPER

CHARLES R. DENNY, JR., in his new position as acting chairman of the FCC, certainly has the good wishes of the radio industry. He has demonstrated a tremendous capacity for effective effort, both as general council for the FCC and as a Commissioner. There is every reason to have confidence in his ability to administer the complex affairs of the FCC organization.

Mr. Denny has been called a Porter disciple, and his designation by President Truman as acting chairman was the result of Paul Porter's recommendation.

It is not yet clear what this will mean to the radio industry. Like Mr. Porter, Charles Denny is a lawyer. He received his A.B. from Amherst in 1933, and his LL.B. from Harvard three years later. After two years with the Washington law firm of Covington, Burling, Rublee, Archeson & Shorb, he entered the Department of Justice as attorney in the condemnation section of the Lands Division.

He rose rapidly in the Government service, joining the FCC in February, 1942, as assistant general counsel in the Division of Litigation and Administration. In October, 1942, he succeeded Telford Taylor as general counsel, and was named a Commissioner for a 7-year term in March, 1945.

Now, the measure of a lawyer's success in the practice of his profession is his ability to produce an answer by which he can gain his point in any given situation. Failing to do this, he must be able to block a decision favorable to his opponent. In other words, to an attorney, it is still possible to win as the result of a postponement. But to any man of business, to whom time is the essence of profit, postponement represents loss of revenue.

These familiar facilities of the legal profession have been used vigorously, effectively and, in the opinion of many leaders of the industry, arbitrarily by Paul Porter in his handling of FM broadcasting. As a result, the reconversion plans of FM transmitter and receiver manufacturers have been delayed at least a year.

Here is a specific example of disservice to the general public and to the workers and management of an industry whose affairs are administered by a man who uses all the devices of the legal profession to prevail over those who disagree with him.

On May 25th, when frequency allocations were assigned to all other services operating above 30 mc., no decision was reached on FM broadcast frequencies — the one development which would benefit the public most, and which could make the greatest contribution to maintaining a high rate of employment in the radio industry after the war. Instead, three alternative assignments were proposed for subsequent investigation.

Manufacturers protested[1] vigorously against this delay in assigning FM broadcast frequencies. Television Broadcasters Association, FM Broadcasters, Inc., and the Pioneer FM Manufacturers Conference promptly passed resolutions calling upon the FCC to make the No. 1 Alternative effective at once, giving FM 48 to 68 mc., with 68 to 74 and 78 to 108 mc. for television.

CHARLES R. DENNY, JR., NOW ACTING CHAIRMAN OF THE FCC

The announcement of the three alternative plans was accompanied by an explanation which stated, in part, that "equipment considerations should not be complicated by moving to the higher frequencies unless it is clear that there will be definite advantages from a propagation standpoint."

However, under pressure from the industry, the final choice of the No. 3 Alternative, moving FM to 88 to 108 mc., was announced on June 27, 1945. This was done in the face of statements from manufacturers explaining that neither designs nor tubes were available for receivers and transmitters on 88 to 108 mc. Moreover, as was disclosed subsequently, the Norton testimony supporting the use of the higher frequencies had been proved, at the Secret Hearing on March 12 and 13, 1945, to be grossly in error.

Confronted by a complete shift of FM frequencies, the Pioneer FM Manufacturers Conference, meeting on July 6th, announced that, as a service to radio listeners, they would provide 2-band FM tuning. Thereupon, Chairman Porter stepped into a situation over which he had no jurisdiction whatever with the pronouncement that "The Commission is informed by transmitter manufacturers that 10-kilowatt transmitters will be immediately available for the new band," and that "the Commission might very well take the position that it was necessary to put an end immediately to all FM transmissions in the old band in order to protect the public from an unnecessary expense[2] and to insure that the change-over to FM's new and permanent home should not be delayed."

Now, the truth was that Chairman Porter had not been informed by any authoritative source that "10-kilowatt transmitters will be immediately available for the new band." That statement was nothing more than a lawyer's answer to justify his position. There was not a word of truth in it, and the RMA reported to him that the transmitter manufacturers would not have 10-kw. FM equipment for 10 to 12 months.

In January, 1946, Chairman Porter stated in an article[3] under his own signature that "A recent canvass of manufacturers made by the Commission revealed encouraging progress in the production of the lower-powered transmitters and the availability of some 10- and 50-kw. transmitters by summer."

Chairman Porter might reply: "All right, I was out twelve months. So what?" To a lawyer, a year's time is not important, but to radio factory workers a year's idleness would likely cost their life's savings, and require them to mortgage their future to keep their families from starving. And to a manufacturer, a year's delay might well mean bankruptcy.

As a public servant, the Chairman of the FCC is not privileged to invent justification for an arbitrary and unsound de-

(CONCLUDED ON PAGE 62)

[1] "FCC Delay Is Threat to Radio Industry," *FM and Television*, June, 1945, page 26.

[2] Set manufacturers testified that the cost to the public of including old-band tuning would be $1.50 to $3.50.

[3] "As I See It" by Paul A. Porter, *The Journal of Frequency Modulation*, February, 1946.

AUDIO DISTORTION IN RADIO RECEPTION

Observations of a Radio Engineer Who Believes That the Best Reproduction Is Exact Reproduction

BY JERRY MINTER*

THIS information represents the efforts of a hobby; it has no particular connection with the business interests of the Measurements Corporation or any other company. The criticisms given in this paper are presented with the hope that they will further the best interests of the radio industry.

It has been customary to specify only the amplitude response and harmonic distortion of audio systems. There are two

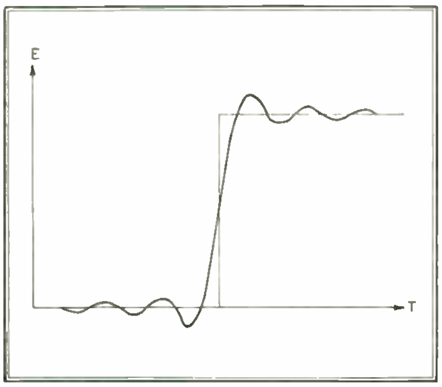


FIG. 1. EFFECT OF TOO SHARP CUTOFF

other important forms of distortion: poor transient response and cross modulation. This paper is concerned with these latter two, since the author feels that ignorance of their importance is chiefly responsible

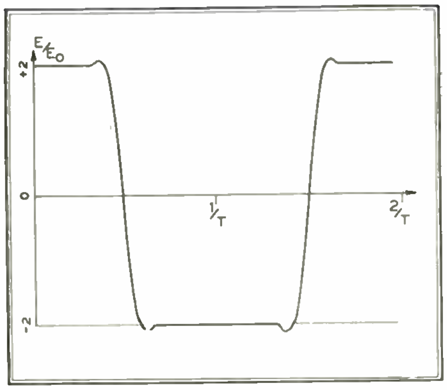


FIG. 2. CRITICALLY DAMPED RESPONSE

for the failure of many so-called "high fidelity" audio system tests.

Transient Response ★ The early connection of amplitude band-width with fidelity of reproduction can probably be attributed to the Bell Telephone Company. The fallacy of neglecting transient band-width of the audio system arose because it was customary to assume that speech and music are made up of continuous tones. We all know that audible sounds have transient character, since they must start and stop sometime. The percussion instruments and staccato score on the brasses particularly demand good transient response.

A characteristic ringing at the cutoff frequency results from insufficient transient band-width or too sharp a cutoff in the amplitude band-width response. Fig. 1 indicates the transient response resulting from the application of a unit or step function to a network having too sharp an amplitude cutoff. The Bell Telephone Company ignored this as long as sufficient damping was present to prevent continuous oscillation (which is called singing). The public has been forced to accept such "Johnny-One-Notes" because the Bell Telephone Company knows best what's good for us.

The transient response can best be

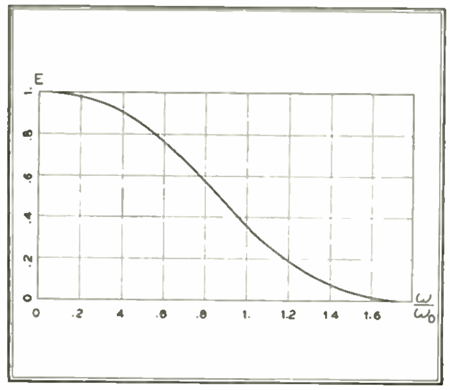
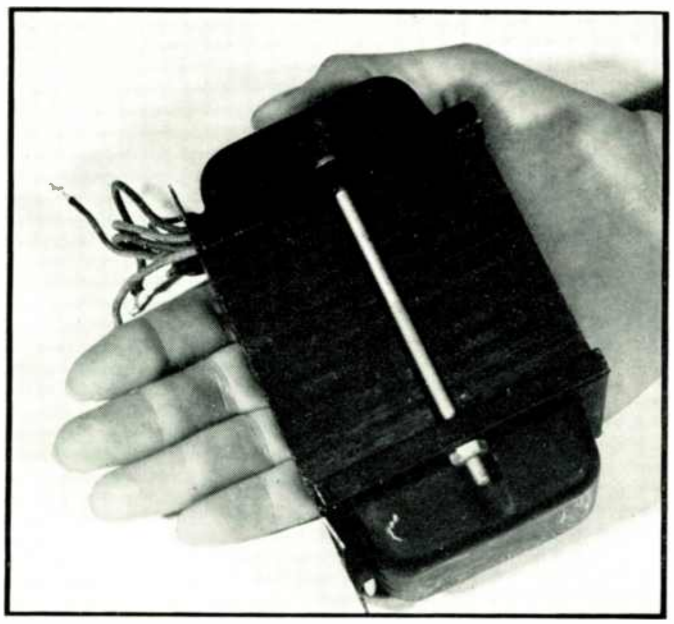


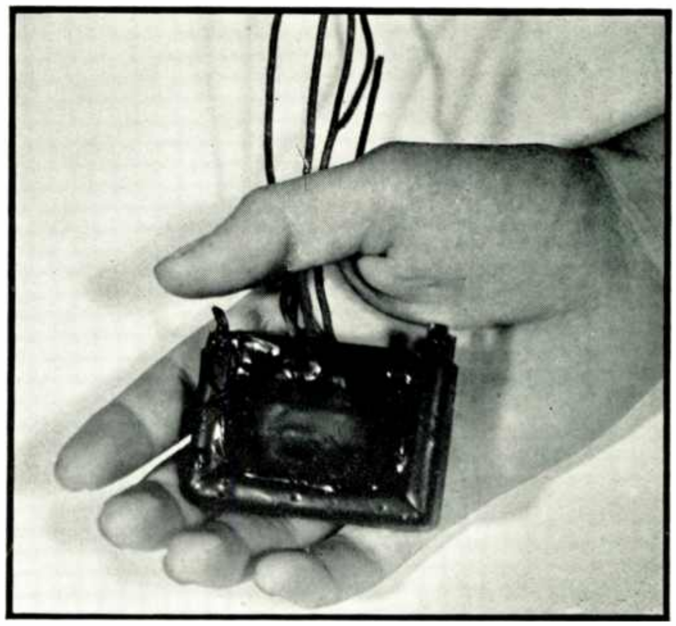
FIG. 3. NETWORK CHARACTERISTIC

measured by applying a square wave of 3 to 10 kc. to the audio system. If the cutoff is gradual and well damped, no Johnny-One-Notes will be observed. Usually output transformer resonance will cause slight oscillations well above the audio range which can be neglected, if well damped. Negative feedback generally accentuates these damped oscillations

*Chief Engineer, Measurements Corporation, Boonton, N. J. A paper delivered before the Radio Club of America, Columbia University, New York City. Offices of the Radio Club are at 11 West 42nd Street, New York.



ADEQUATE TRANSFORMER COSTS $1.79, WEIGHS 5½ LBS.



79-CENT OUTPUT TRANSFORMER FROM RADIO SET, ¾ LB.

which may become continuous at a superaudible frequency and actually overload the amplifier.

Fig. 2 is taken from Kallmann's "Transversal Filters", *Proceedings of the Institute of Radio Engineers*, July, 1940. This represents a critically damped response of a network which has the optimum amplitude characteristic shown in Fig. 3. This curve represents the maximum rate at which the amplitude response can be allowed to drop without introducing ringing or Johnny-One-Notes.

Further acknowledgment of the importance of transient band-widths has come from Dr. Hanson in his recent paper before the 1944 National Electronics Conference in Chicago.

Emphasis is now placed on transient response in television applications, wherein it is obviously of great significance. However the principles apply with equal force to faithful audio reproduction and are perhaps the number one reason why the American public demands the tone control to cut out the Johnny-One-Notes created by our *faithful servant* the Bell Telephone System.

The advent of Frequency Modulation, with its inherent excellent transient response, has permitted my personal observation of sound reproduction free from these effects. The simplicity of direct FM relay offers great promise for reducing this and other forms of audio distortion, without the great expense involved in the installation and maintenance of equally satisfactory long lines and repeaters.

Cross-Modulation Distortion ★ Cross-modulation distortion is defined herein as the generation of sum and difference frequencies when two or more tones are applied simultaneously to a system. Since these sum and difference frequencies do not necessarily bear any harmonic relation to the original tones, the resultant reproduction has a rather confused or muddled background accompanying it.

A test for the presence of such distortion is to note whether a solo instrument in the medium register must have only a soft or subdued accompaniment in order to sound clear. If rather heavy orchestral accompaniment tends to mask the solo instrument, this is probably due to cross-modulation in the system.

Another striking example is presented when the church choir is accompanied by heavy organ bass. Few systems are capable of justice to this combination because of cross-modulation defects.

Such distortions arise chiefly in iron cored transformers and reactors in the system. It has been a common experience for many people to say that FM does not give as much bass response as AM. I have personally observed this effect, since in the New York area several networks originating suitable program material frequently transmit simultaneously via both AM and FM. Invariably the AM seems to have more bass.

Since our Company manufactures a standard signal generator having AM type modulation, I decided to test its modulation system for cross-modulation effects. Fig. 4 indicates the connections and the resulting spectrum for 30% 50-cycle modulation. Only two sum and difference frequencies of 950 and 1,050 cycles are produced about 1,000 cycles, and their magnitude is less than 10 millivolts or 1%. Fig. 5 gives the spectrum for 40% 50-cycle modulation. It can be seen that a whole family of sidebands have been created about 1,000 cycles. Fig. 6 indicates about fifty different sum and difference frequencies for a 50% 50-cycle modulation.

The Model 65-B signal generator uses some negative feedback, and the frequency response is flat within 1 db or 10% to 50 cycles. It can be seen that only 10% of the second harmonic is present on Fig. 6. This amount of second harmonic is scarcely perceptible at such a low frequency because of the harmonic generation present in the human ear itself. The resultant spectrum about 1,000 cycles is definitely noticeable and tends to create the impression of much heavier bass because the human ear tends to react in a somewhat similar manner, and our senses cannot differentiate between synthetic and natural cross-modulation.

In properly designed FM systems, the cross-modulation is much less, since it is not necessary to use iron-core reactors. Hence the false impression of less bass. The absence of cross-modulation results in clean, distinct reproduction. One no longer shudders when the pipe organ hits a heavy bass note, for the choir seems to stand out as tho a screen or curtain had been drawn aside.

I issue a challenge to the AM broadcasters to measure and remedy the cross-modulation distortion in their transmitters.

I also invite the Bell Telephone Company to measure the cross-modulation on their transmission lines and repeaters between even Philadelphia and New York, not to mention Los Angeles and New York.

No wonder the American public doesn't like *high fidelity radios*. I hold in my hand the output transformer removed from a popular make of home receiver. This particular receiver sold for several hundred dollars, and its manufacturer has spent large sums on acoustical improvement but completely neglected the vital output transformer. Fig. 7 shows the cross-modu-

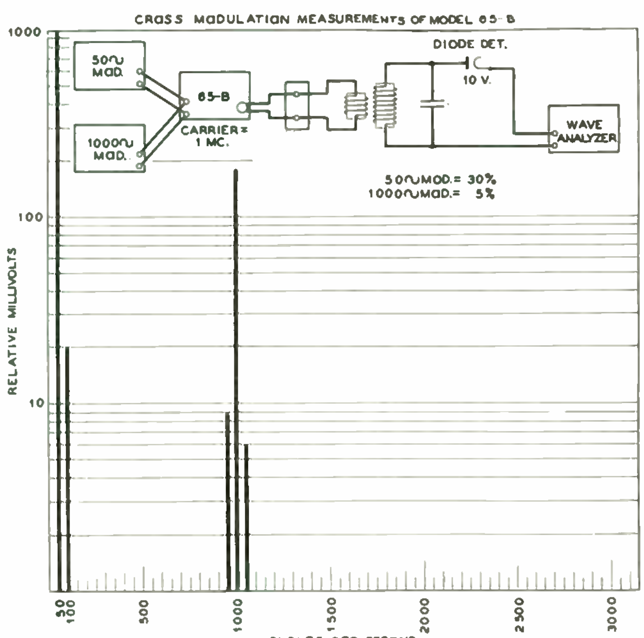


FIG. 4. 30% 50-CYCLE MODULATION AND 5%, 1000 CYCLES

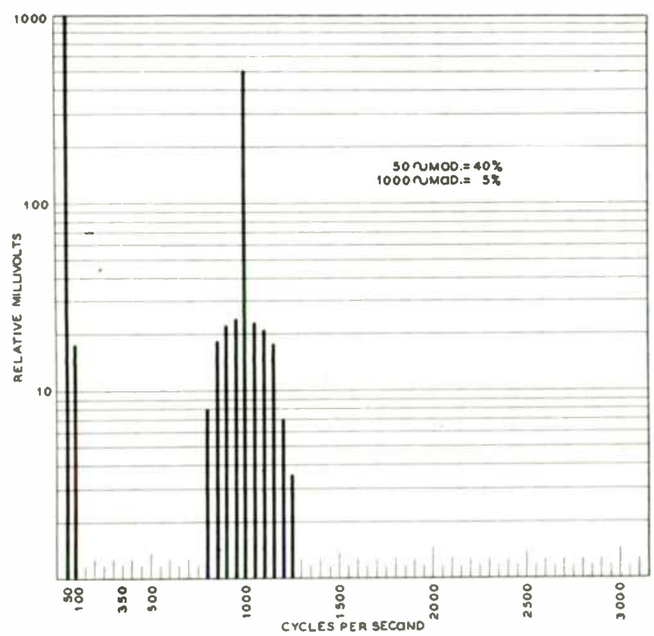


FIG. 5. 50-CYCLE MODULATION INCREASED TO 40%

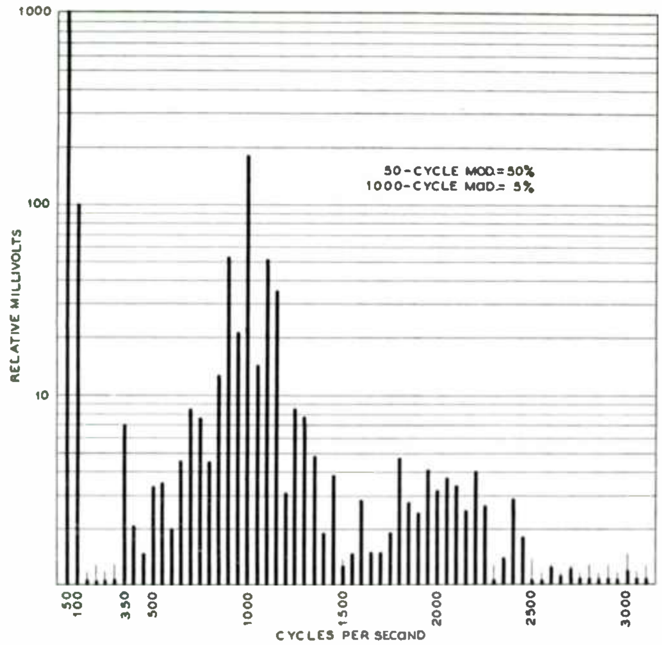


FIG. 6. 50-CYCLE MODULATION INCREASED TO 50%

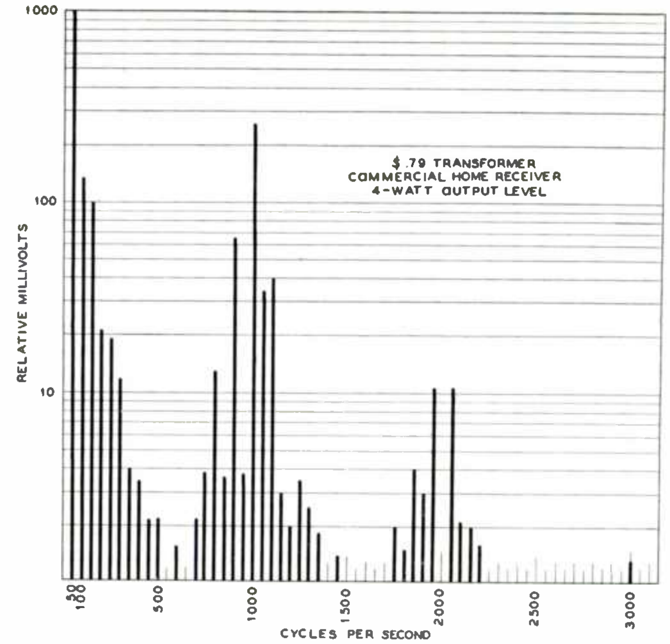


FIG. 7. CROSS-MODULATION IN COMMERCIAL RADIO SET

lation spectrum of this particular receiver with a *resistance* load in place of the speaker. The manufacturer used pentodes without feedback, and I didn't bother taking any overall acoustical data. You will note that the 79¢ output transformer yields a generous spectrum. This data was taken at a 4-watt level, since the pushpull 6V6 amplifier was not capable of supplying more power without serious harmonic distortion.

Fig. 8 was taken after a larger output transformer was substituted. This output transformer could probably be made for $1.79, altho this particular transformer was designed for 25-cycle operation as a power transformer. The center-tapped, high-voltage winding was used for the plate-to-plate winding with the center tap for B+, while the 6-volt filament winding was used for the speaker voice-coil winding. About 8 db of negative feedback was applied after the coupling capacitors in the audio had been increased from .005 to .1 mfd. This feedback helped damp the speaker by lowering the effective output impedance of the amplifier. More feedback would have been desirable if enough gain were available; however, this would have necessitated adding an extra audio amplifier. The 8 db of feedback has practically nothing to do with the improvement in cross-modulation distortion. Just using more iron with less flux density in the output transformer has done the trick. Incidentally the receiver sounds improved beyond expectations.

It may be noted here that John K. Hilliard reported in his article in the December, 1941 *Proceedings of the IRE* that 2% cross-modulation distortion was not objectionable. It can be seen that the spectrum of Fig. 8 just meets this requirement. So much for the $1.00 improvement. Let us hope that postwar receiver manufacturers will at least do this one thing in their more expensive models. Note that the improvement will be most noticeable in FM receivers when tuned to a program originating in the station's own studios and not transmitted via telephone lines.

Good Audio Practice ★ Necessary power output is all embracing, since this determines the amount of iron to be used in the output transformer, size of loudspeaker, acoustical enclosure, etc. Undoubtedly a 5-watt *average* electrical level into a good reproducer is ample for most homes with a reasonably low background or ambient noise level. This does not mean that the amplifier output is limited to 5 watts, but rather that the audio amplifier should

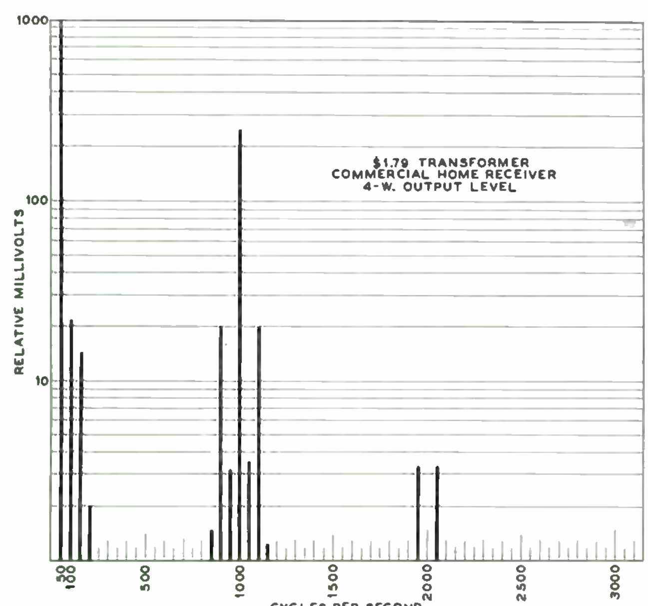


FIG. 8. RESULTS WITH AN ADEQUATE OUTPUT TRANSFORMER

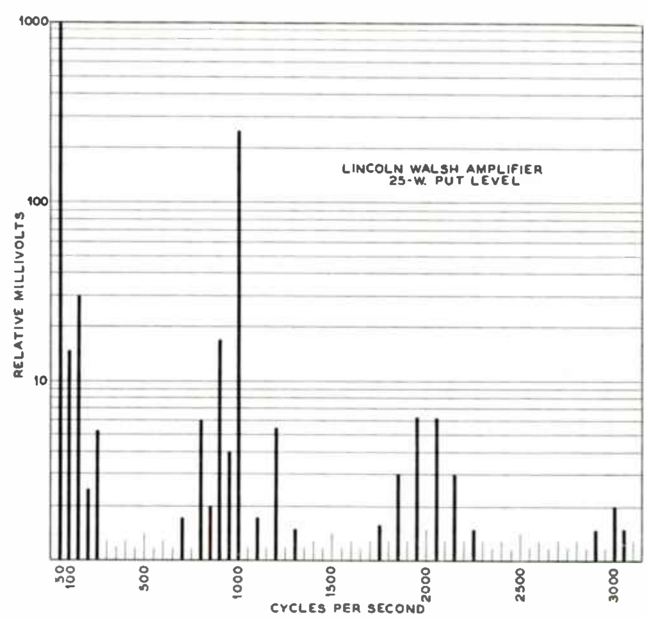


FIG. 9. L-W AMPLIFIER AT 25-WATT OUTPUT LEVEL

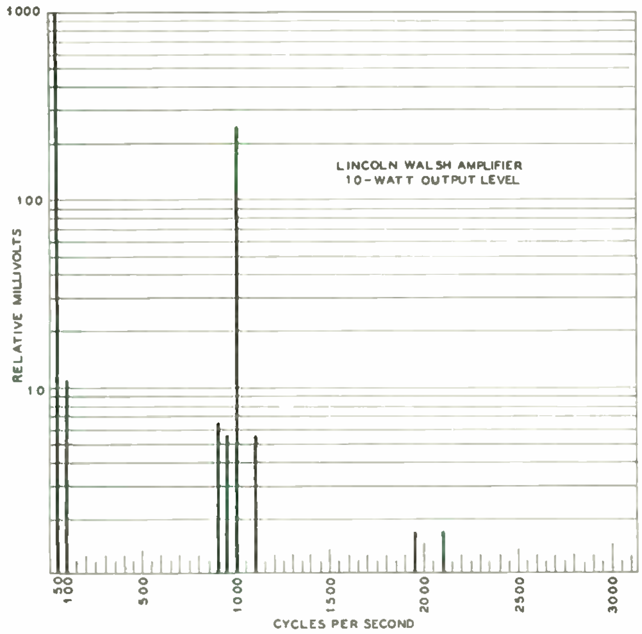


FIG. 10. L-W AMPLIFIER AT 10-WATT OUTPUT LEVEL

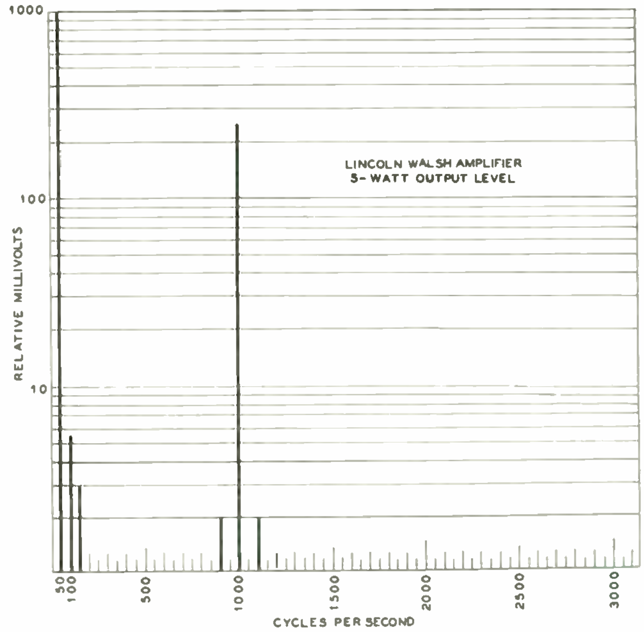


FIG. 11. L-W AMPLIFIER AT 5-WATT OUTPUT LEVEL

be capable of supplying in the neighborhood of 20 watts to take care of the peak power requirements which occur frequently in music. The peaks are of short duration and can be efficiently accommodated by an arrangement developed by Lincoln Walsh. Fig. 9 indicates the cross-modulation spectrum into a resistance load from a Walsh amplifier at the 25-watt level. At this level the two type 2A3 tubes are drawing rather heavy current and practically operating class B, but the output transformer is not generating cross-modulation components as high as 2%. Incidentally the output transformer in the Walsh amplifier resembles in size a 100-watt 60 cycle power transformer.

The Walsh amplifier contains a cathode follower driver and automatically adjusts the bias of the 2A3 tubes which allows them to operate as fixed bias class A output tubes up to about 10 watts. Fig. 10 shows the distortion spectrum at the 10-watt level. Fig. 11 shows the results with the Walsh amplifier at 5 watts. It can be seen that the cross modulation products are less than 2 millivolts or 0.2%.

Of course, it is necessary to convert the electrical output into acoustical sound pressure, and Fig. 12 indicates the overall sound pressure spectrum with 5 watts fed into an HY-12-12 speaker with a QP-5 tweeter. The microphone was placed about 18 ins. directly in front of the speaker which was operated in my home as normally used. It is interesting to note that cross-modulation is present in the speaker, but the components do drop off rather rapidly with increasing frequency. Above 550 cycles, they are less than 2%.

Since natural resonance of the HY-12-12 cone occurs around 45 to 50 cycles, another set of data was taken with 80 cycles substituted for the 50-cycle tone. This acoustical output spectrum is plotted in Fig. 13. It can be seen that the maximum overall distortion amplitude is less than 3%.

It is the consensus of most who have visited my home and listened to good, direct studio FM programs that faithful wide-range audio is truly different. Many have remarked that this doesn't sound like a radio set. Some say that it sounds like the orchestra that they may have heard in Radio City Music Hall or Carnegie Hall, and then I begin to realize that the average citizen has never really heard natural reproduction by radio. Since I have had approximately ten years experience as a musician, *natural* repro-

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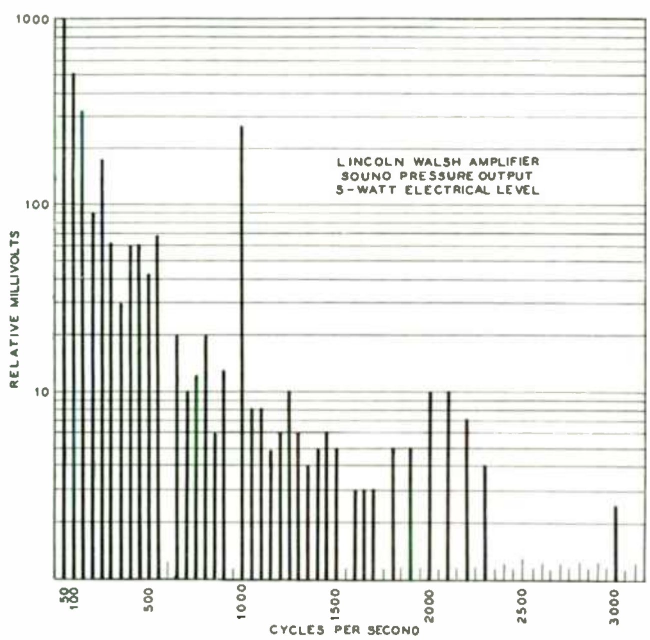


FIG. 12. ACOUSTICAL SOUND PRESSURE AT 5-WATT LEVEL

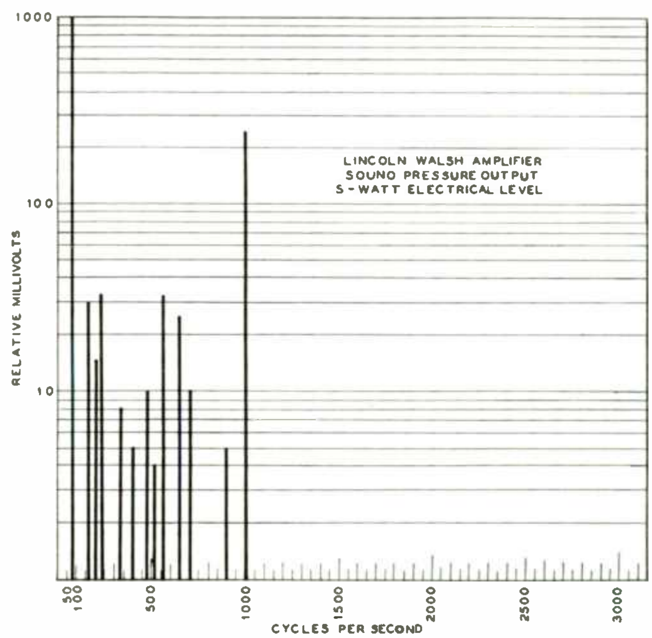


FIG. 13. 80 CYCLES SUBSTITUTED FOR 50 CYCLES USED IN FIG. 12

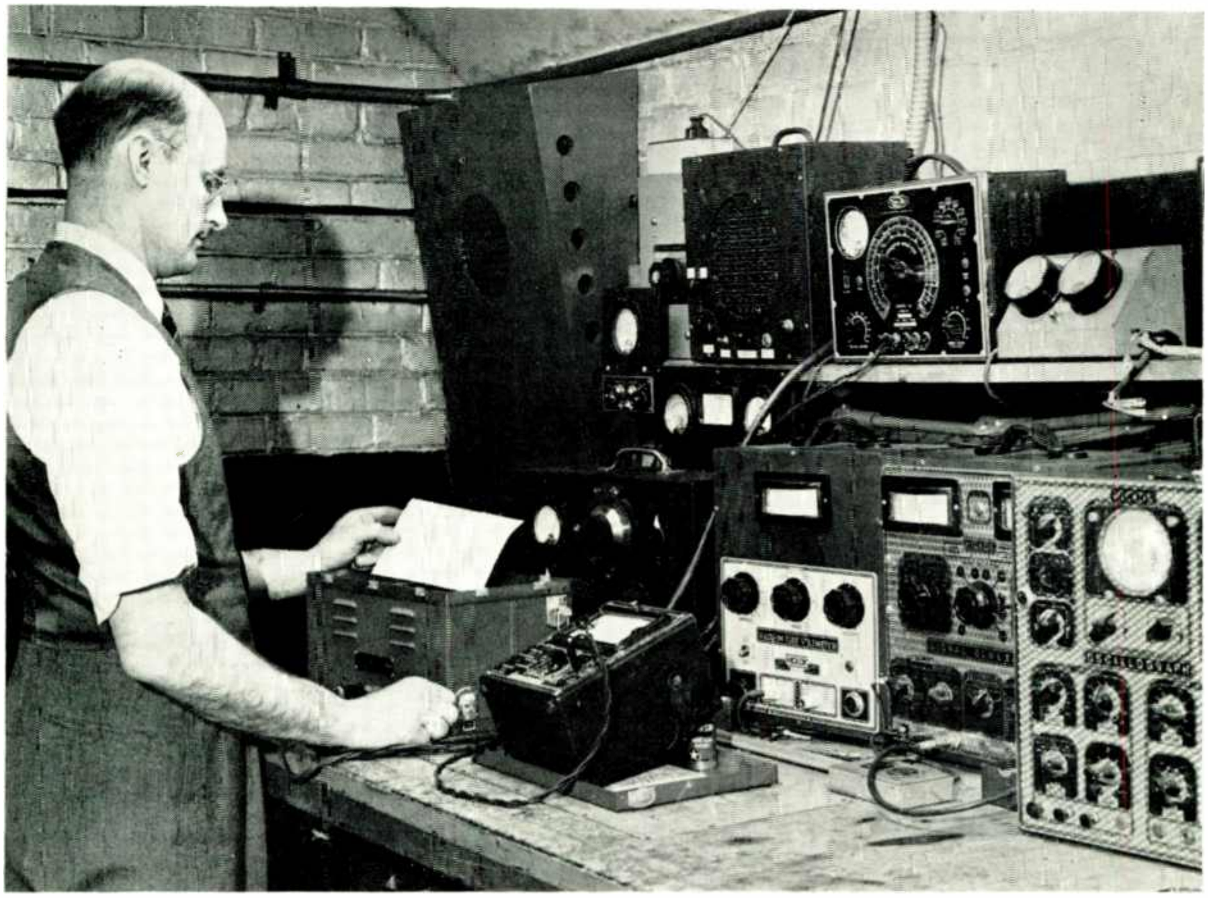


FIG. 1. THE AUTHOR AT THE TEST BENCH IN THE STATE POLICE RADIO LABORATORY AT HARTFORD, CONN.

MAINTENANCE PRACTICES FOR POLICE RADIO

How Maintenance Is Organized and Handled by the Connecticut State Police

BY FRANK A. BRAMLEY*

THE Connecticut 2-way FM State Police installation was begun in 1939 and was completed in 1940. Since that time, the system has grown considerably, and now consists of eleven 250-watt main stations, and three hundred and thirty-two 25-watt, 3-way mobile units.

All of the 250-watt stations are situated on mountain tops and near the center of the serviced area. All are unattended and remotely controlled over telephone lines. The receiving and the transmitting equipments are housed in sheet steel buildings located on the mountain tops, with the control points miles away in police barracks.

A large system such as this is necessarily a 2-frequency system. All of the fixed stations transmit on 39.5 mc., but have receivers on 2 frequencies, 39.5 and 39.18 mc. All the cars receive on 39.5 mc. and normally transmit on 39.18 mc. but are also able to transmit on 39.5 mc., the so-called 3-way frequency for car-to-car communication. This system makes it possible for several main stations to communicate with their cars at the same time, because signals received from the car are on a different frequency, and because, in an FM system, the stronger signal dominates at any one receiving point. The provision for use of a second transmitting frequency for the mobile units is necessary because all receivers in mobile units are tuned to the fixed station frequency of 39.5 mc. If car-to-car communication is desired, the car must change its frequency of transmission from the normal 39.18 to 39.5 mc., which all mobile units can receive also. Such a provision is absolutely essential in any large communication system and is highly desirable for all systems.

There has been some comment to the effect that Connecticut is using more main stations than is necessary to cover so small an area. In one sense this is true, but conditions require the Connecticut State Police to put noise-free signals from at least one station into every square foot of the State, and also to provide secondary service from at least one other station. Then, in case the local station is off the air, satisfactory service can be obtained from at least one other station.

An adequate number of receiving points makes possible low-power mobile equipment with consequent freedom from battery trouble, lower maintenance costs, and greater reliability.

Maintenance Organization ★ Our maintenance organization consists of one Supervisor of Radio Maintenance, three radio technicians and one radio mechanic. In addition, a tower maintenance man is employed under contract to handle all tower and obstacle-light maintenance work.

