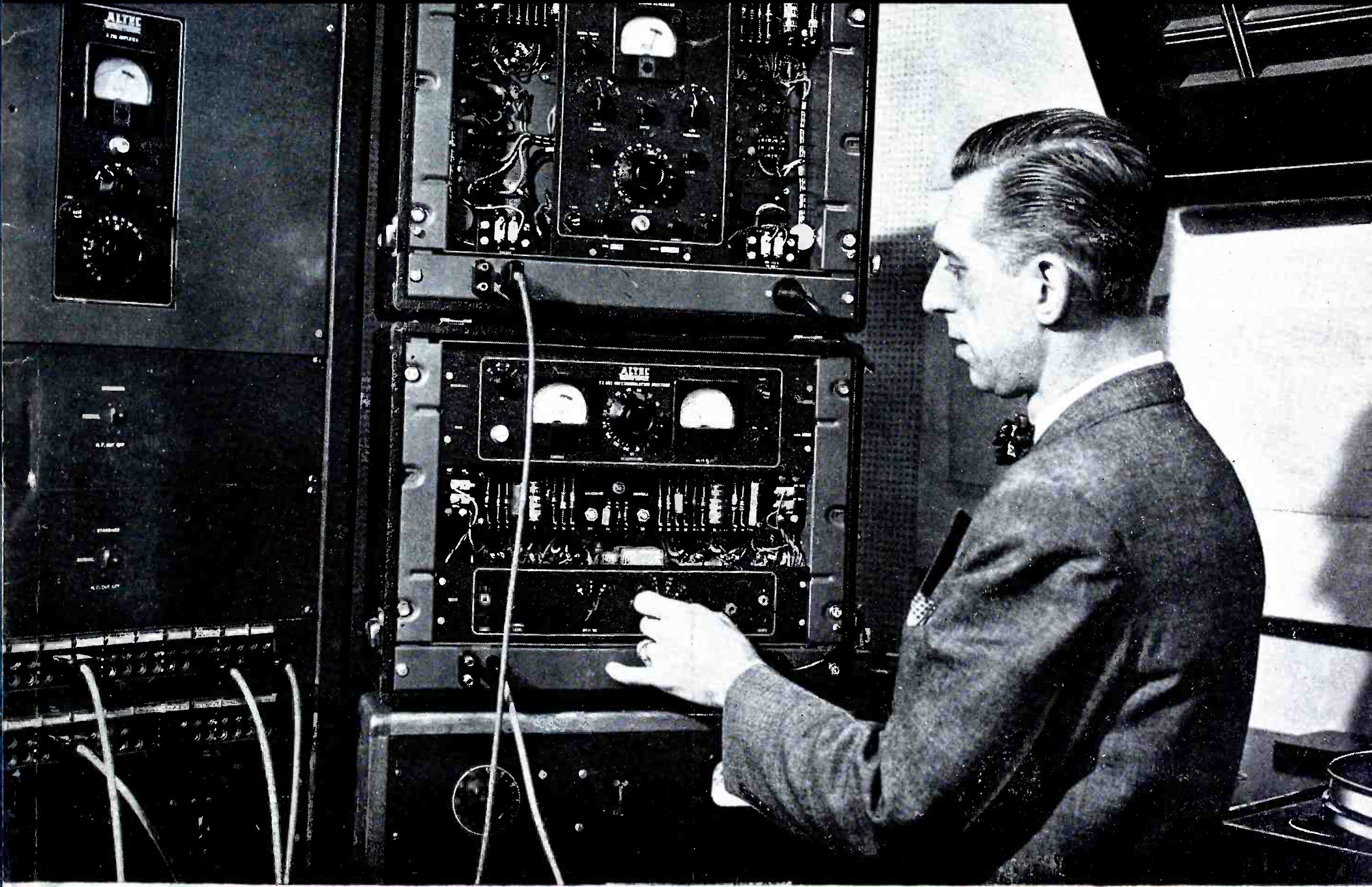
# COMMUNICATIONS

INCLUDING "RADIO ENGINEERING" AND "TELEVISION ENGINEERING"




MARCH

★ ¼-KW A-M AND F-M BROADCAST TRANSMITTER DESIGN

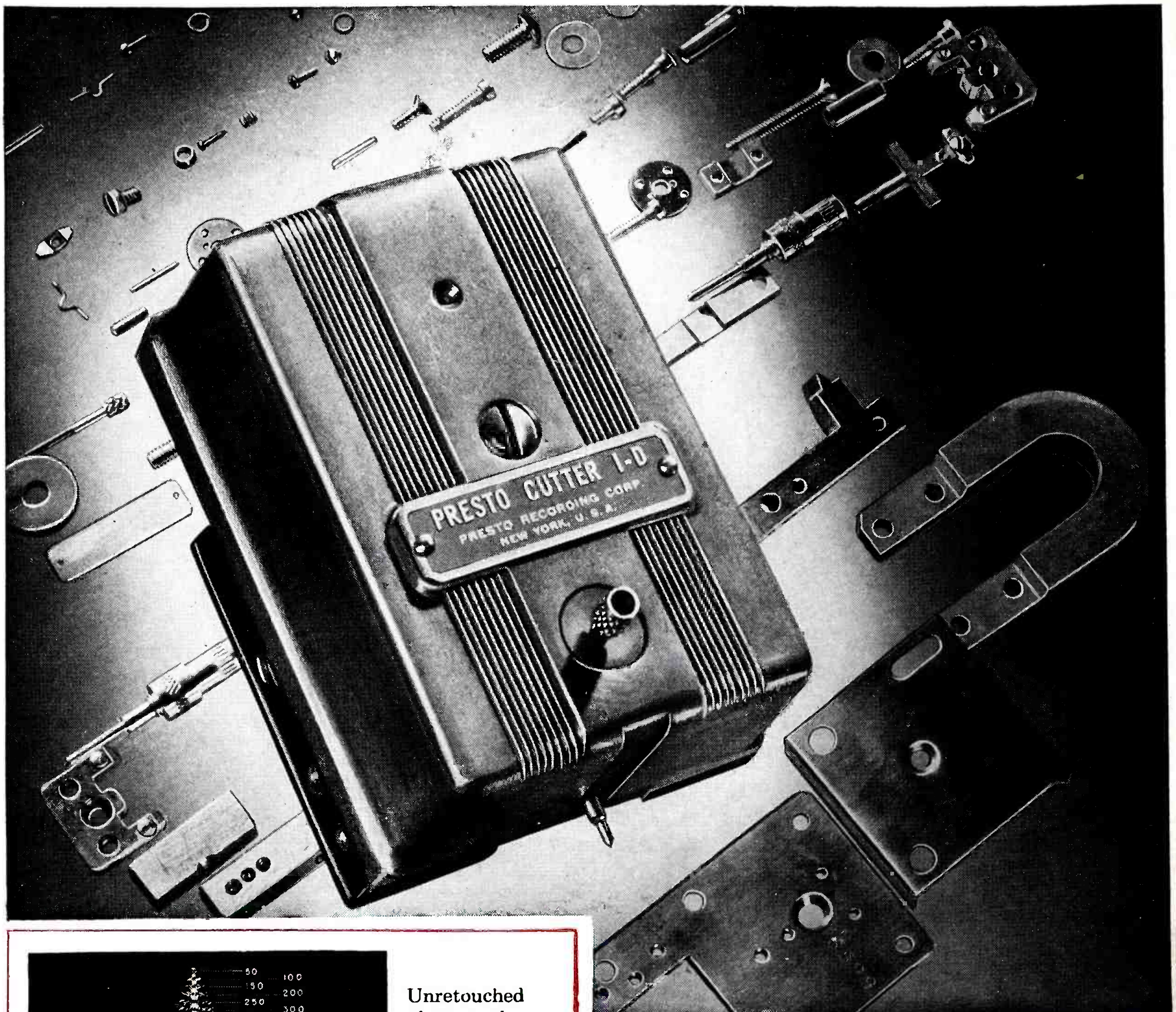
★ REPORT ON THE 1947 IRE NATIONAL CONVENTION

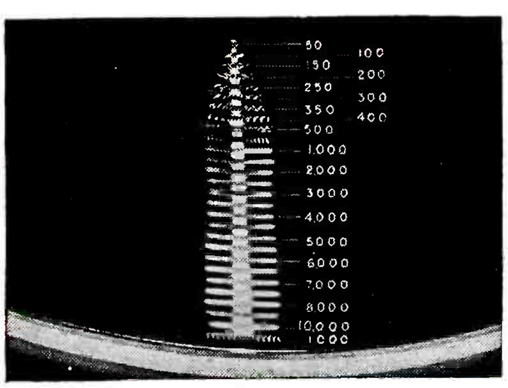
1947

# NOW! a new standard of performance in cutting heads
# THE PRESTO 1-D

▶ The new Presto 1-D Cutting Head offers: *wide range, low distortion, high sensitivity* and *stability through a temperature range of 60°-95° F.* The Presto 1-D Cutting Head is a precision instrument made entirely of precisely machined parts, expertly assembled and carefully calibrated. These factors, plus its sound basic engineering design, produce a cutter unequaled in performance by any other mechanically damped magnetic device.

▶ Note from the light pattern below: The correct location of the cross-over point at 500 cycles, the 6 db per octave slope below this point, and flat response above 500 cycles, which is free from resonant peaks. The range of the cutter is 50-10,000 cycles. The Presto 1-D is damped with "Prestoflex" which is impervious to temperature changes between 60 and 95 degrees Fahrenheit.




Unretouched photograph showing the light pattern. Notice correct location of the cross-over point at 500 cycles.