The State is divided into three maintenance areas and a fairly complete radio shop and spare parts depot is maintained in each area. The whole maintenance organization is on duty during the usual

* Supervisor of Radio Maintenance, Connecticut State Police, Hartford, Conn.

business hours and is on call at all other times.

Selection of Personnel ★ The selection of the personnel for an organization to maintain a communication system is not an easy proposition. There are many methods of doing it; all have their faults. Certainly, if the system is large, the group should be headed by a man of engineering caliber and one who has had extensive maintenance experience. The technicians under his supervision must also be experienced training takes several years at least, and is only successful with men of special aptitude.

In a large system it will be found advisable to employ what may be called a radio mechanic to handle mechanical jobs involved in the installation, transfer, and reinstallation of the equipment. A rather versatile automobile mechanic with a good understanding of electrical principles could qualify for this job. He need not have any technical understanding of radio. Tower maintenance men are usually

- 1 microvolter
- 1 oscilloscope
- 1 audio oscillator
- 1 frequency meter
- 1 communications receiver
- 1 field strength meter
- 1 deviation meter

Next to the volt-ohm-milliammeter, the microvolter is probably the most useful piece of equipment. It is highly desirable that each radio technician have one at his disposal. The speed and accuracy

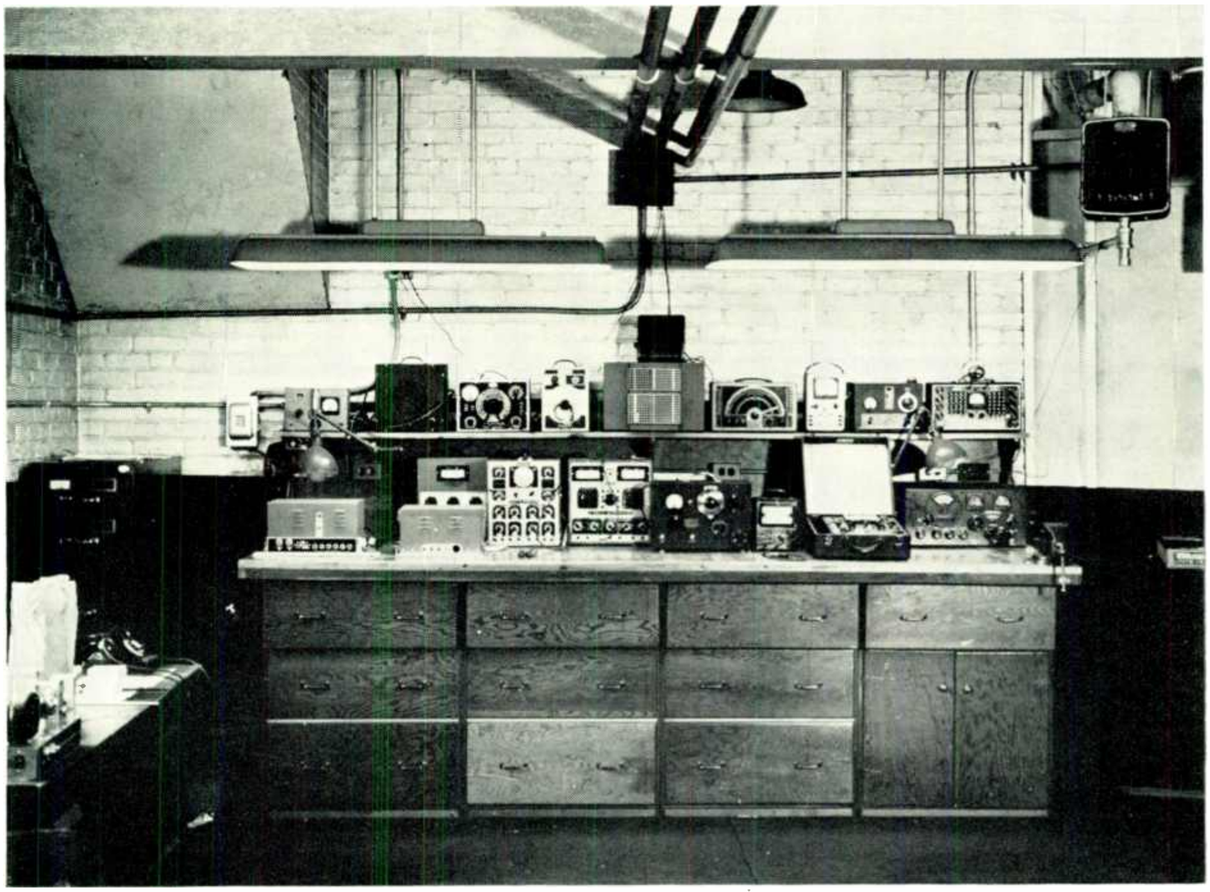


FIG. 2. SERVICE EQUIPMENT AND MEASURING INSTRUMENTS USED AT THE HEADQUARTERS LABORATORY

men able to obtain first grade operators' licenses, although this grade of license is not actually required.

Of even more importance than the training of the technicians is their mental attitude toward the equipment they will be required to maintain. It is of relatively little importance what make or type of equipment is used if the technicians thoroughly believe in its capabilities. A technician who expresses the opinion that the equipment he is to care for is "junk", had best be employed elsewhere.

In general, it will be found desirable to select men from outside the organization who have had extensive radio experience in the maintenance and repair field. Men of the self-trained type, such as develop through amateur radio, are especially desirable. Our experience indicates that it is not desirable to attempt to train men who are already members of the organization. Adequate radio maintenance steeplejacks, employed under separate contract to handle this work.

Maintenance Equipment ★ Each of our technicians is furnished with a car, a complete set of tools, spare parts, and tubes. His test equipment consists of:

- 1 volt-ohm-milliammeter
- 1 portable signal generator and frequency monitor
- 1 tube tester and analyzer
- 1 capacity bridge
- 1 portable decibel meter
- 1 vibrator tester
- 1 vacuum tube voltmeter

Each man has spare mobile and fixed station receivers, and spare mobile transmitters. At the Headquarters Radio Laboratory, views of which are given in Figs. 1 and 2, a somewhat larger stock of tubes, parts, and equipment is available. Here the following test equipment has been found necessary:

with which receivers can be checked for all-round performance with such an instrument makes it well worth the cost.

Our deviation meter, the only type available, does a good job when used within a few hundred feet of a main station, but its sensitivity is so low that it is totally inadequate for use with remote equipment. There is a great need for a deviation meter to monitor remote equipment on a state-wide basis, but such a device does not appear to be available at the present time.

Maintenance Routine ★ It was our original intention to check all equipment at regular intervals. This plan was used for a while but it became apparent that checks on units actually in good working order often produced trouble rather than prevented it. For instance, tube testing often indicated that certain tubes should be replaced. When this was done, often the

CONNECTICUT STATE POLICE
MOBILE RADIO EQUIPMENT

Equipment .... Serial No. ....

Date	Tune Up	Tubes Test—Replaced	Parts Replaced	Condition of Spkr. Vibr., Pigtail, Cables, etc.	Tech.

FIG. 3. THIS IS THE SERVICE RECORD CARD KEPT IN EACH TRANSMITTER AND RECEIVER

new tube would fail a few days later. Realignment may increase the sensitivity of a receiver and, a few days after the adjustments are made, cause the squelch to open too readily. For these reasons and others, regular checks on mobile equipment have been partially abandoned. Regular monthly checks on the condition of aerial rods, handset cords, and vibrators in the mobile units have been found advisable. Weekly routine checks on all main station equipment have continued.

Record Cards ★ Every receiver and transmitter has inserted in it a card, Fig. 3, on which are entered notes concerning each adjustment, repair, or replacement made on that piece of equipment. Record is also made of the complaint, in case no probable cause of trouble is found. In this way, whichever technician is called upon to service a piece of equipment, he has before him a complete record to guide him in further work. Also, he can judge quickly what steps should be taken to put the unit back into service. Availability of spare equipment makes his job relatively simple and about 5% of our equipment is set aside as spare. If it is obvious on quick inspection that the trouble cannot be corrected by a simple adjustment or the insertion of a tube or vibrator, the transmitter, receiver, or power pack can be replaced quickly by a spare.

Technicians are required to make out a separate job report, Fig. 4, for each repair or adjustment made on any piece of equipment. These job reports are sent to Headquarters where the Supervisor can check for proper maintenance procedure and also check against a master list of serial numbers to determine that every piece of equipment is serviced at reasonable intervals. Thus the recurrence of troubles can be observed and correctional procedure instituted.

Main Station Service ★ Remote main stations are checked as carefully and as frequently as weather and time allow. The remoteness and relative inaccessibility of some stations makes frequent checks in wintertime impractical. The reliability of present equipment has made it possible for some of these stations to operate for several months without any attention but, as previously mentioned, weekly checks are desirable.

Main station maintenance records, Fig. 5, are kept with the equipment. A complete sheet is made out in considerable detail for each inspection so that the recurrence of troubles can be observed and corrected before they lead to time off the air.

As is customary with fixed stations, careful attention is paid to voltage and current values. Readings are recorded at each visit. It has been found that particular attention must be paid to plate voltage readings on receivers. Rectifier tubes appear to be the most frequent of tube failures. Complete failure of equipment can be prevented in many instances by replacement of rectifier tubes which fail to deliver full voltage. More than 10% reduction of voltage from normal is not tolerated.

Careful attention to the complete neutralization of the final stage of the transmitter is important in obtaining good tube life.

Maintenance of gas pressure in the transmission line prevents the entrance of moisture and the consequent failure of the antenna system.

The remote control relay attached to the telephone line is critical in adjustment, and must be kept clean. A test power supply, having output voltage adjustable so that current through the relay can be increased in steps of about 1 mil, makes the adjustment of the relay a simple matter, and has been found almost essential in obtaining correct adjustment. Once adjusted and cleaned, such delicate relays will maintain their adjustment for long periods, but to do this they must be provided with dust covers.

The alignment of the remote fixed-station receivers requires skill and experience. While these receivers must be adjusted from time to time, we do not usually attempt to do an alignment job at the remote point. A spare receiver is usually substituted, and the one in use is brought to the shop where it can be checked thoroughly, and any necessary maintenance work done.

We do not attempt to align a fixed station receiver for several days after it has had a major overhaul. It is first temperature-cycled, that is, left operating

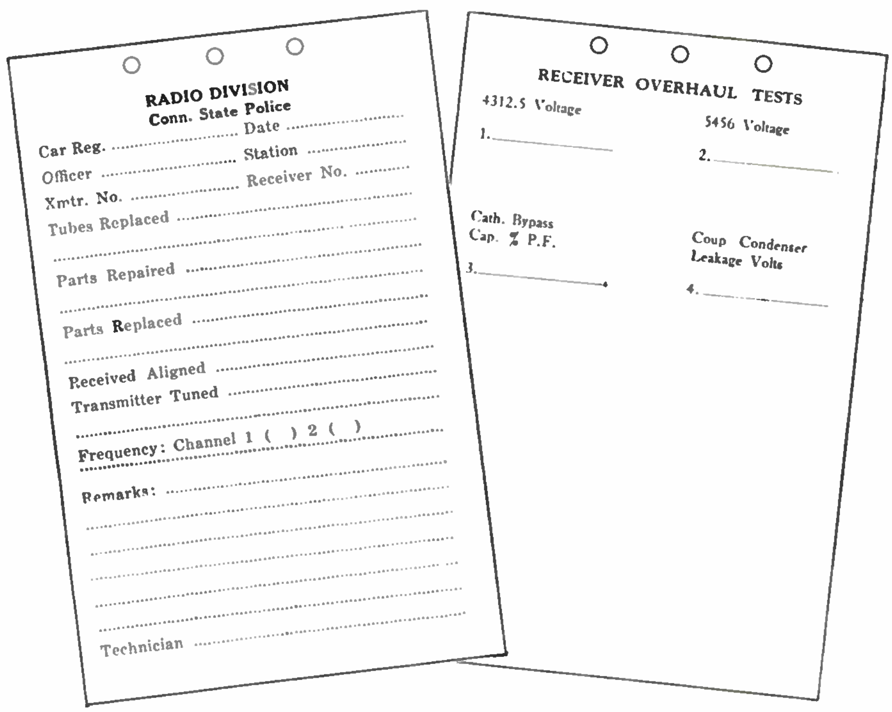


FIG. 4. SERVICE REPORTS ARE SENT TO HEADQUARTERS ON EACH REPAIR JOB

RADIO DIVISION (1)
CONNECTICUT STATE POLICE

MAIN STATION RADIO EQUIPMENT INSPECTION RECORD

STATION ______ DATE ______
INSPECTED BY ______ AND ______
REMOTE EQUIPMENT:
Driveway ______ Entrance Wiring ______
Photocell ______ Relay Condition ______
Tower Lights ______ Emergency Switch ______
External Paint ______ Door Lock ______
Vent Covers ______ Vent Screens ______
Door Seal ______ Inside Paint ______
Phone Line Carbons ______ Phone Line Fuses ______
Housekeeping ______ Record Keeping ______
Heater ______ Trouble Light ______ Fan ______ Broom ______
Fan Thermostat ______ Mats ______ Cabinet ______ SVC.Notes ______
250th Filament Voltage ______
RECEIVER FOR 39.5 KC. : PLATE VOLTAGE ______
Squelch Adjustment ______ Audio Level ______ Decibels
Sensitivity ______ Overhaul ______
RECEIVER FOR 39.18 KC. :
Squelch Adjustment ______ Audio Level ______ Decibels
Sensitivity ______ Overhaul ______
Squelch Relay Mount ______ Plate Voltage ______
TRANSMITTER:
Tuning ______ Frequency ______
Neutralization ______ Power Output ______
Concentric Line Gas Pressure ______ Lbs.
Line Voltage ______ 807 Plate Current ______ 250th Grid ______

RADIO DIVISION
CONNECTICUT STATE POLICE

MAIN STATION RADIO EQUIPMENT INSPECTION RECORD

STATION ______ DATE ______
INSPECTED BY ______ AND ______
BARRACKS EQUIPMENT
Control Unit External Appearance ______
Meter Settings ______ Dial Lights ______
Loudspeaker Quality ______ Volume Control ______
Cars-Thru-Speaker Switch ______ Carrier Reading ______
Transmitted Audio Level ______ Decibels Average
Received Audio Level ______ Decibels Average
Receiver Minimum Volume Control Setting ______
General Overhaul of Apparatus ______
HANGUP BOX: HANDSET CORD ______
Micorphone Quality ______ Output ______
Pushbutton Contacts ______ Switch Contacts ______
POWER SUPPLY:
Squelch Voltage ______ TRANSMIT VOLTAGE ______ Overhaul ______
SPECIAL BARRACKS RADIO EQUIPMENT: ______
GENERAL INSPECTION OF CARS:
CAR REG. ______ CONDITION ______
CAR REG. ______ CONDITION ______
CAR REG. ______ CONDITION ______
CAR REG. ______ CONDITION ______
CAR REG. ______ CONDITION ______
CAR REG. ______ CONDITION ______

RADIO DIVISION
CONNECTICUT STATE POLICE

MAIN STATION RADIO EQUIPMENT INSPECTION RECORD

REMOTE EQUIPMENT--
SPARE TUBES: 250TH ___(1); 866A's ___(2);
866 Jr's ___(2); 807's ___(2); 6L6 ___(1);
7C5 ___(1); 7C7's ___(2); 7A8's ___(2);
117N7GT ___(1); 923 ___(1); 80's ___(2);
6J5 ___(1); 6K6G ___(1); 6K8's ___(2);
6AC7's ___(2); 6SJ7 ___(1); 6H6's ___(2);
6C8G ___(1); 6V6(g) ___(1);
RELAYS: Line Relay ______ Plate ______
Overload ______ Time Delay ______
Antenna ______ Squelch ______
NOTES:

FIG. 5. THIS VERY COMPLETE MAINTENANCE RECORD IS KEPT AT EACH MAIN STATION

all day and turned off at night. After about three days of this, alignment is made. It is then left running continuously for 24 hours and a second alignment is made. This is final, and the receiver is then turned off and stored on the shelf. When it becomes necessary to use this spare, it is put in operation without being touched in any way. Operation will at first be poor, but will gradually come around to peak performance.

Equipment that has been running continuously for a long period, and then is turned off or goes out of service for any reason, is very likely to refuse to start or fail to operate properly when turned on again. Expansion and contraction of old equipment induce failure. Arbitrary replacement of paper and electrolytic condensers in old equipment is desirable for this reason.

Regular checks with a tube tester are made on fixed-station equipment, but replacements are made with caution because a certain percentage of all new tubes are likely to fail. We always stand by for a few hours to be certain the new tubes are going to be satisfactory.

Control Units ★ Headquarters control-unit troubles are confined to tube replacement, relay cleaning, and inspection of the microphone cord and control circuit. Again, the rectifier tube in the power supply is the item that should be checked most frequently. Next in importance are the microphone cord and the control circuit push button. These items must be checked frequently and replaced if they show any signs of wear.

If the control relays are not provided with dust covers, they should be added. We have traced many cases of trouble to this cause. After the installation of covers, relay trouble in the control units dropped to zero.

Automatic Gain Control ★ The use of automatic gain control circuits in control-unit speech amplifiers is highly important, even with an FM system. The widely varying levels of the dispatchers' voices, and the variable speaking distance from the microphone make a constant-output speech system highly desirable. For best operation, it should prevent overload and also bring up the volume of weak voices to a limited extent. Excessive build-up will increase background noise unduly. The slow, spaced, repetition of figures and letters so necessary in police announcements, places a stringent design factor upon any automatic gain system.

To prevent momentary overload, the automatic gain control circuit should be very fast-operating, but at the same time should not change the degree of amplification between spaced syllables. These two factors seem to be impossible to reconcile, and in the end a slower action must be chosen and momentary overloads tolerated.

Circuits having quick, original action and slow decay have been tried, but they introduce a warbling effect that is undesirable. Research along this line might be very helpful.

Mobile Equipment ★ The maintenance of the mobile equipment is the largest item. For the most part, no work is done unless the officer reports trouble, or monitoring indicates the need for service. This may seem to be a haphazard method, but experience indicates that modern FM equipment can be kept running quite reliably by this method, provided that servicing, when necessary, is quite thorough and complete. With two exceptions, it has not been found necessary to replace tubes or parts on an arbitrary basis. The exceptions have been the receiver coupling condenser and the vibrapack buffer condenser. These two condensers are always replaced whenever equipment comes in for service after two years of use.

Tubes or other parts are not replaced unless the performance indicates that it is necessary. Although we believe thoroughly in tube testers and tube testing, tube testers cannot be depended upon to indicate the performance of tubes at high frequencies. A much better indication of overall performance is given by the measurement of receiver sensitivity with a microvolter.

Transmitter output is indicated very satisfactorily by the ability to communicate between known points. Our technicians determine the efficiency of transmitting equipment in a car by attempting to communicate with a relatively distant station in the system. If the report from the dispatcher at the distant station is satisfactory for the distance concerned, we know the performance will be more than adequate for communication within the usual area.

Installation ★ There is no more important item in the maintenance of a large group of cars than proper initial installation. We have found that control cables must be installed in conduit, and that all exposed cables must be fastened securely at intervals of 1 ft. or less, so that no parts can be set into destructive vibration. The equipment must be mounted so that there will be adequate ventilation and it will be kept free from moisture.

It is customary to mount the radio apparatus in the rear compartment. This compartment is seldom really water tight. If it does not leak in an ordinary rainstorm, it will usually leak when the car is washed. Auto mechanics seem to be unable to prevent this from happening, so the only alternative is to install the equipment so that the water will not be able to damage it. One of the best solutions to this problem is to mount the equipment off the floor slightly.

Loud speakers must be mounted so that the beam from the cone is directed at the operator. The speaker should never be mounted on the bulkhead, or with the cone facing the floor. Such a method of mounting makes for muffled reproduction rather than crisp, understandable speech.

The Connecticut State Police pioneered the roof-top aerial. It is still the best where maximum range and minimum noise are required. No other equivalent method has been found, but rear side and cowl-mounted aerials are satisfactory where small areas are to be covered.

The Connecticut State Police use telephone type handsets, with signals reproduced both through the loudspeaker and the earpiece. If accurate, intelligible signals are required under the most adverse conditions, there is still no substitute for an earphone. Placing the handset to the operator's ear automatically insures close talking into the microphone, and correct modulation levels.

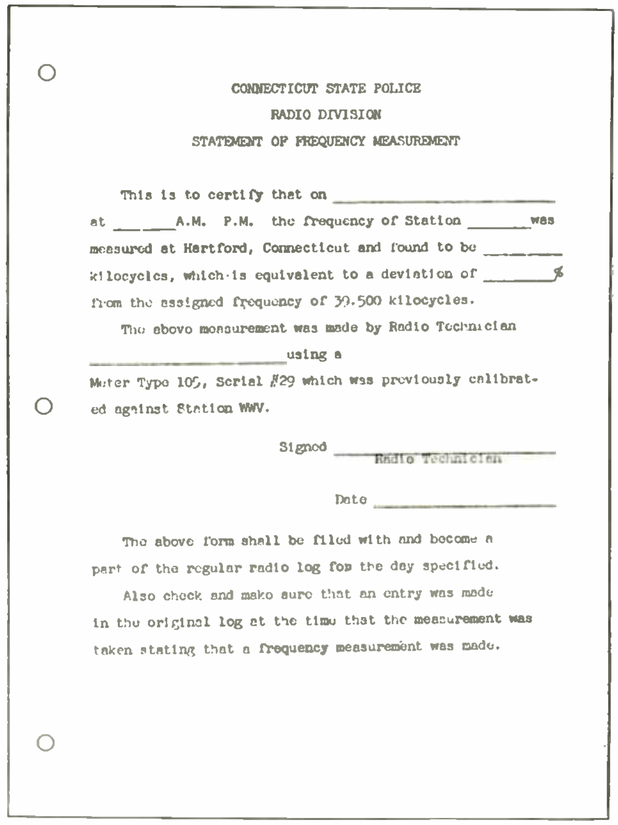
When over-size generators are installed, it is customary to leave the small wires in place that were intended for the original 10-to 15-ampere charging rate. Such wires are unlikely to be adequate for the 40- to 50-ampere charging rates of which a heavy-duty generator may be capable.

Some batteries have a tendency to deliver inadequate voltage after considerable use. They may be quite capable of starting the car and operating it satisfactorily in all respects except the radio apparatus. Radio tubes will not operate properly on low filament voltages, and their ability to do so decreases rapidly with age.

Batteries which develop less than 6.0 volts at their terminals, with the radio equipment as the only load, should be replaced. It will be found less costly to replace a battery occasionally than to replace the tubes frequently to obtain full radio performance.

As an aid to maintaining fully charged batteries, the radio division of the Connecticut State Police has installed at each barracks a type of battery charger that simplifies battery upkeep for the officer. Six-ampere chargers are mounted on the wall of the garage and are provided with several wall outlets. Heavy, flexible leads from the outlets can be connected directly to the battery without removing it from the patrol car. A series arrangement is used, so that it is necessary to have all unused outlets shorted together. This has proven simple enough so that the uninitiated officer can give a weak battery a boost while he is writing his reports, or is on duty at the station.

Vibrators ★ The maintenance of vibrator power packs in an important factor in keeping the system running at peak efficiency. We believe in replacing every vibrator that is at all questionable. If vibrator output voltages go 15% below normal, these units should be replaced. A new vibrator should always deliver full voltage. If the measured output of a new vibrator is less than normal, the pack must be examined for further trouble.



CONNECTICUT STATE POLICE

RADIO DIVISION

STATEMENT OF FREQUENCY MEASUREMENT

This is to certify that on ____________

at ______ A.M. P.M. the frequency of Station ______ was measured at Hartford, Connecticut and found to be ______ kilocycles, which is equivalent to a deviation of ______% from the assigned frequency of 39.500 kilocycles.

The above measurement was made by Radio Technician ____________ using a Meter Type 105, Serial #29 which was previously calibrated against Station WWV.

Signed ____________
Radio Technician

Date ____________

The above form shall be filed with and become a part of the regular radio log for the day specified.

Also check and make sure that an entry was made in the original log at the time that the measurement was taken stating that a frequency measurement was made.

FIG. 6. THIS REPORT FOR FREQUENCY CHECKS MEETS FCC RULES

Battery Maintenance ★ Radio equipment cannot operate satisfactorily unless adequate power is delivered to it. Modern equipment requires at least No. 6 wire from the battery to the equipment. The voltage delivered to the operating equipment should not be less than 5.8 volts. With 25-watt transmitting equipment, it has not been found necessary to use heavy-duty batteries, but with the usual extra police equipment, a heavy-duty generator is required. It is of no use to have a heavy-duty battery without a heavy generator because no more can be taken out of a battery than is put into it, no matter how big the battery may be. A heavy-duty battery merely gives longer reserve operating time with the motor off.

Care must be taken to see that regulating equipment does not cut out before the battery is fully charged, and that the leads from the generator to the battery are large enough to allow the generator to deliver its full rate to the battery. If none is found, the car battery or wiring must be suspected and appropriate action taken.

After 2 years of use we overhaul every power pack. All buffer condensers showing any oil leakage are arbitrarily replaced, and the filter condensers checked to see if capacity and power factor have changed.

Equipment Life ★ Vibrator life has been about one year. With the method of operation in the Connecticut State Police Department, this represents about 3,500 hours, because each car is in use about 10 hours per day.

Tube life has been long with a few exceptions. About 50% of the original tubes are still in use after 5 years. Power output and rectifier tubes are most frequently replaced, and are usually rejected because of low emission. Frequency converters in receivers, 6K8's, are commonly rejected because of high internal noise or

(CONTINUED ON PAGE 78)

FOLDED DIPOLE TURNSTILE FOR FM BROADCASTING

An Explanation of Folded Dipole Design and Characteristics

BY NATHAN W. ARAM*

THE design of high-frequency broadcast antennas is largely influenced by three factors which, taken collectively, are peculiar to this class of radio service.

First, it is usually desirable to obtain equal radiation in all directions in the horizontal plane because the transmitting stations are ordinarily located near the centers of their service areas where tall buildings are available for antenna supports. In order to obtain a non-directional pattern with horizontal half-wave radiating *elements*, which are directional themselves, a combination or array of these elements is required.

Second, it is advantageous to use an array of elements resulting in antenna *gain*. By this we mean that if an antenna with a given transmitter power and location has a gain of 2, the signal strength at a given receiving station is equivalent to that obtained from a transmitter delivering twice the power into an antenna with a gain of 1. This gain would be desirable in any antenna system, but it is practically obtainable only at high frequencies where the wavelength is sufficiently short that complicated arrays can be built in a reasonable space. Antenna gain is accomplished in effect by so designing the array that the radiation is concentrated into the horizontal plane, and only a small part escapes upward.

Third, because the signal strength of a high-frequency station at receiving points within the horizon is proportional to the elevation of the transmitting antenna, the antenna must be located as high as possible above ground. It is therefore placed atop the tallest building or tower available. Such locations impose severe requirements relative to wind and ice loads, lightning, corrosion by smoke fumes, and building restrictions as to height and appearance.

The Turnstile Antenna ★ Among the many arrays which have been designed and tested for high-frequency broadcasting, the "turnstile" antenna has been both successful and popular.[1] This consists basically of two half-wave horizontal antennas in the same plane, crossed at right angles, and with their centers coinciding as in Fig. 1. If these two antennas are excited by equal currents displaced 90° in phase, the figure-eight patterns of the two

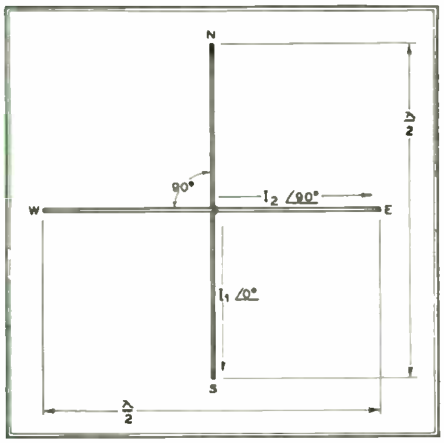


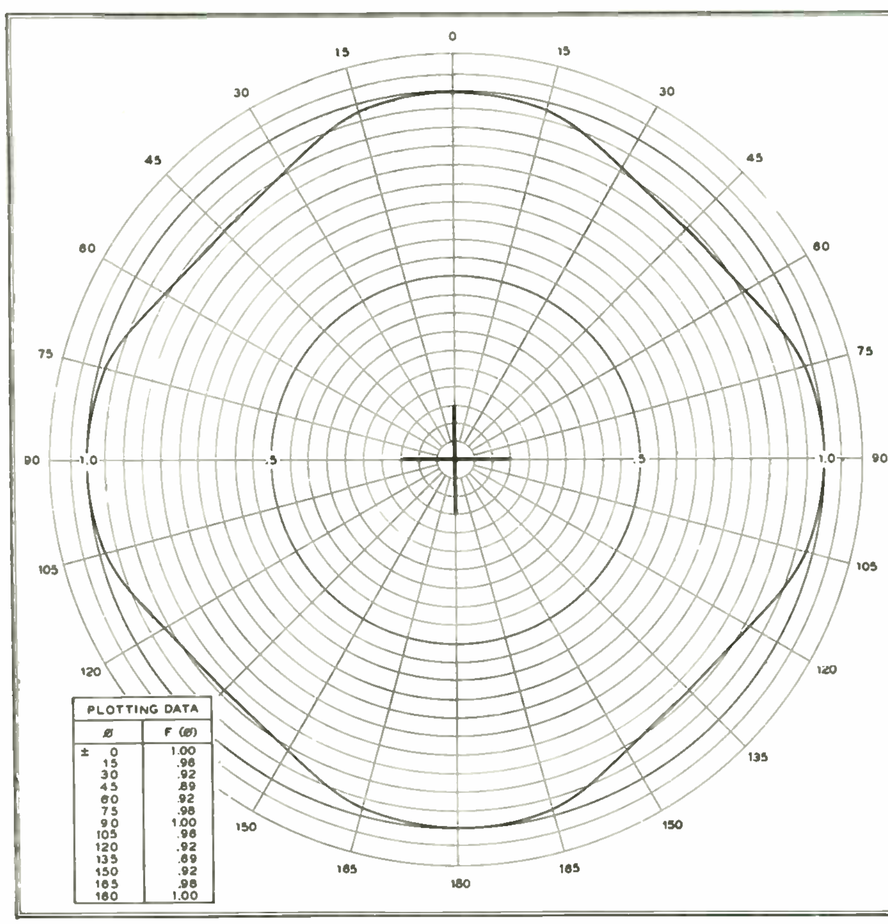
FIG. 1. ELEMENTS OF SINGLE BAY

individual elements combine to form the nearly-circular pattern in the horizontal plane, shown in Fig. 2. We term this much of the whole antenna array a *level* or *bay*.

Now, if a second bay is placed a half wavelength directly above or below the first and the corresponding elements in each vertical plane or *panel* are excited in phase, a portion of the vertical radiation from each level is cancelled by that from the other and, of the total net radiated energy, an increased part is directed outward horizontally. A 2-bay turnstile has a gain of approximately 1, meaning that it is equivalent to a single half-wave vertical antenna, which is the common reference for gain calculations. A 1-bay turnstile has a gain of only .5.

As the number of bays is increased by adding successive levels of radiators spaced vertically at half-wave intervals, the shape of the horizontal pattern is unchanged, but the vertical pattern is modified in such a way that substantial antenna gain results from an extension of the horizontal pattern.

Folded Dipole Turnstile ★ Fig. 3 is a photograph of an improved turnstile designed and first put in operation in 1941. In this design, an effort was made to realize the full theoretical advantages by overcoming



PLOTTING DATA	
Ø	F (Ø)
± 0	1.00
15	.98
30	.92
45	.89
60	.92
75	.98
90	1.00
105	.98
120	.92
135	.89
150	.92
165	.98
180	1.00

FIG. 2. PATTERN OF TWO DIPOLE ELEMENTS, PLOTTED IN THE HORIZONTAL PLANE

* Engineering Department, Zenith Radio Corporation, 6001 Dickens Ave., Chicago 31, Illinois.

[1] G. H. Brown, "The Turnstile Antenna," *Electronics*, April, 1936.

certain shortcomings of earlier practical turnstile arrays.[2] A number of new features were evolved, resulting in an antenna which has been giving satisfactory service for the past four years. Predicted and measured coverages are shown in Fig. 4.

One problem is to obtain the maximum possible percentage of a full half-wave spacing between the bays. This is accomplished by using a feeder system having straight vertical runs without spiral transpositions between the bays, and by using high-velocity coaxial lines in the feeder system. By these expedients, a spacing of 97% of a half-wavelength is obtained while exciting all elements of a vertical panel exactly in the same phase.

The number of radiators to be paralleled in a large array is so great that the terminal impedance becomes a small fraction of the radiation resistance of the

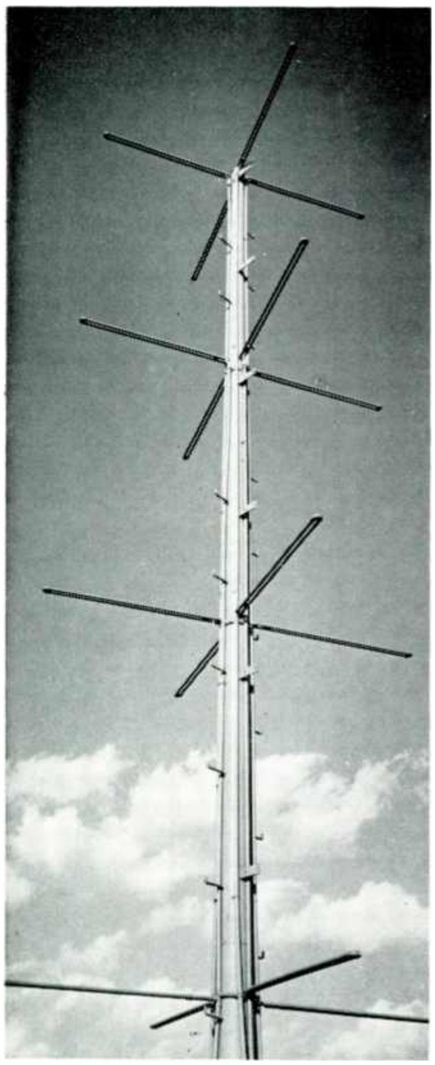


FIG. 3. FOLDED DIPOLES USED AT WWZR

individual elements. In order to avoid power losses and bandwidth limitations imposed by transformers of large ratio, it is advantageous to use high-impedance radiating elements. Half-wave folded dipoles are used for this and other reasons, and the average terminal impedance of each element is adjusted for 280 ohms, resistive. With the feeder connections for one panel as shown in Fig. 5, pairs of elements spaced one wavelength are paralleled, thereby matching the balanced

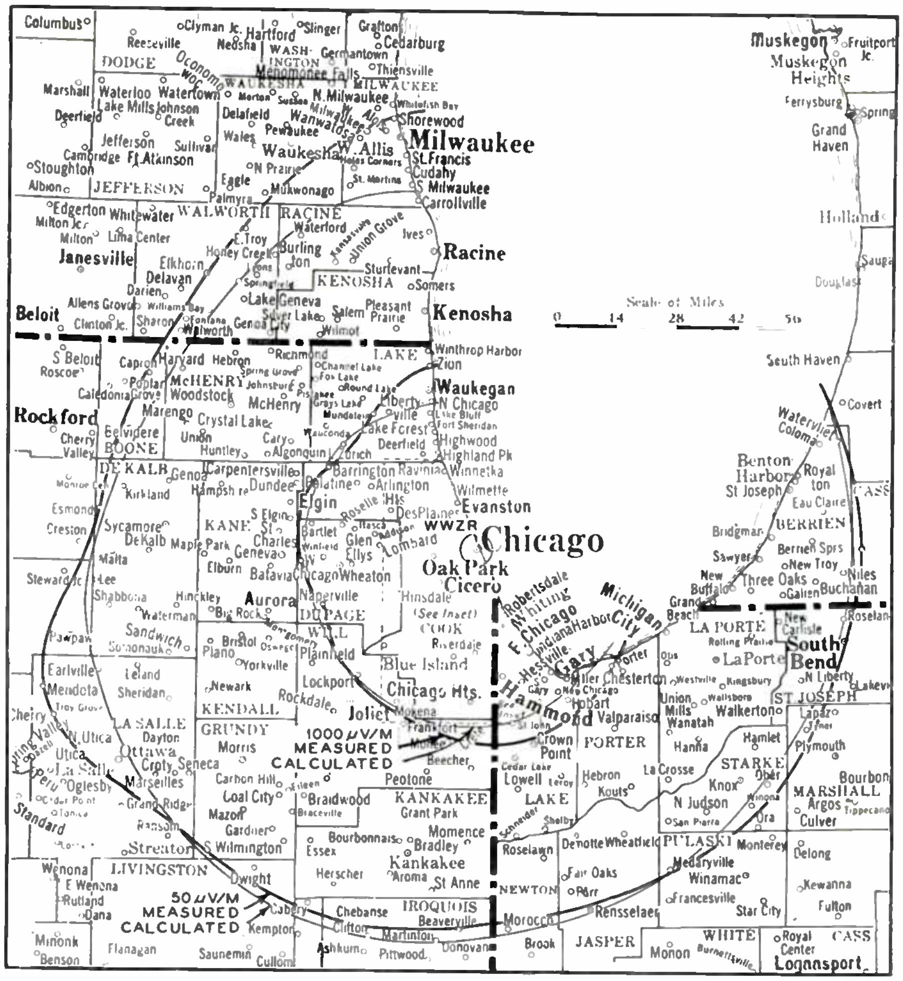


FIG. 4. MEASURED AND CALCULATED CONTOURS OF STATION WWZR, AT CHICAGO

140-ohm coaxial feeder while receiving equal, co-phased excitation.

As protection against lightning or severe static discharges, there is a further advantage in the use of folded dipoles since they are securely grounded to the supporting mast.

The use of folded dipoles in combination with the phasing system results in a bandwidth many times greater than that of a single FM channel. Consequently, the impedance reflected at the transmitter terminals is substantially constant and resistive over a wide range of frequencies, and transmitter distortion due to load impedance variations is thereby minimized. Further advantages of broadband design are that the entire antenna system is non-critical in adjustment, and that the transmitter frequency can be shifted several channels without retuning the antenna.

The phasing circuit used in the original 45-mc. antenna is shown in simplified form in Fig. 6. In the production design for 100-mc. use, the circuit has been changed as shown in Fig. 7. This permits a compact assembly mounting directly below the radiators as shown in the photograph of Fig. 8.

Proper division of power between the various radiators is assured by use of shielded concentric feeders, radiating elements with terminals close against the mast, and careful attention to impedance matching in the feeder system.

As a result of these features, the antenna can be prefabricated to the required final dimensions and assembled in the factory as completely as transportation facilities will permit.

Horizontal Pattern ★ A short discussion of the antenna theory may be of interest. A simple horizontal half-wave radiator in free space has a center impedance of approximately 73 ohms and a horizontal radiation pattern given by the equation

$$F(\phi) = \sqrt{2}\,\frac{\cos\left(\frac{\pi}{2}\cos\phi\right)}{\sin\phi} \qquad (1)$$

where F (ϕ) is the relative field intensity at constant distance, and the angle (ϕ) is measured from the line of the radiator. This is plotted in Fig. 9, pattern A.

When two crossed radiators, or panels of radiators, are fed with quadrature currents of amplitude I_1, and I_2, the resulting pattern is the vector sum expressible in

[2] M. W. Scheldorf, "Circular Antennas for FM Broadcasting," *FM and Television*, May, 1945.

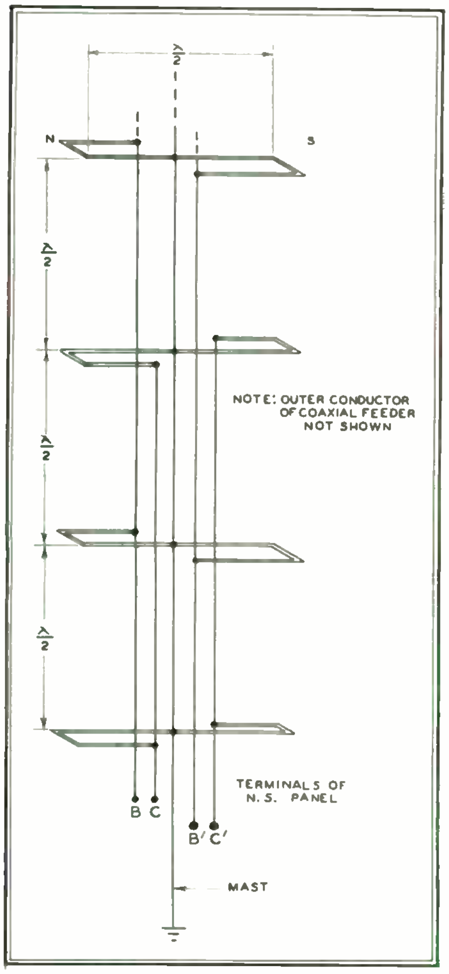


FIG. 5. FEEDER CONNECTIONS OF ONE PANEL

the following form:

$$F^1(\phi) = \left|F(\phi) + J\frac{I_2}{I_1}F\left(\phi + \frac{\pi}{2}\right)\right|(FGF). \quad (2)$$

where FGF is the Field Gain Factor defined in equation (6).

Thus, the pattern can be controlled by the division of current between the two panels. The limits are the figure-8 pattern of one panel and the non-directional pattern most frequently used. An interesting intermediate condition ($I_2/I_1 = 0.5$) results in an elliptical pattern which is useful for stations having elongated service areas.

Non-circular patterns are plotted in Fig. 9. Note that stronger fields are produced in the favored direction as the currents become unequal.

Vertical Pattern ★ Vertical radiation patterns may be computed from the equation

$$F(\theta) = \frac{\sin n\frac{\delta}{2}}{\sin \delta/2}\sqrt{G_p} \quad (3)$$

where

$F(\theta)$ = relative field intensity at constant distance.

θ = vertical angle measured from zenith

$\delta = (\beta d \cos\theta - \alpha) = \frac{\pi}{2}\cos\theta$

$\beta = 2\pi/\lambda$

d = spacing between bays = $\lambda/2$

α = phase progression of currents along one panel = 0.

n = number of bays.

G_p = power gain from Table I.

Patterns for 1- and 4-bay antennas are shown in Fig. 10.

Gain ★ The power gain is given by

$$G_p = \frac{R_{mm}}{\Sigma R_n} n^2 \quad (4)$$

where

G_p = power gain over isolated half-wave antenna.

R_{mm} = resistive component of self-impedance of one element (equal for all elements)

R_m = resistive component of terminal impedance of one element

ΣR_m = summation of R_m from m = 1 to m = 2_n

n = number of bays.

The quantities R_{mm} and R_m are evaluated from published curves of self and mutual impedances for spaced half-wave radiators,[3] and results are given in Table I.

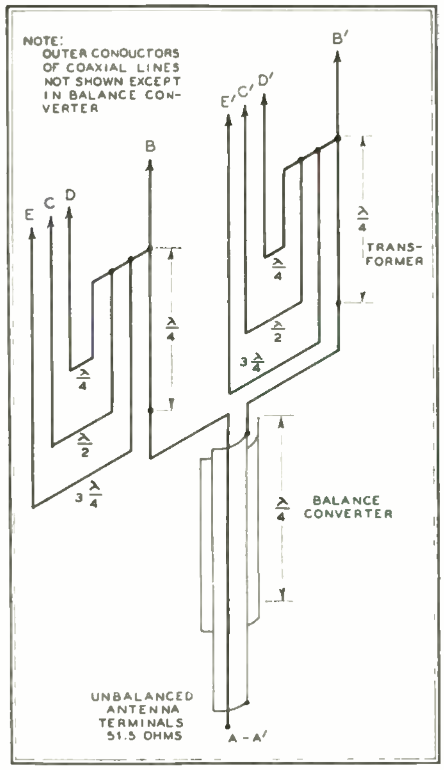


FIG. 7. DESIGN FOR 100-MC. ANTENNA

Effect of Horizontal Pattern upon Gain ★ Gain,

[3] F. E. Terman, *Radio Engineers' Handbook*, McGraw-Hill Book Company, Inc., New York 1943.

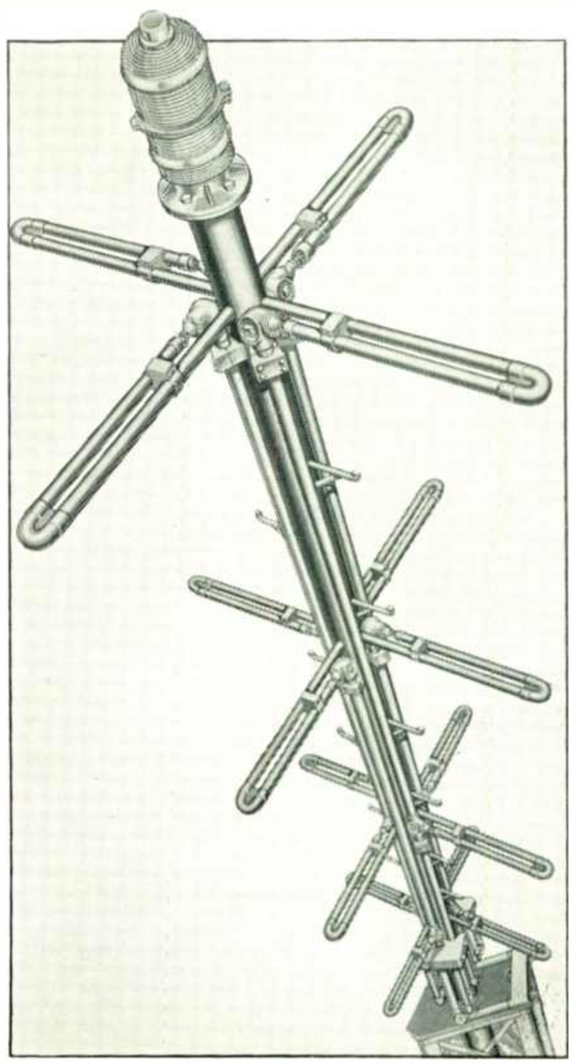


FIG. 8. DETAILS OF RADIATOR MOUNTING

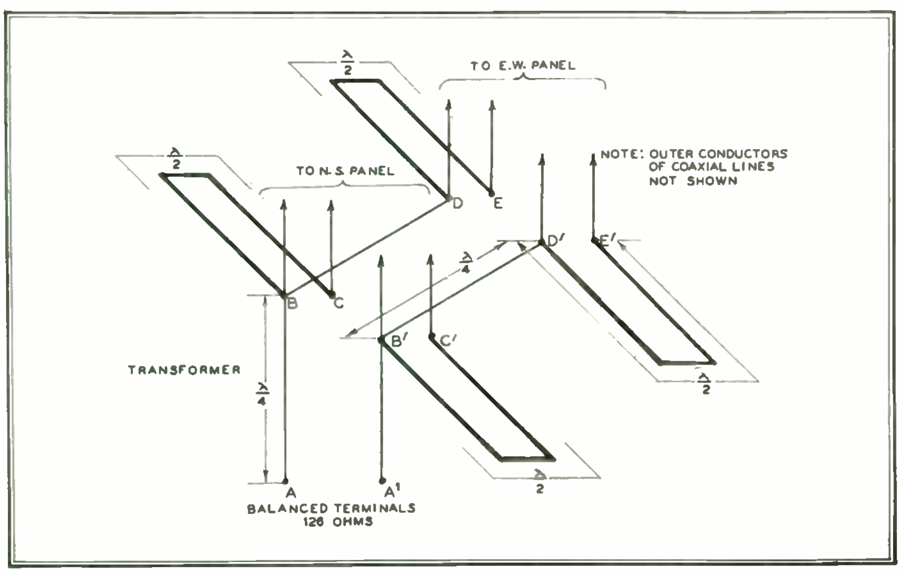
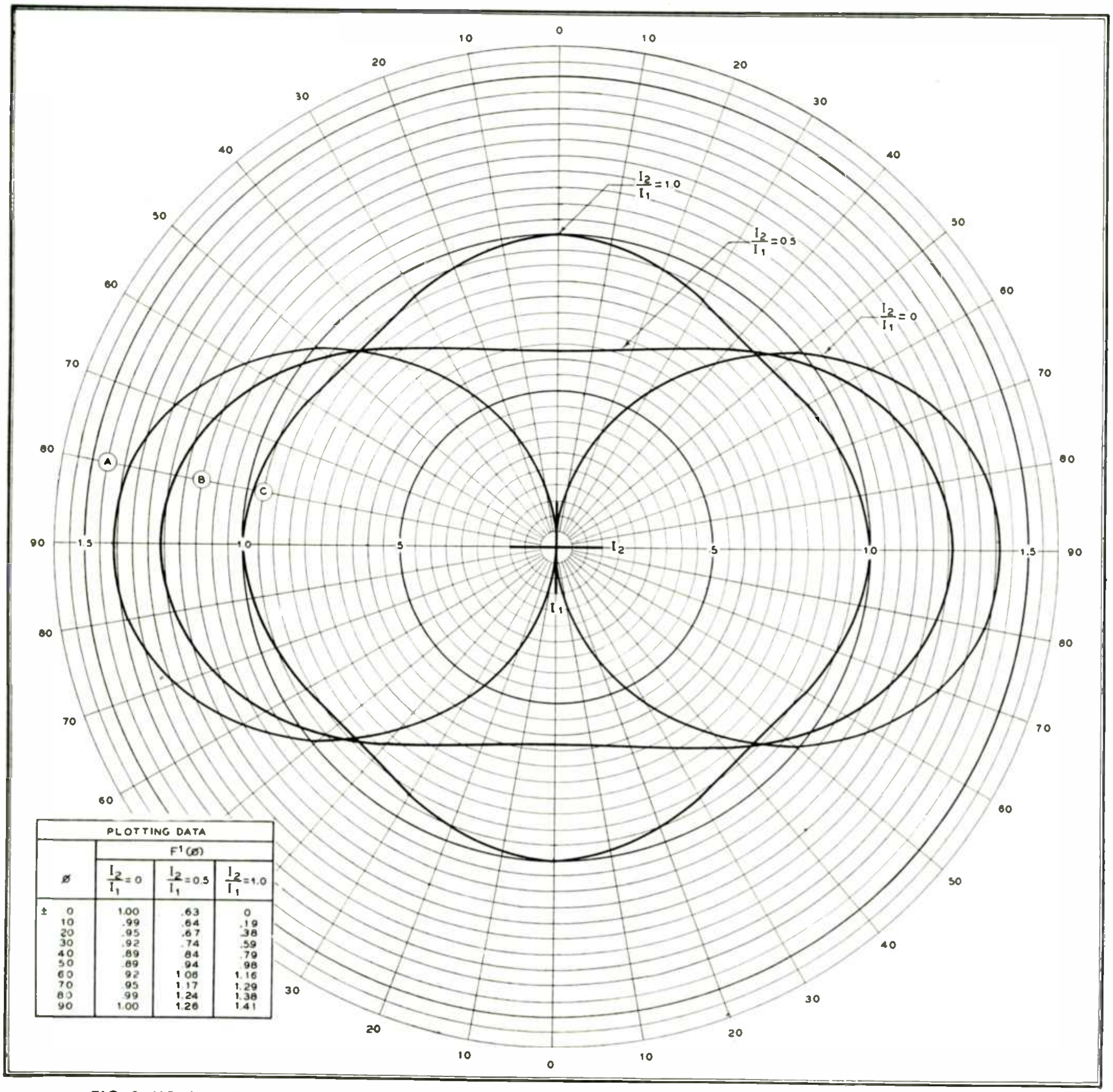


FIG. 6. SIMPLIFIED DIAGRAM OF PHASING CIRCUIT OF THE FIRST 45-MC. ANTENNA



PLOTTING DATA			
	$F^1(\phi)$		
ϕ	$\frac{I_2}{I_1}=0$	$\frac{I_2}{I_1}=0.5$	$\frac{I_2}{I_1}=1.0$
± 0	1.00	.63	0
10	.99	.64	.19
20	.95	.67	.38
30	.92	.74	.59
40	.89	84	.79
50	.89	94	.98
60	92	1 06	1.16
70	.95	1.17	1.29
80	.99	1.24	1.38
90	1.00	1.26	1.41

FIG. 9. HORIZONTAL RADIATION PATTERN OBTAINED BY PLOTTING THE DATA LISTED IN THE TABLE ABOVE

by definition, is computed in the direction of maximum radiation. Since the non-directional turnstile pattern is not exactly circular, as shown in Figs. 2 and 9, the average of the pattern over 360° yields an *average power gain* approximately 10% lower than values shown in Table I.

When the pattern is shaped by using unequal current ratios, the gain in the favored direction is increased over values shown in Table I by a factor

$$\text{Power Gain Factor} = \text{PGF} = \frac{2\left(\frac{I_1}{I_2}\right)^2}{\left(\frac{I_1}{I_2}\right)^2 + 1} \qquad (5)$$

The horizontal radiation pattern plotted from equation (2) is modified by a *field gain factor* FGF to show the effect of power gain

$$\text{FGF} = \sqrt{\text{PGF}} \qquad (6)$$

This has been done in Fig. 9.

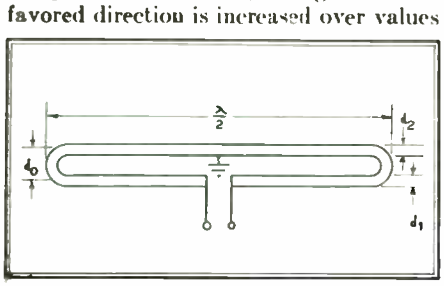


FIG. 11. ELEMENTS OF THE FOLDED DIPOLE

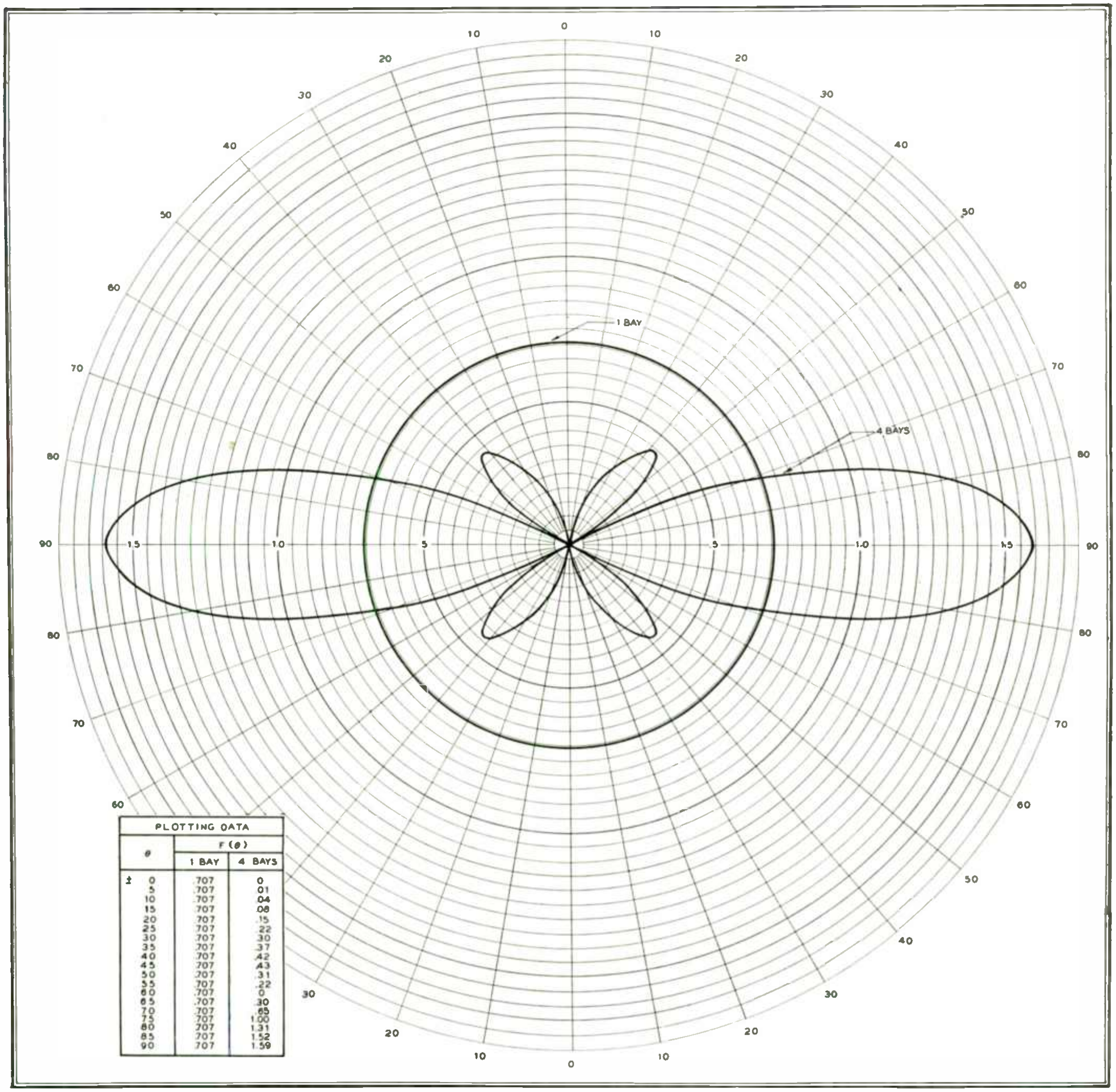
Folded Dipole Radiator ★ The folded dipole [4] shown in Fig. 11 consists of a combination of series-resonant and parallel-resonant circuits which, over a restricted frequency band, may be represented by the equivalent circuit of Fig. 12. Here, the series resonant circuit R_2, L_2, C_2, represents the impedance of a simple half-wave antenna transformed by a ratio depending upon the conductor diameter ratio d_1/d_2. The parallel-resonant circuit R_1, L_1, C_1 represents the two quarter-wave, short-cir-

[4] P. S. Carter, "Simple Television Antennas," *RCA Review*, October 1939.

TABLE I

THEORETICAL POWER GAIN
TURNSTILE ANTENNA

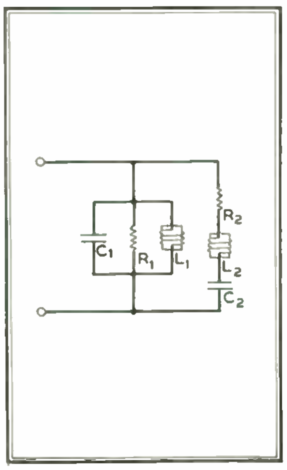
No. of Bays	*Power Gain*
1	0.5
2	1.2
4	2.5
8	5.2
16	10.6
32	21.3



PLOTTING DATA		
θ	F (θ)	
	1 BAY	4 BAYS
± 0	.707	0
5	.707	.01
10	.707	.04
15	.707	.08
20	.707	.15
25	.707	.22
30	.707	.30
35	.707	.37
40	.707	.42
45	.707	.43
50	.707	.31
55	.707	.22
60	.707	0
65	.707	.30
70	.707	.65
75	.707	1.00
80	.707	1.31
85	.707	1.52
90	.707	1.59

FIG. 10. VERTICAL RADIATION PATTERNS PLOTTED FOR 1- AND 4-BAY ANTENNAS, USING THE DATA ABOVE

cuited transmission lines formed by the looped conductors. Since series- and parallel-resonant circuits have reactances of opposite sign, the two impedance characteristics are mutually compensating, and the bandwidth is improved as shown in Fig. 13.



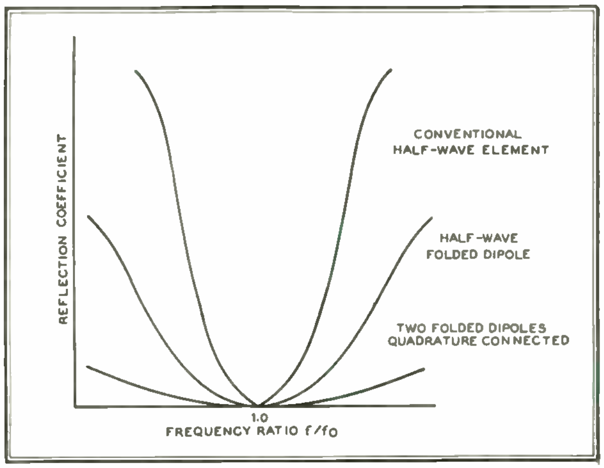


FIG. 12. EQUIVALENT DIPOLE CIRCUIT. FIG. 13. COMPARISON OF CHARACTERISTICS

While the resonant impedance of a folded dipole is a function of the conductor diameter ratio, its terminal impedance in a turnstile array is also affected by the presence of the other radiators in its panel and by the supporting mast.

If the spacing between the two conductors is small, the series-resonant current components in the two conductors produce the same field as would a single current equal to their sum; and the parallel-resonant current components are balanced and produce no radiation. Hence, the radiation field of a folded dipole is the same as that of a simple half-wave radiator with the same power, but the terminal

(CONCLUDED ON PAGE 73)

SPOT NEWS NOTES

Items and comments, personal and otherwise, about manufacturing, broadcasting, communications, and television activities

FCC Explains FM Decision: Seven-page explanation of adverse decision on Zenith-G.E. proposal to reassign approximate old-band frequencies to FM broadcasting was finally released on March 5th. It reads like a legal brief presented on behalf of a defendant who was caught red-handed, but is determined to bluff his way out.

Actually, this is another example of the current Washington pattern of reaching decisions for some undisclosed political, private, or ideological reason, or by total ineptitude, and then attempting to sell it to the public or to industry with double-talk persuasion which discounts average American intelligence, fools no one, and denies all reality.

In this particular instance, the only convincing evidence presented is that the radio listener, whose interest, convenience, and necessity the Commissioners are sworn to protect, has become the Forgotten Man at FCC headquarters.

Mobile Radio: Philco will manufacture communications equipment for trucks, buses, taxis, and police and fire department service. Sales and installation will be handled by Kellogg Switchboard and Supply Company, Chicago.

D. F. Schmit: Elected vice president in charge of engineering of Radio Corporation's RCA Victor division. He has been with RCA since 1930.

California: Colonial Radio Corporation, a Sylvania subsidiary, will produce home radios at a new plant now under construction at Riverside, California.

WFIL-FM: Philadelphia's first FM station is now operating 7 days a week, 3:00 P.M. to 9:00 P.M. on 99.9 mc. with an RCA transmitter, and also on the old frequency of 45.3 mc.

More FM Communications: First construction permit for railroad radio was granted on February 27th to Denver and Rio Grande Western Railroad Company of Denver, Colorado. It covers 32 FM transmitters of 50 watts, operating on 159.81 mc., for end-to-end communication.

FM Royalties: A 20% reduction on FM patent royalties has been extended to set manufacturers by Major Armstrong. Royalty is now approximately 1% of manufacturer's net selling price, or less than 50¢ on an instrument retailing for $100. All new applicants will be licensed under a uniform agreement, and proposals of preferential terms will be rejected, as in the past.

No transmitter royalty will be charged to educational or religious organizations, and payments can be deferred by any veteran who has controlling interest in a new FM station. Royalty-free licenses on U. S. and Canadian military FM equipment are still in effect.

Converting Television Sets: RCA Service shops in New York, Philadelphia, Chicago, and Los Angeles will convert RCA television receivers to the new channels at a charge of $30.

OPA Doings: The ease with which new companies can get high prices on radio sets accounts for the fact that out of 111 concerns which have obtained OPA price schedules, only 38 were in business before the war!

J. M. Wherritt: Missouri State Highway Patrol captain and head of the Communications Division has resigned to manage the new emergency communications division at Aireon Manufacturing Corporation, Kansas City, Kan. For the past 7 years, Captain Wherritt was editor of the *APCO Bulletin*.

Chicago: Hallicrafters has purchased the Electronic Winding Company of Chicago. Personnel and equipment will be moved to 5031 Broadway. Irving Glerum will head the new division, with J. S. Paterson and Frank Mitchell as engineers.

Color Television: Columbia Affiliates Advisory Board, comprising 145 independents of the CBS chain, has adopted a resolution calling upon the FCC to authorize commercial operation of upper-band color television transmitters.

Resolution states that the public "should be saved the expense of double investment in television equipment, and the broadcasters the burden of double losses, both in capital investment and operating expenses, in establishing two services." This resolution was proposed by John M. Rivers, WCSC, Charleston, S. C., and seconded by W. H. Summerville, WWL, New Orleans.

FM in Canada: VE9CM is the FM affiliate of CFCF Montreal. The FM transmitter, operating with 25 watts on 48.8 mc., is located at the Canadian Marconi Company's plant at Mount Royal. It is a Marconi version of Armstrong phase-shift modulation. The antenna, only 125 ft. above the ground, is vertically polarized. Station goes on the air at 5:00 P.M. but does not transmit CFCF's musical programs because of Musician's band on dual programs.

Providence: Two floors of a plant at 55 Cromwell Street, Providence, R. I., have been leased by Cornell-Dubilier for added condenser production.

Major General Roger B. Colton: Awarded the Legion of Merit for outstanding services as Chief of the Material Branch, and Director of the Supply Service, Office of the Chief Signal Officer, from August 1941 to June 1943, and the Distinguished Service Medal for his work as Air Communications Officer, ATS, Wright Field from September 1944 to September 1945. Now retired, he is associated with the consulting firm of Colton & Foss, Inc., 927 15th Street N. W., Washington, D. C.

New Television Sets: OPA has set prices on three television receivers manufactured by Andrea Radio Corporation, Woodside, N. Y. Retail prices for a table model set with a 5-in. picture tube and circuits covering two television bands is $134.55. A console model with a 12-in. tube, covering 5 television bands and 2 AM radio bands, is priced at $499.50. A similar model, with automatic phonograph, is $699.50.

Secondary Coverage: Both AM broadcasters and the FCC attach great importance to the public service value of secondary coverage. Lack of significant qualitative data leaves them unsupported in their position. Letters from listeners who endure the eratic reception of distant stations show a *desire* to listen, but they are no indication of enjoyable reception or adequate service.

The Commission rejected the FM philosophy that when signals drop out, no service is rendered but, with what has become characteristic inconsistency, it considers AM signals, however garbled with selective fading and ridden with squeals, good enough for a large section of the radio audience.

This situation will change quickly enough, though, when sponsors and agency executives begin to take an interest in it, instead of taking it for granted.

Television Color: Broadcasters and manufacturers have definite but widely divergent views concerning the effect of announcing the advent of color television at this particular time.

Prewar experience with television sales showed that the attitude of radio dealers will have a profound effect on the decision which, ultimately, will be rendered by the people whose reactions are being forecast so freely at this time. Thus, regardless of the best-informed assurances, pro or con, as to what public reaction ought to be, we can't get the real answer until the dealers can decide what attitude they will take.

NEWS PICTURE

THIS photograph shows a Panalyzor instrument in operation, by means of which the performance of a 150-mc. transmitter is being observed under test conditions. The transmitter, designed for mobile service, is in a test chamber behind the Panalyzor, where the temperature is being varied over a range of minus 50° to plus 140° F., while the pressure and humidity are also being varied in accordance with extreme conditions. Modulating voltage of 11 kc. is supplied from an audio oscillator at the bottom of the stand.

Action of the Panalyzor shows the waveform each side of the center frequency. When this picture was taken, the image on the screen showed that the carrier was being deviated approximately plus-and-minus 75 kc. At this instant, the carrier is zero, with the bulk of the energy concentrated at plus-and-minus 50 kc., tapering off to 75 kc.

This usual indication of FM transmitter performance gives a complete picture of the output. Originally devised for checking military FM equipment, it will be used now to test both broadcast transmitters and home receivers.

Seated in the foreground of this picture is J. R. Popkin-Clurman, assistant chief engineer of Panoramic Radio Corporation, by whom the Panalyzor was developed.

FIG. 1. FM STATION WMIT, AT AN ELEVATION OF 6,571 FT., IS AT THE HIGHEST POINT ON THE ATLANTIC SEABOARD

WMIT'S 337-MC. STUDIO-TRANSMITTER LINK

Equipment Used for the 116-Mile Link, and a Review of 4 Years' Experience In Its Operation

BY PAUL DILLON*

IN 1941 when WSJS planned the erection of an FM station atop Clingman's Peak, a major problem was that of supplying program service to the transmitter. The terrain over a goodly portion of the distance between the studios in Winston-Salem and the transmitting site is extremely rugged. Fig. 1 shows, for example, the steep drop to the valley below the transmitter on Clingman's Peak. Therefore, it was considered impracticable to install a telephone line to the transmitter, even disregarding the fidelity required for FM transmission. These considerations, together with the difficulty of maintaining a wire line under weather conditions which are sometimes extremely adverse, made it advisable to use an FM radio link for program relaying.

Our Winston-Salem studios are 116 miles distant from the WMIT transmitter on Clingman's Peak at 6,571 ft. elevation. There was much speculation as to the possible success of S-T link operation over this distance. However, after daily use for three and one-half years, the relay link has provided satisfactory service well above 90% of the time, even considering equipment shortages and delays resulting from war conditions.

Of course, to provide optimum program transmission at all times, it is necessary to have two complete transmitting and receiving systems, as well as emergency antennas at both ends of the relay circuit. Future plans for WMIT include such a scheme as well as an increase in power for the relay transmitter. By increasing the power of the W4XGG S-T transmitter, it is felt that the received signal will be more consistent during periods

*Chief Engineer WMIT, Box 192, Marion, N. C

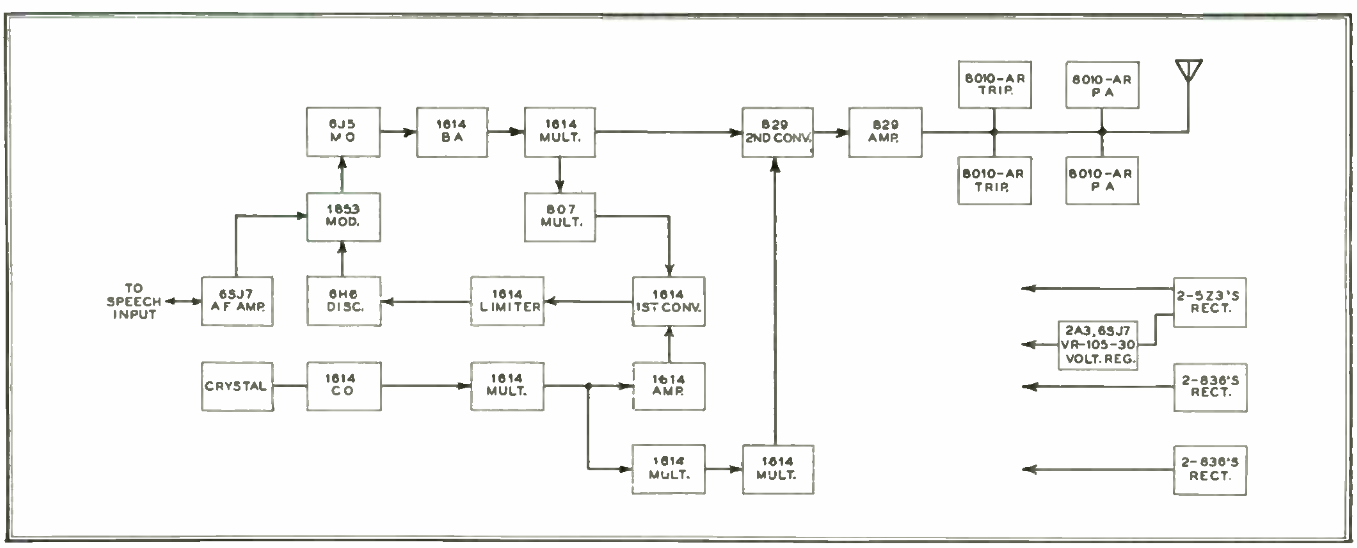


FIG. 3. BLOCK DIAGRAM OF THE 337-MC. BEAM TRANSMITTER WHICH, WITH 25 WATTS OUTPUT, COVERS 116 MILES

of slight tropospheric fading, with which we are troubled occasionally, as well as during those times when a temporarily poor signal results from mistuning of the transmitter or receiver, or at times of partial antenna failure.

Relay Transmitter ★ The S-T transmitter, shown in Fig. 2, is located on the top floor of the Reynolds Building in Winston-Salem, the tallest structure in North Carolina, and is remotely controlled from the WMIT studios. The FM studios are in the same building with those of WSJS, the affiliated AM station.

The relay transmitter has been entirely unattended since the installation was made, except for normal maintenance and inspection. Our transmitting unit was designed by General Electric for broadcast service. It meets all FCC specifications as to distortion, frequency response, and noise level. A modulation and frequency monitor is mounted at the side of the transmitter, as Fig. 2 shows. This provides a visual means for checking output characteristics, and furnishes an audio signal for program monitoring.

Fig. 3 presents a block diagram of the S-T transmitter. It employs a type 6J5 frequency-controlling tube, reactance-modulated by an 1853. The 4640-kc. output of this oscillator is multiplied and amplified by means of triplers and a converter stage. The frequency-modulated output from one of the triplers is added in the plate circuit of the converter tube to the amplified harmonic output of a crystal oscillator which also controls the center-frequency stabilization circuit. The resultant signal at the output of the converter is again amplified and finally tripled to furnish excitation for the final power amplifier.

Both the final tripler and power amplifier stages of the transmitter utilize G.E. type 8010-AR tubes. These are forced-air cooled triodes, designed for high frequency use. The tubes are constructed with heat-radiating fins attached to the plate connection, and disc type grid and cathode leads which decrease inductance in those circuits. The nominal power output of the push-pull final stage is 25 watts.

The transmitting antenna which has been in use for the greater portion of the time W4XGG has been on the air is a 2-wire, horizontally polarized rhombic with legs equivalent to 4.2 wavelengths. The theoretical signal gain of this antenna is 11.0 db relative to a half-wave dipole. The transmitter output power is fed through a length of ⅞-in. coaxial line to a half-wave matching section and then to the terminals of the rhombic.

The rhombic is adjusted by means of sliders for the best operating characteristics. As instruments for measuring radio frequency impedances at this frequency have been unavailable, all adjustments have been made by using the S-T receiver on Clingman's Peak as a field-strength meter, together with indications of proper loading in the power amplifier plate circuit. In the final analysis, a maximum signal input to the receiver is the result to be desired. Thus it seems doubtful if comprehensive measurements would do more, except to determine the power losses in the coupling circuits themselves.

Relay Receiver ★ The 16-tube double superheterodyne used at Clingman's Peak can be seen in Fig. 4. A block diagram of the circuit is shown in Fig. 5. It has a number of interesting features. By a careful selection of frequencies, a single crystal-controlled channel furnishes the oscillator signal for both the first and second converter tubes. As the crystal is kept at a constant temperature, the oscillator harmonics are sufficiently stable that such a scheme operates very satisfactorily.

In the RF input stage of the receiver, as well as for the frequency multiplying stages following the crystal oscillator, acorn type tubes are used. These tubes perform very satisfactorily. However, because of failing cathode emission, their

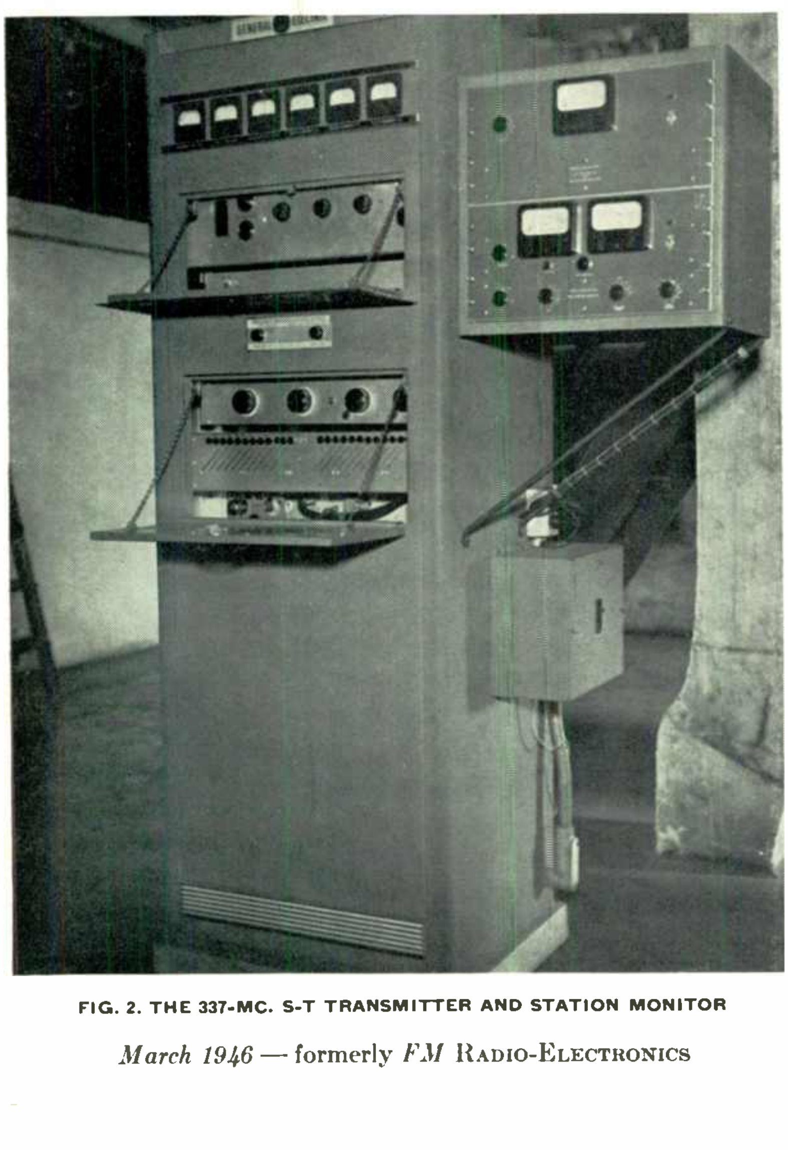


FIG. 2. THE 337-MC. S-T TRANSMITTER AND STATION MONITOR

FIG. 4. S-T RECEIVER AND STUDIO CONTROLS AT WMIT

normal life does not compare favorably with standard types of receiving tubes. The intermediate frequency channels, operating at 41.275 mc. and at 4.3 mc., are of conventional design, feeding a dual-stage limiter using type 6SH7 metal tubes. A double limiter in this receiver provides much more effective action than a single stage, and permits full limiting action with 20 microvolts at the antenna terminals. As a result of the careful design of the time constants in the limiter grid circuits, impulse interference has been kept to a low value under normal conditions. A discriminator of the familiar Seeley type is followed by a 2-channel audio amplifier. This makes available a separate output for monitoring purposes and has, in practice, been used as an emergency program source. A noise-suppressor or squelch circuit silences the audio output in the event of failure of the transmitter, or if the signal becomes abnormally low for any other reason during operating hours.