**PRESTO**

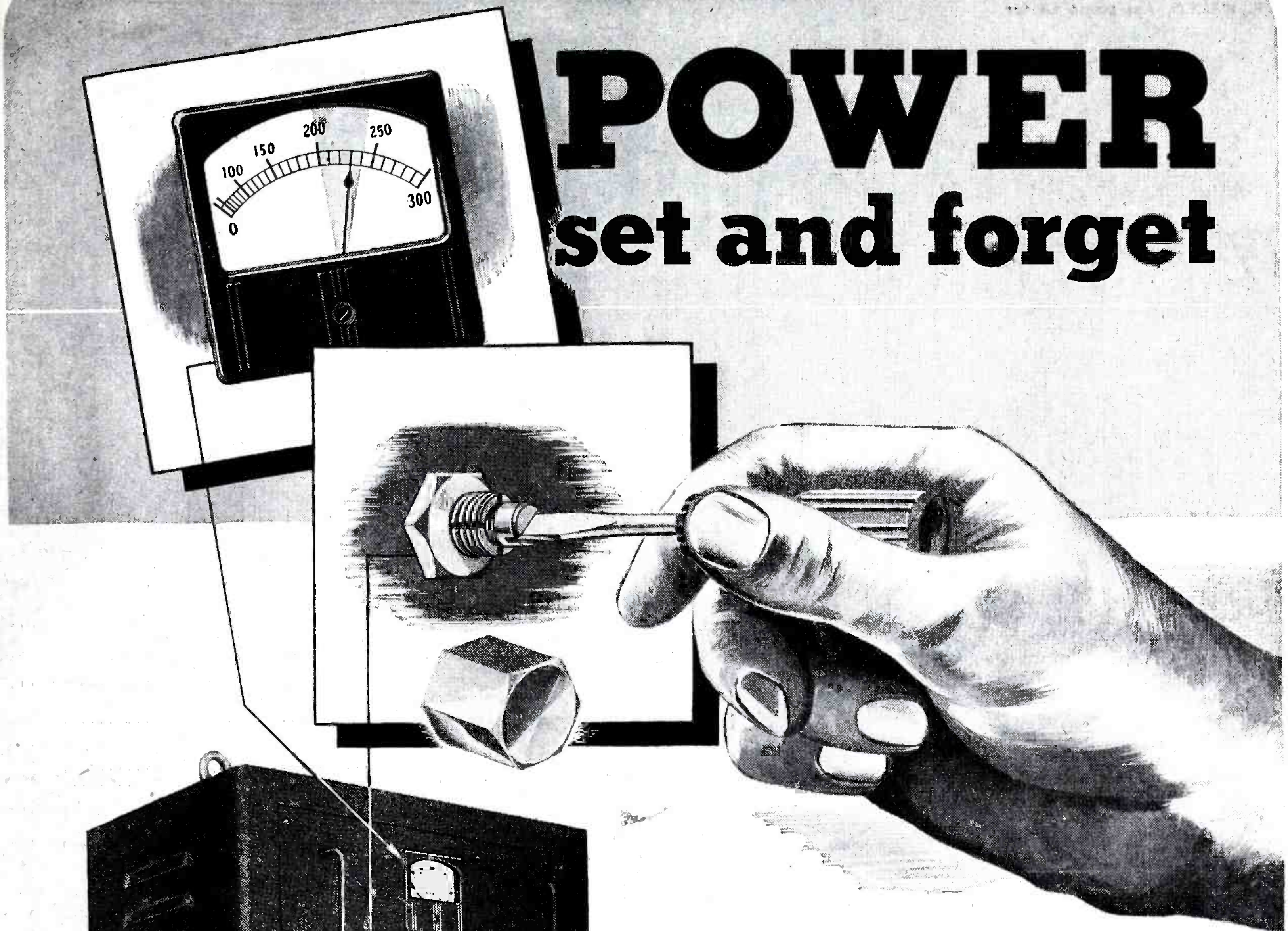
**RECORDING CORPORATION**

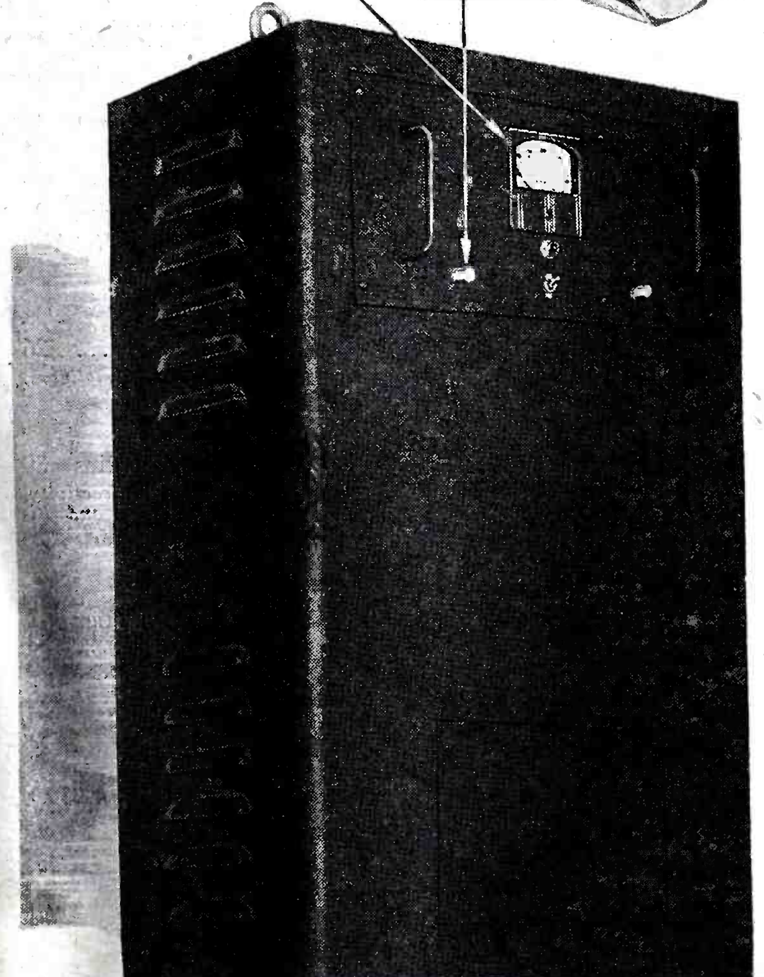
242 WEST 55TH STREET, NEW YORK 19, N. Y.

Walter P. Downs, Ltd., in Canada

*WORLD'S LARGEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT & DISCS*

# POWER
## set and forget



SPECIFIED CONSTANT VOLTAGE is a necessity if costly electrical equipment is to operate economically and efficiently. To provide peak performance and protect your investment, install a SECO Automatic Voltage Regulator. A minimum of effort is involved. Just connect the power source and load — set the output voltage to the value required — and forget. Constant voltage, unaffected by changes in magnitude or power factor of the load, is assured.

If you have an application in mind, outline it to our engineering staff — or write for **BULLETIN 150.**

923 LAUREL STREET
BRISTOL, CONNECTICUT

**SECO** AUTOMATIC VOLTAGE REGULATORS

*The* **Superior Electric** *Company*

LEWIS WINNER, Editor

F. WALEN, Assistant Editor

# COMMUNICATIONS

Including Television Engineering, Radio Engineering, Communication & Broadcast Engineering, The Broadcast Engineer. Registered U. S. Patent Office.

**MARCH, 1947 VOLUME 27 NUMBER 3**

# We See...

The Broadcast Antenna tower-location problem, which increased air traffic has made even more complex, may soon enter the solution stages if a NAB-FCC-CAA program suggested by the NAB engineering committee is carried through. The NAB has asked the CAA and the FCC to assist in the preparation of a series of elevation maps for broadcasters, and set standards for locations of towers with specifications on light mountings.

This approach should relieve both the FCC and the CAA of much of the site-approval burden which CAA officials say has been caused by a lack of personnel. A year ago CAA executives declared that a streamlined processing of site requests would be placed into effect. But budget pruning and other internal complications seemed to interfere with the program.

The creation of the elevation charts and tower-site standards will be quite a tower-location accelerator, and it is hoped that the government agencies will be able to assist in this move immediately . . . an action that will prove a boon to many tower construction and station installation programs.

There's to Be an NAB Revival of the studies of the standards for recording, which was underway and partially completed in 1942, but discontinued because of the war. The original group of about seventy-seven, including transcription and playback manufacturers, will be invited to participate again and help complete the study.

Projects, the group is expected to probe, include styli designs, frequency record standards and universal transcription standards. With the increased exchange of foreign-country transcribed programs, the setting up of international standards for transcriptions and records has become a most important item.

Good work, NAB!

'Twas a Pleasant Surprise to hear that Commodore Edward M. Webster was named by President Truman as the seventh member of the FCC.

A real oldtimer, with nearly forty years of sea and land communications experience, Commodore Webster *knows* his radio, technically and legally. He'll do an outstanding job.

A commendable appointment, Mr. President.

The World Honored the memory of Alexander Graham Bell on the one-hundredth anniversary of his birth in March. His vision, which has so helped mankind, will always be revered.—L. W.

## COVER ILLUSTRATION

**Conducting intermodulation measurements of disc amplifying equipment at the WOR recording studios with an a-f signal generator and intermodulation analyzer.**

*(Courtesy Altec Lansing Corporation)*



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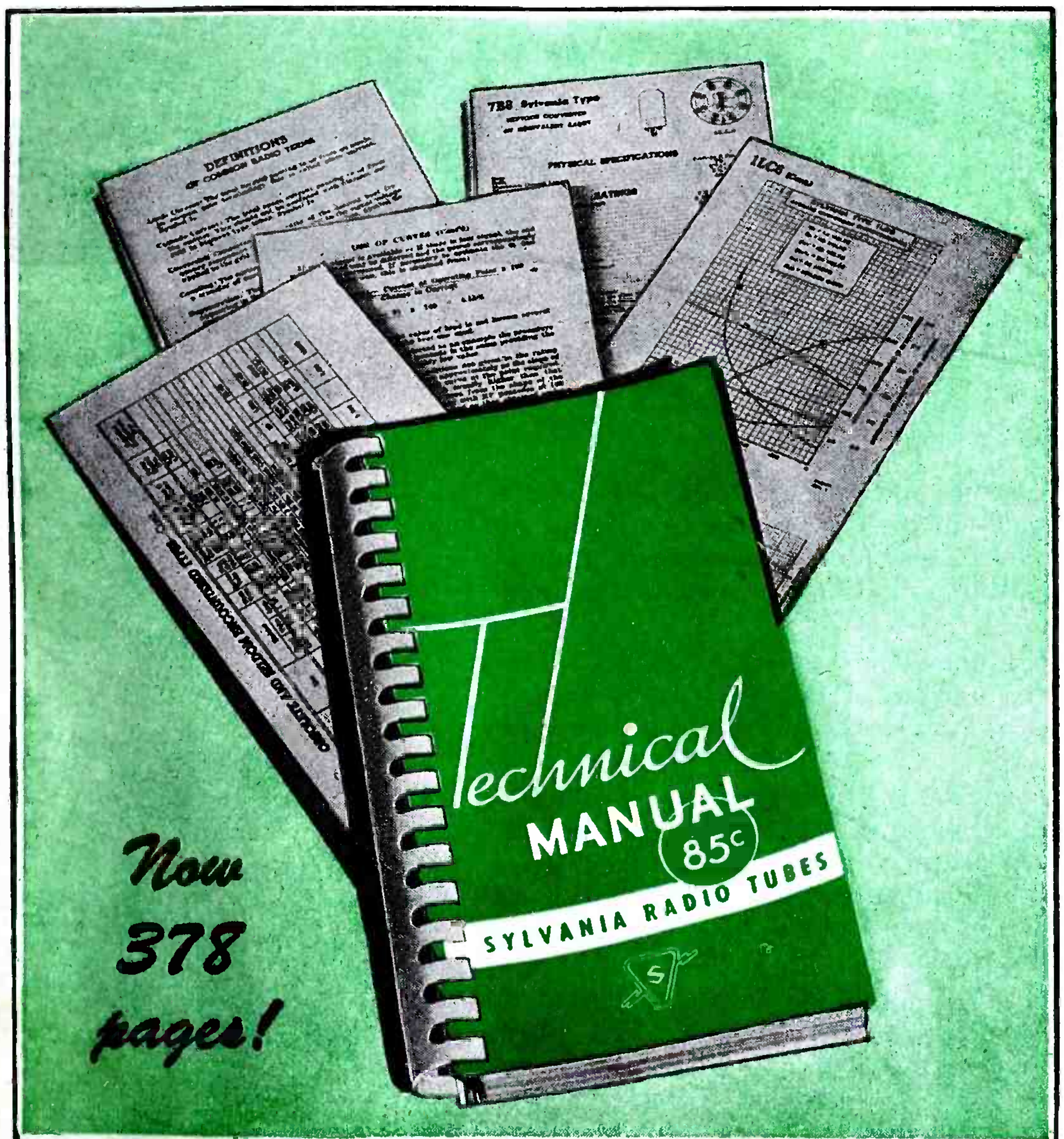
# SYLVANIA NEWS

## CIRCUIT ENGINEERING EDITION

MAR. *Prepared by* SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa. 1947

# NEW SYLVANIA TECHNICAL MANUAL AVAILABLE NOW—FULL OF ESSENTIAL RADIO TUBE DATA

## Handy Volume Describes Over 450 Tubes—Contains Valuable Information for Circuit Designers




The bigger, better-than-ever new Sylvania Technical Manual is available now.

The large number of tube types listed (old and new)—over 450—has been made available as a result of extensive and careful study of radio tube characteristics and applications.

### IMPORTANT INFORMATION

Contents of this descriptive manual include: Fundamental Properties of Vacuum Tubes; Characteristic Curves; General Tube and Circuit Information; Resistance Coupled Amplifier Data—and many more—all of great interest to circuit designers and equipment manufacturers.

### AVAILABLE NOW

We urge you to get a copy right away—because we know you'll find this volume chock-full of invaluable information.

***Available from your Sylvania Tube Distributor or directly from Radio Tube Division, Emporium, Pa.***

# SYLVANIA ELECTRIC

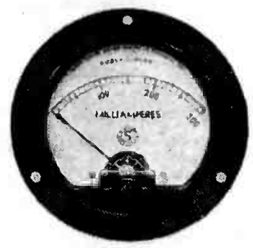
MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS


How often have you wished for a meter you could see *clearly*—the whole scale of it, wherever you were using it—in the dark, under low lights, or even in the kind of glare that causes reflections on the glass—a really illuminated meter? Well, here it is—the result of a new Simpson patented method of illumination.