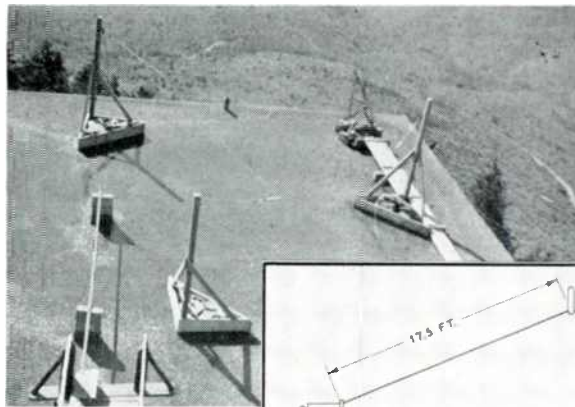


FIG. 6, LEFT. S-T RECEIVING ANTENNA. FIG. 7, BELOW. DETAILS OF THE 337-MC. RHOMBIC ANTENNA

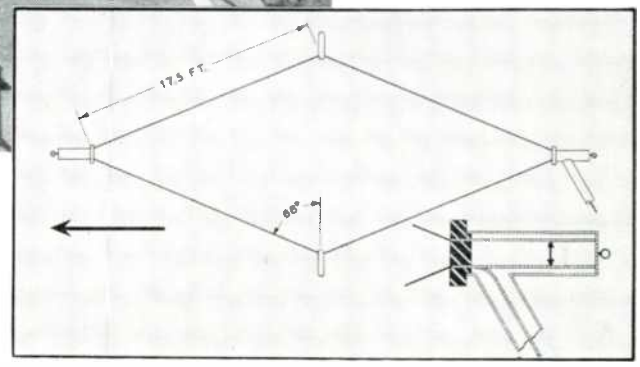
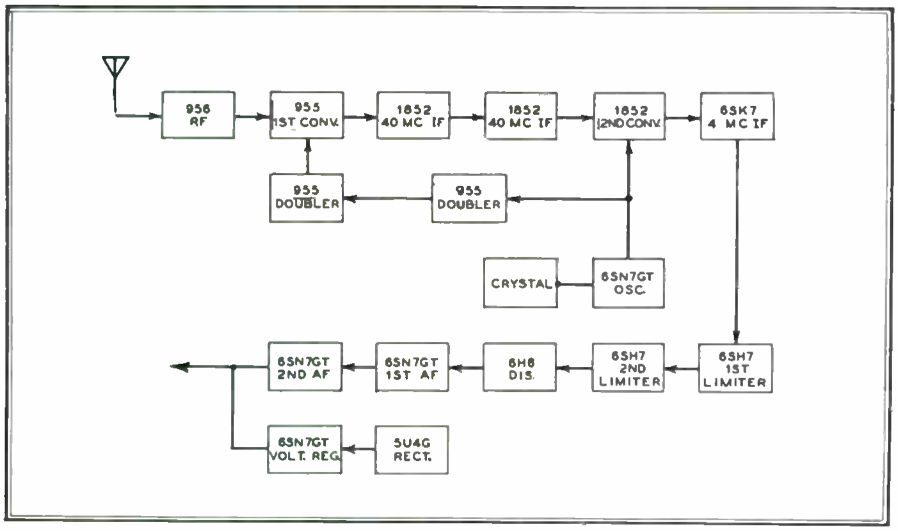


FIG. 5, BELOW. BLOCK DIAGRAM OF THE DOUBLE SUPERHETERODYNE S-T RECEIVER



A voltage-regulated power supply has proved particularly advantageous. When adjusting critically tuned circuits, a marked increase in stability is noted when the regulator is in use.

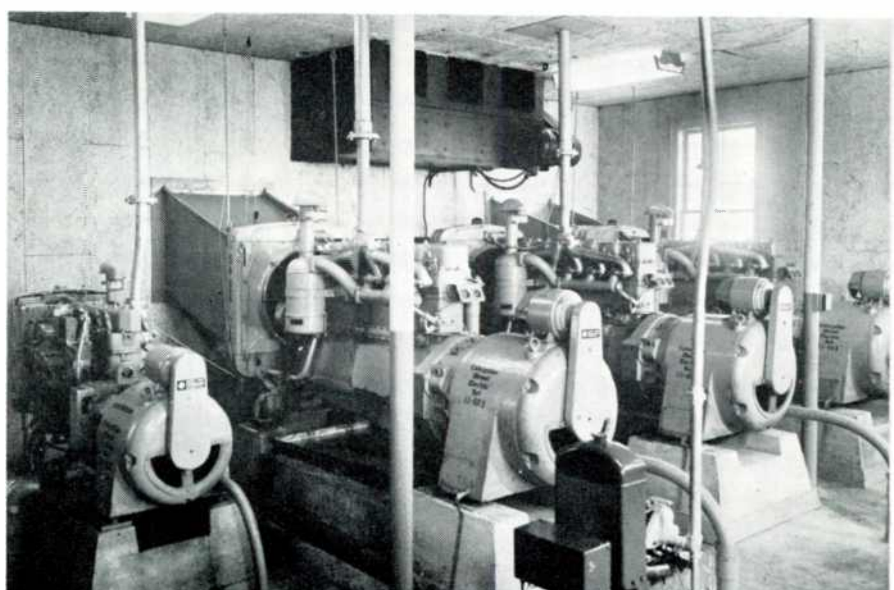
Front panel controls on the S-T receiver provide for adjusting the discriminator transformer secondary trimmer, and for regulating the audio volume to the WMIT speech input equipment.

Receiving Antenna ★ The antenna originally used with the S-T receiver was a half-wave dipole and square-corner reflector. Using this method of pickup, normal signal input to the receiver was of the order of 100 microvolts. This square-corner, or "Kraus" antenna, worked surprisingly well considering its small physical size, and is still used in emergencies.

About a year after the initial installation, a rhombic receiving antenna was tried. The rhombic proved to be consistently more efficient than the smaller dipole and reflector, and has been in use with minor modifications ever since that time. The rhombic we are now using, shown in Fig. 6, is six wavelengths on a side. It has an angle of tilt of 68 degrees and is $3\frac{1}{2}$ wavelengths above the roof of the WMIT transmitter building.

In order that the entire antenna be kept at direct current ground potential, and to simplify insulation problems, a quarter-wave transformer section, enclosed in a copper pipe, is used at each end of the antenna instead of conventional insulators. At the feed end of the rhombic, the inner conductor of a $\frac{7}{8}$-in. concentric transmission line is connected to the junction of the antenna and the quarter-wave section, while the outer conductor is grounded to the sheath surrounding the quarter-wave transformer. In this manner we are able to obtain an approximate impedance match without any physical difficulty, and in such a manner that the coupling ar-

FIG. 8, BELOW. VIEW OF THE DIESEL-ELECTRIC GENERATOR SETS AT WMIT



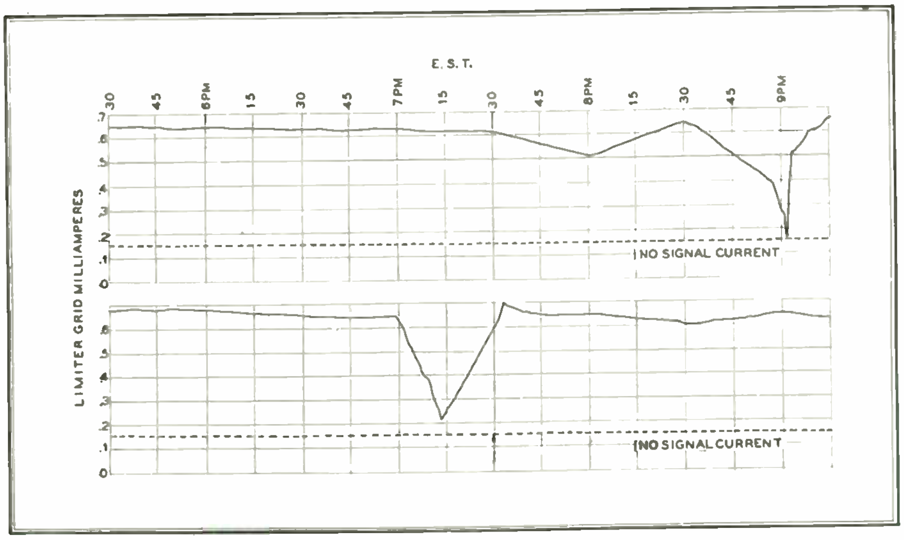


FIG. 10. TYPICAL RECORDINGS OF RECEPTION FROM WINSTON-SALEM ON 337 MC.

rangement is not seriously affected by snow or ice during the winter months.

We estimated that the impedances of the rhombic antenna and of the transmission line are 300 and 75 ohms respectively. By connecting the open end of the transformer across the antenna and the transmission line from one side of the antenna to ground, the effect is the same as connecting to one half of a center-tapped transformer winding, or a 4 to 1 impedance ratio. At the receiver end of the concentric line, the inner conductor is connected to a slider on the RF stage grid inductance. This inductance at 337 Mc. is a silvered ¼-in. square rod about 5 ins. in length.

It has not been possible to conduct as much experimental work with receiving antennas as we have desired, but some work has been done along these lines. At one time, two rhombics were in use, one a full wavelength above the other. This system gave a slightly increased signal pick-up over the present antenna, but during a spell of extremely bad weather both rhombics were blown down and have not been rebuilt. It has occured to us that some sort of dual-diversity scheme, possibly using both horizontal and vertical polarization, might be of value in limiting, to some extent, the seriousness of tropospheric fading. Then, too, we may find that equivalent or better performance than that we are getting now might be obtained by using another type of antenna such as a long wire V, a colinear, or a stacked array of some sort. When time permits, we plan to test several types of antennas to determine which will deliver the best overall results.

WMIT Power Supply ★ In connection with the S-T receiver, it might be mentioned that all electric power required by the WMIT main transmitter, as well as auxiliary receivers and other apparatus, is generated at the mountain-top location. Three 75-kva. diesel-electric Caterpillar sets have been in use from the beginning. They are shown in Fig. 8. It is as impractical to run a line to Clingman's Peak for the transmission of electric power as it is to use a line for programming. In the former case, the problem resolves itself into simply hauling the necessary diesel fuel oil. The WMIT power plant is complete with a specially designed switchboard which includes provision for starting and controlling the machines from the transmitter room. A synchroscope is provided for adjusting the speed of generators so that they can be connected in parallel across the main power bus. Both the switchboard and the operator's control console for the FM broadcast transmitter are shown in Fig. 9.

Mountain-top Studio ★ We have an emergency studio at Clingman's Peak which can be put into use at a moment's notice. Of course, live talent in the Mount Mitchell area is seldom available, so the program transmissions originating at the mountain are usually limited to transcriptions.

Because of the remoteness of the transmitting plant, the Federal Communications Commission has authorized limited use of the WMIT and W4XGG facilities for studio-transmitter communications during non-broadcasting hours. These communication periods are permitted only with reference to station operation or other matters of an emergency nature.

Signal Variations ★ A continuous half-hourly record of the signal strength received from W4XGG has been kept over a period of three years. The signal has proven to be surprisingly consistent. However the records show a number of interesting facts concerning propagation at these frequencies.

Of particular interest are the effects of tropospheric fading, and the variations which appear to occur in more or less daily cycles. The usual trend of the signal over a daylight cycle is that of being above normal in the early morning, gradually dropping to what might be called a median value shortly before noon. The field strength usually remains at approximately this level until several hours after sunset when it rises to a value comparable

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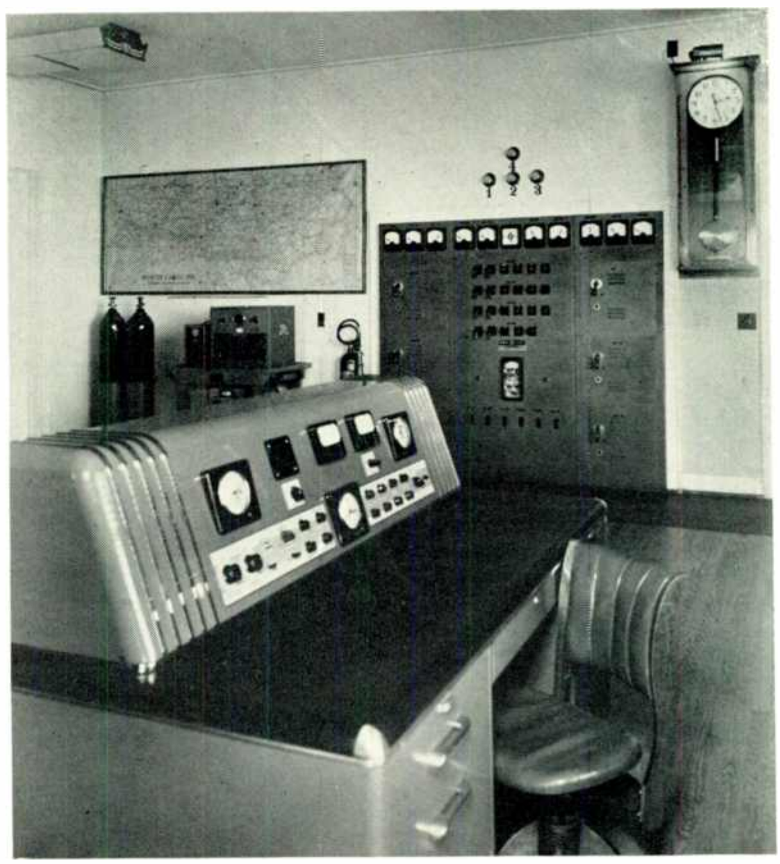


FIG. 9. WMIT OPERATOR'S CONSOLE AND CONTROL BOARD FOR THE GENERATORS

REL FM BROADCAST TRANSMITTERS

Describing Transmitter Designs Employing the Armstrong Dual Channel Direct Crystal Control Modulation System

BY FRANK A. GUNTHER*

On November 6, 1935, Major E. H. Armstrong read a paper and gave a demonstration before the Institute of Radio Engineers in New York City, titled: "A Method of Reducing Disturbances in Radio Signaling by a System of Frequency Modulation." This paper was subsequently published in the May 1936 issue of the IRE proceedings and later reprinted in the June and July 1944 issues of FM AND TELEVISION MAGAZINE.

Thus the invention of a superior method of radio communication was divulged to the art. As this system was originally conceived and developed, the transmitter and receiver portions of the system were inherently superior in performance to all other necessary portions of the complete system such as studio microphones, recordings, turntables, studio to transmitter wire lines, repeater amplifiers, and receiver loudspeakers.

REL, as the pioneer manufacturer of FM broadcast transmitters, has always directed the design of this portion of the system so that the transmitters would be as nearly perfect in performance as modern engineering and manufacturing processes could produce. Many years of engineering and manufacturing experience, plus a large quantity of field performance data furnished to us by broadcasters who have used the equipment over long periods of time, have played a large part in the design of the new FM broadcast transmitter equipment now in production.

The first transmitters using the Armstrong FM system were built by REL, and all the 50-kw. FM transmitters installed up to the present time are of REL manufacture. Many of these stations, both of high and low power, have provided continuous and reliable operation since 1939.

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

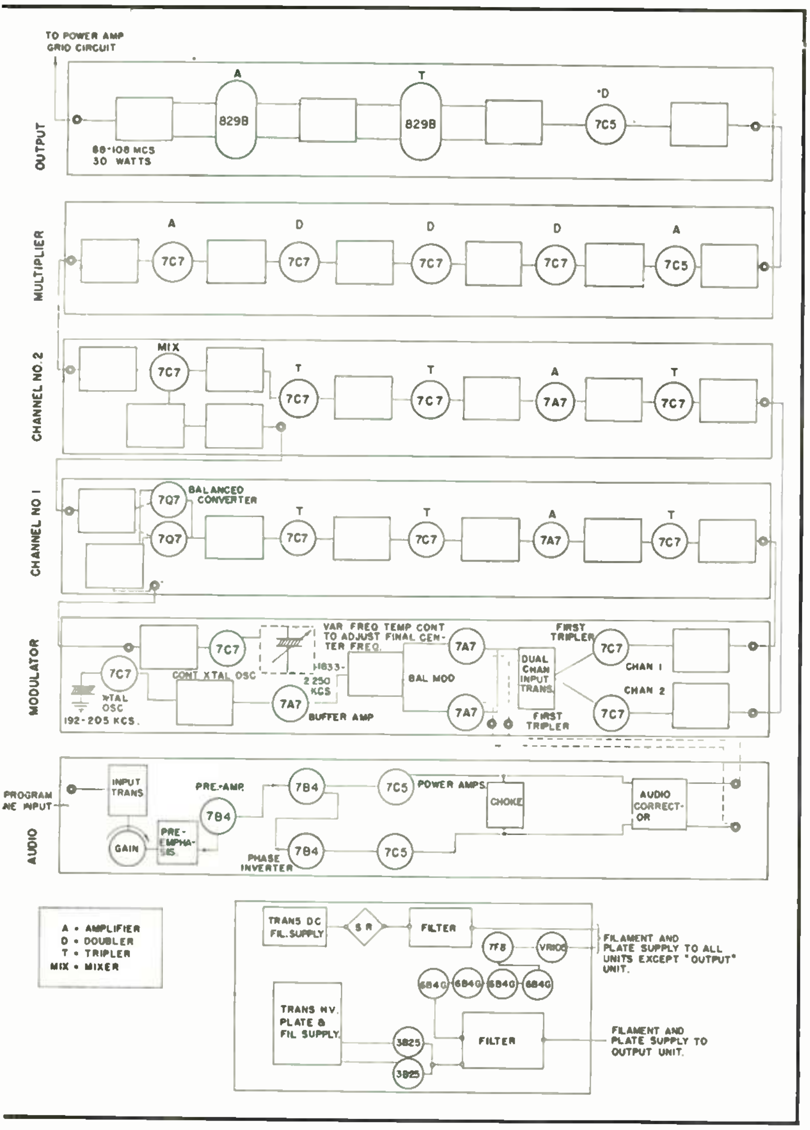


FIG. 1. BLOCK DIAGRAM OF THE REL-ARMSTRONG DUAL CHANNEL MODULATOR

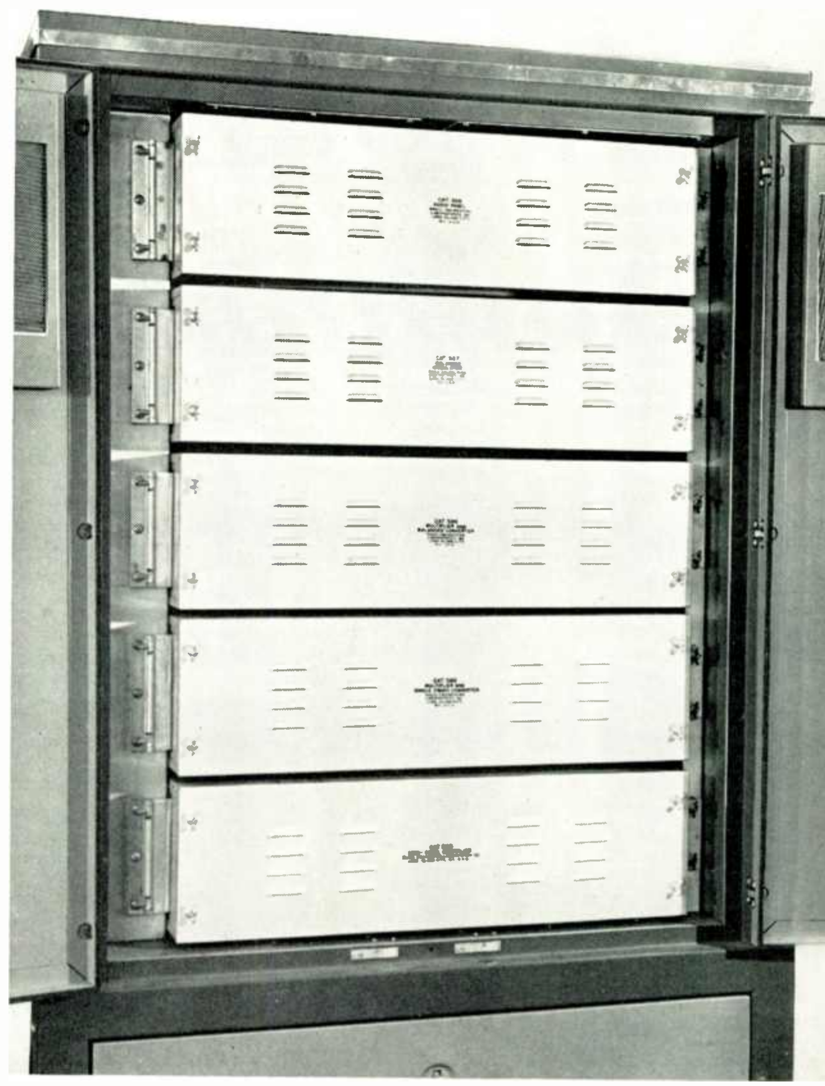


FIG. 2. MODULATOR PANELS ASSEMBLY

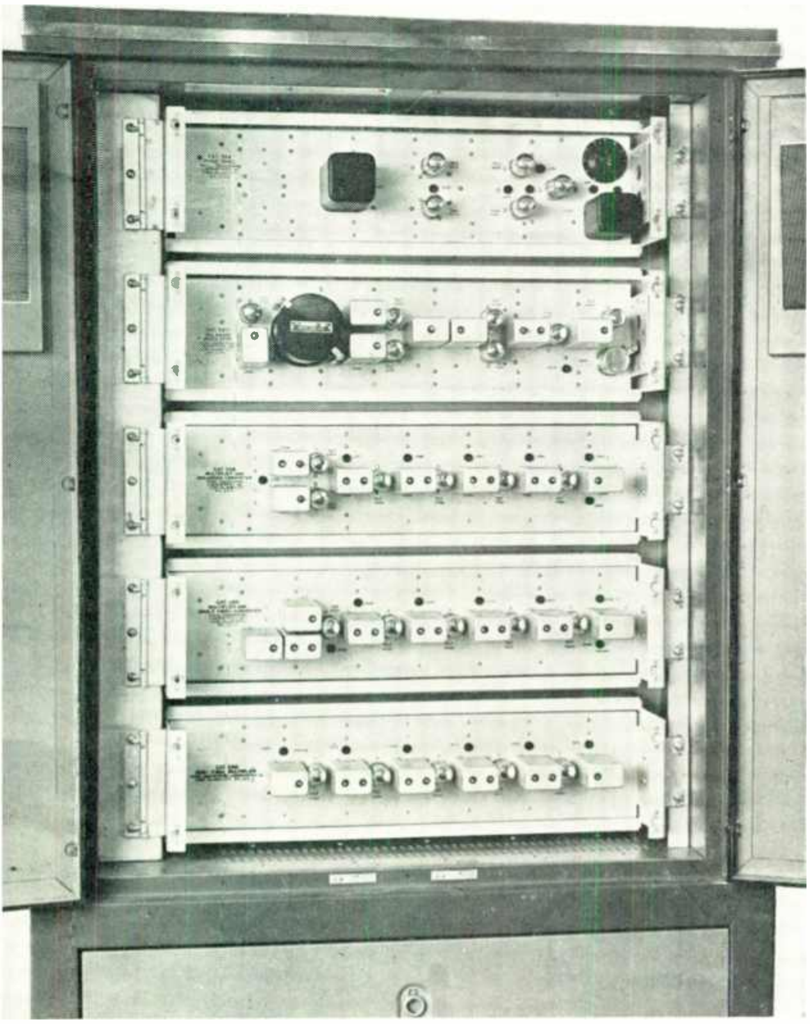


FIG. 3. MODULATOR UNITS WITH COVERS REMOVED

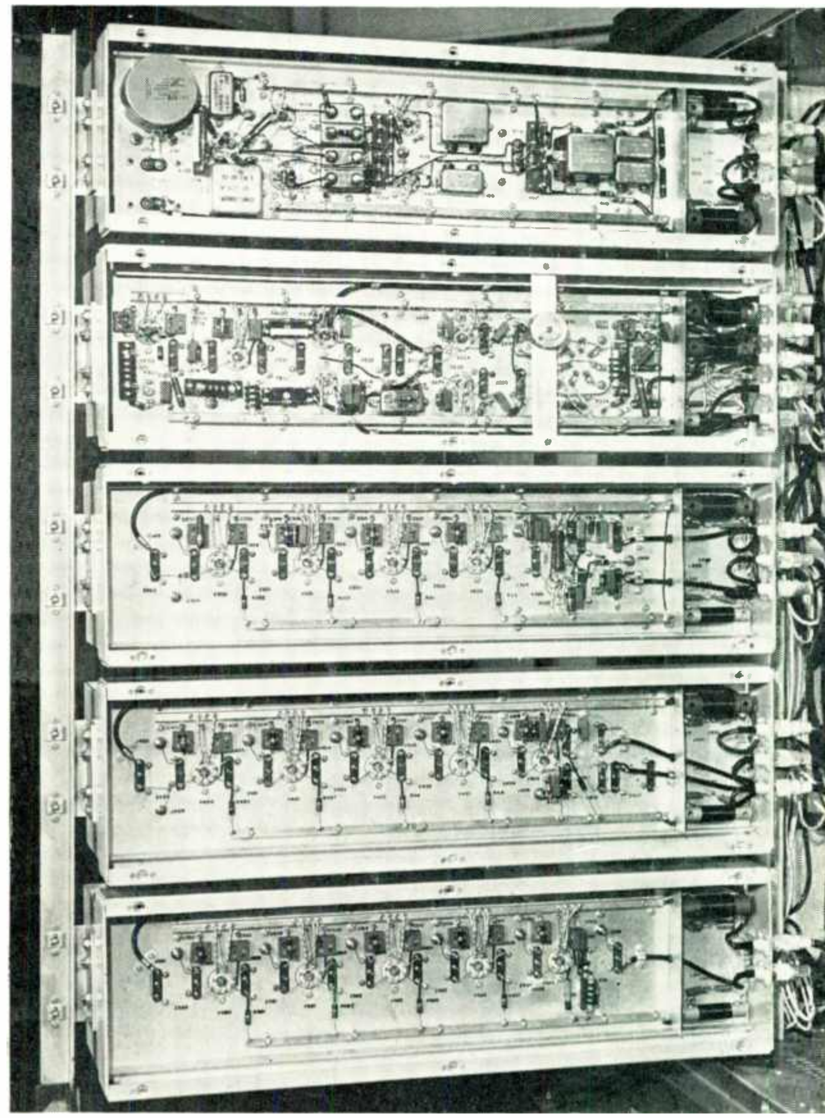


FIG. 4. MODULATOR UNITS SWUNG OUT FOR ACCESS TO THE REAR

Equipment Requirements ★ From the broadcaster's viewpoint, the major points of interest in the selection of new FM broadcasting equipment are these:

1. It must be designed to meet all FCC requirements in regard to standards of good engineering practice.

2. It is desirable that it meet all of the proposed RMA standards.

3. That it exceed, insofar as possible, every one of the minimum requirements in both cases above.

4. That all this be accomplished in as fool-proof and straightforward a manner as possible.

5. That the mechanical design be such as to permit easy and quick replacement of all components should the need ever arise.

6. That components and mechanical portions of the equipment such as cabinets, doors, chassis, and wiring be the best that the state of the art permits without concession to cost.

Past experience by broadcasters in Frequency Modulation indicates quite definitely that these points add up to being able to put out the most reliable signal of the best quality in any given area. FM broadcasting is unique compared to AM broadcasting in that differences in transmission quality can now be heard by the careful listener. This has been borne out by experience in communities with several FM broadcasting stations in operation, from which the listeners could choose.

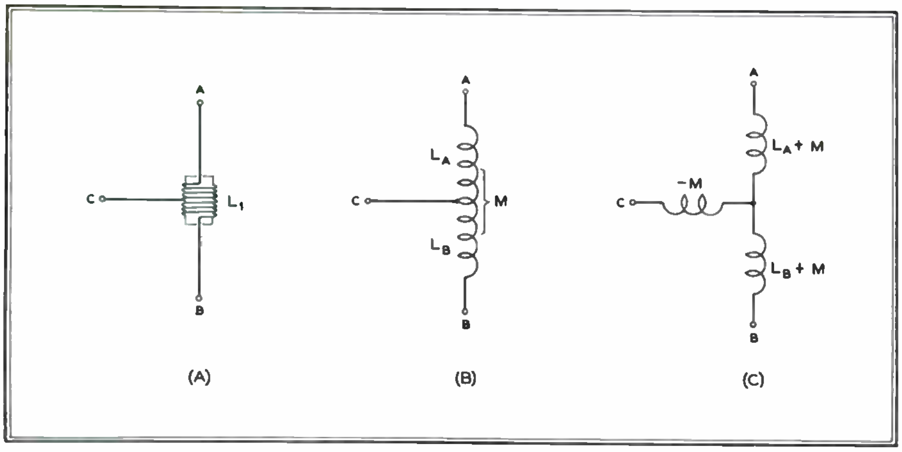
Modulation Methods ★ In 1938, when REL began engineering work on the first FM broadcast transmitter, a basic choice had to be made between several possible methods of modulation. At that time, the only method with an operating record covering thousands of hours was Major Armstrong's phase-shift method. During the period from 1938 until the beginning of the war, several other makes of transmitters were introduced, using other methods to accomplish frequency modulation. REL, however, continued to use the phase-shift method which, meanwhile, had been adopted as standard for all mobile FM equipment.

At the beginning of the war, when all work along these lines was halted, a review of the field performance of the various methods was made, covering the previous 2½ years. The net result of our review, we felt, doubly confirmed the wisdom of our original choice of the phase-shift method.

Furthermore, at that time, a significant improvement in the phase-shift method had been introduced by Major Armstrong, and distinguished by us as the *dual channel* method. This improvement had been incorporated in numerous transmitters on the air when the war began.

With the termination of World War 2, REL picked up, roughly speaking, where we left off in 1941, with the use of the dual channel FM system. It is interesting to note that while REL was the only broadcast transmitter manufacturer to use the phase-shift principle before the war, there are now at least three prominent manufacturers in this group.

REL transmitters presently in production are in the 250-watt, 1,000-watt, and 3,000-watt classes. 10,000- and 50,000-



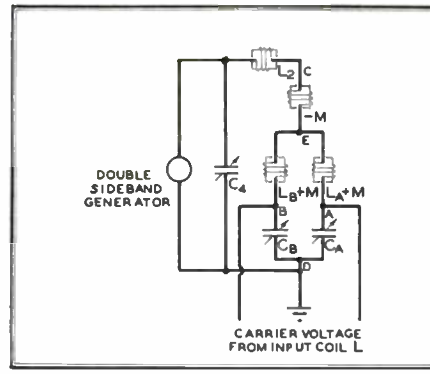


FIG. 5, LEFT. THE 3-TERMINAL NETWORK
FIG. 7, ABOVE. EQUIVALENT CIRCUIT SHOWING ELEMENTS OF DIAGRAM IN FIG. 5

watt transmitters are being designed for contemplated production in 1946.

The Basic Phase-Shift Modulator ★ All these transmitters employ the latest version of the dual channel phase-shift modulator, which is comprised of six basic units: the audio panel, balanced modulator, multiplier and balanced converter, multiplier and single-ended converter, the semi-final multiplier, and the final multiplier. Fig. 1 is a block diagram of the overall modulator. Fig. 2 is a rear view of the upper half of the 1-kw. transmitter with the cabinet doors open, while Fig. 3 shows the first five basic modulator units with their covers removed. Since pin jacks are easily accessible for each unit to facilitate preliminary adjustments, a vacuum-tube voltmeter, supplied with each transmitter, is all that is required for lining up the various stages. Each unit is hinged at the left, and can be swung out from the cabinet by releasing the Dsuz fasteners at the right. To remove an entire unit, it is only necessary to take out the pin from the hinge at the left hand side. All mechanical tolerances are held to within a few thousandths of an inch to permit interchangeability in the field if necessary.

Fig. 4 is a rear view of the modulator units, and shows the neat wiring layout and the military system used for the identification of all components. The output of the fifth unit, the semi-final amplifier, is used to feed the final multiplier, located at the front of the transmitter. This sixth unit employs a pair of 829B tubes to deliver an output of 30 watts. This is sufficient to drive either the 250-watt or 1,000-watt transmitter without any further amplification.

Review of a Simplified Phase-Shift Modulator ★ A simplified circuit of the improved Armstrong phase-shift modulator is shown in Fig. 5.

The output of a crystal-controlled oscillator, operating at a frequency in the order of 200 kc., is passed through a buffer amplifier whose tuned output circuit is inductively coupled to the input coil L of a balanced modulator.

The voltage appearing across the modulator input coil L is applied to the 90° phase-shift network CRRC. At the applied frequency, about 200 kc., the reactances of CC very greatly exceed the resistances of RR, so that the current in CRRC leads the applied voltage from coil L by practically 90°.

The voltage drops across the resistors RR are therefore practically 90° out of phase with the voltage across the input coil L. The common cathode lead from the modulator tubes is connected to the common junction of RR, while the grids of the tubes are connected to the extremities of RR. Thus the grids are excited in opposite polarity by voltages across RR that have been shifted 90° along the time axis with respect to the voltage across the input coil L.

The balanced modulator operates on the principle that the carrier component is balanced out because the plates are connected in parallel while the grids are excited in push-pull. The net RF current drawn by the modulator plates has an amplitude proportional to the amplitude of the audio modulating voltage and a polarity dependent on the polarity of the modulating voltage. The center frequency voltage at the modulator input coil is led

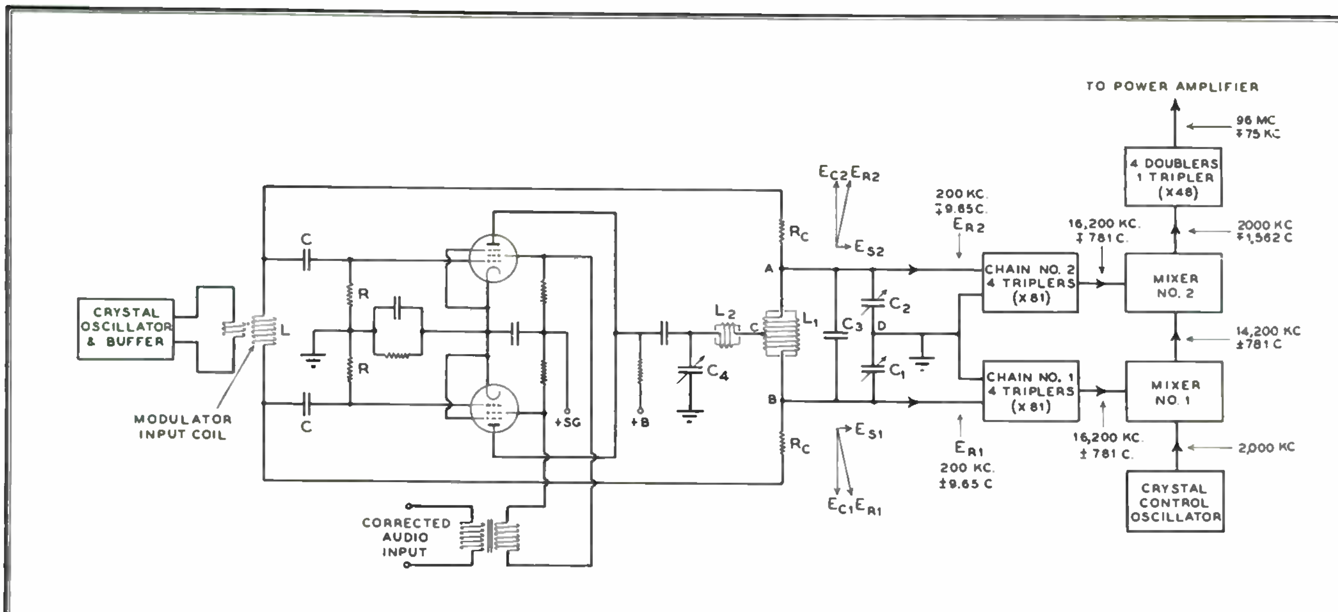


FIG. 6. BLOCK DIAGRAM OF THE ARMSTRONG DUAL CHANNEL MODULATOR, SHOWING ESSENTIAL ELEMENTS OF THE CIRCUIT

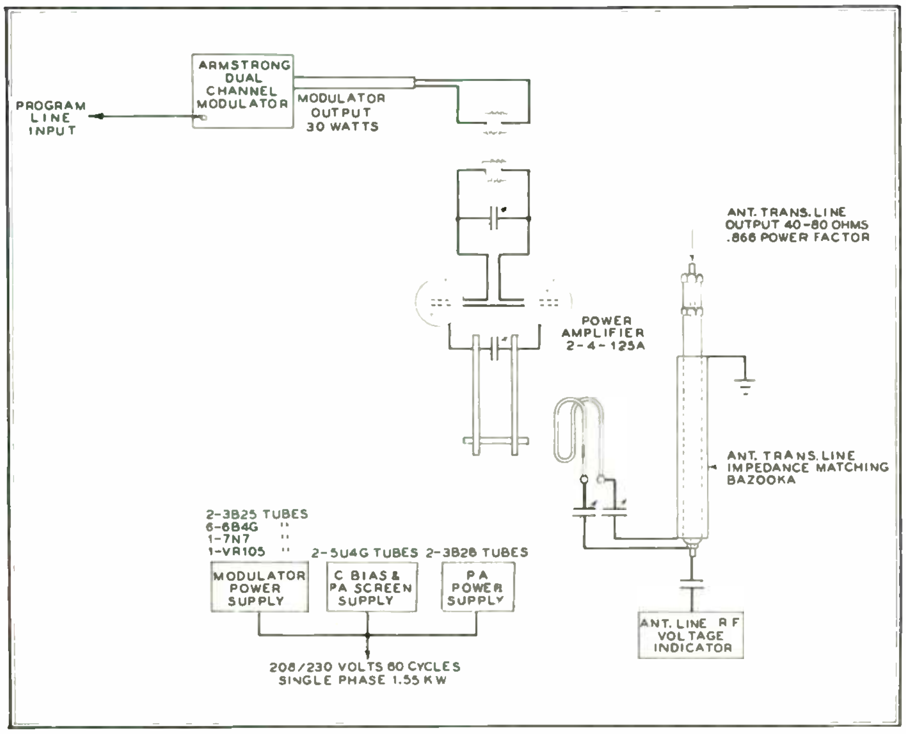


FIG. 8. BLOCK DIAGRAM OF THE 250-WATT FREQUENCY MODULATION TRANSMITTER

through resistors R_cR_c, around the modulator, and is applied to the opposite terminals A,B of the tuned circuit $L_1C_1C_2C_3$.

With respect to the center frequency voltage applied at points A,B, the tuned circuit $L_1C_1C_2C_3$ is at parallel resonance, so that the current drawn from the input coil L through R_cR_c is in phase with the input coil voltage. The center frequency voltage appearing across points A,B, by virtue of the currents drawn through R_cR_c, is therefore in phase with the voltage at the modulator input coil. By grounding the common junction of condensers C_1 and C_2, equal center frequency voltages of opposite polarity are applied to the tripler grids, as shown by vectors E_{c1} and E_{c2} in the small vector diagrams.

The above condition occurs in the absence of modulation. Actually, of course, during most of the time the transmitter is on the air, audio voltage is applied to the modulator screen grids and a double sideband is created. The manner in which the double sideband is added to the carrier by way of network L_2C_4 will now be explained.

The coil L_1, Fig. 5, has two terminals and a center tap, and can be regarded as a 3-terminal network. This is illustrated in Fig. 6 at (A). Each half of coil L_1 represents inductance in itself. This type of inductance is termed self-inductance, and is the amount of inductance offered by the turns in each half of the coil when the other half is disconnected. The self-inductances are denoted by L_A and L_B in diagram (B) of Fig. 6.

When both sections of the coil are connected in series, the field set up about each section sweeps across the turns of the other section. This mutual induction effect causes the inductance of the entire coil to be increased. Thus the inductance of the coil becomes the sum of the self-inductances of its sections, increased by twice the amount of mutual inductance M. In diagram (B) of Fig. 6, the inductance offered by the coil between terminals A,B, is $L_A + L_B + 2M$.

This leads to the three-terminal network of diagram (C), Fig. 6, which is the equivalent of the coil in diagrams (A) and (B). The equivalence can be easily checked by adding the inductances between each pair of terminals.

Between terminals A,C, the inductance is $L_A + M - M$ or simply L_A, the self-inductance of the turns in the upper section. Between terminals C,B, the inductance is $L_B + M - M$ or simply L_B, the self-inductance of the turns in the lower section. Finally, between terminals A,B, the inductance is $L_A + M + L_B + M$, or $L_A + L_B + 2M$, that is, the sum of the self-inductances increased by twice the mutual inductance, or again the value to be expected.

Coil L_1 of Fig. 5 can be replaced by the mathematically equivalent network of diagram (C) Fig. 6. This substitution has been made in Fig. 7 where the circuits to which the output of the balanced modulator is delivered have been redrawn. In Fig. 7 the generator represents the double sideband voltage developed by the modulator. The capacity across L_1 of Fig. 5 has been assumed in Fig. 7 to reside entirely in two series variable condensers C_A and C_B, rather than in the form of a fixed capacity C_3 and two variables, C_1 and C_2, as in Fig. 5. This change has been made to simplify the explanation of circuit operation, since the fixed condenser C_3 of Fig. 5 is employed solely to avoid the use of excessively large variable condensers.

The tuned circuit $L_1C_1C_2C_3$, Fig. 5, is resonant to the center frequency voltage applied at terminals A,B. Thus, in Fig. 7, the total capacitive reactance of C_A and C_B in series is equal to the total inductive reactance of $L_A + M$ in series with $L_B + M$. Because of the circuit symmetry, the inductive reactance of $L_A + M$ equals the capacitive reactance of C_A, and the inductive reactance of $L_B + M$ equals the capacitive reactance of C_B. Therefore, between point E in Fig. 7 and ground, the parallel branches C_A, $L_A + M$ and C_B, $L_B + M$ are series resonant at the

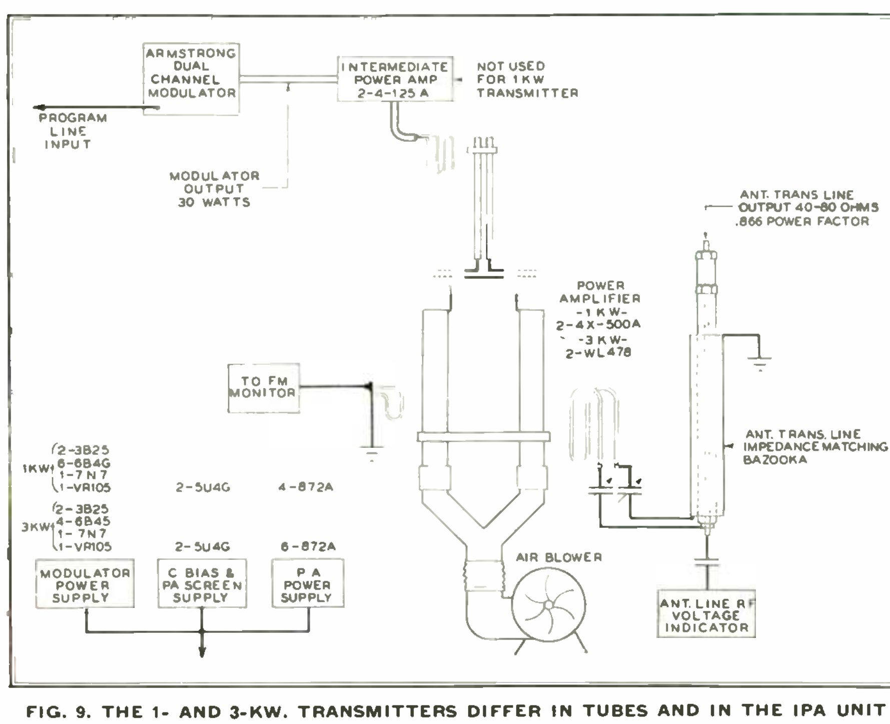


FIG. 9. THE 1- AND 3-KW. TRANSMITTERS DIFFER IN TUBES AND IN THE IPA UNIT

center frequency. The only opposition to current flow at the center frequency between point E and ground is the low resistance of the coil sections.

The inductance of coil L_2 is sufficiently in excess of the negative inductance $-M$ between points C and E to cancel $-M$ and to leave a positive remainder of inductance that can be tuned to parallel resonance at the center frequency by means of condenser C_4. In this way, the balanced modulator delivers its output to a resistive load.

The current in the inductive branch, comprised of $L_2 - M$, and the low resistances between point E and ground, lags the voltage applied from the double sideband generator by practically 90°. At point E, the current divides equally between the series resonant paths to ground. The voltages across the condensers C_A and C_B are equal to each other, and both of the voltages lag the branch currents by another 90°. Thus the double sideband voltages appearing across C_A and C_B are equal in magnitude, of the same polarity with respect to ground, with the phase of both voltages differing by 90 + 90 or 180° with respect to the sideband voltage at the balanced modulator outputs.

Since a 90° phase shift was introduced in the excitation of the balance modulator which carried over into the modulator output, the subsequent shift of 180 degrees leaves the double sideband voltages appearing across C_A and C_B in phase quadrature with respect to the center frequency voltage appearing across the modulator input coil.

The center frequency voltage is applied in diminished amplitude at points A,B, causing center frequency voltages to appear across C_A and C_B in opposite polarity with respect to ground. The double sideband voltages across C_A and C_B are in the same polarity with respect to ground. It follows that the phase difference between the carrier and double sideband voltages across one condenser will be in the form of a 90° lead at the same time as the phase difference across the other condenser is in the form of 90° lag.

This is illustrated by the small vector diagrams in Fig. 5. The sideband voltages E_{S1} and E_{S2}, created across condensers C_1 and C_2, are in phase and equal. The center frequency voltages E_{C1} and E_{C2}, across the same condensers, are equal but of opposite polarity, each differing in phase from the sideband voltage by 90°.

The resultant frequency-modulated voltage E_{R1} appearing across C_1 leads the center frequency component E_{C1} at the same time as the resultant voltage E_{R2} across C_2 lags the carrier component E_{C2}. The resultants are therefore frequency-modulated voltages that are alike except for the fact that the frequency of one voltage is increasing at the same time as the frequency of the other voltage is decreasing.

Thus the frequency-modulated voltage E_{R1} across C_1 is increasing in frequency while the frequency-modulated voltage E_{R2} across C_2 is decreasing in frequency. If the frequency deviation of the voltage is, say, 9.65 cycles, then the frequency-modulated voltage across C_1 can be described as having the frequency 200 kc. ± 9.65 cycles, while that across C_2 can be described as 200 kc. ∓ 9.65 cycles.

an output of 16,200 kc. ∓ 781 cycles.

The output of each tripler chain is applied to a mixer stage. Tripler chain No. 1 delivers a frequency of 16,200 ± 781 cycles to mixer No. 1. This mixer also receives a voltage from the crystal-controlled control oscillator, which has a frequency of approximately 2,000 kc.

With this control oscillator frequency applied to mixer No. 1, together with the output of tripler chain No. 1 at 16,200 ± 781 cycles, the difference frequency appearing in the output of mixer No. 1 is 14,200 kc. ± 781 cycles. This frequency is applied to mixer No. 2 along with the output of the tripler chain No. 2 at 16,200 kc. ∓ 781 cycles. The difference of the center frequeneics is 16,200−14,200 or 2,000 kc. The difference of the frequency deviations, which at any time are of opposite sign, is twice the deviation of

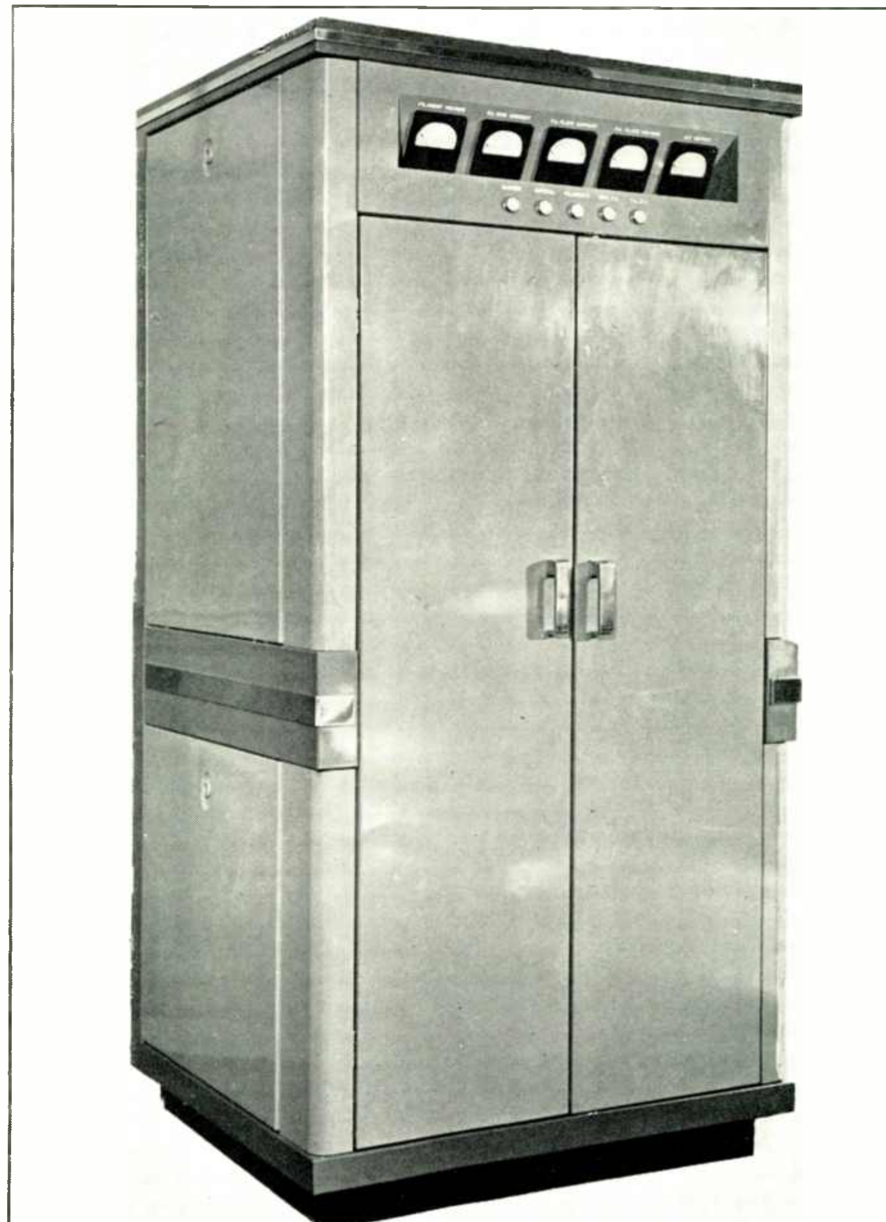


FIG. 10. THE 1-KW. TRANSMITTER, FINISHED IN 2-TONE LACQUER, HAS THE OUTWARD APPEARANCE OF CONVENTIONAL DESIGN

Frequency Multiplication System ★ Each of these two output voltages of the modulator is passed through its own chain of four triplers, giving a multiplication of both the center frequency and the frequency deviation by a factor of 3^4 or 81.

If the frequency at the input of tripler chain No. 1 is 200 kc. ± 9.65 cycles, then the output of the chain will have a frequency of 16,200 ± 781 cycles. Because of the opposite frequency deviation of its input, tripler chain No. 2 will deliver each frequency, or 2 × 781 = 1,562 cycles.

The frequency at the output of mixer No. 2 may therefore be described as 2,000 kc. ∓ 1,562 cycles. After passing through four doublers and a tripler, in which multiplication of 48 is obtained, the frequency becomes 96 mc. ∓ 75 kc. These values are modified, of course, to produce an output of the assigned transmitter frequency.

Advantages of the Improved Modulator ★ When the outputs of the chains of triplers are combined with the output of a crystal-control oscillator in the two mixers, as described above, the center frequency of the output of mixer No. 2 is the same as that of the control oscillator, regardless of any small variations in the frequency of the oscillator used to excite the modulator.

Suppose, for example, that the frequency of the oscillator which excites the modulator drifts from 200 to 201 kc., that is, to a frequency 1 kc. too high. The center frequencies of the voltages at the inputs of the tripler chains will also be 1 kc. high, while at the output of the triplers, the voltages will be 81 kc. high. The output of mixer No. 1 will have a center frequency that is 81 kc. high, but the frequency at the output of mixer No. 2 will not contain the 81 kc. error, because it is the difference between two frequencies, each of which is 81 kc. high.

The frequency stability of the output frequency of the transmitter is therefore dependent on the stability of the control oscillator alone, and is independent of the first oscillator, used to excite the modulator. It is not imperative that the first oscillator be crystal controlled, although a crystal is usually employed as a matter of convenience, since it insures that the tripler chains will not be detuned by a large drift in the oscillator frequency.

Just as the effects of drift, or slow variation in the frequency of the oscillator used to excite the modulator, is balanced out, so also rapid variations are balanced out. Thus the improved modulator tends to overcome any slight noise or hum modulation that occurs in the first oscillator.

The phase shift method of securing frequency modulation was very early noted for the practical absence of distortion. The dual channel principle has added a significant increment to this margin. Beside meeting the FCC's Standards of Good Engineering Practice as applied to overall broadcast station performance, the wave form distortion of the dual channel modulator drops to the vanishing point in the middle and upper ranges. This has a very important bearing on the production of unwanted intermodulation products. These are extremely low in the REL modulator, and this fact no doubt accounts for the frequently reported clarity and "clean-ness" of the transmissions.

The design of the modulator was guided at every step by consideration of simplicity, ruggedness, ease of access for servicing, and very conservative operating margins. The physical layout conforms closely to circuit functions, greatly facilitating understanding and maintenance. By careful attention to detail, a design has been evolved permitting the inclusion of the modulation equipment in the main transmitter frame, with consequent gains in efficiency and simplicity.

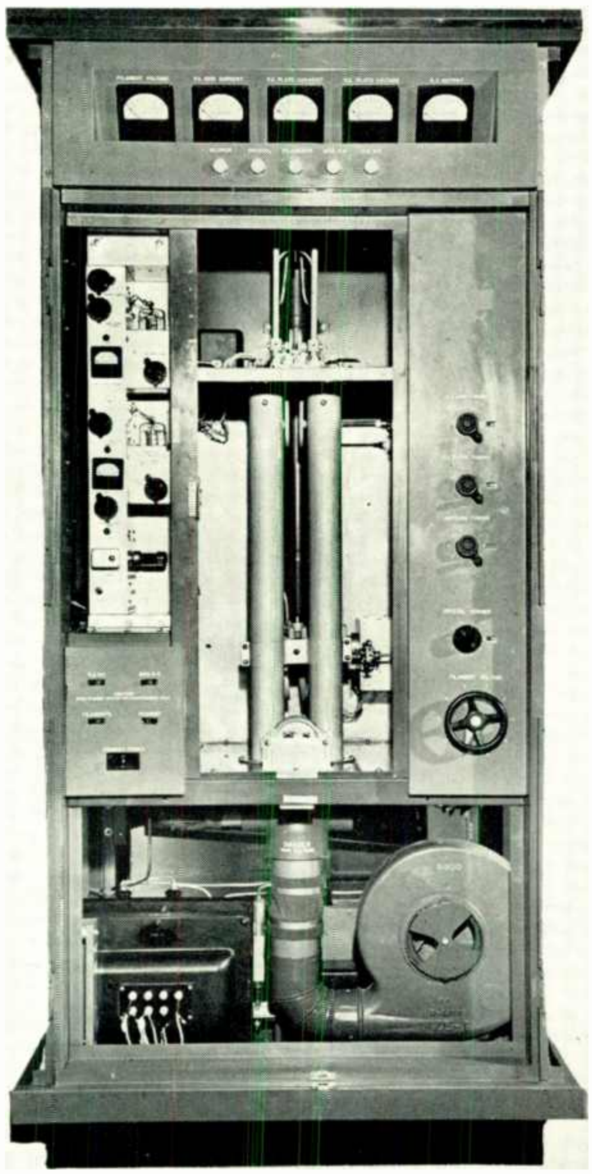


FIG. 11. FRONT OF THE 1-KW. TRANSMITTER, WITH PANELS REMOVED, SHOWING THE PHYSICAL ARRANGEMENT OF THE OUTPUT CIRCUIT

Transmitter Design ★ Transmitters in each power class are designed for full-power operation on any selected frequency between 88 and 108 mc. All components are fungus and moisture proofed and conform to the rigid war time specifications set up under JAN and ASA. Inductors, buses, and other parts in the high frequency circuits are heavily silver-plated. Every transmitter is designed to operate satisfactorily over a temperature range of minus 0°C. to plus 60°C.

The cabinets are finished in two-tone green polished lacquer with chrome trim. The doors and removable panels are fitted with switches connected into the safety interlock system. The cabinets are pressurized and openings are sealed with special gaskets so that the entrance and exit of air can be controlled. Air intakes and outlets are provided with filters. This prevents the entrance of dust through the outlets when the transmitter is shut down, and removes dust from the air drawn in. Power lines can be brought into the cabinets from the right or left sides or from the rear, or through the bottom from a floor trench. Appropriately located conduit knockouts are provided.

The proper primary power input voltage and conditions in the high power circuits of the transmitter are read from meters installed at the top front panel of the cabinet.

The principal circuits in the modulator chassis are equipped with built-in meters, and all other circuits can be examined through tip jacks. For this purpose, a high impedance volt-ohm meter is supplied as an integral part of the transmitter. The front panel of the cabinet also carries a vacuum-tube voltmeter which is arranged to measure RF voltages on the antenna transmission line. This meter is a means of monitoring relative power outputs.

The installation of the transmitter can be completed very quickly for, after it has been set in its permanent position, it is only necessary to bring in the primary power leads and audio program circuit and make the antenna connection.

250-Watt Transmitter ★ While all transmitters in the various power classes are identical in regard to their electrical performance, the 250-watt unit is somewhat smaller than the 1- and 3-kw. types, and is not designed for the subsequent addition of a power amplifier.

Fig. 8 is a block diagram of the 250-watt transmitter. Following are the electrical and mechanical specifications:

POWER OUTPUT: 50 to 250 watts as measured into a single ⅞-in. concentric antenna transmission line terminated in its characteristic impedance. An appropriate matching section is provided. The power amplifier has a plate efficiency in excess of 70% under normal operating conditions. Relative output measurements are made by means of a vacuum tube voltmeter coupled to the transmission line at the output of the transmitter. This measurement method is used in rating all REL transmitters.

PRIMARY POWER: 208 to 230 volts, 60 cycles, single phase, 1,550 volt-amperes for 250 watts output.

TUBE COMPLEMENT: Two 4-125A, two 3B28, two 5U4G, two 829B, two 7C5, thirteen 7C7, five 7A7, three 7Q7, two 7B4, one 7N7, one 7H7, three 7A4, two 3B25, one VR-105, four 6B4G, one 2X2.

CABINET DATA: The cabinet is 6 ft. high, 38 ins. wide, and 24 ins. deep. Sufficient clearance should be allowed for: rear door 36 ins. wide; split front door where each side is 17 ins. wide; 30 ins. on each side of the cabinet should be reserved in order to permit easy access. Approximate net weight is 800 lbs.

1-Km. Basic Transmitter ★ Fig. 9 shows a block diagram of the 1- and 3-kw. transmitters. The two types differ in their tube complements, as indicated, and in the omission of the intermediate power amplifier from the 1-kw. transmitter.

POWER OUTPUT: 250 to 1,000 watts as measured into a single ⅞-in. concentric antenna transmission line terminated in its characteristic impedance. An appropriate matching section is provided. The power amplifier has a plate efficiency in excess of 70% under normal operation conditions.

PRIMARY POWER: 208 to 230 volts, 60 cycles, single phase, 3,750 volt-amperes for 1,000 watts output.

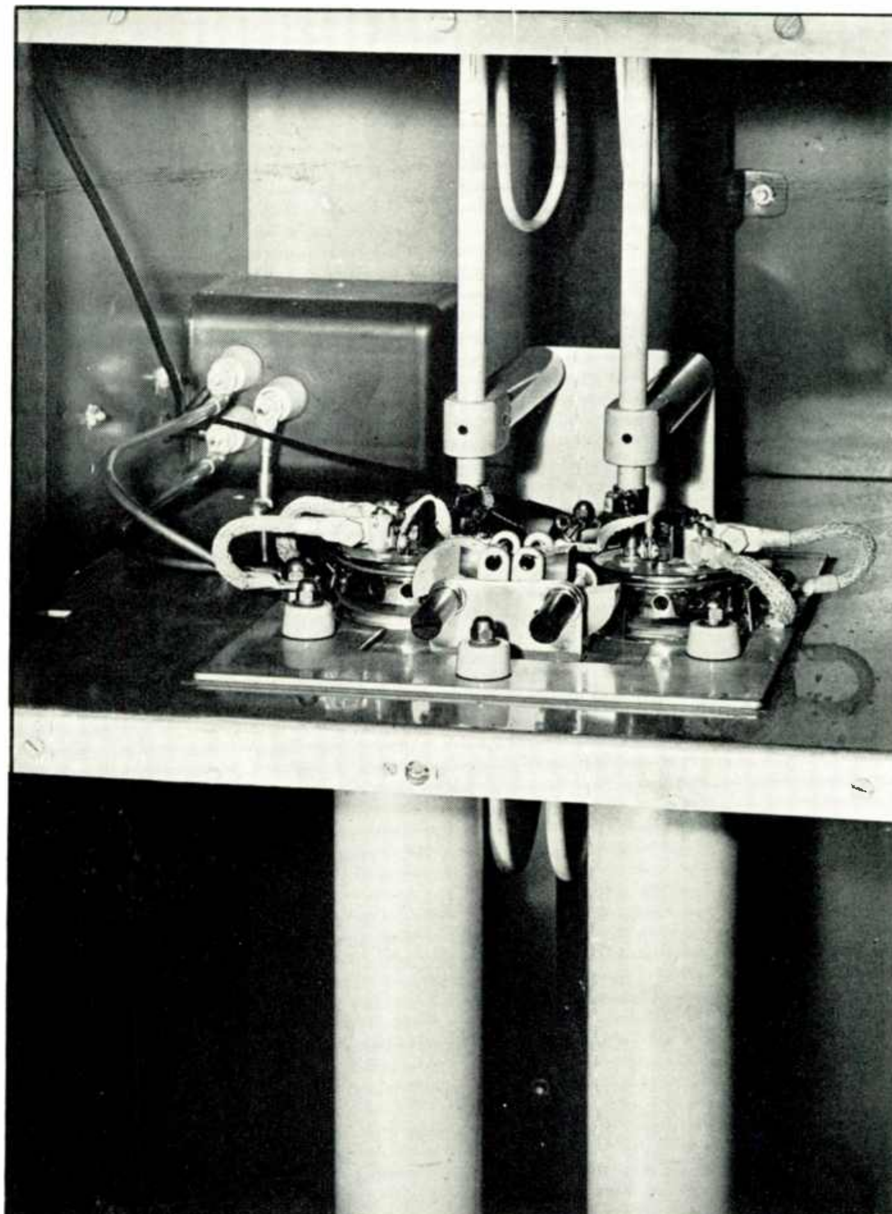


FIG. 12. TWO EIMAC 4X-500A TUBES ARE USED IN THE 1-KW. FM TRANSMITTER

TUBE COMPLEMENT: Two 4X500A, four 872A, two 5U4G, two 829B, two 7C5, thirteen 7C7, five 7A7, three 7Q7, two 7B4, one 7N7, one 7H7, three 7A4, two 3B25, one VR-105, four 6B4G, one 2X2.

CABINET DATA: The cabinet is 7 ft. high, 40 ins. wide, and 36 ins. deep. Sufficient clearance should be allowed for: rear door 27¼ ins. wide; split front door where each side is 15 ins. wide; and 30 ins. on each side of cabinet should be reserved in order to permit easy access. Approximate net weight is 1,300 lbs.

Fig. 10 is a front view of the 1-kw. transmitter as it appears in actual operation. Fig. 11 shows the internal construction, with the doors and panels removed, giving access to the interior of the PA chamber and the final multiplier unit. Between the PA lines is the antenna bazooka for push-pull coupling to the single-ended transmission line. In the lower right hand part of the PA chamber is the high frequency vacuum tube voltmeter for measuring RF output. The vertical panel at the right contains the PA grid, PA plate, and antenna tuning controls, and a crystal vernier for adjusting the transmitter to center frequency. These four controls are equipped with turn counters, so that settings can be read accurately and recorded for reference purposes. The large wheel at the bottom of this panel is a Variac control for all filaments.

On the left is a vertical chassis carrying the final section of the dual channel modulator circuit. This chassis can be swung out on hinges, or removed completely.

The blower, in the base of the transmitter, is insulated mechanically and electrically from the plate lines. Mechanical isolation is necessary to prevent the transfer of vibration to the tubes.

• Fig. 12 is a close-up of the power amplifier stage of the 1-kw. transmitter, showing the two Eimac 4X-500A tubes inserted in the plate lines for cooling purposes. The grid lines rise above the tubes, while behind these is the coupling loop for output measurement.

Fig. 13 is a right-hand view with the doors and panels removed. The power controls and power supply, like the other circuit elements, are mounted on hinged chassis, making the components accessible from the exterior of the cabinet. The main transmitter wiring is not run inside the cabinet, but through vertical and horizontal ducts built into the framework of the transmitter, and covered by the outside panels.

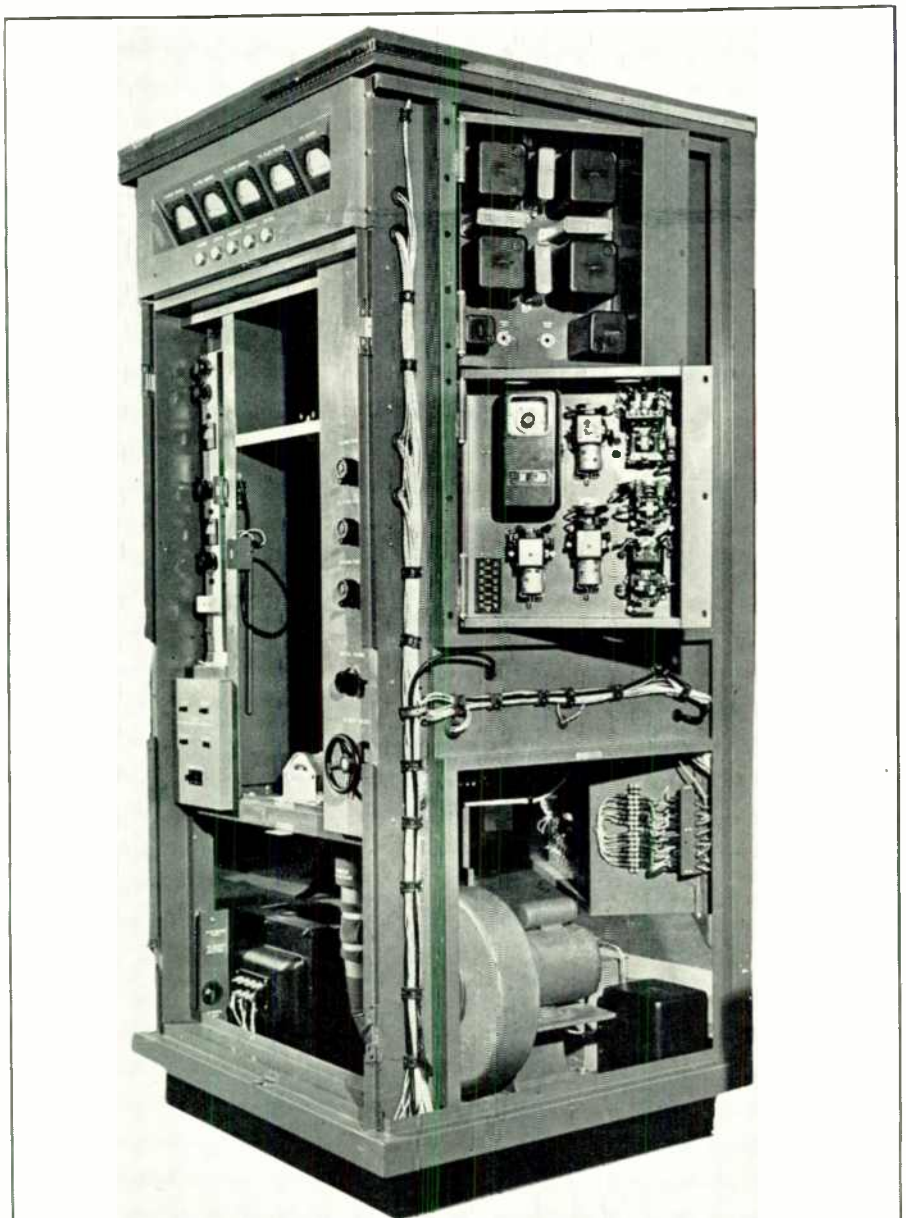


FIG. 13. MECHANICAL DESIGN DETAILS ARE DISCLOSED IN THIS VIEW OF THE 1-KW. UNIT

3-Kw. Transmitter ★ As Fig. 8 shows, the design of the 3-kw. transmitter is similar to that of the 1-kw. model except for changes in the tubes, and the addition of the intermediate power amplifier. Following is a summary of the specifications:

Power Output: 1,000 to 3,000 watts as measured into a single 1⅝-in. concentric antenna transmission line terminated in its characteristic impedance. An appropriate matching section is provided. The power amplifier has a plate efficiency in excess of 70% under normal operating conditions.

Primary Power: 208 to 230 volts, 60 cycles, three-phase, 7,000 volt-amperes for 3,000 watts output.

Tube Complement: Two WL478, six 872A, one 4-125A, two 5U4G, two 829B, two 7C5, thirteen 7C7, five 7A7, three 7Q7, two 7B4, one 7FB, one 7H7, three 7A4, two 3B25, one VR-105, four 6B4G, one 2X2.

Cabinet Data: The cabinet size is identical with the 1-kw. transmitter.

Overall Performance ★ In each power class, up to and including the 3,000-watt transmitter, the power amplifier employs a pair of tetrodes in a push-pull circuit.

Push-pull amplifiers were employed so as to derive the added advantage that, with the failure of one tube, the transmitter can still continue on the air, though with reduced output. Furthermore, since the higher frequencies are becoming more and more occupied, less concern need be felt regarding the possible radiation of even harmonics.

Other advantages derived from the use of tetrodes include low grid drive, no neutralization, low power consumption, and low tube costs. To illustrate, the power amplifier of the first 1,000-watt transmitter on laboratory test, operating at 104 mc. with a grid drive of 20 watts, delivered 1,000 watts measured in the dummy load at an overall efficiency of 74%.

Preliminary laboratory measurements indicate that all three types show the following characteristics:

Center frequency stability limits the drift to ⅕ the permissible amount of plus or minus 2,000 cycles from the assigned frequency.

Frequency modulation noise level on the carrier within the band of 50 to 15,000 cycles is more than 70 db below 100% modulation.

Amplitude modulation on the carrier band of 50 to 15,000 cycles was measured at more than 60 db below 100% modulation.

Audio frequency harmonic distortion ½ db throughout the full audio frequency range from 50 to 15,000 cycles, as referred to a 1000-cycle standard.

Audio frequency harmonic distortion as measured through the entire transmitter from the audio panel input terminals to and including the de-modulated signal as recovered in the receiver is 9/10 of 1% at 50 cycles, and less than 4/10 of 1% at all frequencies above 100 cycles at 100% modulation. At frequencies in the middle and high registers, the distortion is so low that reliable measurements cannot be made

DIRECTORY OF FM BROADCAST STATIONS

Commercial and Educational FM Stations Projected and Operating in the U. S. up to March 1, 1946

This listing shows the licensee status, FM call letters if the station is on the air, name of the licensee, name of the engineering consultants, estimated cost, call letters of the AM affiliate, if any, the type of FM station.

[1]Application filed — [2]Conditional Grant issued — [3]Construction Permit granted — [4]License issued and station on the air
C Community Station — E Educational Station
M Metropolitan Station — R Rural Station
MR May be Metropolitan or Rural Station

ALABAMA

ANNISTON

[2]Harry M. Ayers — WHMA — MR

BIRMINGHAM

[1]Birmingham Bcstg. — WBRC
George C. Davis $75,000.
[2]Birmingham News Co. — WSGN — MR
John Barron $113,350.
[2]Johnston Bcstg. Co. — WJLD — M
Lohnes & Culver $58,500.
[1]Voice of Alabama, Inc. — WAPI
Paul F. Godley $78,700.

HUNTSVILLE

[1]Huntsville Times Co., Inc. — WSGN
Holmes & Greene Sts.
John Barron $34,800.

MOBILE

[1]Giddens & Rester
Downtown Theatre Bldg.
Com. Rad. Equip. Co.
$30,300.
[2]Mobile Daily Newspapers, Inc. — M
304 Government St.
Jansky & Bailey $72,500.
[2]Paper Bcstg. Co. — WALA — M
Ring & Clark $100,000.

MONTGOMERY

[2]G. W. Covington, Jr. — WCOV — M
Holey & Hillegas $44,750.
[2]Montgomery Bcstg. Co., Inc. $47,400. — WSFA — MR

TUSCALOOSA

[1]James R. Doss — WJRD
Com. Rad. Equip. Co.

ARIZONA

PHOENIX

[1]Sun Country Bcstg. Co.

TUCSON

[1]Sun Country Bcstg. Co.

ARKANSAS

FORT SMITH

[1]KWHN Bcstg. Co., Inc.
P. O. Box 799.
John Barron $41,100.
[2]Donald W. Reynolds — MR
505 Rogers Ave.
George C. Davis $110,600.

CALIFORNIA

ALAMEDA

[2]Times-Star Publishing Co. — M
1511 Park St.
John Barron

ALHAMBRA

[1]Southern Cal. Associated Newspapers
11 South Stoneman Ave.
Ring & Clark $12,000.

BAKERSFIELD

[1]McClatchy Bcstg. Co. — KERN
$34,000.

BERKELEY

[2]Central Cal. Bcstrs. Inc. — KRE — M

EUREKA

[1]Redwood Bcstg. Co. Inc. — KIEM
$12,300.

FRESNO

[2]KARM, George Harm Station — KARM — M
[1]McClatchy Bcstg. Co. — KMJ
$61,000.
[2]J. E. Rodman — KFRE — MR
McNary & Wrathall
$64,975.

GLENDALE

[1]Southern Cal. Associated Newspapers
333 N. Brand Blvd.
$12,000.

HOLLYWOOD

[1]Hollywood Community Radio Group
1655 N. Cherokee St.

LOS ANGELES

[1]American Bcstg. Co., Inc. — KECA
$98,750.
[1]Earle C. Anthony, Inc. — KFI
Glenn D. Gillett
$103,085.
[1]Beverly Hills Bcstg. Co.
2335 Westwood Blvd.
Com. Rad. Equip. Co.
[1]Cannon & Callister — KIEV
[1]Columbia Bcstg. System — KNX
[1]Consolidated Bcstg. Corp. — KGER
Com. Rad. Equip. Co.
$53,860.
[1]Echo Park Evangelistic Assn. — KFSG
[1]Hollywood Community Rad. Grp.
[1]Hughes Productions
7000 Romaine St.
$155,600.
[1]International Union
411 W. Milwaukee, Detroit
John J. Keel
[4]KHJ-FM Don Lee Bcstg. System — KHJ — M
99.7 mc. No. 259 (44.5 mc.)
[4]KTLO M.G.M. Studios, Inc. — M
100.1 mc. No. 261 (46.1 mc.)
[1]Los Angeles Bcstg. Co., Inc. — KFAC
Ron Oakley $40,415.
[1]National Bcstg. Co.
$190,000.
[1]Radio Broadcasters, Inc. — KRKD
[1]Standard Bcstg. Co. — KFVD
John A. Smithson
$46,000.
[1]Television Prod., Inc.
[1]Dorothy S. Thackrey — KMTR
[1]Times-Mirror Co.
202 W. First St.
Com. Rad. Equip. Co.
$176,700.
[3]U. of So. C. (42.9 mc.) — E
[1]Warner Bros. Bcstg. Corp. — KFWB
Paul F. Godley $65,000.

MARYSVILLE

[2]Sacramento Valley Bcstrs. — MR
424 Fourth St.
Com. Rad. Equip. Co.
$70,800.

MODESTO

[1]McClatchy Bcstg. Co.

MONTEREY

[1]Monterey Peninsula Bcstg. Co. — KDON

OAKLAND

[2]Tribune Building Co. — KLX — M
$17,750.
[2]Warner Brothers — KWBR — M
Gille Bros. $34,300.

ONTARIO

[2]Daily Report — C
212 East B St.
Com. Rad. Equip. Co.
$30,650.

PALO ALTO

[2]Peninsula Newspapers, Inc. — C
248 Hamilton Ave.
$36,256.

PASADENA

[1]Southern Cal. Bcstg. Co. — KWKW
Paul Spargo $43,900.
[1]Times-Mirror Co.
Los Angeles

RICHMOND

[2]Contra Costa Bcstg. Co. — C
202 Tenth St.
John Barron $30,300.

RIVERSIDE

[2]Bcstg. Corp. of America — KPRO — MR
Glenn D. Gillett
$16,000.

SACRAMENTO

[2]Lincoln Dellar — KXOA — M
Ring & Clark $28,000.
[2]McClatchy Bcstg. Co. — KFBK — M
George C. Davis $61,000.
[1]Royal Miller Radio — KROY
Ring & Clark $33,600.
[3]Unified School Dist. — E

SALINAS

[1]Luther E. Gibson
516 Marin St., Vallejo

SAN BERNARDINO

[3]City High School Dist. — E
[2]Lee Bros. Bcstg. Co. — KFXM — M
George W. Ewing
$17,500.
[2]Sun Co. of San Bernardino — M
466 Court St.
Com. Rad. Equip. Co.
$24,240.

SAN BRUNO

[1]Radio Diablo, Inc.

SAN DIEGO

[2]Airfan Radio Corp., Ltd. — KFSD — M
Com. Rad. Equip. Co.
$22,200.
[1]Union-Tribune Pub. Co.
941 Second Ave.
Ring & Clark $51,250.