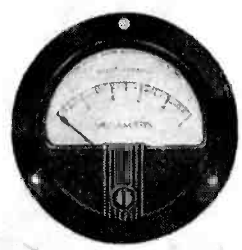
On these new Simpson Illuminated Meters (voltmeters, ammeters, milliammeters, and microammeters), every fraction of the dial face is flooded with light—there isn't a spot of shadow. And this isn't a dull glimmer of light. It's a full and even radiance.

An ingeniously shaped Lucite cone carries the light from a recessed bulb in the back of the instrument through the front edge that surrounds the entire dial. This makes possible the use of the standard Simpson metal dial. Unlike translucent dials, it cannot fade or discolor so that reading becomes difficult. It cannot warp or buckle, causing the pointer to stick, or distorting readings. The bulb recess is neoprene sealed.

Behind the refinement of this superior illumination lies the basic reason for preferring Simpson instruments—their in-built accuracy. That high quality which is the indispensable component of every Simpson instrument makes sure that the accuracy will *stay* there, year after year.



**OPEN FACE**



**SHROUD STYLE**

**2" Round Case.** Flange diameter, 2-3/4"; depth overall, 2-5/16"; body diameter, 2-11/64"; scale length, 1-7/8".

**3" Round Case.** Flange diameter, 3-1/2"; depth overall, 2-1/4"; body diameter, 2-3/4"; scale length, 2-9/16"

**3" Rectangular Case.** Width, 3"; height, 3-1/8". Mounts in round hole. Body diameter, 2-3/4"

**2" Rectangular Case.** 2-3/8" square. Mounts in round hole. Body diameter, 2-3/16".

**SIMPSON ELECTRIC COMPANY**
**5200-5218 W. Kinzie Street, Chicago 44, Illinois**
**In Canada, Bach-Simpson, Ltd., London, Ont.**

Simpson

INSTRUMENTS THAT STAY ACCURATE

# NEW 5516 INSTANT-HEATING VHF BEAM PENTODE

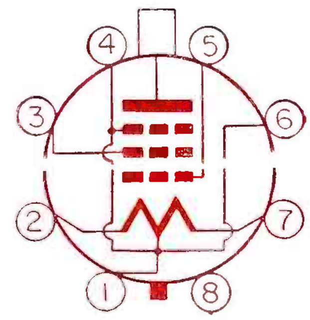
**18 WATTS**

**USEFUL POWER OUTPUT FOR MOBILE F-M WITHOUT NEUTRALIZATION**

**165 MC**


***IT WAS NOT EASY . . .*** Compact though it is, the new 5516 is a far cry from the cathode-type tubes previously used in mobile vhf equipment. Design and production headaches for instant-heating vhf beam pentodes increase in geometric progression with the operating frequency. A glance at 5516 constructional advantages discloses unusual measures taken to solve such problems. Yes, the 5516 of necessity costs more, but it does a *real* job at 165 mc.

***WHAT THE 5516 DOES FOR YOU . . .*** 5516 useful power outputs at 165 mc of 18 watts f-m, 12 watts a-m (more at lower frequencies) are not theoretical but are based on actual tested transmitter designs. Low internal tube drop gives high output at low plate potential, with simplified power supply requirements. Instant-heating filament permits tremendous savings in battery drain — mobile or aircraft. One 2E30 doubler or tripler drives a 5516 in plate-modulated class C to full output at 165 mc. Ratings — designed for mobile use — are CCS and equally suitable for the fixed station. Also the 5516 requires no neutralization in properly designed circuits. Write today for complete data sheet.




**BASING — BOTTOM VIEW**

| Pin | Connection | Pin | Connection |
|---|---|---|---|
| 1 | Fil. center tap & beam plates | 5 | Control grid |
| 2 | Filament | 6 | Same as pin 1 |
| 3 | Screen grid | 7 | Filament |
| 4 | Same as pin 1 | 8 | No connection |
| | | Cap | Plate |

## HYTRON TYPE 5516
### INSTANT-HEATING VHF BEAM PENTODE

**GENERAL CHARACTERISTICS**

| | |
|---|---|
| Filament | oxide-coated, center-tapped |
| Potential (a-c or d-c) | 6.0 ± 10% volts |
| Current | 0.7 ampere |
| Grid-plate capacitance | 0.12 max $\mu\mu f$ |
| Input capacitance | 8.5 $\mu\mu f$ |
| Output capacitance | 6.5 $\mu\mu f$ |
| Maximum overall length | 3-21/32 inches |
| Maximum diameter | 1-7/16 inches |
| Base | low-loss, medium-shell, 8-pin octal |

**ABSOLUTE MAXIMUM CCS RATINGS**

| | | Mod.* | Unmod. | |
|---|---|---|---|---|
| D-c plate potential | 80 mc | 475 | 600 | v |
| | 135 mc | 395 | 500 | v |
| | 165 mc | 355 | 450 | v |
| D-c plate power input | 80 mc | 30 | 45 | w |
| | 135 mc | 26.5 | 40 | w |
| | 165 mc | 23.5 | 35 | w |
| D-c plate current | | 75 | 90 | ma |
| D-c screen potential | | 250 | 250 | v |
| Plate dissipation | | 10 | 15 | w |

**USEFUL POWER OUTPUT (CCS) — TYPICAL OPERATION#**

| Service | Up to: 165 | 135 | 80 | mc |
|---|---|---|---|---|
| Class C unmod. or f-m | 18 | 24 | 30 | w |
| Class C plate-modulated | 12 | 16 | 20 | w |

*Carrier condition with max modulation percentage of 100. #Useful power output to load equals plate power output less circuit and direct radiation losses.

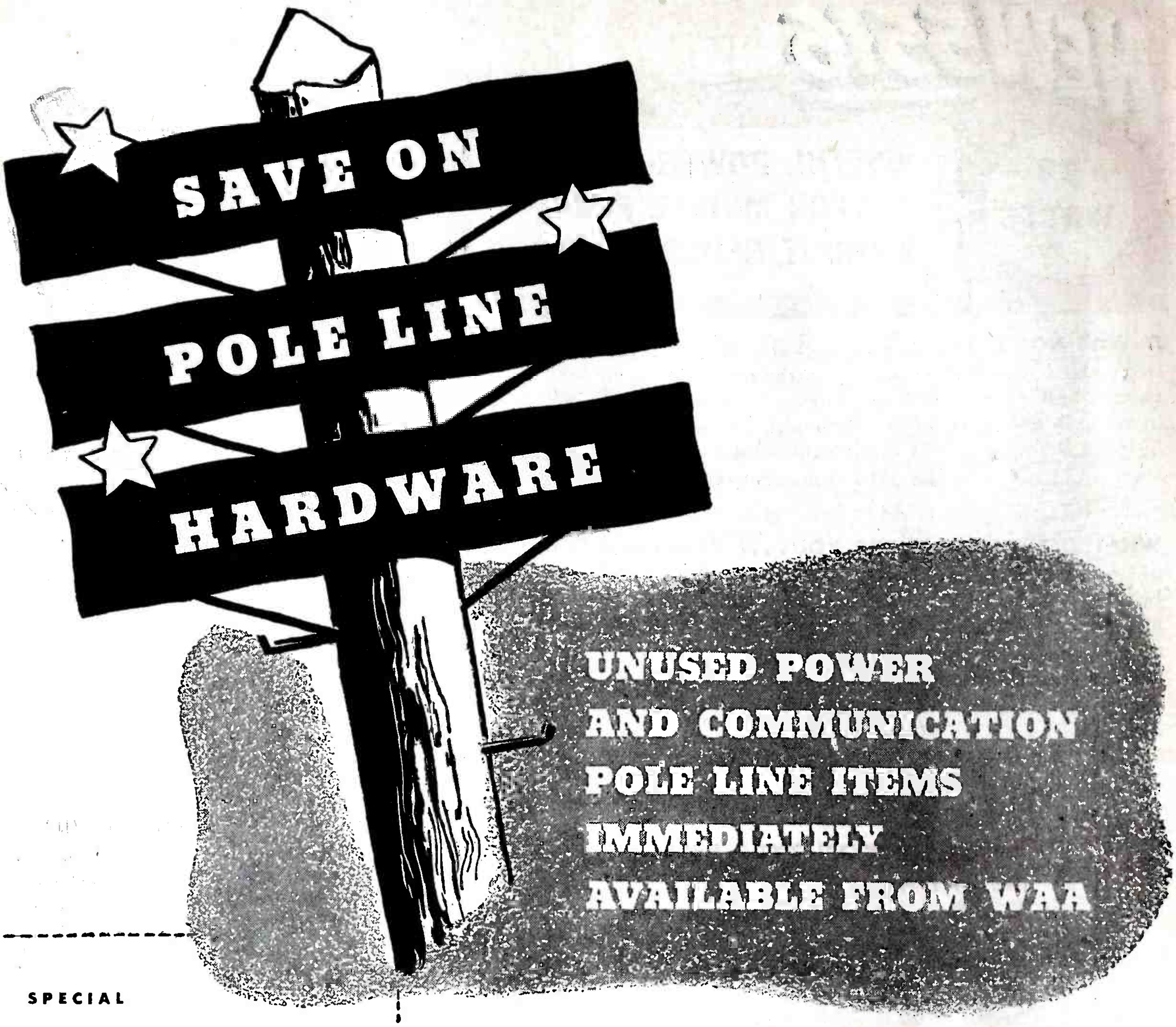
## 5516 CONSTRUCTIONAL ADVANTAGES

- Zirconium-coated plate, gold-plated control grid, carbonized screen grid enable maximum possible vhf ratings, despite compact size.
- Special, rugged filament suspension avoids short circuits and burn-outs in rigorous mobile applications.
- Three separate base-pin connections to filament center tap provide for lowest possible cathode lead inductance.
- Dishpan stem and compact structure give short, heavy leads with low inductance and capacitance.

SPECIALISTS IN RADIO RECEIVING TUBES SINCE 1921

**HYTRON RADIO AND ELECTRONICS CORP.**

MAIN OFFICE: SALEM, MASSACHUSETTS




**SPECIAL**

In addition to the four Regional Offices shown at right, all other Regional Offices will dispose of $800,000 worth of used material and unused material in broken packages during March, April, and May. Each office will conduct Sealed Bid Competitive Sales. Make sure you have a chance to bid. Write each office today and have your name put on the list to receive the Sealed Bid Offering literature on Pole Line Hardware.

Why wait for scarce items when you can meet new installation and maintenance requirements now—and do it at a substantial saving?

In the next three months WAA will put $1,500,000 worth of unused items in standard package quantities on the market at rock bottom fixed prices—well below market. You can make your purchases through your distributor—or direct from the WAA offices in Los Angeles, Birmingham, Cincinnati, or Philadelphia. Most items have previously been offered to priority holders and anyone can arrange for immediate inspection and purchase. For specific details, specifications, prices, contact your distributor or the above WAA offices today.