SAN FRANCISCO

[1]American Bcstg. Co. — KGO
Kear & Kennedy
$98,750.
[2]Associated Bcstrs., Inc. — KSFO — M
Royal V. Howard
$36,000.
[1]Don Lee Bcstg. System — KFRC
$131,860.
[1]Hearst Publications, Inc.
Hearst Bldg.
Gille Bros. $125,500.
[1]Hughes Productions
7000 Romain St., L.A.
$155,600.
KALW Board of Education Unified Sch. Dist. (42.1 mc.)
[1]KJBS Bcstrs. — KJBS
Jansky & Bailey $52,755.
[1]National Bsctg. Co., Inc. — KPO
$190,000.
[1]Pacific Agri. Foundation
87 E. San Antonio St.
San Jose
Ring & Clark $132,050.
[1]S. H. Patterson — KSAN
[1]Scripps-Howard Radio, Inc.
[1]Dorothy S. Thackrey — KYA

SAN JOSE

[1]Santa Clara Bcstg. Co.
[2]Valley Bcstg. Co. — MR

SAN LUIS OBISPO

[2]Valley Elec. Co. — KVEC — M
Lohnes & Culver
$40,200.

SAN MATEO

[2]Amphlett Printing Co.

SAN PEDRO

[1]San Pedro Printing & Pub. Co.
356 West Seventh St.
Ring & Clark $12,000.

SANTA ANA

Voice of the Orange Empire — KVOE

SANTA BARBARA

[1]New-Press Publishing Co. — KTMS
Com. Rad. Equip. Co.
$55,385.

SANTA MARIA

[2]Santa Maria Daily Times — C
207 W. Main St.
Ron Oakley $19,865.

SANTA MONICA

[1]Santa Monica School Bd.

STOCKTON

[1]College of the Pacific — E
[1]McClatchy Bcstg. Co. — KWG
$30,500.
[2]E. F. Peffer — KGDM — MR
Lloyd R. Amco $25,000.

COLORADO

COLORADO SPRINGS

[1]Out West Bcstg. Co. — KVOR
$32,000.

DENVER

[1]KLZ Bcstg. Co.
Shirley-Savoy Hotel
[1]National Bcstg. Co., Inc. — KOA
$190,000.

PUEBLO

[1]Curtis P. Ritchie — KGHF
Com. Rad. Equip. Co.
$19,050.

CONNECTICUT

BRIDGEPORT

[1]Travelers Bcstg. Ser. — WTIC
Ring & Clark $92,250.
[2]Yankee Network, Inc. — WICC
$68,000.

DANBURY

[2]Berkshire Bcstg. Corp. — C
[1]Danbury News-Times Co.

HARTFORD

[1]Hartford Times Inc. — WTHT
George C. Davis
$192,000.
[1]State Bcstg. Corp.
George C. Davis $56,000.
[4]WDRC-FM WDRC Inc. — WDRC — M
94.3 mc. No. 232 (46.5 mc.)
[4]WTIC-FM Travelers Bcstg. Ser. Corp. — WTIC — M
93.5 mc. No. 228 (45.3 mc.)

MERIDEN

[2]Silver City Crystal Co. — M

NEW HAVEN

[2]Elm City Bcstg. Corp. — WNHC — M

NEW LONDON

[2]Thames Bcstg. Corp. — WNLC — M
Ring & Clark $21,060.

STAMFORD

[1]Stephen R. Rintoul — WSRR
McNary & Wrathall
$12,610.
[1]Western Conn. Bcstg. Co.
258 Atlantic St.
George C. Davis $20,850.

WATERBURY

[2]American Republican, Inc. — WBRY — M
McNary & Wrathall
$32,760.
[1]Mitchell G. Meyers, Reuben E. Aronheim, Milton H. Meyers
[1]Harold Thomas — WATR
Herbert L. Wilson
$55,050.

DELAWARE

WILMINGTON

[1]Delaware Bcstg. Co. — WILM
[1]WDEL, Inc. $41,000. — WDEL

DISTRICT OF COLUMBIA

WASHINGTON

[1]Capital Bcstg. Co. — WWDC
McNary & Wrathall
$50,000.
[1]Cowles Bcstg. Co. — WOL
Worthington C. Lent
$117,500.
[4]Commercial Radio Equipment Co.
1319 F St., NW $43,500.
[1]Crosley Corp. $200,000.
Crosley Sq., Cincinnati
[1]Evening Star Bcstg. Co. — WMAL
Worthington C. Lent
[1]Marcus Loew Booking Agency
1540 Broadway, N.Y.C.
Jansky & Bailey $31,000.
[1]Metropolitan Bcstg. Corp.
1743 G St., NW
Raymond M. Wilmotte
$35,300.
[1]Mid-Coastal Bcstg. Co.
815 Fifteenth St., NW
Ring & Clark $80,000.
[1]National Bcstg. Co. — WRC
$53,000.
[1]Potomac Cooperative Federation
2621 Virginia Ave., NW
[1]Times Herald
1317 H St., NW
$100,000.
[1]WINX Bcstg. Co. — WINX
Jansky & Bailey $91,950.

FLORIDA

CORAL GABLES

[1]Southern Media Corp.
1235 Ingraham Bldg., Miami
John J. Keel $11,300.

DAYTONA BEACH

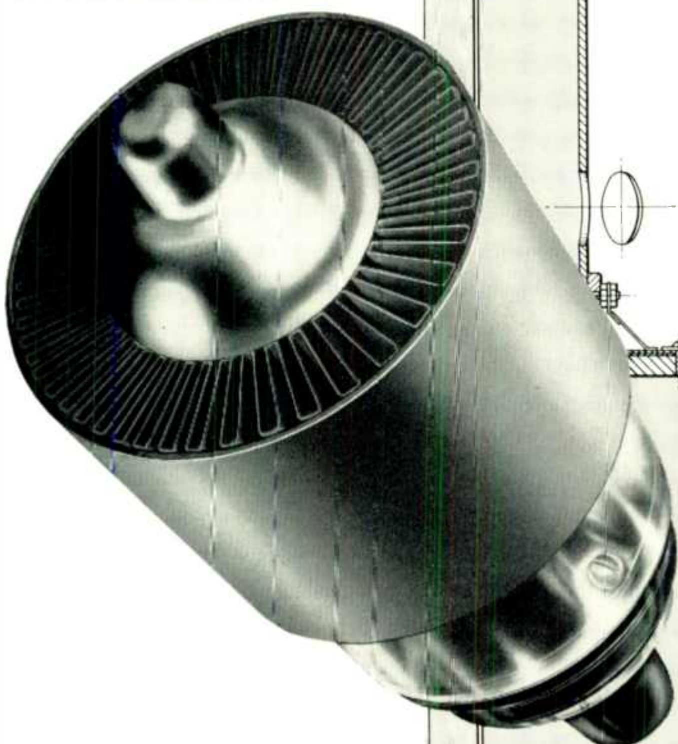
[1]News-Journal Corp.
128 Orange Ave.
Ring & Clark $65,250.

FT. LAUDERDALE

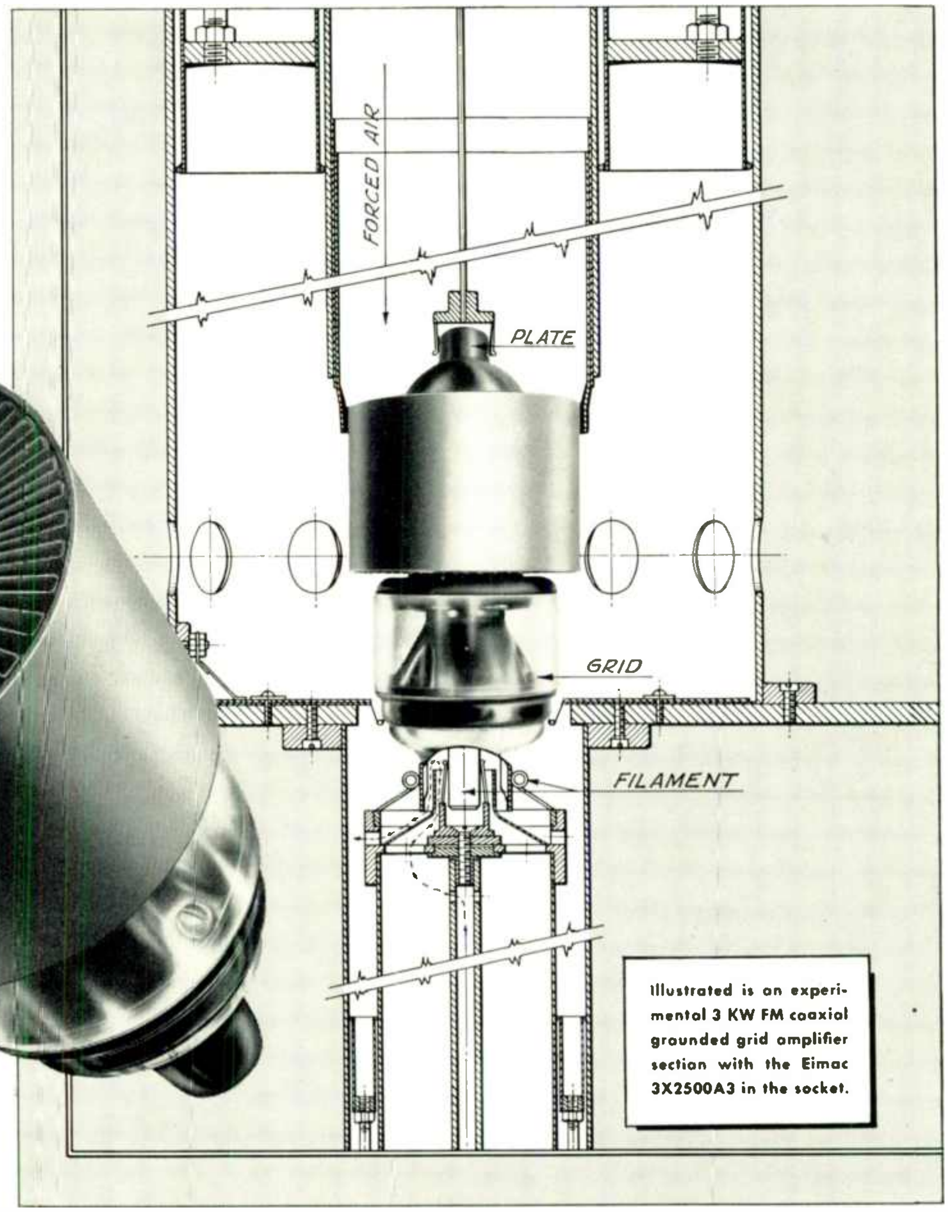
[2]Gore Publishing Co. — M
231 SE First Ave.
Ben Ackerman $20,700.

Eimac TUBES

THE COUNTERSIGN OF DEPENDABILITY IN ANY ELECTRONIC EQUIPMENT



EIMAC 3X2500A3



Illustrated is an experimental 3 KW FM coaxial grounded grid amplifier section with the Eimac 3X2500A3 in the socket.

READY FOR FM NOW

3500 watts (useful*) output at 88 to 108 mc

The radical and efficient mechanical design of this new Eimac external anode triode makes it ideal for use in any type transmitter circuit. For example, note in the illustration above how well the arrangement of the terminals enables it to fit into a grounded grid amplifier. Its design features will be very much appreciated in the efficient layout of FM transmitters—grounded grid or neutralized. In typical grounded grid operation at 110 mc, the Eimac 3X2500A3 will provide 3½ KW of useful* output with only 3000 volts on the plate. Furthermore, only 800 watts (approx.) of driving power are required for such operation. To get your FM transmitter on the air quickly and efficiently, use the new Eimac 3X2500A3 tube—tried and proven for the job. Complete technical data is available now. 1151

** Power actually delivered to the load.*

Typical Operation (110 mc., 1 tube)

D-C plate voltage	3000 volts
D-C plate current	1.6 amps.
D-C grid voltage	-350 volts
D-C grid current	250 ma.
Driving Power (Approx.)	800 watts
Plate dissipation (Approx.)	1500 watts
Total power output (Approx.)	3800 watts
Useful power output	3500 watts

FOLLOW THE LEADERS TO

Eimac REG. U. S. PAT. OFF. TUBES

EITEL-McCULLOUGH, INC.
1151L San Mateo Ave., San Bruno, Calif.
Plants located at: San Bruno, Calif. and Salt Lake City, Utah
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco 11, Calif., U.S.A.

CALL IN AN EIMAC REPRESENTATIVE FOR INFORMATION

ROYAL J. HIGGINS (W9A10)...600 S. Michigan Ave., Room 818, Chicago 5, Illinois. Phone: Harrison 5948.

V. O. JENSEN, General Sales Co., 2616 Second Ave., Seattle 1, Washington. Phone: Elliott 6871.

M. B. PATTERSON (W5C1)...1124 Irwin-Kessler Bldg., Dallas 1, Texas. Phone: Central 5764.

ADOLPH SCHWARTZ (W2CN)...220 Broadway, Room 2210, New York 7, N. Y. Phone: Cortland 7-0011.

HERB BECKER (W6QD)...1406 S. Grand Ave., Los Angeles 15, California. Phone: Richmond 6191.

TIM COAKLEY (W1KKP)...11 Beacon Street, Boston 8, Massachusetts. Phone: Capitol 0050.

CAUTION!

Check serial numbers on Eimac tubes before you buy. Be sure you're getting newest types. Look for latest serial numbers.

JACKSONVILLE
[2]City of Jacksonville WJAX M
[2]Florida Bcstg. Co. WMBR M
Ring & Clark $68,500.
[2]Jacksonville Bcstg. Corp. WPDQ M
[1]Metropolis Co. WJHP
Beecher Hayford $63,500.

MIAMI
[1]Paul Brake
3820 Wood Ave.
[1]Fort Industry Co. WFTL
[2]Isle of Dreams Bcstg. Corp. WIOD M
Jansky & Bailey $54,755.
[2]Miami Bcstg. Co. WQAM M
Ring & Clark $50,000.

MIAMI BEACH
[2]A. Frank Katzentine WKAT M
McNary & Wrathall
$24,500.

ORLANDO
[2]Orlando Daily Newspapers MR
238 S. Orange Ave.
Ring & Clark $60,000.

PENSACOLA
[1]Pensacola Bcstg. Co. WCOA
$24,900.

ST. AUGUSTINE
[1]Fountain of Youth Bcstg. Co. WFOY
Frank H. McIntosh
$12,600.

ST. PETERSBURG
[2]Pinellas Bcstg. Co. WTSP M
George C. Davis $57,500.

TAMPA
[1]Tampa Times Co. WDAE
Ring & Clark
[2]Tribune Co. WFL M
McNary & Wrathall
$63,360.

WEST PALM BEACH
[1]WJNO Inc. WJNO

GEORGIA

ATLANTA
[1]Atlanta Bcstg. Co. WATL
[1]Atlanta Journal Co. WSB
Frank McIntosh
$306,500.
[1]Board of Education E
[2]Constitution Pub. Co. M
148 Alabama SW
Ring & Clark $32,860.
[1]Liberty Bcstg. Corp. WAGA
$125,000.
[1]Wilson & Cope
75 Marietta St.

AUGUSTA
[2]Augusta Bcstg. Co. WRDW M
George C. Davis $36,700.
[2]Augusta Chronicle Bcstg. Co.

CEDARTOWN
[1]Northwest Ga. Bcstg. Co. WGAA
Lohnes & Culver $34,650.

COLUMBUS
[2]Columbus Bcstg. Co. WRBL M
Ring & Clark $46,360.
[2]Ga.-Ala. Bcstg. Corp. M
17 W. 12th St.
Ring & Clark $50,000.
[1]Valley Bcstg. Co. WDAK
Lohnes & Culver $41,900.

LA GRANGE
[1]LaGrange Bcstg. Co. WLAG
Holey & Hillegas $29,000.

MACON
[1]Macon-Telegraph Publishing Co.
450 Cherry St.
Ring & Clark $100,000.
[2]Middle Ga. Bcstg. Co. WBML M
George C. Davis $56,000.
[2]Southeastern Bcstg. Co. WMAZ M
George C. Davis $46,000.

MOULTRIE
[2]Frank R. Pidcock, Sr. WMGA M
George C. Davis $35,000.

ROME
[2]Rome Bcstg. Corp. WRGA M

SAVANNAH
[2]Atlantic Bcstg. Co.
[2]Savannah Bcstg. Co. WTOC M
Claude M. Gray $59,450.
[1]WSAV Inc. WSAV

VALDOSTA
[2]E. D. Rivers WGOV MR
McNary & Wrathall
$27,360.

IDAHO

BOISE
[2]Boise Bcstg. Station KIDO M
James Johntz, Jr.
$11,680.
[1]Queen City Bcstg. Co.,
66 Cobb Bldg., Seattle
$28,560.

NAMPA
[2]Frank E. Hurt and Son KFXD M

POCATELLO
[2]Radio Service Corp. KSEI M

TWIN FALLS
[1]Radio Bcstg. Corp. KTFI
Franklin U. Cox $16,400.
[1]H. Dudley Swim
113 Shoshone St., N

ILLINOIS

AURORA
[2]Copley Press, Inc. WCBS M
Ring & Clark $45,000.

BLOOMINGTON
[2]Radio Station WJBC WJBC M
A. James Ebel

BROOKFIELD
[2]George M. Ives $3,750. C

CARBONDALE
[2]Southern Ill. Bcstg. Corp. M
211 W. Main St. $24,500.

CHAMPAIGN
[2]Champaign News-Gazette, Inc. WDWS C
Paul F. Godley $15,800.

CHICAGO
[1]Agricultural Bcstg. Co. WLS
Jansky & Bailey
$130,600.
[1]Amalgamated Bcstg. System, Inc.
[1]American Bcstg. Co., Inc. WENR
$122,000.
[1]Balaban & Katz Corp. WBKB
Capt. W. C. Eddy
$61,200.
[1]Chicago Federation of Labor WCFL
Edwards & Martin
$30,405.36
[1]Drovers Journal Pub. Co. WAAF
McNary & Wrathall
$63,500.
[1]Dual Engineering Corp.
767 Milwaukee Ave.
E. C. Horstman $70,550.
[1]International Union
411 W. Milwaukee,
Detroit $110,500.
[1]Johnson Kennedy Radio Corp. WIND
George C. Davis $34,000.
[1]Knight Radio Corp.
44 E. Exchange St.,
Akron, O. $100,000.
[1]Lincoln-Belmont Pub. Co. and Myers Pub. Co.
[1]National Bcstg. Co., Inc. WMAQ
$66,000.
[1]Oak Park Realty and Amusement Co., 1540 Bway, N.Y.C.
Jansky & Bailey
$104,000.
[1]Radio Station WAIT WAIT
John Barron $42,100.
[1]Radio Station WGES WGES
John Barron $42,100.
[1]Radio Station WSBC WSBC
[1]Raytheon Mfg. Co.
$75,000.
Waltham, Mass.
[1]Telair Co.
1700 Firestone Pkwy.,
Akron, O.
[4]WBBM-FM Columbia Bcstg. System M
99.3 mc. No. 257 (46.7 mc.)
[4]WBEZ Bd of Education (42.5 mc.) E
[4]WDLM Moody Bible Institute WMBI M
99.7 mc. No. 259 (47.5 mc.)
[4]WEHS WHFC Inc. WHFC M
100.1 mc. No. 266 (48.3 mc.)
[4]WGNB WGN Inc. WGN M
98.9 mc. No. 255 (45.9 mc.)
[1]WJJD Inc. WJJD
George C. Davis
[4]WWZR Zenith Radio Corp. M
98.5 mc. No. 253 (45.1 mc.)

DECATUR
[1]Commodore Bcstg., Inc. WSOY
John Barron $47,800.

ELGIN
[1]Copley Press, Inc.
164–168 DuPage St.
$45,000.

EAST ST. LOUIS
[1]Miss. Valley Bcstg. Co. WTMV
$39,550.

EVANSTON
[2]North Shore Bcstg. Co., Inc. C
1045 Chestnut Ave.,
Wilmette
Com. Rad. Equip. Co.
$16,675.
[2]Sentinel Radio Corp. C

FREEPORT
[2]Freeport Journal-Standard Pub. Co. M
12–16 N. Galena Ave.
Walter F. Kean $33,750.

HARRISBURG
[2]Harrisburg Bcstg. Co. WEBQ MR
J. B. Caraway, Jr.
$29,400.

HERRIN
[2]Orville W. Lyerla WJPF MR
John Barron $14,700.

JOLIET
[1]Copley Press, Inc.
78 N. Scott St. $45,000.

KANKAKEE
[2]Kankakee Daily Journal M

MACOMB
[1]Western Ill. St. Teachers Coll. E

MT. VERNON
[2]Midwest Bcstg. Co. M
107½ Tent St. $57,300.

PEORIA
[1]Commodore Bcstg., Inc.
357 N. Main St., Decatur
John Barron $69,050.
[1]F. F. McNaughton
[1]Mid-State Bcstg. Co.
[1]Midwest FM Network, Inc.
435 N. Michigan Ave., Chicago
G. W. Lang $45,000.
[1]Peoria Bcstg. Co. WMBD
Theodore A. Giles
$53,865.

QUINCY
[2]Lee Bcstg., Inc. WTAD M
George C. Davis $63,060.
[2]Quincy Newspapers, Inc. WSOY M
John Barron $72,050.

ROCKFORD
[2]Rockford Bcstrs., Inc. WROK M
George C. Davis $23,510.

ROCK ISLAND
[2]Rock Island Bcstg. Co. WHBF M
George C. Davis $120,000.

SPRINGFIELD
[1]Commodore Bcstg., Inc.
357 N. Main St., Decatur
$17,800.
[1]WCBS, Inc. WCBS
Wallace F. Wiley
$39,550.
[2]WTAX, Inc. WTAX

URBANA
[4]WIUC U. of Ill. (42.9 mc.) E

WAUKEGAN
[2]Keystone Printing Service M
116–120 Madison St.
A. James Ebel $47,050.

INDIANA

BLOOMINGTON
[1]Trustees of Ind. U. E

COLUMBUS
[2]Syndicate Theatres, Inc. M

CONNERSVILLE
[2]News-Examiner Co. M
406 Central Ave.
McNary & Wrathall
$26,130.

ELKHART
[2]Truth Pub. Co., Inc. WTRC M
Com. Rad. Equip. Co.
$100,000.

EVANSVILLE
[1]Tri-State Bcstg. Corp.
[4]WMLL Evansville On The Air WEOA-WGBF M
94.7 mc. No. 234 (44.5 mc.)
[4]WOWO-FM Westghse. Radio Stations M
95.9 mc. No. 240 (44.9 mc.)

FORT WAYNE
[1]Farnsworth Television & Radio WGL
Ring & Clark $40,000.
[1]Midwest FM Network, Inc. $15,000.
435 Michigan Ave., Chicago
[1]Northeastern Ind. Bcstg. Co.

GARY
[1]Gary Bcstg. Corp.
545 Broadway
Garo W. Ray $11,300.

HAMMOND
[1]Radio Station WJOB WJOB
Jansky & Bailey $12,860.

INDIANAPOLIS
[1]William H. Block Co.
50 N. Illinois St.
Albert Freeland $59,000.
[1]Capitol Bcstg. Corp. WISH
$60,000.
[1]Evansville on the Air, Inc. WEOA
$67,790.
[1]Indiana Bcstg. Corp. WIBC
Paul F. Godley $51,310.
[1]Indianapolis Bcstg., Inc. WIRE
Jansky & Bailey
$155,000.
[1]Scripps-Howard Radio, Inc.
1121 Union Central Bldg.
Cincinnati, Ohio
$100,000.
[1]Universal Bcstg. Co., Inc.
[4]WABW Associated Bcstrs., Inc. M
94.9 mc. No. 235 (47.3 mc.)
[1]WFBM, Inc. WFBM
John Barron $93,000.

KOKOMO
[2]Kokomo Bcstg. Corp. WKMO M
John Barron $25,500.

LAFAYETTE
[2]WFAM, Inc. WASK M
Jansky & Bailey $28,500.

MARION
[1]Chronicle Pub. Co., Inc.

MUNCIE
[1]Donald A. Burton WLBC
Com. Rad. Equip. Co.
$41,577.

NEW CASTLE
[1]Courier-Times, Inc.
218 S. Fourteenth St.
Jansky & Bailey $21,000.

SHELBYVILLE
[2]Shelbyville Radio, Inc. M
121 E. Washington St.
McNary & Wrathall
$24,870.

SOUTH BEND
WSBF South Bend Tribune WSBT M
101.3 mc. No. 267 (47.1 mc.)

TERRE HAUTE
[1]Banks of the Wabash, Inc. WBOW
John B. Caraway
$25,000.
[2]Wabash Valley Bcstg. Corp. M
308 Fairbanks Block

W. LAFAYETTE
[1]Trustees of Purdue U. E

IOWA

AMES
[1]Ia. St. Coll. of Agr. and Mech. Arts E

BURLINGTON
[2]Burlington Bcstg. Co. KBUR MR
Don Kessner $40,100.

CEDAR RAPIDS
Gazette Co. M
500 Third Ave., SE
George C. Davis $40,900.

DAVENPORT
[1]Tri-City Bcstg. Co. WOC
$50,000.

DES MOINES
[2]Central Bcstg. Co. WHO MR
Ring & Clark $125,000.
[2]Cowles Bcstg. Co. KRNT MR
[1]Kingsley H. Murphy KSO
Jansky & Bailey $58,500.

DUBUQUE
[2]Dubuque Bcstg. Co. WKBB MR
Com. Rad. Equip. Co.
$21,300.
[2]Telegraph-Herald KDTH MR
George C. Davis $44,010.

IOWA CITY
[3]KSUI State U. of Ia. (42.7 mc.) E

MASON CITY
[1]Lee Radio, Inc. $163,000. KGLO

WATERLOO
[2]Josh Higgins Bcstg. Co. KXEL MR
$94,500.

KANSAS

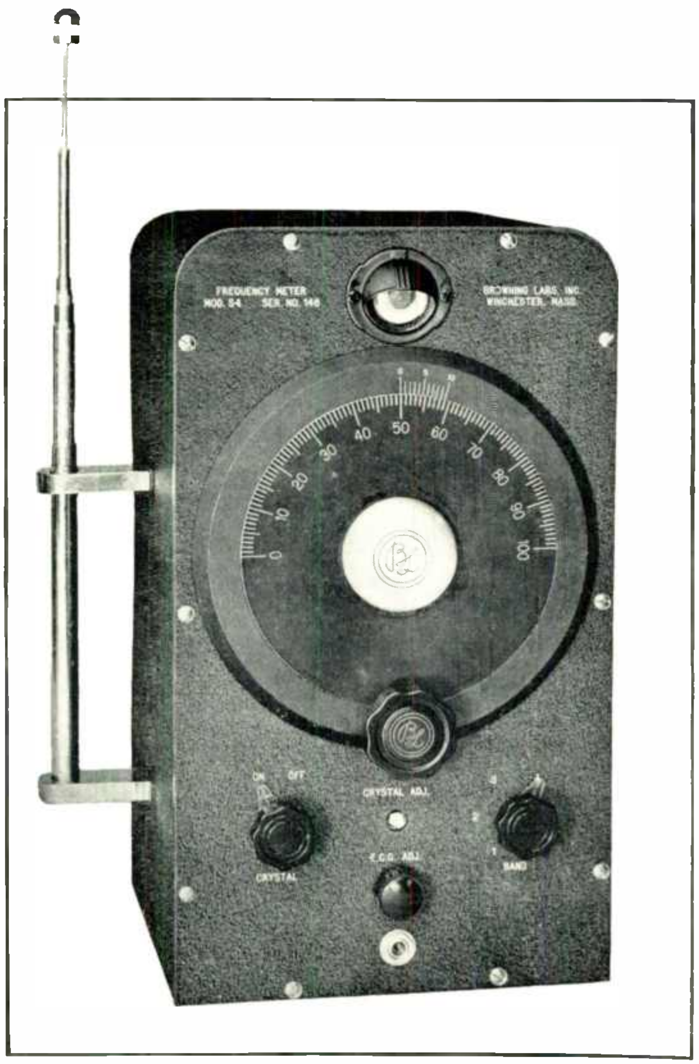
HUTCHINSON
[1]Hutchinson Pub. Co.
Lohnes & Culver
$62,000.

KANSAS CITY
[1]KCKN Bcstg. Co. KCKN

LAWRENCE
[2]World Co. M
722 Massachusetts St.
Com. Rad. Equip. Co.
$28,522.

TOPEKA
[2]Topeka Bcstg. Assn., Inc. WIBW M
K. G. Marquardt
$23,878.

WICHITA
[2]Farmers & Bankers Bcstg. Corp. KFBI M
George C. Davis $67,000.
[2]Radio Station KFH Co. KFH M
John Barron $110,550.
[2]Wichita Beacon Bcstg. Co. M



The new Model S4 meets all FCC requirements for the emergency services. AC-DC operation

A Message to Manufacturers of

EMERGENCY COMMUNICATIONS EQUIPMENT

Even before the war, some of the leading manufacturers of emergency radio equipment adopted the standard practice of including a BROWNING Frequency Meter in every quotation on new or replacement installations. There were sound reasons for this:

1. A precision frequency meter (accurate to plus-or-minus .0025%) is a necessary part of every communications system, because FCC rules require periodic frequency checks on each transmitter.

2. BROWNING Frequency Meters are widely preferred by radio supervisors not only because of their accuracy, but because they are so easy and quick to use.

If your representatives are not already including one or more of these BROWNING instruments in their quotations on AM or FM installations, we believe, from the experiences of other concerns, that it will be to their advantage to adopt this general practice in the future.

We'll be glad to furnish technical data and prices on request. Be sure to tell us the frequencies covered by the equipment you manufacture. Address:

BROWNING LABORATORIES, Inc.

WINCHESTER + MASSACHUSETTS

KENTUCKY

ASHLAND

[1]Ashland Bcstg. Co. $11,300. — WCMI

BEATTYVILLE

[4]WBKY U. of Ky. (42.9 mc.) — E

HENDERSON

[2]Henderson Bcstg. Co., Inc. $27,530. — WSON

HOPKINSVILLE

[1]Hopkinsville Bcstg. Co. McNary & Wrathall $11,480. — WHOP

LEXINGTON

[2]American Bcstg. Corp. — WLAP — M

LOUISVILLE

[2]Courier-Journal & Louisville Times Co. — WHAS — M

[2]Northside Bcstg. Corp. Perry W. Esten $41,000. — WGRC — M

[2]WAVE, Inc. Ring & Clark $100,000. — WAVE — M

OWENSBORO

[2]Owensboro Bcstg. Co., Inc. Ring & Clark $40,000. — WOMI — M

PADUCAH

[2]Paducah Bcstg. Co., Inc. McNary & Wrathall $24,700. — WPAD — M

[2]Paducah Newspapers, Inc. — M

WINCHESTER

[1]Winchester Sun Co., Inc. Wall & Cleveland Sts. McNary & Wrathall $16,630.

LOUISIANA

ALEXANDRIA

[2]Alexandria Bcstg. Co., Inc. $13,700. — KALB — M

[2]Central La. Bcstg. Corp. 530 Murray St. John Barron $12,850. — C

[1]James A. Noe Bernhardt Bldg., Monroe, La. $20,500.

BATON ROUGE

[4]WBRL Baton Rouge Bcstg. Co., Inc. 96.1 mc. No. 241 (44.5 mc.) — WJBO — M

[3]WLSU Bd. of Supervisors of La. St. U. and Agri. & Mech. Col. — E

LAKE CHARLES

[1]James A. Noe Bernhardt Bldg., Monroe, La. $25,500.

MONROE

[1]James A. Noe $25,000. — KNOE

NEW ORLEANS

[2]Loyola University $44,000. — WWL — M

[1]George A. Mayoral, William Cortada & Ramon Cortada 2490 Dreux Ave. $93,500.

[1]James A. Noe Frank McIntosh $138,000. — WNOE

[1]Stephens Bcstg. Co.

[2]Supreme Bcstg. Sys., Inc. — MR

[2]Times Picayune Pub. Co. 601 North St. John Barron $130,800. — M

SHREVEPORT

[1]James A. Noe Bernhardt Bldg., Monroe $20,500.

MAINE

AUGUSTA

[1]Gannett Publishing Co. 119 Exchange St. $31,333.

BANGOR

[2]Portland Bcstg. System 645-A Congress St., Portland $30,789.23 — WGAN — M

PORTLAND

[1]Portland Bcstg. System Roger W. Hodgkins $25,000. — WGAN

[1]Yankee Network, Inc.

MARYLAND

ANNAPOLIS

[2]Capital Bcstg. Co. Carvel Hall Hotel Glenn D. Gillett $32,350. — M

BALTIMORE

[2]A. S. Abell Co. Baltimore & Charles Sts. Jansky & Bailey $63,300. Atlas Bcstg. Co. 101 Old Town Bk. Bldg. McNary & Wrathall $40,610. — M

[2]Baltimore Bcstg. Corp. George C. Davis $18,360. — WCBM — M

[2]Baltimore Radio Show, Inc. John Barron $126,070. — WFBR — M

[2]Belvedere Bcstg. Corp. 1408 Kingsway Rd. Lohnes & Culver $37,750.

[1]Hearst Radio, Inc. Com. Rad. Equip. Co. $65,000. — WBAL

[2]Maryland Bcstg. Co. Jansky & Bailey $145,000. — WITH — M

[2]Monumental Radio Co. George C. Davis $16,560. — WCAO — M

FREDERICK

[2]Monocacy Bcstg. Co. George C. Davis $29,500. — WFMD — M

HAGERSTOWN

[2]Hagerstown Bcstg. Co. Martin Kiebert, Jr. $40,210. — WJEJ — M

OLNEY

[1]FM Dev. Foundation 970 National Press Bldg. Washington, D. C. Jansky & Bailey $133,500.

SALISBURY

[2]Peninsula Bcstg. Co. Ring & Clark $40,000. — WBOC

MASSACHUSETTS

BOSTON

[1]E. Anthony & Sons, Inc. 575 Pleasant St., New Bedford Paul F. Godley $141,000.

[1]Columbia Bcstg. System $198,000. — WEEI

[1]Fidelity Bcstg. Corp. 80 Mason St. Jansky & Bailey $66,000.

[1]Matheson Radio Co., Inc. $45,000. — WHDH

[1]Northern Corp.

[1]Templetone Radio Mfg. Corp. New London

[1]Unity Bcstg. Corp.

[4]WBZ-FM Westgse. Radio Stations 100.7 mc. No. 264 (46.7 mc.) — M

BROCKTON

[2]Cur-Nan Co. 10 Postoffice Sq., Boston Garo W. Ray $16,000. — C

[1]Enterprise Pub. Co. 60 Main St. Jansky & Bailey $36,500.

[1]Mitchell G. Meyers, Ruben Aronheim and Milton H. Meyers 717 Main St., Fitchburg R. W. Hodgkins $16,700.

CAMBRIDGE

[1]Harvey Radio Labs. 447 Concord Ave. $27,700.

FALL RIVER

[2]Fall River Bcstg. Co. Raymond M. Wilmotte $33,000. — WSAR — M

FITCHBURG

[2]Mitchell G. Meyers, Ruben E. Aronheim and Milton H. Meyers — WEIM — M

GREENFIELD

[2]John W. Haigis Thomas R. Humphrey $19,500. — WHAI — C

[2]Recorder Publishing Corp. 397 Main St. Jansky & Bailey $42,500. — C

HAVERHILL

[2]Haverhill Gazette Co. 179 Merrimac St. Frank McIntosh $28,725. — M

HOLYOKE

[2]Hampden-Hampshire Corp. Lohnes & Culver $80,000. — WHYN — M

LAWRENCE

[2]Hildreth & Rogers Co. George C. Davis $19,060. — WLAW — M

LOWELL

[1]Merrimac Bcstg. Co. — WLLH

NEW BEDFORD

[1]E. Anthony & Sons, Inc. Paul F. Godley $29,435. — WNBH

[2]Bay State Bcstg. Co. 229 Coffin Ave. Jansky & Bailey $76,500.

Bristol Bcstg. Co., Inc. — WOCB — M

NORTH ADAMS

[2]James A. Hardman 25 Bank St. Paul Godley $42,800. — M

PAXTON

[4]WGTR The Yankee Network, Inc. 103.1 mc. No. 276 (44.3 mc.) — M

PITTSFIELD

[2]Eagle Publishing Co. 33 Eagle St. Paul F. Godley $60,000. — C

[2]Monroe B. England McNary & Wrathall $23,400. — WBRK — M

SALEM

[2]North Shore Bcstg. Co. — WESX — C

SPRINGFIELD

[4]WBZA-FM Westgse. Radio Stations 97.1 mc. No. 246 (48.1 mc.) — M

[2]WMAS, Inc. — WMAS — M

WALTHAM

[1]Raytheon Mfg. Co. Foundry Ave. Raymond M. Wilmotte $75,000.

WORCESTER

[4]WTAG-FM Worcester Tele. Pub. Co. 102.7 mc. No. 274 (46.1 mc.) — M

MICHIGAN

ANN ARBOR

[2]Washtenaw Bcstg. Co. — WPAG — M

[3]WATX Regents of U. of Mich. (42.1 mc.)

BATTLE CREEK

[1]Federated Pub., Inc. $13,000. — WELL

BAY CITY

[1]Bay Bcstg. Co., Inc. Jansky & Bailey $40,000. — WBCM

BENTON HARBOR

[2]Palladium Pub. Co. 61–65 Wall St. Raymond M. Wilmotte $31,450. — M

DEARBORN

[2]Herman Radner Frank H. McIntosh $16,100. — WIBM — C

DETROIT

[3]Board of Education — E

[1]James F. Hopkins $14,000. — WJBK

[2]King-Trendle Bcstg. Corp. Edwards & Martin $33,460. — WXYZ — M

[1]Knight Radio Corp. 44 E. Exchange St., Akron, O. $100,000.

[1]Telair Co. 1700 Firestone Pky., Akron, O.

[2]UAW-CIO Bcstg. Corp. John J. Keel $110,500. — WJBK — M

[4]WENA Evening News Assn. 96.9 mc. No. 245 (44.5 mc.) — WWJ — M

[4]WLOU John Lord Booth 96.5 mc. No. 243 (44.9 mc.) — WJLB — M

[2]WJR, The Goodwill Station C. C. Jinks $100,000. — WJR — M

ESCANABA

[2]John P. Norton 520 Third Ave., S $23,000. — M

FLINT

[2]Flint Bcstg. Co. George C. Davis $21,500. — WFDF — M

[1]International Union 411 W. Milwaukee, Detroit $34,250.

GRAND RAPIDS

[1]Fetzer Bcstg. Co. John Fetzer $93,000. — WJEF

[1]Grand Rapids Bcstg. Corp. 1325 Underwood Ave., SE A. James Ebel $33,100.

[1]King-Trendle Bcstg. Corp. $41,545. — WOOD

[1]Lear, Inc. 1480 Buchanan Ave., SW

[1]Midwest FM Network, Inc. 435 N. Michigan Ave., Chicago $45,000.

[1]Leonard A. Versluis George C. Davis $28,000. — WLAV

JACKSON

[1]WIBM, Inc. Frank H. McIntosh $8,100. — WIBM

KALAMAZOO

[1]Western Mich. Coll. of Education — E

LANSING

[2]WJIM, Inc. C. L. Bredy $11,850. — WJIM — MR

MUSKEGON

[2]Ashbacker Radio Corp. Edwards & Martin $12,000. — WKBZ — M

PONTIAC

[2]Pontiac Bcstg. Co. McNary & Wrathall $106,030. — WCAR — M

PORT HURON

[2]Times Herald Co. 907 Sixth St. George C. Davis $44,300. — M

ROYAL OAK

[1]Royal Oak Bcstg. Co. — WEXL

SAGINAW

[2]Saginaw Bcstg. Co. Frank H. McIntosh $26,500. — WSAM — M

WYANDOTTE

[2]Wyandotte News Co. 3042 First St. C. H. Wesser $16,260. — C

MINNESOTA

DULUTH

[1]Elmer A. Benson Appleton, Minn. $27,000.

MANKATO

[2]F. B. Clements & Co. George C. Davis $50,360. — KYSM

MINNEAPOLIS-ST. PAUL

[1]Henry H. Bank and H. Z. Mendow Hodgson Bldg.

[1]Elmer A. Benson Appleton, Minn.

[1]Columbia Bcstg. Sys., Inc. $91,700. — WCCO

[2]Independent Merchants Bcstg. 1730 Hennepin Ave. George C. Davis $60,000.

[2]Minn. Bcstg. Corp. McNary & Wrathall $109,860. — WTCN — M

MOORHEAD

[1]KVOX Bcstg. Co. John Barron $20,800. — KVOX

ROCHESTER

[1]Elmer A. Benson $27,000. Appleton, Minn.

[2]Southern Minn. Bcstg. Co. Ring & Clark $60,200. — KROC — M

ST. CLOUD

[1]Times Publishing Co. Com. Rad. Equip. Co. — KFAM

ST. PAUL

[2]KSTP, Inc. B. Ross Hilker $225,000. — KSTP — MR

[2]WMIN Bcstg. Co. $51,360. — WMIN — M

WINONA

[1]Winona Radio Service John Barron $61,050. — KWNO

MISSISSIPPI

CLARKSDALE

[2]Birney Imes, Sr. — WROX — M

COLUMBUS

[1]Maj. Birney Imes, Jr. — WCBI

JACKSON

[2]Lamar Life Ins. Co. — WJDX — MR

MERIDIAN

[1]Maj. Birney Imes, Jr. Gilmer Hotel, Columbus

TUPELO

[1]Maj. Birney Imes, Jr. — WELO

MISSOURI

COLUMBIA

[1]Stephens College

JOPLIN

[2]Joplin Bcstg. Co. John Barron $14,350. — WMBH

KANSAS CITY

[2]Kansas City Star Co. John Barron $170,850. — WDAF — M

[1]KCKN Bcstg. Co. 901 N. 8 St., Kansas City, Kan.

[1]KCMO Bcstg. Co. — KCMO

[3]KICR School District

[4]KMBC-FM Midland Bcstg. Co. 97.9 mc. No. 250 (46.5 mc.) — M

[4]KOZY Com. Rad. Equip. Co. 99.9 mc. No. 260 (44.9) — M

[2]WHB Bcstg. Co. Ring & Clark $50,000. — WHB — M

ST. JOSEPH

[1]KFEQ, Inc. — KFEQ

ST. LOUIS

[1]Board of Education — E

[1]Columbia Bcstg. System $91,700. — KMOX

[1]Globe-Democrat Pub. Co. 1133 Franklin Ave. McNary & Wrathall $148,000.

[2]Missouri Bcstg. Corp. Com. Rad. Equip. Co. $30,000. — WIL — M

[2]Thomas Patrick, Inc. John Barron $106,846. — KWK — M

[2]Pulitzer Publishing Co. KSD M
Robert L. Coe $33,860
[2]St. Louis University WEWM
Frank H. McIntosh
[2]Star-Times Publishing Co. KXOK M
A. F. Reckert $23,100.

SPRINGFIELD

[1]Springfield Bcstg. Co. KGBX
Com. Rad. Equip. Co. $161,300.

NEBRASKA

LINCOLN

[2]Cornbelt Bcstg. Corp. KFOR M
$102,200.
[1]KFAB Bcstg. Co. KFAB
George C. Davis $97,000.

OMAHA

[1]Central States Bcstg. Co. KOIL
George C. Davis $173,000.
[2]Inland Bcstg. Co. KBON M
Com. Rad. Equip. Co. $37,700.
[2]World Publishing Co. KOWH MR
Glenn D. Gillett $39,000.

NEVADA

LAS VEGAS

[2]Nevada Bcstg. Co. $8,500. KENO C

RENO

Reno Newspapers, Inc. M
123 N. Center St.
Marvin Selmes $51,935.

NEW HAMPSHIRE

CLAREMONT

[2]Claremont Eagle, Inc. M
19 Sullivan St.
R. M. Wilmotte $26,750.

MANCHESTER

[2]Harry M. Bitner WFEA M
[2]Radio Voice of N.H., Inc. WMUR M
Jansky & Bailey

MT. WASHINGTON

[4]WMTW The Yankee Network, Inc. R
98.1 mc. No. 251 (43.9 mc.)

PORTSMOUTH

[2]WHEB, Inc. WHEB M

NEW JERSEY

ALPINE

[4]WFMN E. H. Armstrong M
98.9 mc. No. 255 (43.1 mc.)

ASBURY PARK

[2]Asbury Park Press, Inc. C
605 Mattison Ave.
Paul F. Godley $38,350.

ATLANTIC CITY

[2]Neptune Bcstg. Corp. WFPG M
[2]Press-Union Pub. Co. WBAB M
Paul F. Godley $31,400.

BRIDGETON

[2]Eastern States Bcstg. Corp. WSNJ M
John Barron $35,050.

JERSEY CITY

[1]Bremer Bcstg. Corp. WAAT M

NEWARK

[1]Evening News Pub. Co.
215 Market St.
Paul F. Godley $119,400.
[1]Fidelity Media Bcstg. Corp.
222 Tonnele Ave., Jersey City
Paul F. Godley $42,600.
[1]International Union
411 W. Milwaukee, Detroit $110,500.
[1]N. J. Bcstg. Corp. WHOM
W. C. Lent $36,500.
[1]North Jersey Radio, Inc.
[1]Radio Projects, Inc.
[3]WRGO Bd. of Education

NEW BRUNSWICK

[2]Home News Pub. Co. C
127 Church St.
W. C. Lent $46,000.

PASSAIC

[1]Passaic Daily News
140 Prospect St.
Paul F. Godley $39,810.

PATERSON

[1]North Jersey Bcstg. Co., Inc. WPAT
Ring & Clark $45,000.
[2]Passaic Daily News C

TRENTON

[2]Mercer Bcstg. Co. M
10 S. Stockton St.
R. M. Wilmotte $20,450.
[1]Trent Bcstg. Corp. WTTM

NEW MEXICO

ALBUQUERQUE

[1]Regents of the U. of N. M. E

NEW YORK

ALBANY

[1]WOKO, Inc. WOKO
Jansky & Bailey $19,200.

BINGHAMTON

[4]WNBF-FM W. B. Jones Adv. Agency M
96.3 mc. No. 242 (44.9 mc.)

BROOKLYN

[1]Frequency Bcstg. Corp.
1250 Atlantic Ave.
R. M. Wilmotte $79,500.
[1]Elias I. Godofsky
26 Court St. $46,800.

BUFFALO

[2]Roy L. Albertson WBNY M
R. M. Wilmotte $58,700.
[1]Buffalo Bcstg. Corp. WGR
George C. Davis $39,000.
[2]WBEN, Inc. WBEN MR
Paul F. Godley $193,530.
[3]WCAH Bd. of Education E
(42.9 mc.)
[2]WEBR, Inc. WEBR M
Ring & Clark $125,000.

CORAM

[1]Suffolk Bcstg. Corp.

CORNING

[2]Evening Leader M
114 Walnut St.
Com. Rad. Equip. Co. $21,360.

DUNKIRK

[2]Dunkirk Printing Co. C
8–10 E. Second St.
Com. Rad. Equip. Co. $25,300.

ELMIRA

[2]Elmira-Star-Gazette, Inc. WENY
George C. Davis $60,000.

FLORAL PARK

[1]Board of Education E
Sewanhaka High School

HORNELL

[2]W. H. Greenhow Co. MR
85 Canisteo St. $31,160.

ITHACA

[2]Cornell University WHCU R
True McLean $35,000.

JAMAICA

[1]Radio Projects, Inc.
Rm. 2201, 233 Bway, N.Y.C.
Jansky & Bailey $25,050.

JAMESTOWN

[2]James Bcstg. Co., Inc. WJTN M
Jansky & Bailey $39,560.

KINGSTON

[1]Kingston Bcstg. Corp. WKNY

MOUNT VERNON

[1]Hudson Bcstg. System
1775 Broadway, N.Y.C.
$19,050.

NEW YORK CITY

[1]Amalgamated Bcstg. Sys.
11–15 Union Sq.
[1]American Bcstg. Co., Inc. WJZ
Kear & Kennedy
$41,750.
[1]Book of the Month Club Bcstg. Corp.
385 Madison Ave.
R. M. Wilmotte $62,300.
[1]Edgar C. Brown
180 W. 135th St.
[1]Debs Mem. Radio Fund WEVD
R. M. Wilmotte $45,100.
[1]Bernard Fein $22,900.
26 Pinecrest Drive
Hastings-on-the-Hudson
[1]William G. H. Finch
[1]Greater N. Y. Bcstg. Corp. WNEW
Glenn D. Gillett $37,500.
[1]Hearst Radio, Inc. WINS
Com. Rad. Equip. Co. & Herbert L. Wilson
$65,000.
[1]Metropolitan Bcstg. Ser.
111 Broadway
McNary & Wrathall
$40,000.
[1]News Syndicate Co., Inc.
220 E. 42 St.
H. L. Wilson $50,000.
[1]N.Y. Sun Bcstg. Co., Inc.
Rm. 736, 280 Bway
$91,000.
[1]NMW Bcstg. Co., Inc.
346 W. 17 St.
[1]Peoples Radio Foundation, Inc.
100 Fifth Ave. $19,500.
[1]Supreme Bcstg. Sys., Inc.
37–21 85 St. $93,500.
Jackson Heights, L.I.
[4]WABC-FM CBS, Inc. M
96.9 mc. No. 245 (46.7 mc.)
[1]WABF Metropolitan Television, Inc. M
98.5 mc. No. 253 (47.5 mc.)
[4]WBAM Bamberger Bcstg. Ser., Inc. WOR M
96.5 mc. No. 243 (47.1 mc.)
[1]WCUV Columbia U.
[3]WBNX Bcstg. Co., Inc. WBNX
H. L. Wilson $30,700.
[4]WEAF-FM National Bcstg. Co., Inc. M
97.3 mc. No. 247 (45.1 mc.)
[4]WGYN Muzak Radio Bcstg. Stn., Inc. M
96.1 mc. No. 241 (44.7 mc.)
[4]WHNF Marcus Loew Booking Agency WHN M
99.3 mc. No. 257 (46.3 mc.)
[1]WLIB, Inc. WLIB
Kear & Kennedy
$68,860.
[1]WMCA, Inc. WMCA
Kear & Kennedy
$40,000.
[4]WNYC-FM Municipal Bcstg. Sys. M
94.5 mc. No. 233 (43.9 mc.)
[4]WNYE Bd. of Education, Brooklyn (42.1 mc.) E
[4]WQXQ Interstate Bcstg. Co. WQXR M
97.7 mc. No. 249 (45.9 mc.)

OGDENSBURG

[2]St. Lawrence Bcstg. Corp. WSLB R
$16,250.

OSWEGO

[2]Palladium-Times, Inc. M
172–176 W. First St.
Com. Rad. Equip. Co.
$14,610.

POUGHKEEPSIE

[1]Poughkeepsie Newspapers, Inc. WKIP
Com. Rad. Equip. Co.
$46,000.

ROCHESTER

[2]Amalgamated Bcstg. System, Inc. M
[1]Monroe Bcstg. Co., Inc.
191 E. Ave.
Jansky & Bailey $60,000.
[4]WHEF WHEC, Inc. WHEC M
98.5 mc. No. 253 (44.7 mc.)
[4]WHFM Stromberg-Carlson Co. WHAM M
98.9 mc. No. 255 (45.1 mc.)

SCHENECTADY

[4]WBCA Capitol Bcstg Co., Inc. MBS M
101.1 mc. No 266 (44.7 mc.)
[4]WGFM General Elec. Co. WGY M
100.7 mc. No. 264 (48.5 mc.)

SYRACUSE

[2]Central N.Y. Bcstg. Corp. WSYR M
John Barron $22,000.
[2]Onondaga Bcstg. Corp. WFBL M
Lohnes & Culver $28,624.
[2]Radio Projects, Inc. M
[2]Syracuse Bcstg. Corp. WOLF M
[2]WAGE, Inc. WAGE M
C. W. Brannen $27,750.

TROY

[1]Troy Bcstg. Co., Inc. WTRY
Lohnes & Culver $52,218.
[2]Troy Record Co. M
501 Broadway
John Barron $55,850.

UTICA

[2]WIBX, Inc. WIBX M
John Barron $41,300.

WATERTOWN

[2]Brockway Co. WWNY M
George C. Davis $35,060.

WEST NEW BRIGHTON

[1]Radio Projects, Inc.
Rm. 2201, 233 Bway, N.Y.C. $17,550.

WHITE PLAINS

[2]Westchester Bcstg. Corp. WFAS C
McNary & Wrathall
$60,760.

NORTH CAROLINA

BURLINGTON

[2]Alamance Bcstg. Co., Inc. WBBB M
George C. Davis $24,500.

CHARLOTTE

[2]Southeastern Bcstg. Co. WBT M
[1]Southeastern Bcstg. Co. WBT
Ring & Clark $66,000.

DURHAM

[2]Durham Radio Corp. WDNC M
Raymond M. Wilmotte

FAYETTEVILLE

[2]Cape Fear Bcstg. Co. WFNC M
Lohnes & Culver $15,000.

GASTONIA

[2]F. C. Todd WGNC MR

GOLDSBORO

[1]Eastern Carolina Bcstg. Co. WGBR
John Barron $34,100.

GREENSBORO

[1]Greensboro Bcstg. Co., Inc. WGBG
John Barron $27,300.
[2]Greensboro News Co. M
N. Davis & Gaston Sts.
Lohnes & Culver $79,800.
[1]N. C. Bcstg. Co., Inc. WBIG
Ring & Clark $75,000.

HICKORY

[2]Catawba Valley Bcstg. Co. WHKY MR

HIGH POINT

[2]High Point Enterprise, Inc. M
[2]Radio Station WMFR WMFR M
John Barron $14,800.

RALEIGH

[1]News & Observer Pub. Co.
[2]WPTF Radio Co. WPTF MR
McNary & Wrathall
$118,610.

ROANOKE RAPIDS

[2]Telecast, Inc. M
Paul F. Godley $29,280.
[2]WCBT, Inc. WCBT M
George C. Davis $35,000.

ROCKY MOUNT

[2]Josh L. Horne M
150 Howard St.
John Barron $35,300.
[2]William Avera Wynne WEED M
George C. Davis $36,000.

SALISBURY

[2]Piedmont Bcstg. Corp. WSTP M
Lohnes & Culver $41,500.

WASHINGTON

[2]Tar Heel Bcstg. Sys., Inc. WRRF M
George C. Davis $32,500.

WILMINGTON

[2]Richard Austin Dunlea WMFD M
Ring & Clark $30,000.
[2]Wilmington Star-News Co. M
Murchison Bldg.
R. M. Wilmotte $53,340.

WILSON

[1]P. D. Gold Pub. Co.
113 Rear Goldsboro
John Barron $27,200.
[1]Penn Thomas Watson WGTM
McNary & Wrathall
$69,800.

WINSTON-SALEM

[1]Piedmont Pub. Co. WSJS
John Barron
[2]WAIR Bcstg. Co. WAIR M
George C. Davis $57,000.
[4]WMIT Gordon Gray WSJS R
97.3 mc. No. 247 (44.1 mc.)

NORTH DAKOTA

FARGO

[1]Northwest Bcstg. Co.
Gardner Hotel

OHIO

AKRON

[1]Akron Radio Corp.
2200 First Central Tower
John Barron $44,800.
[1]Knight Radio Corp.
44 E. Exchange St.
Ring & Clark $125,000.
[1]Allen T. Simmons WADC
George C. Davis $49,000.
[1]Summit Radio Corp. WAKR
Kear & Kennedy $26,610.
[1]Telair, Inc.
1200 Firestone Parkway
Paul F. Godley $67,350.
[1]United Bcstg. Co. $53,600. WHKK

ALLIANCE

[2]Review Publishing Co. M
28–32 Linden Ave.
Jansky & Bailey $23,550.

ASHLAND

[2]Beer and Koehl $30,000. MR
40–46 E. Second St.

ASHTABULA

[1]WICA, Inc. WICA
John Barron $31,050.

ATHENS

[2]Messenger Publishing Co. M
43 W. Union St.
Glenn D. Gillett $26,500.

BELLAIRE

[1]Tri-City Bcstg. Co.
3266 Guernsey St.
Odes E. Robinson
$34,500.

CANTON

[1]Ohio Bcstg. Co. $30,500. WHBC

CINCINNATI

[2]Buckeye Bcstg. Co. WJJD M
George C. Davis $139,000.
[2]Cincinnati Times Star Co. WKRC MR
G. A. Wilson $76,500.
[2]Crosley Corp. WLW M
Ring & Clark
[2]Scripps-Howard Radio, Inc. WNOX M
Ring & Clark $200,000.
[2]L. B. Wilson, Inc. WCKY M
Ring & Clark $150,000.

CLEVELAND

[1]Cleveland Bcstg., Inc.
1708 Union Commerce Bldg.
[1]International Union
411 W. Milwaukee, Detroit $110,500.

LONG SCALE, WIDE RANGE VOLT-OHM-MILLIAMMETER

DOUBLE SENSITIVITY D. C. VOLT RANGES
0-1.25-5-25-125-500-2500 Volts, at 20,000 ohms per volt for greater accuracy on Television and other high resistance D.C. circuits.
0-2.5-10-50-250-1000-5000 Volts, at 10,000 ohms per volt.

A. C. VOLT RANGES
0-2.5-10-50-250-1000-5000 Volts, at 10,000 ohms per volt.

OHM-MEGOHMS
0-400 ohms (60 ohms center scale)
0-50,000 ohms (300 ohms center scale)
0-10 megohms (60,000 ohms center scale)

DIRECT READING OUTPUT LEVEL DECIBEL RANGES
−30 to +3, +15, +29, +43, +55, +69 DB

TEMPERATURE COMPENSATED CIRCUIT FOR ALL CURRENT RANGES D.C. MICROAMPERES
0-50 Microamperes, at 250 M.V.

D. C. MILLIAMPERES
0-1-10-100-1000 Milliamperes, at 250 M.V.

D. C. AMPERES
0-10 Amperes, at 250 M.V.

OUTPUT READINGS
Condenser in series with A.C. Volts for output readings.

ATTRACTIVE COMPACT CASE
Size: 2½" x 5½" x 6". A readily portable, completely insulated, black, molded case, with strap handle. A suitable black, leather carrying case (No. 629) also available, with strap handle.

LONG 5" SCALE ARC
For greater reading accuracy on the Triplett RED • DOT Lifetime Guaranteed meter.

SIMPLIFIED SWITCHING CIRCUIT
Greater ease in changing ranges.

Write for descriptive folder giving full technical details

Precision first ...to last

Triplett

STANDARDS ARE SET BY TRIPLETT

ELECTRICAL INSTRUMENT CO. BLUFFTON, OHIO

[1]National Bcstg. Co., Inc. $190,000. — WTAM
[1]Scripps-Howard Radio, Inc. 1121 Union Central Bldg. Cincinnati $100,000.
[1]Telair Co. 1200 Firestone Parkway, Akron
[1]United Bcstg. Co. $130,000. — WHK
[1]United Garage & Ser. Corp. 2020 W. Third St. May, Bond & Rothrock $66,300.
[4]WBOE Bd. of Education (42.5 mc.) — E
[1]WGAR Bcstg. Co. Ring & Clark $175,000. — WGAR
[1]WJW, Inc. $70,000. — WJW

COLUMBUS

[1]Crosley Corp. $225,000. — WLW
[1]Ohio Council of Farm Cooperatives. 16 E. Broad St.
[1]The Pixleys Robert C. Higgy $81,100. — WCOL
[1]United Bcstg. Co. $97,060. — WHKC
[1]Unity Corp. $19,650. 1014 Edison Bldg., Toledo
[4]WELD WBNS, Inc. 94.5 mc. No. 233 (44.5 mc.) — WBNS — M

DAYTON

[1]Crosley Corp. $160,000. 9th & Elm Sts., Cincinnati
[1]Great Trails Bcstg. Corp. George C. Davis $53,000. — WING
[1]Miami Valley Bcstg. Corp. Frank McIntosh $40,200. — WHIO

DOVER

[1]Tuscora Bcstg. Co. 350–62 Reporter Ct.

EAST LIVERPOOL

[1]Ohio Bcstg. Co. $43,350. — WHBC

FINDLAY

[1]Findlay Radio Co. $20,000. — WFIN

FOSTORIA

[2]Laurence W. Harry 920 N. County Line St. $7,754. — C
[1]Lucian E. Kinn 963 N. Union St.

FREMONT

[2]Robert F. Wolfe Co. RFD No. 1 $38,500. — C

HAMILTON

[2]Fort Hamilton Bcstg. Co. Robert C. Higgy $7,800. — WMOH — C

JACKSON

[1]Board of Education — E

LIMA

[1]Unity Corp., Inc. $30,900. 1014 Edison Bldg., Toledo

LORAIN

[1]Lorain Journal Co.

MANSFIELD

[1]Mansfield Journal Co.
[1]Richland, Inc. — WMAN
[1]Unity Corp. Inc. $19,650. 1014 Edison Bldg., Toledo!

MARION

[1]Marion Bcstg. Co. Robert C. Higgy $17,469.30. — WMRN
[1]Ohio Bcstg. Co. $24,250. — WHBC
[1]RadiOhio, Inc. $20,850. 33 N. High St., Columbus

NEWARK

[2]Advocate Printing Co. 25 W. Main St. Jansky & Bailey $80,000. — M

PORTSMOUTH

[1]RadiOhio, Inc. $24,850. 33 N. High St., Columbus

SPRINGFIELD

[1]RadiOhio, Inc. $22,850. 33 N. High St., Columbus
[1]Radio Voice of Springfield George C. Davis $24,000. — WIZE
[1]Unity Corp., Inc. $27,800. 1014 Edison Bldg., Toledo

STEUBENVILLE

[1]Valley Bcstg. Co. George C. Davis — WSTV

TOLEDO

[1]Board of Education — E
[2]Fort Industry Co. Jansky & Bailey $115,000. — WSPD
[1]Toledo Blade Co. 533 Superior St. Worthington C. Lent $57,700.
[2]Unity Corp., Inc. 1014 Edison Bldg. A. R. Bitter $59,100. — M

WARREN

[2]Nied and Stevens Paul F. Godley $25,900. — WRRN — C

WOOSTER

[1]Wooster Republican Ptg. 212 E. Liberty St. W. C. Lent $35,325.

YOUNGSTOWN

[2]WFMJ Bcstg. Co. McNary & Wrathall $72,695. — WFMJ — M
[2]WKBN Bcstg. Corp. McNary & Wrathall $115,060. — WKBN — MR

ZANESVILLE

[1]RadiOhio, Inc. $30,250. 33 N. High St., Columbus

OKLAHOMA

ARDMORE

[2]John F. Easley — KVSO — M

LAWTON

[2]Okla. Quality Bcstg. Co. — KSWO — M

MUSKOGEE

[2]Muskogee Bcstg. Co. 800 Manhattan Bldg. Paul F. Godley $38,000. — M
[1]Okla. Press Publishing Co. Com. Rad. Equip. Co. $22,300. — KBIX

NORMAN

[1]KOKU St. U. of Okla.

OKLAHOMA CITY

[2]KOMA, Inc. $98,060. — KOMA — MR
[2]Plaza Court Bcstg. Co. — KOCY — MR
[1]Sooner Bcstg. Co. 2712 First National Bldg.
[2]O. L. Taylor W. G. Egerton $135,300. — KTOK — M
[2]WKY Radiophone Co. McKey & Shaw — WKY — MR

SHAWNEE

[2]KGFF Bcstg. Co. Com. Rad. Equip. Co. $15,708. — KGFF — M

STILLWATER

[1]Okla. Agri. & Mech. College

TULSA

[2]Fred Jones Bcstg. Co. 1201 S. Boston St. John Barron $113,800. — M
[1]Tulsa Bcstg. Co. Paul F. Godley $118,600. — KTUL
[1]World Publishing Co. and Tulsa Tribune Co. 317 S. Boulder McNary & Wrathall $112,860.

WEATHERFORD

[1]R. H. Burton, Pres. Southwestern Inst. of Tech. — E

OREGON

EUGENE

Sch. Dist. No. 4, Lane County — E

GRANTS PASS

[1]Southern Ore. Bcstg. Co. $12,300. — KUIN

MEDFORD

[2]Medford Printing Co. George C. Davis $22,000. — KRNR — C
[2]Mrs. W. J. Virgin David H. Ross $15,300. — KMED — M

PORTLAND

[2]Broadcasters Oregon, Ltd. R. E. Tarbet, Grant R. Kelley $25,000. — M
[2]KALE, Inc. — KALE — M
[2]KOIN, Inc. Jansky & Bailey $40,000. — KOIN — M
[2]KXL Broadcasters John Barron $34,550. — KXL — MR
[2]Oregonian Publishing Co. Harold C. Singleton $64,230. — KGW — M
[2]Pacific Radio Advertising Ser. Harold C. Singleton — KWJJ — M
[1]Westinghouse Radio Stations, Inc. — KEX

PENNSYLVANIA

ALLENTOWN

[2]Lehigh Valley Bcstg. Co. John Barron $104,300. — WSAN — M

ALTOONA

[2]Gable Bcstg. Co. McNary & Wrathall $53,500. — WFBG — M

BEAVER FALLS

[1]Beaver County Bcstg. Corp. 622 Seventh Ave.
[1]Tribune Printing Co. 715 Thirteenth St. W. C. Lent $15,250.

BETHLEHEM

[1]Associated Broadcasters, Inc. 516 Northampton St., Easton $43,900.
[2]Bethlehem Globe Pub. Co. 202 W. Fourth St. Lohnes & Culver $65,700. — M

BRADFORD

[2]Bradford Publications, Inc. — M
43 Main St.
Jansky & Bailey $36,050.

BUTLER

[1]Butler Bcstg. Co. — WISR
George C. Davis $21,500.
[1]Eagle Printing Co., Inc.
114 116 W. Diamond St.
McNary & Wrathall

CLEARFIELD

Airplane and Marine Instruments, Inc. — M

DU BOIS

[2]Tri-County Bcstg. Co. — WCED

EASTON

[2]Easton Publishing Co. — C

ERIE

[2]Presque Isle Bcstg. Co. — WERC — M
[1]Unity Corp., Inc. $19,350.
1014 Edison Bldg., Toledo

HARRISBURG

[1]Keystone Bcstg. Corp. $60,000. — WKBO
[2]Patriot Co. — M
Paul F. Godley $48,260.
[2]WHP, Inc. — WHP — M
McNary & Wrathall $137,250.

HAZLETON

[1]Hazleton Bcstg. Ser., Inc. — WAZL
$43,900.

JOHNSTOWN

[4]WJAC, Inc. — WJAC — M
McNary & Wrathall $55,900.

LANCASTER

[2]Peoples Bcstg. Co. — M
R.D. 3
Lohnes & Culver $75,800.
[2]WGAL, Inc. — WGAL — M
McNary & Wrathall $40,900.

LEWISTOWN

[2]Lewistown Bcstg. Co. — WMRF — M
George C. Davis $12,950.

MEADVILLE

[2]H. C. Winslow — M
883 Water St.

NEW CASTLE

[1]WKST, Inc. — WKST
John Barron $21,050.

PHILADELPHIA

[1]Amalgamated Bcstg. System, Inc.
[1]Percy B. Crawford
P. O. Box 1
R. M. Wilmotte $35,000.
[1]Crescent Bcstg. Corp.
1017 Public Ledger Bldg.
[1]Gibraltar Service Corp. — WPEN
H. C. Vance $50,250.
[1]Independence Bcstg. Co. — WHAT
[1]Junto, Inc.
[4]KYW-FM West'g'se Radio St'ns — M
100.3 mc. No. 262 (45.7 mc.)
[1]Wm. Penn Bcstg. Co.
[1]Philadelphia Inquirer
400 N. Broad St.
W. C. Lent $150,500.
[1]Trustees of U. of Pa.
[4]WCAU-FM WCAU Bcstg. Co. — WCAU — M
102.7 mc. No. 274 (46.9 mc.)
[1]WDAS Bcstg. Station, Inc. — WDAS
Jansky & Bailey $42,950.
[4]WFIL-FM WFIL Bcstg. Co. — WFIL — M
103.1 mc. No. 276 (45.3 mc.)
[4]WIP-FM Pennsylvania Bcstg. Co. — M
97.5 mc. No. 248 (44.9 mc.)

PITTSBURGH

[1]Allegheny Bcstg. Corp. — KQV
Kear & Kennedy $92,250.
[4]KDKA-FM West'g'se Radio St'ns — M
94.1 mc. No. 231 (47.5 mc.)
[1]Liberty Bcstg. Co. $61,500.
708 Sinclair Bldg.
Steubenville, Ohio
[1]Pittsburgh Radio Supply House $21,850 — WJAS
[1]Scripps-Howard Radio, Inc.
1121 Union Central Bldg., Cincinnati $100,000.
[1]WCAE, Inc. — WCAE
James E. Wetherell and Leonard Kapner $33,580
[1]West Virginia Radio Corp.
446 Spruce St.
Morgantown, W. Va.
Jansky & Bailey $80,700.

POTTSVILLE

[1]Miners Bcstg. Service
Coal and E. Norwegian Sts.

READING

[1]Berks Bcstg. Co. — WEEU
Com. Rad. Equip. Co. $29,800.
[2]Hawley Bcstg. Co. — M
30 N. Fourth St
John Barron $26,100.
[1]Reading Bcstg. Co. — WRAW
George C. Davis $27,828.

SCRANTON

[2]Scranton Bcstrs. Inc. — WBGI — M
McNary & Wrathall $49,600.

SHARON

[1]Sharon Herald Bcstg. Co. — WPIC
McNary & Wrathall $56,110.

STATE COLLEGE

[1]Penna. State College

SUNBURY

[2]Sunbury Bcstg. Corp. — WKOK — M
George C. Davis $32,500.

UNIONTOWN

[2]Fayette Bcstg. Corp. — WMBS — M
George C. Davis $22,060.
[2]Uniontown Newspapers Inc. — MR

WASHINGTON

[1]Observer Publishing Co.
122 S. Main St.
W. C. Lent $28,050.
[1]Washington Bcstg. Co. — WJPA

WEST CHESTER

[1]State Teachers College

WILKES-BARRE

[2]Louis G. Baltimore $62,000 — WBRE — M
[1]Scranton-Wilkes-Barre-Pittston Bcstg. Co., Inc.
156 Prospect St.
R. M. Wilmotte $23,984.

WILLIAMSPORT

[2]WRAK, Inc. — WRAK — M
George C. Davis $35,060.

YORK

[2]Susquehanna Bcstg. Co. — WSBA — M
George C. Davis $29,860.
[2]White Rose Bcstg. Co. — M
35 E. King St.
[2]York Bcstg. Co. $40,900. — WORK

PUERTO RICO

SAN JUAN

[1]Puerto Rico Communications Authority
Salvador Brau between San Jose and Cristo Sts.
Gleason W. Kentrick $50,500.
[1]Radio Americas Corp.
4 Muella St.
Jansky & Bailey $24,500.

RHODE ISLAND

PAWTUCKET

[1]Pawtucket Bcstg. Co. — WCFI
McNary & Wrathall $37,360.

PROVIDENCE

[1]Cherry & Webb Bcstg. Co. — WPRO
McNary & Wrathall $90,000.
[1]Colonial Bcstg. Co.
635 Hospital Trust Bldg.
Glen Gillett $73,975.
[1]Outlet Co. $41,000. — WJAR
[1]Providence Journal Co.
75 Fountain St.
Jansky & Bailey $89,555.
[1]A. A. Schecter
RFD #2
Shinglehouse Road
Ossining, N. Y.
[1]Yankee Network, Inc. $67,000. — WEAN

SOUTH CAROLINA

ANDERSON

[2]Wilton E. Hall — WAIM — MR
G. C. Davis $48,000.

CHARLESTON

[2]Atlantic Coast Bcstg. Co. — WTMA — M
Ring & Clark $45,700.

COLUMBIA

[2]Surety Life Ins. Co. — WIS — M
Jansky & Bailey $116,000.

GREENVILLE

[2]Greenville News-Piedmont Co. — WFBC — M
Jansky & Bailey $122,100.
[2]Textile Bcstg. Co. — WMRC — M
John Barron $58,800.

GREENWOOD

[2]Grenco, Inc. — WCRS — M
McNary & Wrathall $20,860.

ROCK HILL

[2]York County Bcstg. Co. — WRHI — C
McNary & Wrathall $8,050.

SPARTANBURG

[2]Spartanburg Advertising Co. — WSPA — MR
Ring & Clark $175,000.
[1]Spartanburg Bcstg. Co. — WORD
$29,250.

TENNESSEE

BRISTOL

[2]Radiophone Bcstg. Station — WOPI

CHATTANOOGA

[2]Unity Bcstg. Corp. — M
1024 Hamilton Natl. Bk.
[1]WAPO Bcstg. Service — WAPO
[2]WDOD Bcstg. Corp. — WDOD — M
George C. Davis $58,000.
[1]Mark K. Wilson
406 Loveman Bldg.
O. K. Garland $51,300.

CLARKSVILLE

[2]William Kleeman — WJZM — M
[2]Leaf-Chronicle Co. — M
112 S. Second St.
George Reynolds $22,750.

JACKSON

[2]Sun Publishing Co., Inc. — WTJS — M
George C. Davis

JOHNSON CITY

[2]WJHL, Inc. — WJHL — M
W. G. Egerton $64,250.

KNOXVILLE

[2]S. E. Adcock — WROL — M
S. E. Adcock $60,000.
[1]American Bcstg. Corp. $14,860. — WBIR
[2]Knoxville Publishing Co. — M
618 S. Gay St.
Ring & Clark $100,000.

MEMPHIS

[2]Herbert Herff — M
295 Union Ave.
John Barron $42,800.
[1]Memphis Publishing Co. — WMC
George C. Davis $117,500.
[2]Hoyt B. Wooten — WREC — MR

NASHVILLE

[1]Nashville Radio Corp.
1100 Broadway $115,000.
[2]WSIX Bcstg. Station — WSIX — M
Ring & Clark $91,000.
[4]WSM-FM Nashville L. & A. Ins. — M
100.1 mc. No. 266 (44.7 mc.)

TEXAS

ABILENE

[2]Reporter Bcstg. Co. — KRBC — M
Com. Rad. Equip. Co. $25,000.

AMARILLO

[1]Amarillo Bcstg. Corp. — KFDA
[1]Plains Radio Bcstg. Co. — KGNC
W. G. Egerton $64,250.

AUSTIN

[1]Frontier Bcstg. Co., Inc. — KNOW
Com. Rad. Equip. Co. $39,860.

BEAUMONT

[2]KRIC, Inc. $23,500. — KRIC — M

BROWNSVILLE

[4]Brownsville Herald Pub. Co. — C
1263 SE Adams St.
Jansky & Bailey $13,350.

COLLEGE STATION

[2]Agricultural & Mechanical College of Texas — WTAW — M

DALLAS

[2]A. H. Belo Corp. — WFAA — M
A. Earl Cullum Jr. $98,300.
[2]KRLD Radio Corp. — KRLD — MR
Ring & Clark $175,000.

EL PASO

[1]Independent School Dist.
100 W. Rio Grande St.

FORT WORTH

[2]Carter Publications, Inc. — WBAP — MR
Ring & Clark $91,000.

GALVESTON

[2]KLUF Bcstg. Co., Inc. — KLUF — M
Com. Rad. Equip. Co. $25,000.

HARLINGEN

[2]Harbenito Bcstg. Co., Inc. — KGBS — M
[1]Valley Publishing Co.
213 S. Second St. $13,350.

HOUSTON

[2]Houston Printing Corp. — KPRC — M
George C. Davis $29,985.
[2]KTRH Bcstg. Co. — KTRH — M
George C. Davis $91,860.
[1]Lee Seegal Bcstg. Co.
Citizens Bank Bldg.
Texas Star Bcstg. Co. — KTHT
Com. Rad. Equip. Co. $136,500.
[1]U. of Houston

McALLEN

[1]Valley Evening Monitor, Inc.
21 S. 12th St. $13,350.

WMIT'S 337-MC. LINK

(CONTINUED FROM PAGE 43)

with that recorded in the early morning.

This does not mean that every day follows the same pattern, but over a long period of time, the average signal strength curve does have that general characteristic. Tropospheric disturbances are noticed frequently but occur with no particular regularity. It has been almost invariably true, however, that when the received signals reach the highest values, they are more subject to severe fades than at normal intensity.

The curves given in Fig. 10 show two examples of severe tropospheric fading. From our experience it would seem that when the signal is unusually strong, possibly as a result of reflection from high, billowy clouds, the chances of fading, brought about by air-masses or cloud formations blocking the signal path or causing other reflections which cancel out the original signal, are much more probable than under ordinary circumstances.

That is, the strength is highest in the early morning and late evening, and varies about an average value during the middle of the day. This same change in refraction capability would bring about stronger reflections than normal and would consequently result in signal strengths either higher or lower than might be expected had the same reflections taken place at some other time of the day.

Conclusions ★ From the experience gained in nearly four years of S-T program relaying, it is our opinion that, for any similar relay system, the required amount of maintenance will increase greatly as the distance between relay points is increased. That is, even though the normal signal is perfectly usable, it would appear to be good engineering practice to keep the relay path as short as possible. Even the reduction of the transmission distance by a mile or two would be of value. For example, when a circuit such as this is operated over its maximum range, all RF and IF stages in the receiver must be kept in perfect alignment so as to pass the full 100-kc. deviation. If this is not done, the noise level may be objectionably high.

Over short distances, on the other hand, it would be entirely permissible to decrease the audio input to the transmitter, during emergencies, to eliminate distortion resulting from receiver mistuning. In the way, the noise level could be kept low over the entire system. Sub-standard results over long distances might result from weak tubes at either the transmitter or the receiver, or from incorrect adjustment of either of the antennas. In our particular installation, for example, certain tubes in both the transmitter and receiver must be replaced at intervals of approximately three months. If the relay distance were shortened, it is entirely possible that these tubes could be kept in operation for a much longer period.

One comment should be added concerning interference from natural or man-made static with program relaying. It can be stated as a definite fact that no trouble from static pick-up of any sort has been experienced with this system. It is quite common in summer months for the thunder and lightning of severe electrical storms to become most annoying, yet cause no disturbances whatsoever in the relay receiver. It is a strange but familiar experience to see lightning flashes without hearing an accompaniment of static on the program.

FCC'S HELP IS NEEDED

(CONTINUED FROM PAGE 23)

cision which is not only contrary to the interest, convenience, and necessity of radio listeners, but which had such a costly effect on labor and industry, Chairman Porter was not prosecuting a case against workers and manufacturers. The law was not even involved.