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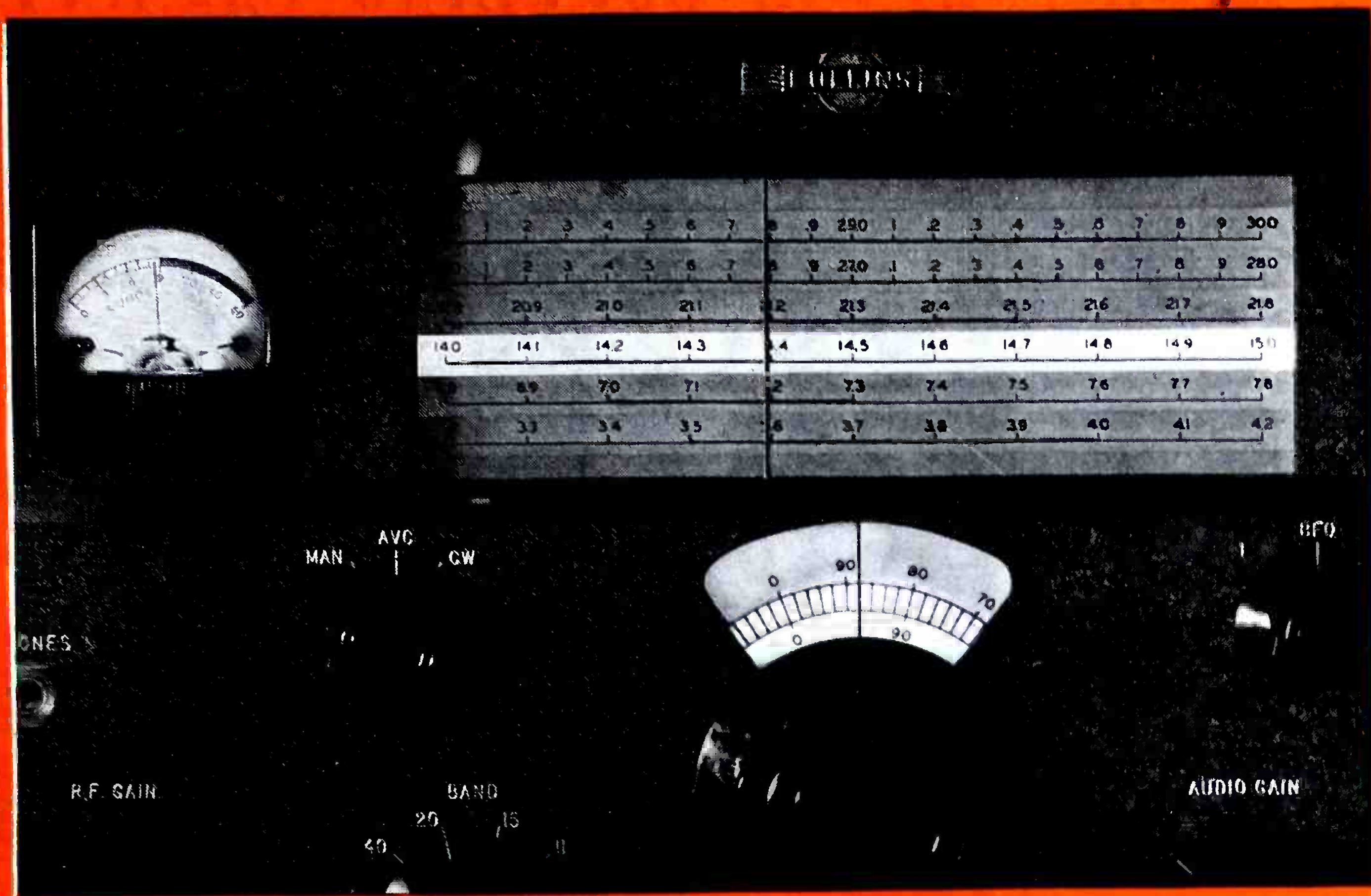
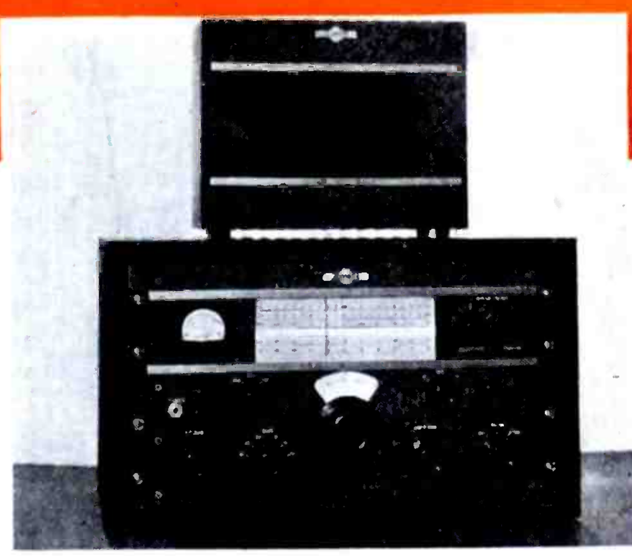



# The Collins Band-Lighted Dial Gives You *Added Pleasure*



Wherever the Collins 75A receiver is shown—hamfests, fairs, club meetings—the band-lighted dial wins enthusiastic endorsement from all who can crowd close enough to see it. And no wonder! It's so easy to use, both visually and mechanically, that once you've used it you'll see why it ranks high among the many new features of this receiver.

Here's how it works. The dial amply covers six amateur bands—80, 40, 20, 15, 11 and 10 meters. When you turn on the filament supply, the dial lights are turned on. *But only the band selected for use is lighted!* There's no band pointer to get out of adjustment, no feeling for the detent action, *and no scanning the dial to see where the frequency indicator is!* With only one band lighted at a time you just naturally read the correct figures at first glance.

The vernier dial, which gives you directly the exact frequency to within 1 kc (2 kc on 11 and 10 meters), works the same way. Only the band you're listening to is lighted. The frequency shown in the photograph is 14,394 kc.

The band-lighted dial is further proof of Collins interest in amateurs. In every equipment designed and built for amateurs by Collins, you'll find engineering that advances the art of amateur radio.

**FOR RESULTS IN AMATEUR RADIO, IT'S . . . COLLINS**

**COLLINS RADIO COMPANY, CEDAR RAPIDS, IOWA**

**11 W. 42nd St., New York 18, N. Y.** | **458 S. Spring St., Los Angeles 13, Calif.**

# THE HIGH-VOLTAGE COUPLING CAPACITOR

## *that paved the way to Low-Cost Carrier Telephone Systems*

Thanks to the development of the Sprague High-Voltage Coupling Capacitor, one line —the power line—can now provide both power and telephone services in rural areas on the Rural Electrification Authority System.

When the entire rural carrier current telephone program was stymied and about to be junked for want of a safe, low cost means of coupling telephones to a 7200 volt distribution line, *Sprague came through.*

The Sprague coupling capacitor is a safe, low cost, hermetically-sealed, corona-free coupling unit only one-tenth the size and weight of other capacitor types formerly considered for this purpose. It is glass enclosed and completely weather proof.

Although operated on 7200 volt distribution circuits in this case, Sprague High-Voltage Coupling Capacitors will withstand ten 1½ x 40 microsecond test impulses of 95 KV.

This .002 mfd. capacitor is conservatively rated at 8700 volts, 60 cycle AC.

**SPRAGUE ELECTRIC COMPANY**
**NORTH ADAMS MASSACHUSETTS**

**HAVE YOU A COUPLING CAPACITOR APPLICATION?**

In furtherance of their extensive coupling capacitor research, Sprague engineers will welcome the opportunity to discuss other applications where high-voltage units of this general type may prove useful.

# SPRAGUE

**PIONEERS OF ELECTRIC AND ELECTRONIC PROGRESS**

LABORATORY INSTRUMENTS FOR SPEED AND ACCURACY

# -hp- 200B AUDIO OSCILLATOR

1. FAST—no zero setting required
2. STABLE—constant output, low distortion
3. VERSATILE—3 bands, wide frequency range

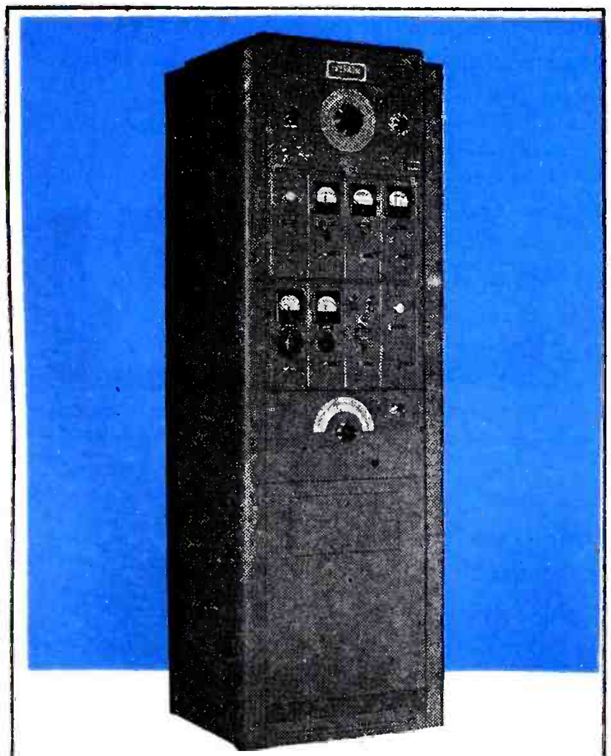

The model 200B *-hp-* Audio Oscillator brilliantly combines the virtues of coil-condenser and beat frequency types for swift, accurate operation under any condition. No longer are frequency zero settings necessary. Even during initial warm-ups, or line voltage variations as high as 10%, thermal frequency change is less than 2%. This high order of stability is maintained throughout the instrument's operating range—20 cps to 20 kc.

Model 200B supplies 1 watt or 22.5 volts output into a matched resistance load of 500 ohms and provides 25 volts on an open circuit. These outputs are constant within ±1 db between 20 cps and 15 kc. And distortion is limited to less than 1% between 35 cps and 15 kc.

This easy-to-operate audio oscillator has but three controls—main frequency dial (directly calibrated), a range switch selecting one of three frequency bands (with generous overlap) and a simple output amplitude control.

The versatile *-hp-* Model 200B is ideal for many uses—testing amplifiers, loudspeakers, transmitter audio responses; for modulating signal generators, driving ac bridges; or wherever a stable audio test signal is required.

The *-hp-* Model 200B Audio Oscillator is ready for early delivery—yours may be shipped from stock. Write or wire now for details.



## Operadio makes 1500 tests per day with -hp- Oscillators

Operadio Manufacturing Co., St. Charles, Ill., uses three-band -hp- Audio Oscillators similar to the Model 200B, in over a dozen of their loudspeaker test racks. Fast-tuning -hp- oscillators make it possible for an inspector to check from 1000 to 1500 speakers a day on each of these units. This results in high-speed, mass production that meets the rigid specifications and close tolerances maintained in all Operadio products.

**HEWLETT-PACKARD COMPANY**
**1341E PAGE MILL ROAD, PALO ALTO, CALIFORNIA**

**Power Supplies • Frequency Standards • Amplifiers • Electronic Tachometers
Frequency Meters • UHF Signal Generators • Square Wave Generators
Noise and Distortion Analyzers • Audio Signal Generators • Attenuators
Audio Frequency Oscillators • Wave Analyzers • Vacuum Tube Voltmeters**

# *Writing with your voice*

Years ago Alexander Graham Bell dreamed of "a machine that should render visible to the eyes of the deaf, the vibrations of the air that affect our ears as sound." He never realized that dream, but his researches led to the invention of the telephone.

Today Bell Telephone Laboratories have turned the dream into a fact — translating the spoken word into readable pictures.

By this new invention of the Laboratories, the talker speaks into a microphone. Vibrations of the voice are unraveled through electronic circuits, and then are reassembled as luminous patterns which travel across a screen. Each syllable of sound has a distinctive shape and intensity.


*Science unravels speech*

Visible speech is still in its infancy, and is not yet available to the public. But educators of the deaf are now evaluating it. Indications are that the deaf can learn to read the patterns and, by comparing the patterns their own voices make with the patterns of correct speech, can improve their diction.

Patterns of visible speech also provide a means for analyzing and recording sound in the study of phonetics and of languages. Eventually, visible speech may make possible visual telephony for the deaf.

This is but one of many contributions by Bell Telephone Laboratories to the understanding and control of sound.

**BELL TELEPHONE LABORATORIES** *EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE*

COMMUNICATIONS

LEWIS WINNER, Editor

MARCH, 1947

# 2-Control 250-Watt A-M BROADCAST TRANSMITTER

by HARVEY KEES

Electronics Research, Inc.

THE TREND TOWARD SIMPLIFIED station operation has accented the need for streamlined equipment with a minimum of controls for both large and small stations, particularly the smaller station with a limited crew. Accordingly in designing a 250-watt unit for WBOW simplification and minimum-control factors were studied carefully and it was found possible to design a transmitter with quite a few simplification features, such as one tunable r-f circuit, an integral monitor speaker and a simplified metering and control arrangement.