Only the truth was involved in this situation. Since the facts were readily available concerning the time required to produce 10-kw. transmitters, he either failed to inquire from authoritative sources, or deliberately and arbitrarily disregarded the truth.

It might be unfair to mention this matter at all if it were an isolated instance. But it is not. There have been many other, similar instances in his brief career at the FCC. He has not even been frank and honest with his own colleagues.

In January of this year, Chairman Porter wrote [3]: "The 300 grants to FM applicants which have been made up to this writing have been conditional grants and they will not be made final until the applicants satisfy the Commission as to their program plans and other operating policies."

But when he testified before the Senate Appropriations Subcommittee on February 13 and 14, 1946 he said, "We are not interested in the slightest degree in the composition of that (program) traffic as to what they say or as to what use is made of it."

Chairman Porter has stated that "most persons in positions of public responsibility are motivated only by the desire to do the job which they took an oath to perform." [4]

As a lawyer, he may have felt that his responsibility was to win his argument, and that any testimony under oath is justified by expediency.

But broadcasters, radio listeners, factory workers, and manufacturers are not defendants in some suit, with the FCC Chairman or the Commissioners as prosecutors. While there are legal aspects to some of the FCC's responsibilities, and although the conduct of the hearings is patterned after court procedure, the Commission is not intended to serve primarily as a judicial body, but as an implementing agency to facilitate the progress of a highly technical industry in its expanding service to the public.

Months wasted by Paul Porter's failure to see his responsibilities in their true light can never be recovered.

Now, Commissioner Denny's elevation to the position of acting chairman has come at a critical time in the progress of FM broadcasting. He can, if he chooses, make himself known as the man who pulled the chocks from in front of the FM wheels, and set the radio industry rolling up to a new, high level of public service and prosperity.

[4] From a letter by Chairman Porter, *FM* AND TELEVISION, September, 1945, page 56.

ACTUAL SIZE. RCA Leads the Way In Metal, Glass and Miniature Electron Tubes

IN TUBES, RCA MINIATURES ARE THE ANSWER

for FM—for Television—for HF Communications

Consider these advantages of RCA Miniature Tubes for high-frequency applications:

HIGH GAIN—Lower inter-electrode capacitances and reduced lead inductance values improve circuit performance.

LOW LOSS—The short, low-resistance element leads serve as the contact pins; these, with the glass button seal provide a low-loss base.

LESS SPACE—Small dimensions of tubes permit closer spacing of components on a smaller chassis.

PREFERRED TYPES—Mass production is concentrated on a few types that meet all normal design requirements, resulting in higher tube quality at lower prices.

RCA tube application engineers are ready to consult with manufacturers on any problems, concerning the use of electron tubes—metal, miniature, or glass. For technical information on RCA tubes, write RCA Commercial Engineering Department, Section D-13C, Radio Corporation of America, Harrison, N. J.

THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA

TUBE DIVISION

RADIO CORPORATION of AMERICA

HARRISON, N. J.

SAN ANGELO
[1]KGKL, Inc. Com. Rad. Equip. Co. $36,750. — KGKL

SAN ANTONIO
[1]Southland Industries, Inc. Ring & Clark $250,000; — WOAI
[1]Sunshine Bcstg. Co. W. G. Egerton $216,510. — KTSA
[2]Walmac Co. $42,545.65. Com. Rad. Equip. Co. — KMAC — M

TEMPLE
[2]Bell Bcstg. Co., Inc. $24,850. — KTEM — C

TEXARKANA
[2]KCMC, Inc. Clarence O. Simmons $25,000. — KCMC — M

TYLER
[2]East Texas Bcstg. Co. — KGKB — M

VERNON
[2]Northwestern Bcstg. Co. Durward J. Tucker $18,250. — KVWC — M

WACO
[1]Frontier Bcstg. Co. $35,250. — WACO

WICHITA FALLS
[2]Times Publishing Co. Ring & Clark — WACA — M
[1]Wichita Broadcasters — KWFT

UTAH

SALT LAKE CITY
[2]Intermountain Bcstg. Corp. John M. Baldwin $19,360. — KDYL — M
[4]KSL-FM Radio Service Corp. 100.1 mc. No. 261 (44.7 mc.) — M

VIRGINIA

DANVILLE
[1]Piedmont Bcstg. Corp. George C. Davis $45,000. — WBTM

HARRISONBURG
[1]Shenandoah Valley Bcstg. Corp. Newman Bldg.

LYNCHBURG
[2]Lynchburg Bcstg. Corp. George C. Davis $45,500. — WLVA — M
[2]Old Dominion Bcstg. Corp. John Barron $41,600. — M

NEWPORT NEWS
[1]Hampton Roads Bcstg. Corp. George C. Davis $37,000. — WGH

NORFOLK
[2]WTAR Radio Corp. $39,805. — WTAR — M

PORTSMOUTH
[2]Portsmouth Radio Corp. George C. Davis $36,500. — WSAP — M

RICHMOND
[2]Havens & Martin, Inc. McNary & Wrathall $40,425. — WMBG — M
[1]Larus & Bros. Co., Inc. Paul F. Godley $124,600. — WRVA
[1]Richmond Radio Corp. Jansky & Bailey $46,000. — WRNL

ROANOKE
[1]Roanoke Bcstg. Corp. George C. Davis $56,000. — WSLS
[1]Times-World Corp. George C. Davis $66,500. — WDBJ

WINCHESTER
[2]Richard Field Lewis Jr. — WINC — MR

WASHINGTON

SEATTLE
[2]Evergreen Bcstg. Corp. Raymond H. Hilgers $37,300. — KEVR — M
KTYW
[2]Fisher's Blend Station, Inc. Ring & Clark $154,800. — KOMO — MR
[2]Queen City Bcstg. Co., Inc. James B. Hatfield $135,000. — KIRO — MR
[2]Radio Sales Corp. R. M. Wilmotte $31,000. — KRSC — M

SPOKANE
[1]Louis Wasmer, Inc. C. W. Evans $49,860. — KHQ, KGA

WEST VIRGINIA

BECKLEY
[2]Beckley Newspapers Corp. 341 W. Prince St. Jansky & Bailey $36,550. — M
[2]Joe L. Smith Jr. McNary & Wrathall $51,110. — WJLS — MR

BLUEFIELD
[2]Daily Telegraph Printing Co. Lohnes & Culver $94,750. — WHIS — MR

CHARLESTON
[1]Charleston Bcstg. Co. Ring & Clark $80,000 — WCHS
[1]Kanawha Valley Bcstg. Co. $28,800. — WGKV

CLARKSBURG
[1]Charleston Bcstg. Co. — WBLK

HUNTINGTON
[2]Huntington Bcstg. Corp. 1811 Kite Ave. Lohnes & Culver $35,200. — M
[1]WSAZ, Inc. — WSAZ

LOGAN
[1]Clarence H. Frey & Robert O. Greever, Box 720 Odes E. Robinson $35,000. — WLOG

MORGANTOWN
[2]W. Va. Radio Corp. Jansky & Bailey $22,700. — WAJR — C

PARKERSBURG
[1]Ohio Valley Bcstg. Corp. Odes E. Robinson $28,500. — WPAR

WHEELING
[1]Community Bcstg., Inc. McNary & Wrathall $31,360. — WKWK
[1]W. Va. Bcstg. Co. $98,500. — WWVA

WISCONSIN

DELAFIELD
[3]State Radio Council

GREEN BAY
[2]Green Bay Newspaper Co. Walnut & Madison Sts. George C. Davis $45,000. — M

GREENFIELD
[2]William C. Forrest RFD #2, Pynette, Wis.
[1]Midwest Bcstg. Co. 800 Brunder Bldg., Milwaukee

JANESVILLE
[1]Gazette Printing Co. John B. Caraway, Jr. — WCLO

LA CROSS
[2]WKBH, Inc. Jansky & Bailey $59,300. — WKBH — MR

MADISON
[2]Badger Bcstg. Co. George C. Davis $154,000. — WIBA — MR
[3]State Radio Council

MARSHFIELD
[1]Dairylands Bcstg. Service Central Ave. Jansky & Bailey $35,533.55.

MILWAUKEE
[1]Hearst Radio, Inc. $198,000. — WISN
[1]Myles H. Johns 225 E. Bradley Rd. Nathan Williams $123,000.
[2]Midwest Bcstg. Co. — M
[1]Midwest FM Network, Inc.
[2]Milwaukee Bcstg. Co. Jansky & Bailey $16,060. — WEMP — M
[1]Wisconsin Radio, Inc. 435 N. Michigan Ave. Chicago $200,000.
[4]WMFM The Journal Co. 92.3 mc. No. 222 (45.5 mc.) — WTMJ — M

OSHKOSH
[2]Oshkosh Bcstg. Co. Nathan Williams $123,000. — WOSH

RACINE
Racine Bcstg. Corp. George C. Davis $29,560. — WRJN — M

RICHFIELD
[1]The Journal Co.

SHEBOYGAN
[2]Press Publishing Co. George C. Davis $36,500. — WHBL — M

STEVENS POINT
[1]Dairylands Bcstg. Service Central Ave. Marshfield, Wis. $25,000.

SUPERIOR
[4]WDUL Head of The Lakes Bcstg. Co. 92.3 mc. No. 222 (44.5 mc.) — WEBC — M

WAUSAU
[2]Record Herald Co. 316 Scott St. — M

WISCONSIN RAPIDS
[1]Dairylands Bcstg. Service Central Ave. Marshfield, Wis. $25,000.

WYOMING

CHEYENNE
[2]Frontier Bcstg. Co. Marvin Stimes $22,860. — KFBC — M

...to KEEP CUSTOMERS COMING!

Bringing radio repairing right out in the open for all your customers, this Raytheon Bonded Electronic Technician display tells them exactly how you operate in *their* interest. And that means *profitable* repeat business.

This is only one of many ways your prospects and patrons will learn to identify your shop with fair prices, quality work and guaranteed reliability. Find out how you can qualify to become a Bonded Electronic Technician. Bonded service means better customer relations. For full details, see your Raytheon distributor today.

RAYTHEON
MANUFACTURING COMPANY

Excellence in Electronics

RADIO RECEIVING TUBE DIVISION
NEWTON, MASS. • NEW YORK • CHICAGO

ANOTHER REASON WHY IT PAYS TO QUALIFY AS A RAYTHEON BONDED ELECTRONIC TECHNICIAN

Thanks to 7 tough Years . . .

. . . this greatest of test instruments has been tested into top ranking reputation

The Simpson 260 has out-sold and out-performed every other even remotely similar test instrument in the electronic and electrical fields ever since its introduction in 1939. Through the ensuing seven years, covering the War period, circumstances gave it a gruelling test for accuracy never visioned by its makers. It stands today as irrefutable proof that Simpson design and Simpson quality produce accuracy that *stays* in an instrument year after year.

The demand for the 260 from men who first used it in the Armed Services (in laboratories of 300 government agencies and universities, and on the battlefields the world around) has now been added to its enormous popularity among radio servicemen. The Simpson 260 is easily the world's most popular high-sensitivity set tester for television and radio servicing.

The basic reason for this out-selling and out-performing by the Simpson 260 is this: It out-values every other similar instrument in the field. You cannot touch its precision, its useful ranges, or its sensitivity in any other instrument selling for the same price or even substantially more.

SIMPSON ELECTRIC COMPANY
5200-5218 W. Kinzie St., Chicago 44, Ill.

Simpson

INSTRUMENTS THAT STAY ACCURATE

SIMPSON 260, HIGH SENSITIVITY SET TESTER FOR TELEVISION AND RADIO SERVICING

Ranges to 5000 Volts—Both A.C. and D.C.
20,000 Ohms per Volt D.C.
1000 Ohms per Volt A.C.

At 20,000 ohms per volt, this instrument is far more sensitive than any other instrument even approaching its price and quality. The practically negligible current consumption assures remarkably accurate full scale voltage readings. Current readings as low as 1 microampere and up to 500 milliamperes are available.

Resistance readings are equally dependable. Tests up to 10 megohms and as low as ½ ohm can be made. With this super sensitive instrument you can measure automatic frequency control diode balancing circuits, grid currents of oscillator tubes and power tube, bias of power detectors, automatic volume control diode currents, rectified radio frequency current, high-mu triode plate voltage and a wide range of unusual conditions which cannot be checked by ordinary servicing instruments. Ranges of Model 260 are shown below.

Price, complete with test leads....................$33.25
Carrying case 4.75

Volts D.C. (At 20,000 ohms per volt)	Volts A.C. (At 1,000 ohms per volt)	Output
2.5	2.5	2.5 V.
10	10	10 V.
50	50	50 V.
250	250	250 V.
1000	1000	1000 V.
5000	5000	5000 V.

Milli-amperes D.C.	Micro-amperes	Ohms	
10	100	0-1000	(12 ohms center)
100		0-100,000	(1200 ohms center)
500		0-10 Megohms	(120,000 ohms center)

(5 Decibel ranges: —10 to +52 DB)

ASK YOUR JOBBER

AMPHENOL *Leads*

with a new TWIN-LEAD TRANSMISSION LINE

Greater Signal Strength
Low-Loss, High Efficiency
Tops in Weather Resistance

ELECTRICAL DATA

Twin 300 Lead: Amphenol "Twin-Lead" Transmission Line is available in 300 ohm impedance value. RMA standardized on 300-ohm lead-in line for Television as the most efficient over broadband operation.

Twin 150 Lead: Amphenol also supplies 150 ohm twin-lead to those interested in particular applications and experimental work.

Twin 75 Lead: Designed especially for amateurs who operate in very narrow bands of frequency or one particular frequency. Ideal for dipoles with a nominal impedance of 72 ohms at the frequency for which they are cut.

Dielectric constant of Polyethylene—2.29. Capacities (mmf per ft.): "300"—5.8; "150"—10; "75"—19.

Velocity of propagation (approx.): "300"—82%; "150"—77%; "75"—69%

Power factor of Polyethylene—up to 1000 Mc—.0003 to .00045. Attenuation—FM and Television Band.

Megacycles	300-ohm DB per 100 Ft.	150-ohm DB per 100 Ft.	75-ohm DB per 100 Ft.
25	0.77	0.9	1.7
30	0.88	1.03	2.0
40	1.1	1.3	2.5
60	1.45	1.8	3.4
80	1.8	2.25	4.3
100	2.1	2.7	5.0
200	3.6	4.7	8.3

Amphenol's "Twin-Lead" is a solid dielectric line that transmits signals from antenna to FM and Television receivers with extremely low loss. It's tough . . . inexpensive . . . easy to install . . . repels water . . . and is unaffected by acids, alkalies and oils because the dielectric is Amphenol Polyethylene.

In temperatures as low as –70°F. Twin-Lead Transmission Line stays flexible and does not become brittle after continuous aging in sunlight. In such outstanding qualities Amphenol's "Twin-Lead" is a wire of exceptional efficiency, life and utility.

AMERICAN PHENOLIC CORPORATION
Chicago 50, Illinois
In Canada • Amphenol Limited • Toronto

Depend upon AMPHENOL *Quality*

U. H. F. Cables and Connectors • Conduit • Fittings • Connectors (A-N, U. H. F., British) • Cable Assemblies • Radio • Antennas • Plastics for Industry

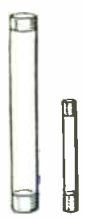
IN SMALL PLACES

MANY of the new electronic devices are small, and it is hard to wire them efficiently where the leads have to come out of a hermetically sealed unit. Corning headers like the ones shown take the grief right out of such installations, making it easier for the designer and simplifying the assembly operation.

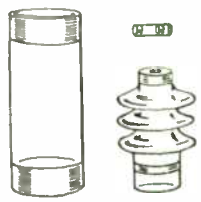
They are available either with or without metallizing, depending on whether or not you want a true hermetic seal. In either case they are economical of space, time and labor. For with them you can get a number of leads in a small space, and yet they assemble in one operation. And they're rugged, resisting thermal shock and soldering. They have a high insulation resistance and a low loss factor. And they can be made quickly in large quantities.

You know best what your own problems are. So look at the products shown below. If hermetic seals or assembly troubles are dogging you, there's probably a Corning Electronic product to do the job for you. To make sure, write, wire or phone The Electronic Sales Department, E-3, Technical Products Division, Corning Glass Works, Corning, New York. One of our engineers will be knocking at your door immediately to see if he can help. Don't put it off. Get in touch with us today.

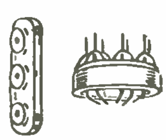
NOTE—*The metallized Tubes and Bushings, Headers and Coil Forms below are all made by the famous Corning Metallizing Process. Can be soldered into place to form true and permanent hermetic seals. Impervious to dust, moisture and corrosion.*



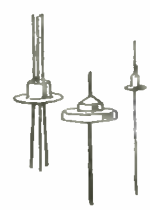
Metallized Tubes *for resistors, capacitors, etc. 20 standard sizes $\frac{1}{2}$" x 2" to $1\frac{1}{4}$" x 10". Mass-produced for immediate shipment.*



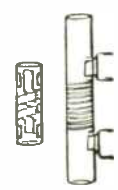
Metallized Bushings. *Tubes in 10 standard sizes, $\frac{5}{16}$" x $\frac{25}{32}$" to 1" x $4\frac{7}{32}$" in mass production for immediate shipment.*



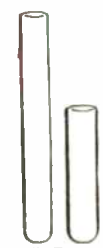
Headers — *The best way to get a large number of leads in a small space for assembly in one operation.*



Eyelet Terminals — *Single or multiple eyelets permit design flexibility. Standard items readily available in quantity.*



Coil Forms—*Grooved for ordinary frequencies—metallized for high frequencies. In various designs and mountings.*



VYCOR Brand cylinders—*very low loss characteristics. Stands thermal shock up to 900°C Can be metallized.*

"VYCOR", "CORNING" *and* "PYREX" *are registered trade-marks and indicate maufacture by Corning Glass Works, Corning, N. Y.*

Electronic Glassware

TRADE MARK VYCOR REG. U.S. PAT. OFF.

T. M. REG. CORNING U.S. PAT. OFF.

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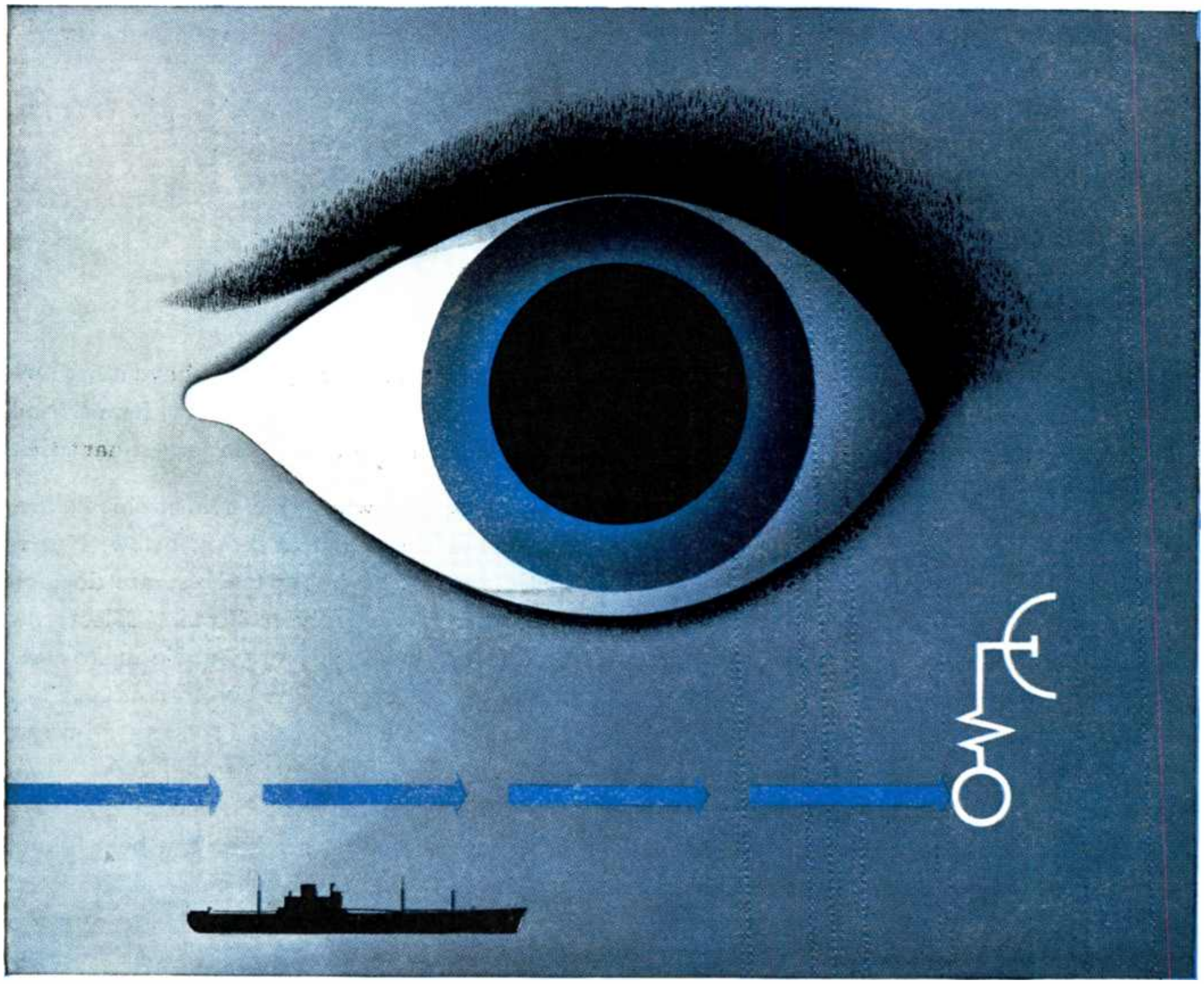

Look ahead ~~to~~ with Radar by Sperry

• This year, Sperry Gyroscope Company introduces its new *Radar* equipment for marine use.

Sperry *Radar* has been conceived to function better in this fundamental service: *To enable ships to operate on schedule regardless of visibility*...through thick fog, heavy rain, dense smoke, darkness.

As an aid to navigation it picks up channel markers and buoys; assists in making landfalls with assurance; spots icebergs, floating derelicts and other hazards projecting above surface. It also permits vessels to enter harbors and proceed with all due safety and caution through fog. Another important feature: Sperry *Radar* provides a Gyro-Compass-controlled image and can be operated by bridge personnel without extensive technical background.

In design and construction, Sperry *Radar* reflects this company's many years of experience in precision manufacture of marine equipment—as well as its outstanding achievements in the field of electronics. In simplicity and dependability, this new *Radar* exemplifies again Sperry's ability to build superior products for merchant ship service.

Sperry Radar Features:

- Designed to meet all Class A specifications of the U. S. Coast Guard.
- Maximum range 30 miles—minimum, 100 yards.
- 10-inch picture on a 12-inch screen.
- Images presented in true or relative relationship at option of operator.
- Gives accurate ranges read from indicator instead of estimated from scope.
- Backed by world-wide service.

SPERRY GYROSCOPE COMPANY, INC. GREAT NECK, N. Y.

★

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GYROSCOPICS • ELECTRONICS • RADAR • AUTOMATIC COMPUTATION • SERVO-MECHANISMS


POLICE

At Last! A Complete

INFORMATION SOURCE

on all phases of

FM BROADCASTING

The Standard Handbook of

FM RADIO

FREE

with your subscription to FM and TELEVISION

FM and TELEVISION Magazine, now in its sixth year of publication, has the well-earned reputation of being "The Complete and Authoritative Source of Information on FM and Television."

Devoted exclusively to these two subjects, it covers all phases of broadcasting's greatest fields of postwar expansion, from station planning, equipment, and operation to program techniques and listener reactions.

Information presented in FM and TELEVISION is *authoritative*. Articles are written by men chosen for their personal knowledge and experience with their subjects—men of the highest professional standing.

Of equal importance, articles in FM and TELEVISION present *complete* information, graphically illustrated by detailed photographs and drawings, handsomely printed on the finest quality of paper found in any radio publication.

Whatever your particular place in the business of broadcasting, you will find FM and TELEVISION an essential source of new ideas and inspiration. You should subscribe NOW. If you use the coupon on this page, we'll send you, *without charge*, a copy of the new FM RADIO HANDBOOK.

for Station Officials, Engineers, Program Directors, and Advertising Executives

Here is the *first* and *only* book which covers all phases of FM broadcasting. Except for a brief introduction chapter on the background of FM, it is a strictly postwar book, in both text and illustrations.

This standard FM RADIO HANDBOOK was planned and edited by recognized authorities on the subject of Frequency Modulation. The individual chapters were written by men chosen for outstanding ability in their respective fields.

This is no pocket-size compilation of condensed information, but a book 8¾ by 11 5/8 inches, handsomely printed, and profusely illustrated with detailed photographs and drawings.

ANSWERS TO YOUR QUESTIONS

You will find the FM RADIO HANDBOOK of inestimable value because there is no phase of radio on which there has been so *little* authoritative information, and so *much* mis-information. Among the innumerable questions answered in this book are:

- Why is the coverage of an FM station the same day or night?
- What is the cost of erecting and operating an FM station?
- Is there any difference between FM and AM microphone technique?
- Can FM deliver a greater audience impact than AM?
- What is the proper procedure for making a field strength survey?
- When should an S-T link be used between a studio and the transmitter?
- What are the different types of FM transmitters, and why do they differ?
- How can the range of an FM transmitter be predetermined?
- What has been the practical experience in the operation of satellites?
- Why is pre-emphasis used, and what purpose does it serve?

In short, the FM RADIO HANDBOOK presents all the information that the editors, with 7 years of FM experience, have found that broadcasters require. Remember, this is not a book you will glance through quickly and put away in your bookcase. You'll keep it *on the top of your desk* where you can refer to it whenever Frequency Modulation broadcasting is under discussion.

Take your choice of the paper-bound edition at $1.50 or the life-time library binding at $4.00, BUT PLACE YOUR ORDER WITHOUT DELAY!

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FOLDED DIPOLE ANTENNAS

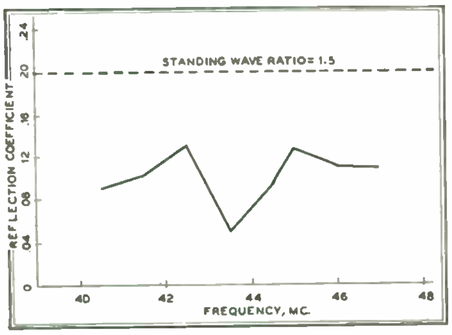
(CONTINUED FROM PAGE 37)

conditions are improved with respect to impedance and bandwidth.

Bandwidth ★ In addition to band-broadening in the radiators themselves, there is a further improvement due to the odd-quarter-wave phasing lines used to connect the two panels as shown in Figs. 6, 7. If a resonant impedance $Z_1 \lfloor \theta$ is viewed through a quarter-wave line of characteristic impedance Z_0, it is transformed to a value

$$Z_2 = \frac{Z_0^2}{Z_1} \lfloor -\theta$$

having an equal phase angle but of opposite sign. Hence, the net impedance obtained by paralleling Z_1 and Z_2 is reactance-compensated, and the band-width is again improved as shown by Fig. 13.



The measured impedance characteristic of an experimental 4-bay antenna is shown in Fig. 14. Assuming a standing wave ratio of 1.5 as a reasonable tolerance for impedance-matching purposes, the impedance is seen to be well within this limit over a frequency band greater than ± 7½%.

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 4)

of a single model in order to please individual dealers or to cater to fancied sectional prejudices."

You might think that the preceding paragraphs were written by a radio manufacturer who was in the radio business during the years following World War 1. Actually, they are quoted from C. B. Larrabee, president and publisher of *Printers' Ink*. He has not only set forth the errors of our industry in the past, but he has probably enumerated those which will be repeated in the course of the next few years.

2. The following correspondence is published because it represents an exchange of opinions typical of the arguments that are still heard between broadcasters, executives of manufacturing concerns and, though rarely now, between engineers.

Terms of the wager offered by Dale

(CONTINUED ON PAGE 74)

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 73)

Pollack, chief engineer of Templetone Radio Mfg. Corporation, were published on the Spot News page last month.

Bloomington, Ind.
February 7, 1946

Dear Mr. Pollack:

This is to acknowledge your letter of February 2.

My original offer, made at the November 1944 IRE meeting in Rochester in the presence of about 500 radio engineers, still stands.

I will bet 1,000 dollars with any one that during the five-year period after the war, in any one year *more* AM receivers will be manufactured and sold than AM-FM or FM sets.

What the public is interested in is the radio service that it gets. This yardstick is the number of receivers it buys, not the dollars it pays for them. One can see how ridiculous it would be to argue that shortwave service is of real value to the public because equipment sold yearly running into millions of dollars has shortwave. Shortwave is just a sales feature and has no real service value as far as the American listening audience is concerned. It is my feeling that FM as now set up is in the same category as shortwave — it will be just another band and will be ballyhooed to sell high-price merchandise.

If you have real faith in FM, the true yardstick is number of sets sold, and I shall be glad to take you on this basis.

Very truly yours,
SARKES TARZIAN

New London, Conn.
February 15, 1946

Dear Mr. Tarzian:

For a man who claims that FM cannot be justified on economic grounds, I found your letter to be inconsistent. You have told me that an FM receiver could not be justified because of its excessive cost and that, therefore, you were undertaking to provide AM service at ultra-high frequencies so that it could be received on simple, non-costly equipment by merely providing an additional position on the band switch.

May I remind you that this is a world based largely on a money economy? We are not in business to sell a given quantity of radio receivers. We are in business to make money. The profit we make — excuse me if I am too obvious — is determined by our dollar-volume, not by the quantity of sets we sell. I am willing to bet with you that we will make more money selling sets with FM than sets without, and you evidently do not have enough faith in AM to take me up on this.

Have you ever tried to make a horse out of a donkey? As you full well realize, adding FM to a receiver is not the simple

(CONTINUED ON PAGE 75)

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 74)

matter of adding another band to a standard set.

You have to start with the FM set. After you have the FM set, it is a simple matter to add AM to it, and our contention is that the AM band is merely a second band, like short wave, added to an FM set to give it additional customer appeal.

I hope you will reconsider my proposal, therefore, or suggest a reasonable alternate.

Very truly yours,
DALE POLLACK

Bloomington, Ind.
February 18, 1946

Dear Mr. Pollack:

My interest with respect to radio is not limited primarily to how much money Templetone or other manufacturers make out of it. This is taken care of automatically when a good economical service is given to the American public. I am interested in the overall picture of the broadcasters, the listening audience who pays for everything, and the set manufacturers. I do not think it is to the over-all, long-range interest of the radio industry and the public to charge them two times as much for a given service because a few set manufacturers selfishly think they can make more money that way, or that a few inventors can recoup their investments. It is to our long-range interest to give a satisfactory service at the lowest possible cost. It is because AM does this better than FM that more AM receivers will be sold every year than FM. You, too, I know realize this, and therefore want to hedge on the issue involved.

My original offer made two years ago still stands and I will take on as *many* people as are willing to wager 1,000 dollars on this issue.

Very truly yours,
SARKES TARZIAN

P.S. Referring to your horse and donkey analogy, you gentlemen are trying to prove that the American public is made up of millions of donkeys and I think you will learn that they do have horse sense and will take care of the smart operators who place them in the donkey class. — S. T.

New London, Conn.
February 27, 1946

Dear Mr. Tarzian:

It is a shocking thing in the year 1946 to find an intelligent radio engineer who still believes that AM can provide more satisfactory broadcast service than FM. Opinions such as this were normal in 1935 and 1936. I would suggest that you investigate carefully the theoretical difference between AM and FM, and that you also make a practical listening test in a

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WHAT'S NEW THIS MONTH

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location such as New England, where the poor soil conductivity makes satisfactory AM coverage in the low-frequency broadcast band a practical and a theoretical impossibility.

You appreciate that it takes about 20 years for an invention to find wide acceptance by the public. The majority of receivers may or may not have FM in 5 years, but in 10 years every receiver will have FM and you, too, will be an enthusiastic supporter. I once worked for the RCA myself and I saw many die-hards there converted after they had a chance to listen to FM programs for a few days.

The first successful automobile, I believe was made in 1897. Yet there were more horses still in use in 1908 than automobiles. Perhaps in 1908 you would have said that the horse could provide the public with better service than the automobile since the public was still buying more horses than automobiles. Apparently you maintain that the automobile manufacturers were "smart operators" to offer the public automobiles at $1000 apiece when they could get the same service from horses at $100 apiece?

I might mention that name calling is a debating device often used when ordinary logical arguments have been exhausted. My argument with you has nothing whatever to do with Templetone. I am interested merely in seeing that the public gets the best possible service at the lowest possible overall cost. If receiver manufacturers profit as a result, very good. If you think that the public can get adequate service from $9.95 AM sets, you are welcome to that belief. I do not share it.

Therefore, I will take you on a dollar-volume basis over a 4-year period, or on a unit-volume basis over an 8-year period.

Yours truly, DALE POLLACK.

AUDIO DISTORTION

(CONTINUED FROM PAGE 27)

duction does not sound unreal to me. Regardless of the Bell Laboratories, CBS, or NBC, with their fact-finding tests to contrary, I side with Major Armstrong and say: give the public wide-range audio up to 15,000 cycles. Better receivers will be accepted because there will be some reason to want them, if suitable programs are provided by the radio stations and their associated networks. Even programs involving no music, such as Abie's Irish Rose, become much more enjoyable with a wide range system. One gets a feeling of *presence* — after a moment of scientific reflection, this sensation of presence is natural, because the higher frequencies are instinctively associated with nearby sounds since the higher frequencies are attenuated more rapidly as the distance is increased.

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For the *second, consecutive* year

In 1945, as in 1944, *FM* AND TELEVISION Magazine showed the largest increase in annual volume of advertising over the previous year of any paper in the radio or electronics field* ★ ★ ★ This is no fortuitous accident. It is an assumption of leadership resulting from a unique and highly useful editorial service to *the men who set the pace the industry follows*—the readership, in short, that makes advertising profitable ★ ★ ★ For example: All the enormous postwar expansion in communications for point-to-point, mobile, and relay services is being built around Frequency Modulation. For nearly six years, *FM* AND TELEVISION Magazine has been the only complete source of information in this field. ★ ★ ★ It is logical, therefore, that more and more manufacturers are shifting their advertising to *FM* AND TELEVISION, in order to reach the largest purchasers of FM communications and broadcast equipment, and all the associated components and replacement parts required in these installations ★ ★ ★ ★ ★

FM AND TELEVISION 511 FIFTH AVENUE, NEW YORK 17, N. Y.

* As shown in summaries published in Printers' Ink. Increase for 1945 over 1944 was 44%, compared to other radio and electronics papers which ranged from a loss of 8% to a gain of 13%.

AUDIO DISTORTION

(CONTINUED FROM PAGE 76)

It is well known that one really *feels* low notes. At the higher sound levels, the ear does cross-modulate as previously mentioned, and this is interpreted as the sensation of bass. In November, 1941 Mr. Sheppard presented a paper on Synthetic Bass before the I. R. E. Rochester Fall Meeting which demonstrated how effectively artificial cross-modulation produced by vacuum tubes and associated circuits could simulate actual bass response. The thing missing in his demonstration was the physical feeling that always accompanies such heavy bass response. If it were possible to use such a synthetic system in conjunction with a suitable direct-connected, floor-driving system, very effective bass sensations could probably be produced without the need for such large console cabinets. Such synthetic bass cross-modulation should necessarily be confined to the region below 500 cycles where it would not produce such objectionable masking as the usual type of cross-modulation mentioned herein.

MAINTENANCE PRACTICES

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low conversion efficiency, although they may appear to be satisfactory on a tube checker.

Condenser failures, as has been mentioned, are chiefly buffer and audio coupling units. The dry type electrolytic condensers, used as high-voltage filter in receivers, have been very satisfactory. Low-voltage cathode bypass condensers and multiple RF and AF condenser blocks have been much less so. Low-voltage electrolytics seem to have very short life. We avoid their use. Paper condenser blocks also seem to be unsatisfactory unless they are of the oil filled can type.

Antenna Maintenance ★ The top-mounted antenna must be provided with a base spring. The flexible connection between the antenna rod and transmission line, terminating inside the spring, can be a service problem. The ¼-in. braid usually provided is good for less than 10,000 miles. By using braid sold for generator brush leads, obtainable at auto supply stores, longer life has been obtained. It seems to be good for 100,000 miles. Rear side-mounted aerials must also be provided with springs or they will be subject to frequent breakage.

All main stations use coaxial antennas mounted on 180-ft. steel masts and fed with 7/8-in. concentric copper line. These lines are filled with dry nitrogen at about 25 lbs. pressure. There has been a tendency for these lines to develop slow leaks, but no real trouble has occurred except in those cases where there has been severe

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MAINTENANCE PRACTICES

(CONTINUED FROM PAGE 78)

icing or lightning damage. Why lightning damage should occur on grounded systems is difficult to explain, but it does. In one case, the ¼-in. center conductor was melted in two and shorted to the tube. More frequently, lightning enters by way of the telephone or power lines. Damage to these facilities, and to the relays and transformers attached to them, has been common. Relays and transformers should be easily accessible, or of plug-in type, to facilitate quick repairs. Adequate fusing and heavy grounding of all equipment is essential.

Remote-Control Telephone Lines ★ The most frequent cause of failure of remote equipment is the power or telephone circuits. Telephone circuit failures are the most frequent of all. If an absolute maximum of dependability is required, relay circuits should be employed to control remote transmitters and receivers. Such equipment is now available, and will be installed in Connecticut as soon as possible.

Frequency Measurements ★ In Connecticut, where all main stations can be heard at our Hartford Headquarters, frequency measurements are made from that point once each month. A frequency meter is calibrated against WWV by the zero beat method immediately before the measurement is taken. Signed reports of the results are mailed to each station and a copy to each technician. The form is shown in Fig. 6.

Each technician is provided with a portable frequency monitor that is checked against the Headquarters equipment. With this meter he can make the necessary checks on the mobile equipment in the field. Records of frequency measurements on mobile units are kept by the technician and notations are also made on the individual record card in each transmitter.

We would like to check our cars for off-frequency operation by means of an automatic frequency indicator installed at each of our fixed stations. Such an instrument should be operated by a radio receiver. Then we would be able to tell immediately if any car transmitter had drifted from its assigned frequency. This would eliminate the need for routine checks.

Summary ★ If some of the information presented here is not in agreement with practices followed by other systems, the reason lies in the fact that, either through trial-and-error or planned elimination, our procedures have been worked out over a period of years from the experience of handling a comparatively large number of fixed and mobile stations. Thus they are not based on the arbitrary opinions of any one individual.

More for Your Money

An FM transmitter is not something you buy every day . . . it must serve you a *long time*. It should therefore be purchased with the greatest of care.

REL FM transmitters are built with one basic idea in mind—***to incorporate every single feature demanded by the Broadcaster.*** That is why so much attention has been directed toward providing **maximum performance, reliability, simplicity, accessibility** of all parts—and use of the best components.

It is REL's constant specialization and concentration on manufacture of FM equipment specifically designed to meet the requirements of the Broadcaster that makes it possible to offer such fine equipment at such low prices.

Investigate before you buy! If your location permits, visit our plant and see the REL transmitters in production . . . or consult our nearest sales representative for further details.

PIONEER MANUFACTURERS OF FM TRANSMITTERS EMPLOYING ARMSTRONG PHASE-SHIFT MODULATION

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