#### Tubes Used

The circuit chosen for the WBOW transmitter used an 807 crystal-oscillator stage, 807 buffer, 813 power amplifier and two parallel 805s in a high-level-modulated final r-f amplifier stage. In the audio system we used a pair of push-pull 805 class-*B* modulators driven by push-pull 2A3s.

Plate voltage for the 805s and 813 was supplied by a 1,250-volt rectifier system employing two 872s. The only other power supply used was a 300-volt source using a 5T4 rectifier. A variac control was provided for maintaining constant a-c line voltage input to the transmitter.

#### R-F Circuits

Broad-band, untunable circuits were selected for the plate circuits of the 807 oscillator, 807 buffer, and 813 power-amplifier stages. These consist simply of parallel-resonant circuits, formed by the plate chokes and plate-to-ground capacities of the stages involved. The bandwidth of these circuits is in the order of several hundred kilocycles, afforded by high L/C ratios, thus eliminating the need for any adjustable circuit elements.

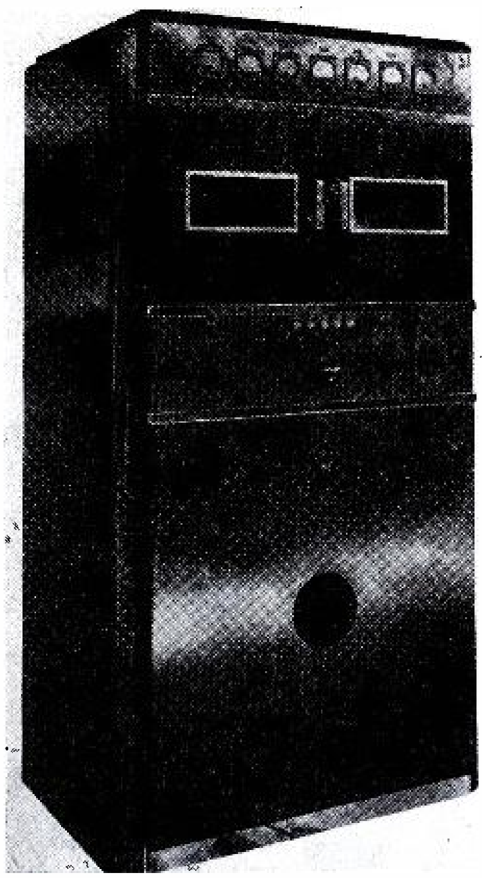


Figure 1
Front view of the WBOW transmitter. Audio monitor speaker is in lower panel, gain control above speaker.

Fixed capacitors and variable inductances were chosen for the plate circuit of the final r-f stage to obtain sufficient selectivity for harmonic rejection, front-panel controls being provided for resonating the circuit and varying the load coupling.

Neutralization of the final 805 stage is accomplished by use of an inductance connected between the plates and grids of the tubes, which resonates with the plate-to-grid capacity. No provision was made for changing the value of the neutralizing inductance because experience indicated that this was unnecessary. It has been observed that even when this neutralizing system is considerably out of adjustment, better neutralization is obtained than with properly adjusted more conventional circuits.

A *thermocell*[1] was included in the oscillator stage. This device consists of a low-drift crystal and temperature chamber in an envelope the size of a 6L6 metal tube. FCC requirements regarding the reading and recording

**Transmitter Built for WBOW, Terre Haute, Indiana, Features Simplified Tuning Controls, Plate Tank of Final Amplifier Only Tunable R-F Circuit; Grid-Current Metering System; Integral Monitor and Accessible Components to Facilitate Maintenance and Servicing.**

of the crystal temperature every half hour are waived when this type of crystal oven is employed.

#### Audio Circuits

A rather conventional circuit was chosen for the audio section of the transmitter, class *B* 805s driven by class *A* 2A3s. Inverse feedback was employed over the two stages.

The design provides for the feeding of a small portion of the output of the modulator stage to an audio monitor speaker mounted in the transmitter cabinet.

#### Design Considerations

At first an attempt was made to design a transmitter using only two tube types; 807 oscillator, 807 buffer, 805 amplifier, and a pair of 805s in the final with an audio section consisting of a pair of 807s driving a pair of 805 class *B* modulators. In a breadboard layout it was found much more convenient to use an 813 instead of an 805 to drive the final r-f stage, because of the more simple neutralization and drive problems with the 813. In the finally-accepted lineup of 807-807-813-805's, it was possible to operate the first three tubes under very conservative conditions.

In the audio section of the transmitter measurements showed that harmonic distortion from a system using 807's with inverse feedback in the driver stage was approximately twice that obtained from a similar system using 2A3s. A final design using 2A3s was therefore adopted.

In preliminary thinking consideration was given to the possibility of using other types of tubes, such as 810s and 828s, in the final r-f and modulator stages. It is believed that somewhat lower distortion characteristics might be obtainable from a design employing these tubes, but this would be at the expense of considerable added complications involving bias sources and protective devices. Fully acceptable performance is possible with the circuit chosen, using 805s.

The integral monitor speaker on the transmitter was adopted after several complex r-f monitoring installations had been observed at a number of broadcast stations. It was felt that while the integral monitoring system left some things to be desired, it would at least tend to provide the transmitter operator with a reasonably reliable idea of what was being transmitted, and a source of program monitor which could not easily be wrecked by uninspired personnel.

#### Design Improvements

The WBOW transmitter was built with materials on hand or most easily obtainable.

It is felt that several improvements could be made in future designs. The variable inductances used in the final r-f stage are not of the optimum size, a rather low *Q* being necessary in the final plate circuit to reduce heating and utilize the variable coils to best advantage. It is probable that a transmitter using variable air capacitors would be more desirable, although no serious troubles have so far resulted from use of the variable inductances.

The audio high-frequency response and distortion characteristics of the transmitter could probably be improved if the modulation transformer were replaced. The transformer employed was an old one that happened to be on hand, and it seems to be the weak point in the audio system. One of the characteristics of the modulation transformer, observed with a distortion meter, was that different distortion percentages existed across different portions of the output winding. It is not known if this is a typical characteristic of all similar modulation transformers, and the point will be investigated further as materials become available. Minor changes in the inverse feedback circuit may prove desirable.

#### Performance

Operation of the WBOW transmitter is quite simple. The equipment is placed in operation by depressing the filament and plate start buttons, the a-c line voltage is set at 115 volts, and the final tuning and loading controls are adjusted to give the desired power output, as indicated by the antenna current meter. Routine duties of the transmitter operator are at a minimum, mainly keeping the a-c line voltage at 115 volts and making log

[3] G. E. type G-30.

Figure 2
Rear view of transmitter. On lower left wall is low-voltage power supply and above are oscillator, buffer, amplifier and final stages. High voltage *B* supply and modulation choke are on floor of cabinet.

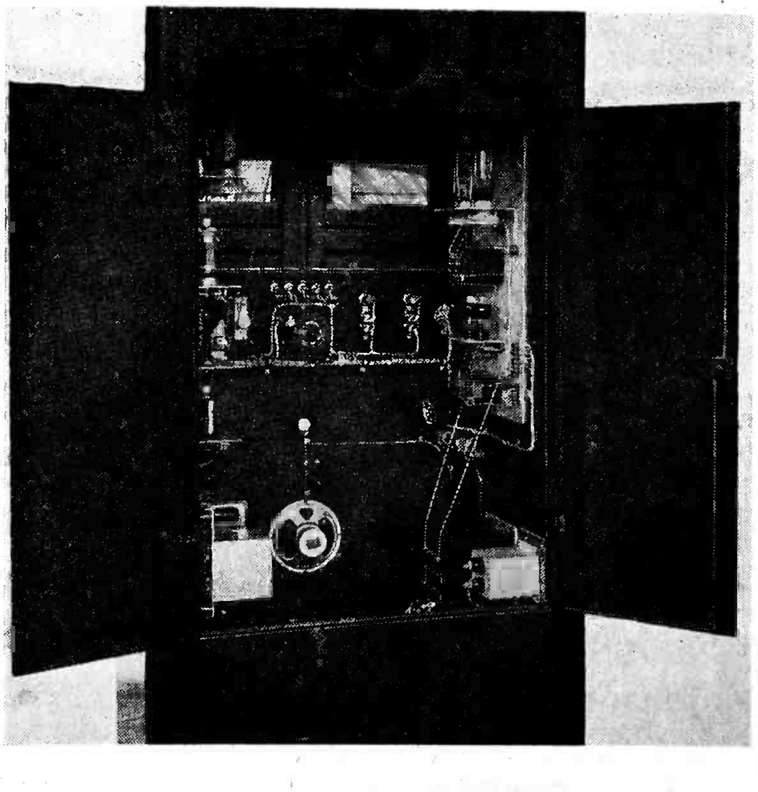
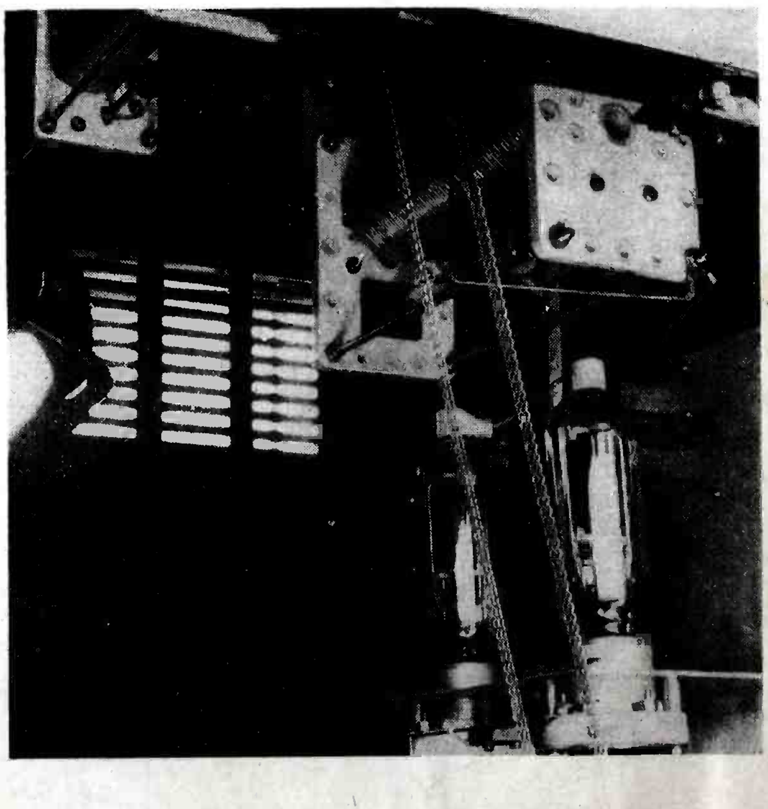


Figure 3
Final r-f tube and variable plate-coil section.



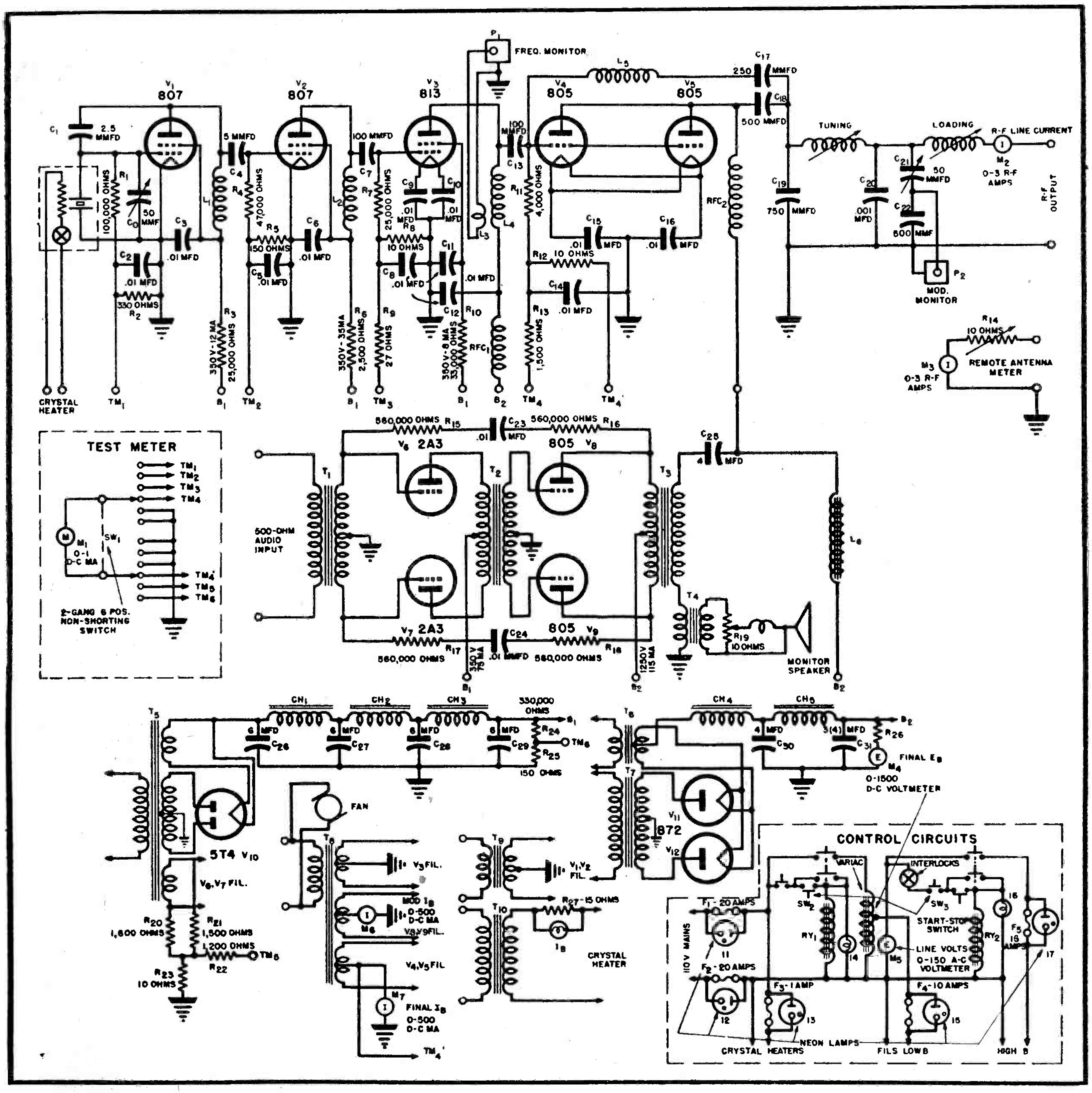



**Figure 4**

**Circuit of the WBOW transmitter. The $L_1$, $L_2$, $L_3$, $L_4$ and $L_5$ inductances consist of 3 7/8" winding of No. 32 wire on a 3/4" form, 3 7/8" winding of No. 30 wire on 3/4" form, 4" winding of No. 26 wire on a 1" form, two turns of No. 12 wire wound around base of $L_3$ and a 4 1/4" winding of No. 28 wire on a 1 1/2" form, respectively. The $T_1$ transformer is a line-to-push-pull grid type; $T_2$, 2A3 plate-to-805 grid type; $T_3$ class *B* 805-to-load type, and $T_4$, 50/5-ohm matching type. $SW_2$ and $SW_3$ are start-stop switches.**

entries required by the FCC. Potential sources of trouble are quickly localized by a *test meter* which is shunted to read center scale under normal conditions, a low grid-current reading on any stage revealing a defect in that or a preceding stage.

Tests made on the completed transmitter indicate that a 100% modulated output of 250 watts is obtainable with a final stage efficiency of over 70%. The overall frequency response characteristic is flat within 1/2 db from 30 to 7,000 cycles. Harmonic distortion is under 2.5% at 95% modulation. The background noise level, consisting mainly of 120-cycle hum, is down over 60 db from 100% modulation. Carrier shift is less than 3%. The audio input impedance measures 500 ohms, and a sine-wave input level of 6 db is required for 85% modulation. Approximately 1,500 watts input from the a-c power line is needed.

#### Metering and Control Circuits

Seven meters, employed on the transmitter, are mounted conventionally across the upper horizontal panel. From left to right, these meters are: (1) *test meter,* calibrated in percent above and below normal, which can be switched to read 807 oscillator-grid current, 807 buffer-grid current, 813 amplifier-grid current, 805 final-amplifier grid current, 2A3 plate current, and low *B* supply voltage; (2) *a-c line voltage;* (3) *modulator plate current;* (4) *final plate current;* (5) *final plate*

(*Continued on page* 37)

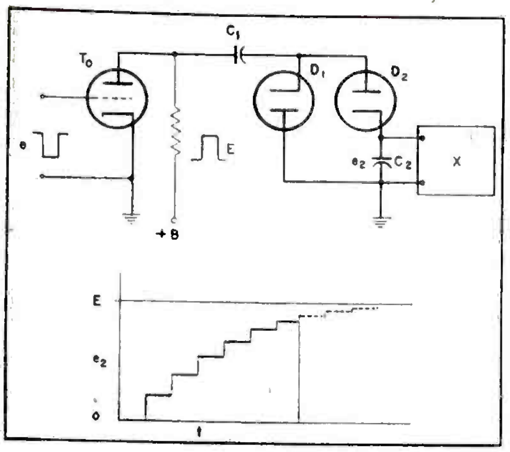



Figure 2 (Hallmark paper)

Conventional counter used in a television system.

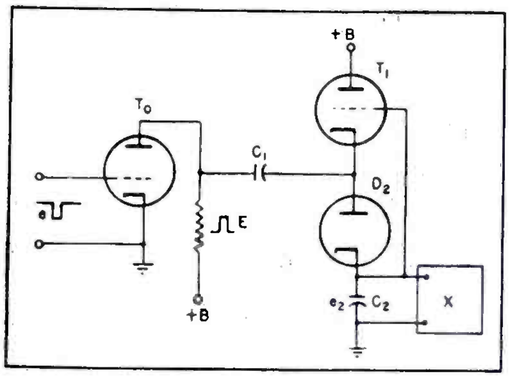



Figure 3 (Hallmark paper)

Modified linear counter providing a 525:1 ratio.

# A Report On the

## COUNTER-TIMER FOR TELEVISION


*C. E. Hallmark*

*Farnsworth Television & Radio Corp.*


THE SCANNING FUNCTION in a television system requires a stable source of timing frequencies. The use of automatic-frequency controlled synchronization in receivers imposes still more stringent requirements on the stability of these frequencies. The afc method of synchronization is the equivalent of a low-loss resonant system loosely coupled to the driving source and therefore possesses narrow band properties. It is this fact which results in the noise immunity realized and also the more exacting requirements on timer stability. This is apparent from the fundamental fact that a narrow band system cannot respond to rapidly varying frequencies. Tentative standards have been established limiting the line-to-line irregularity as well as the maximum rate of change and peak-to-peak deviation of the horizontal synchronizing signal to values which are thought to satisfy the needs for afc controlled receivers.

The master timer must also meet the requirements for good interlace. This requires that the vertical pulse be rigid in phase with respect to the horizontal pulse to minimize spurious moire patterns and permit a maximum vertical resolution. Using this method of control Hallmark stated that it has been possible to secure a utilization factor of .9, with a test pattern from a receiver for study. This can be attributed to vertical resolution, the result of a gating technique used in deriving the vertical pulse in the transmitter timer. In Fig. 1 appears a block diagram of the preferred timer arrangement used, with a modified conventional-counter frequency divider.

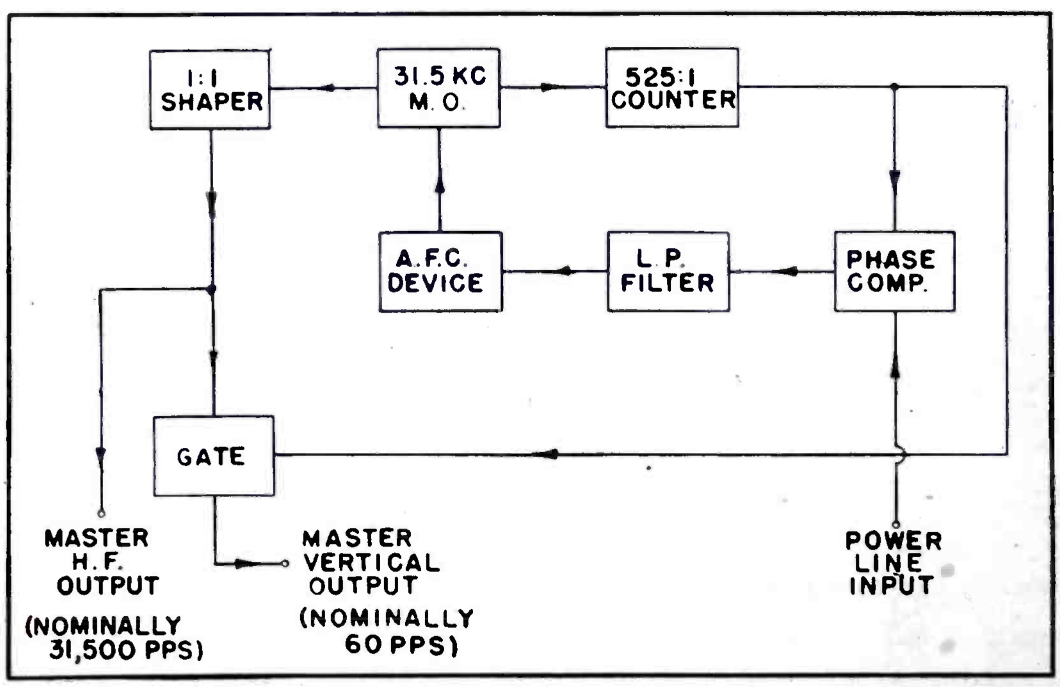
In the conventional counter circuit (Figure 2). the *staircase* voltage function $e_3$ rises in an exponential manner resulting in a limitation in the realizable count-down ratio. The exponentiality is due to d-c restorer action of the diode, $D_1$, which returns the potential of one plate of the capacitor, $C_1$, to zero during the negative excursion of the signal *E*.

In the modified counter (Figure 3) the diode restorer is replaced by a cathode follower, $T_1$. The reference potential to which capacitor, $C_1$, is returned is no longer zero but depends upon the number in the pulse counting sequence. The result is a staircase voltage function which rises linearly within the limit of distortion of the cathode follower.

It has been found that stable triggering of the blocking oscillator can be accomplished with about two volts. This means that the count-down ratio can be extended to approximately 200 to 1 in this circuit by adjustment of the capacitor ratio $C_2/C_1$. Stable count-down ratios of this order have been realized. It has been possible to extend the ratio even beyond this figure by increasing the negative voltage. However, practical engineering limitations on grid bias and other factors are encountered. The timer, as used in a commercial system, used two count-down stages to obtain a 525-1 ratio and was sufficiently stable for use over 10% variations in line and plate voltages.

Figure 1 (Hallmark paper)

Functional block diagram of a preferred arrangement for timing in a television system.

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## THEORETICAL AND PRACTICAL ASPECTS OF F-M BROADCAST ANTENNA DESIGN


*Phillip H. Smith*

*Bell Telephone Labs.*


A DISCUSSION OF THE STRUCTURAL assembly, radiating elements and associated feed system used in cloverleaf antennas was offered in this paper.

Among the factors analyzed were the overall lengths which it was disclosed determines the power gain of an antenna array, with the particular shape or arrangement of the radiating elements playing a minor role. The factors that do limit the gain in a practical antenna array are excessive circuit losses and distortion of the desired pattern.

The two limiting factors that prompt a reduction in gain are shown in Figure 4. It will be noted that if the beam deflection error (the accidental tilting of the beam away from the horizontal plane) amounts to as much as 3°, it would, for this reason alone, be impossible to achieve an effective power gain of over 5, regardless of the antenna height.

Other important design considerations, in addition to the circuit loss and pattern distortion, analyzed were antenna spacing (half wavelength being recommended), bandwidth (not a problem in f-m), and interelement feed lines whose capacity usually limits the power-handling capability of the antenna system.

In a discussion of the mechanical and electrical features it was pointed out that in the four conductors, each outlining a

# 1947 IRE NATIONAL CONVENTION

leaf of a cloverleaf to constitute the basic design, currents all flow in the same direction around the conductors (for instance, all clockwise) so that radial components of current in adjacent conductors tend to cancel, whereas peripheral currents add around the ring. The result is, in effect, a current ring substantially in phase at all points.

Figure 5 shows a comparison of the measured elevation plane pattern with a calculated pattern in which all elements were assigned equal current amplitudes. In this pattern the measured antenna was fed by a single feed line with the radiating elements connected at half-wave points along the line. The anti-resonant impedance of each four-leafed radiating unit is roughly 400-600 ohms, and approximately five units match the characteristic impedance of the line comprising the tower section below the lowest radiating unit to give unity standing wave in this section.

With the cloverleaf, over the entire f-m broadcast band, a single element length results in a standing wave which is easily matched to the main line with a two-section transformer. Vertically polarized radiation from the tower is minimized by bypassing, through external *suppressor* wires, a small portion of the main feed line current. The wires are supported from the radiating loops near the point where they emerge from the tower; the amplitude of the current flowing in them is controlled by the selection of the proper wire size and the distance from the tower. In practice, they are placed about 4½" out from the tower face and employ ¼" stranded cable. The diameter or position of the wires are not critical.

A two-section tuner for matching the antennas to the transmission line was also discussed. This consists of two adjustable bulges, about ⅛ wavelength long at the operating frequency, supported on the inner conductors. Thus, in the whole antenna structure, no insulators whatsoever are used.

## Highlights of Papers Presented by Hallmark, Wells and Reed, Smith, Loughlin, Brunetti, Cohen and Bloom, Davis and Lader, Goldberg and Bath, Moskowitz and Greig.

### TRENDS IN AIR NAVIGATION

***H. Davis and L. Lader***

***Watson Laboratories***

Reporting on solutions to air navigation problems Davis and Lader said that they depend largely upon the radio engineer. While there are sufficient navigation aids to navigate and land any properly equipped aircraft at properly equipped airports, the problem is complex when large traffic densities are involved.

When the en-route problem and the approach and landing problem is solved a serious bottleneck appears as a possibility on the airport runways and taxiways. A high definition radar which feeds information to a traffic-light system on the airport is in process of development and may eliminate traffic snarls on the airport itself.

The initial approach problem is probably the most serious problem existing today. Present trends are to use combination of the omni-directional range (modulation frequency being reduced from 60 to 30 cycles), distance measuring equipment and a ground surveillance radar.

Long distance navigation does not have a system at present which meets the requirements set up by international standardizing organizations. The best solution to date, l-f loran, may be considered only an interim solution.

Considering short distance navigation in this country, the present trend is to provide the pilot with his distance and direction from a known point by means of the v-h-f omni-directional range for azimuth information and distance by means of radar interrogator-responders known as distance measuring equipment (DME). At the same time, a complete picture of the air traffic is presented to ground controllers for adequate scheduling. In dense traffic areas where the economics permit, the ground radar provides this information. In less dense area, ground computers and position reporting may be employed. Certain integrated systems were described at the IRE sessions, but they are in early stages of development and they must await comparison tests and evaluation. Meanwhile the combination of distance and direction presented to the pilot on meter-type instruments should alleviate the en-route, short distance navigation problem and readily permit automatic flight.

The core of the short-range air navigation system of the immediate future is the distance measuring equipment. A number of independent developments of this equipment have been undertaken at 200 mc and 1,000 mc and several have been brought to a high degree of refinement. Operation is based on the measurement of the two-way transit time between air and ground beacons with a direct reading display of range information. The rate of approach and information for homing or orbiting may be secured directly from the derivative of the range with respect to time. The research and development of the equipment has proceeded on two inde-

**Figure 4 (Smith paper)**

**Factors affecting the gain of f-m antennas: *1*, perfect adjjustment with no losses and 100% efficiency; *2*, perfect adjustment but with circuit losses of .004 db/feet; *3*, *4* and *5*, beam direction errors of 1°, 2° and 3°.**

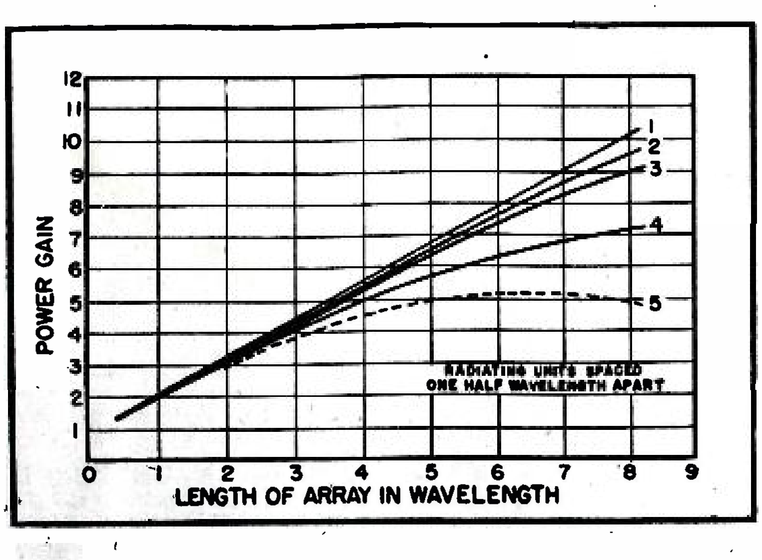
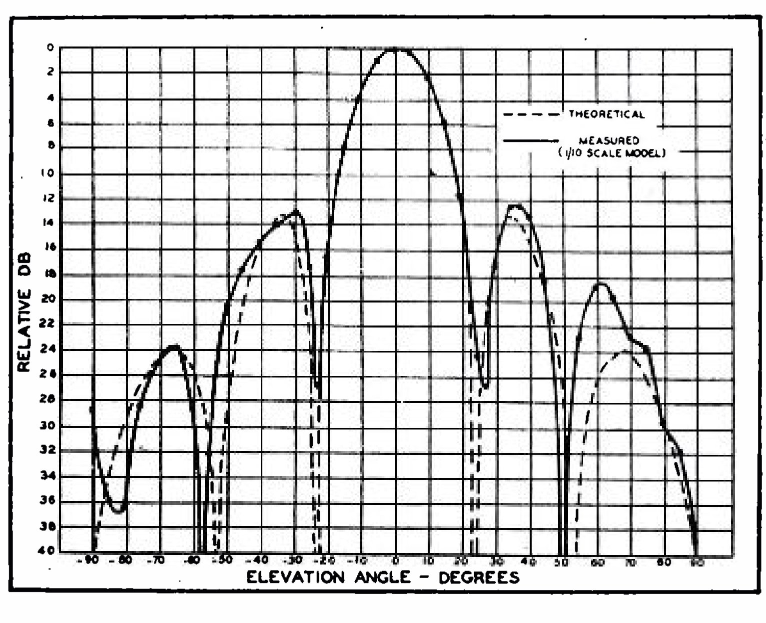



**Figure 5 (Smith paper)**

**Comparison of the measured elevation plane pattern with a calculated pattern in which all elements are assigned equal current amplitudes.**



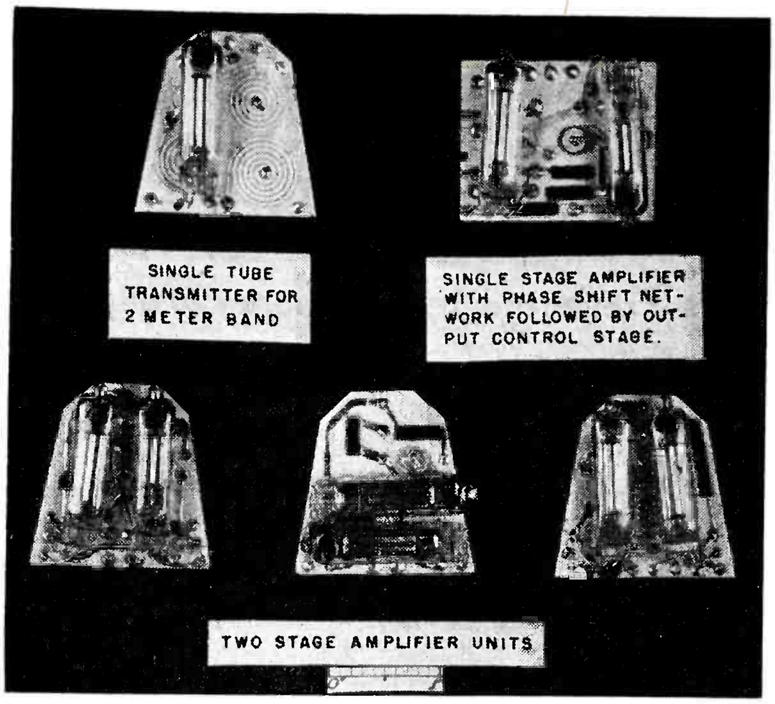



Figure 7, left (Brunetti paper)
Assortment of units printed on ceramic plates. Spiral coils, resistors and wiring have been applied with silver or carbon paints.

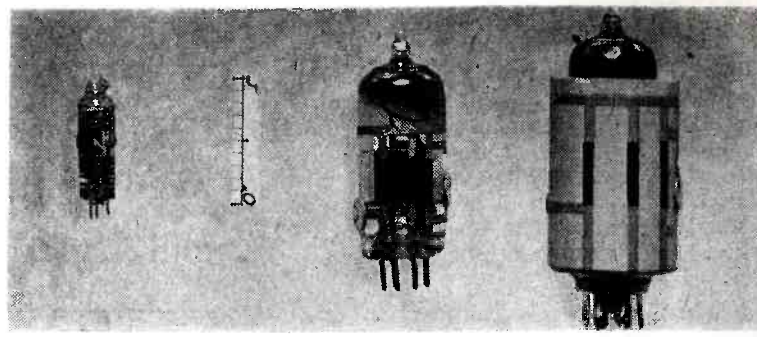


Figure 6 (Brunetti paper)
At left, a s-w transmitter printed on the glass envelope of a subminiature tube. Length is 1", diameter is ¼". Center, a double-stage amplifier printed on the glass envelope of a 6J6 miniature dual triode. Right, unit similar to that shown in the center, except that the circuit is printed on a cylindrical steatite plate. Plate is attached to the tube socket into which tube is plugged.

pendent lines. One end-product is a broad-band equipment using inherently stable 1,000-mc cavities and the other is a crystal referenced, narrow band system. Both types provide approximately 100 channels between 960 and 1,215 mc.

Davis and Lader indicated that it has been generally agreed that the DME must perform a number of important auxiliary functions. One such function is the complete automatic two-way reporting of navigational data using decade counters.

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## ELECTRONIC WIRING TECHNIQUES

*Cledo Brunetti*

*National Bureau of Standards*

A variety of miniature receivers and transmitters using subminiature and miniature tubes, with wiring applied to small plates or cylindrical surfaces through stencils (silver and carbon inks or paints) by hand painting, spraying, photochemistry, chemical reduction, an abrasive blast, printing in vacuum chambers or punch-press production were described in this paper.

While the processes result in true miniature circuits, their major value lies in affording substantial economies in manufacture. Wiring errors on the assembly line are eliminated as each unit is a reproduction of the master pattern.

Brunetti pointed out that maintenance can be reduced by printing all the units of large receivers in plug-in fashion. Should circuit failure occur, the units and tubes can be unplugged, tested and the defective ones replaced.

Metallic paints developed can be used for printing circuits on practically all types of surfaces from glass to plastics. The circuits may be designed to give satisfactory operation from -60° to 150° F in relative humidities ranging up to 100%.

In the simplest method described, circuits are painted on free-hand with a camel's-hair brush. Tiny ceramic capacitors and subminiature radio tubes are soldered in place to complete the circuit. For mass production, screen stencils made of silk or metal can be used. Photographic methods are employed to block out the desired stencil pattern.

Spray-gun methods described included spraying paint and pure metal onto surfaces through circuit-defining stencils. The metal can be applied in wire, powder or molten form. Another variation involves spraying chemical mixtures through stencils from a dual-nozzle gun, in the same order as that in which they would be mixed in the laboratory. In another technique, a metal-plated plastic is used. Part of the metal is "sprayed off" the surface, using a stencil which leaves the proper circuit pattern. The vacuum processes involve the distillation of metal or carbon films onto the surface in a vacuum.

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## F-M/TV P-A TUBE AND GROUNDED-GRID CAVITY CIRCUIT

*H. D. Wells and R. I. Reed*

*General Electric Company*

The effectiveness of the grounded-grid cavity circuit for u-h-f video services has prompted the development of a water-cooled triode with parallel-plane terminals, GL-9C24, for use in a class *B* and *C* r-f amplifier that requires no neutralization.

In a grounded-grid cavity, operating at 220 mc as an r-f amplifier in class *B*, the tube's rating are: d-c plate voltage 5,000; d-c plate current, 2 amperes; plate input, 10 kw; plate dissipation, 5 kw. As a class *C* telegraph power amplifier or oscillator, maximum ratings are: d-c plate voltage, 6,500; d-c plate current, 2 amperes; d-c grid voltage -850; d-c grid current, .25 ampere; plate input, 12 kw; plate dissipation, 5 kw.

Cavity consists of cathode and anode coaxial circuits extending above and below a ground plane at which the tube is located. Thirty-ohm one-quarter wavelength lines are foreshortened by tube interelectrode capacitances and tuned by movable shorting plungers. Conductors are 6" and 10" diameter. Tuning plungers have beryllium copper fingers contacting the outer and inner conductors. These are made up in the form of a continuous U-shaped cross section fastened to an aluminum ring, which is driven by push rods. The cathode line length is adjustable up to 23"; the anode line, up to 29". These lines are bolted together at the removable ground plane.

Anode and cathode mica bypass capacitors are frustums of a right circular cone surrounding the tube.

Beryllium copper fingers on the inner conductors of the capacitors make contact with the tube cathode and anode flanges. Fingers of the same material on the ground plane make contact with the grid flange.

Radio-frequency input and output coupling is accomplished through the use of adjustable probes located close to the tube.

A re-entrant anode is used to make the effective length of the anode line as short as possible. The grid is a tungsten helix welded on tantalum stay rods and is supported by a low-inductance truncated cone. This cone shields the filament from the anode resulting in a plate-filament capacitance of 0.47 mmfd. Inner filament terminal is cooled by injecting water into a hole in the cathode post and heat is removed from the outer terminal by a water-cooled connector. The cathode-grid and grid-plate seals are air-cooled.

An adapter bolted to the cathode end of the tube serves many purposes. First, since its outer diameter is identical to that of the tube anode flange, the same bypass capacitor design can be used at the cathode and anode ends of the cavity. Second, it carries filament current to one leg of the filament. Third, it carries a water-cooling line to cool the tube. Fourth, it carries a perforated-copper tubing air-cooling ring to supply an air blast on the grid-filament glass seals, and fifth, it carries a filament bypass capacitor with its beryllium copper fingers contacting the center filament post.

Glass seals are cooled by air jets from a perforated-copper tubing ring mounted below the ground plane.

Oscillator and amplifier cavities are similar except for the cathode r-f input probe on the amplifier and the provision for feedback in the oscillator.

Two flat rings 8" in diameter mounted one on each side of the ground plane and connected together with feed-through insulators provide feedback.

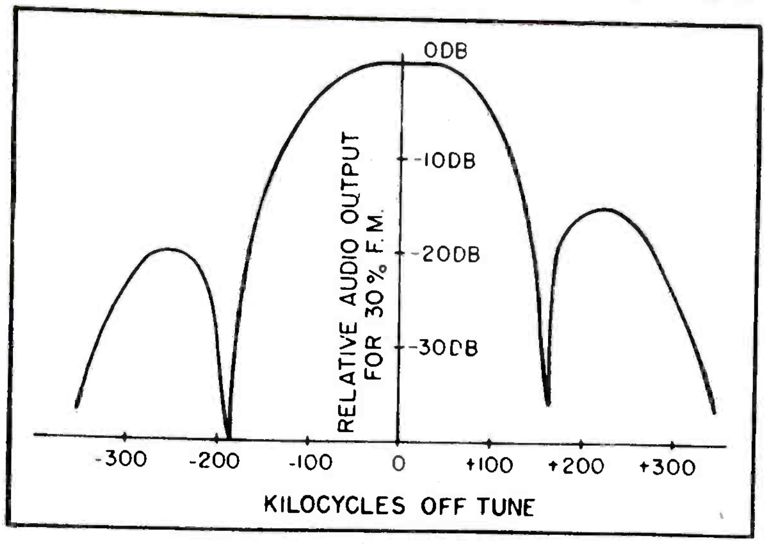


Figure 8, below (Loughlin paper)
Limiter characteristic for dynamic limiter.

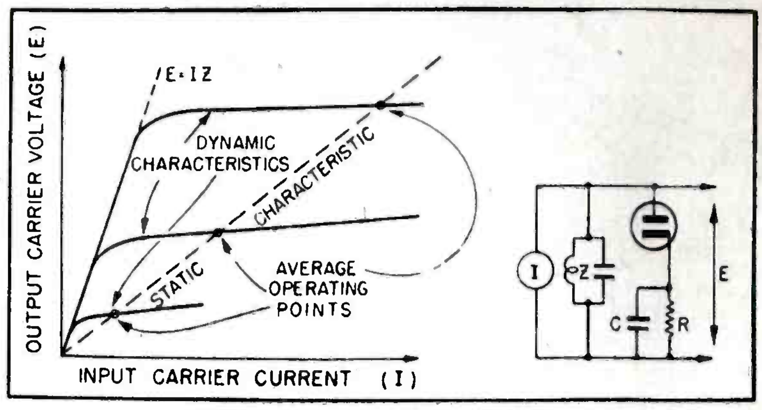


Figure 9 (Loughlin paper)
Typical tuning characteristic for an f-m receiver using dynamic limiter.

## F-M DETECTOR SYSTEMS

**B. D. Loughlin**
**Hazeltine Electronics Corporation**

A REVIEW OF THE GENERAL PERFORMANCE characteristics of several widely used f-m detector systems, namely those using grid-bias limiters followed by balanced discriminators, those using locked oscillators either including or followed by a discriminator and those using ratio detectors, was offered in this paper. Typical variations with average carrier level of performance characteristics such as a-m rejection, downward a-m capability, and audio output were discussed. The grid-bias limiter-discriminator detectors and the locked oscillator f-m detector systems were described as having a fixed threshold level and a fixed output. It was pointed out that the ratio detector has a variable threshold level and an audio output which is proportional to the applied carrier level.

In a discussion of an f-m detector system using a diode for a dynamic limiter, followed by a balanced discriminator, Loughlin pointed out that a high-conductance diode biased by a battery and placed in shunt with a high-impedance resonant circuit, fed by a constant current carrier source, produces an effective voltage limiter of the fixed threshold type. This diode voltage limiter is readily modified to have a variable level threshold, determined by average carrier level, by replacing the bias battery with a long time constant parallel resistor-capacitor network. The resulting output from the dynamic limiter is a carrier whose amplitude is proportional to the average value of the applied carrier current, but which is relatively free of a-f a-m of the applied carrier.

By following the dynamic limiter by a balanced discriminator, it is possible to produce an f-m detector system which has a variable threshold level and an audio output which is proportional to the applied carrier level. Loughlin showed that it is also possible to provide a practical detector system using a germanium crystal diode for the voltage limiter. It was pointed out that the diode dynamic limiter type of f-m detector permits the use of relatively low-conductance diodes in the discriminator section, and only one high conductance diode need be used, that being in the limiter circuit.

Describing an idealized type of f-m detector system, which uses a pair of logarithmic detectors, Loughlin showed that the differential output from a pair of logarithmic detectors, each one of which is proceeded by side tuned filters, is a linear function of frequency and independent of input signal amplitude. If the logarithmic detectors maintain their logarithmic relationship down to the noise level of the system, the result can be an f-m detector which rejects downward amplitude modulation until the instantaneous signal approaches the noise level, and the detector side responses will be masked by noise. With this type of ideal detector system, the range of linearity of the detector characteristic is limited by the noise, thus giving a wider linear range for increased signal levels. While this type of idealized logarithmic f-m detector can be set up in the laboratory, using a rather complex arrangement, it is not suggested for a practical detector system. It does, however, have useful mathematical applications since it describes an ideal f-m detector in terms of the convenient mathematical functions of the exponential and the logarithm.

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## MICROPHONISM IN A SUBMINIATURE TRIODE

**V. W. Cohen and A. Bloom**
**National Bureau of Standards**

RESULTS OF A STUDY of microphonism in subminiature triodes (filamentary triode with approximately plane and grid structures), and a general discussion of microphonic phenomena and some of the techniques used in its study, were offered by Cohen and Bloom. The tests made were of necessity a very small statistical sample of the tube.

In this paper, microphonism was considered to be any change in plate current of a tube due to vibration of any tube element.

Plate current variations have been ascribed to a number of different causes:

(1) Variations caused by changes in the interelectrode spacing, produced by mechanical or acoustical excitation of the bulb or base.

(2) Intermittent contacts in the tube, caused by either poor welds or other defects in design or workmanship.

(3) Fluctuating electrical leakage, due either to getter material on the mica, or to cathode sputtering of the mica.

(4) Charging of the dielectric as a result of pressure. This has been suggested as a possible cause, but has not yet been proven a factor.

Analyzing considerations of elastic properties, Cohen and Bloom stated that the vibrations of any complex structure can be understood in terms of the resonant frequencies of its various modes of vibration, pointing out that the obvious modes of vibration are:

(*1*) The entire mount vibrating as a cantilever structure supported by the stem leads. This will generally be at a low frequency accompanied by shock against the bulb, which will excite the higher harmonics of all other modes of vibration.

(*2*) The filament vibrating as a stretched string. This will be characterized by low damping or sharp resonance. In case of shock excitation all the higher harmonics will be present.

(*3*) The grid side rods can vibrate in two ways, either as a bar clamped at one end and the other rattling in the mica hole, or as a bar supported at each end.

(*4*) The grid turns vibrating as curved bars clamped at each end to the side rods.

(*5*) The plate structure, vibrating as a stiff diaphragm. This type may be negligible because of the extremely high frequencies involved.

The resonant frequencies were not visible under microscope examination with stroboscopic light. An attempt was made to calculate these frequencies from their elastic properties. Some delicate measurements were made on the elastic constants of the grid structure. The parts appeared to be quite soft or well annealed. While approximate values of frequency could be calculated, internal friction was probably so great that the amplitude at resonance was less than that observable optically.

To study the resonances, the tube was vibrated through a range of frequencies up to 20,000 cps and the variations in plate current observed as the voltage variations across a resistor in the plate circuit. Tests were made with zero bias on the control grid.

The tube output can be applied either to a c-r oscilloscope or to a wave analyzer. It is important the 'scope have a range up to 100,000 cps, because of the presence of harmonics of the vibration frequency. In one problem where sharp pulses were observed in the tube output, a video amplifier flat to 4 mc was used to obtain a clear picture of the characteristics of the pulse.

A shaker used was made from a speaker magnet, with a piece of sponge rubber used as the spring element. This furnished a spring of low restoring force with consequent low resonant frequency.

Since the output frequencies in the high audio and supersonic region were of interest the spring was designed to give a resonant frequency of about 300 cycles. There was one minor resonance at 350 cycles and no others below 7,000 cycles. The amplitude and velocity of the vibrator were measured by means of a magnetic pickup, calibrated in the low frequency region with a microscope.

The design of the pickup presented some difficulties because of the small displacement involved, as low as $5 \times 10^{-6}$ inches at higher frequencies and because

(*Continued on page* 40)

# Your Cable Problems

*stated here*

**★ ANSONIA ★**

# Ankoseal

*answers here*

We have designed many cables which have solved a multitude of problems. When you come to Ansonia for something original in cables, our engineers will turn out a product to meet your specific requirements.

*Photo courtesy Bakelite Review*

**THE ANSONIA ELECTRICAL DIVISION**
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# Load Characteristics of

# TELEVISION ANTENNA SYSTEMS

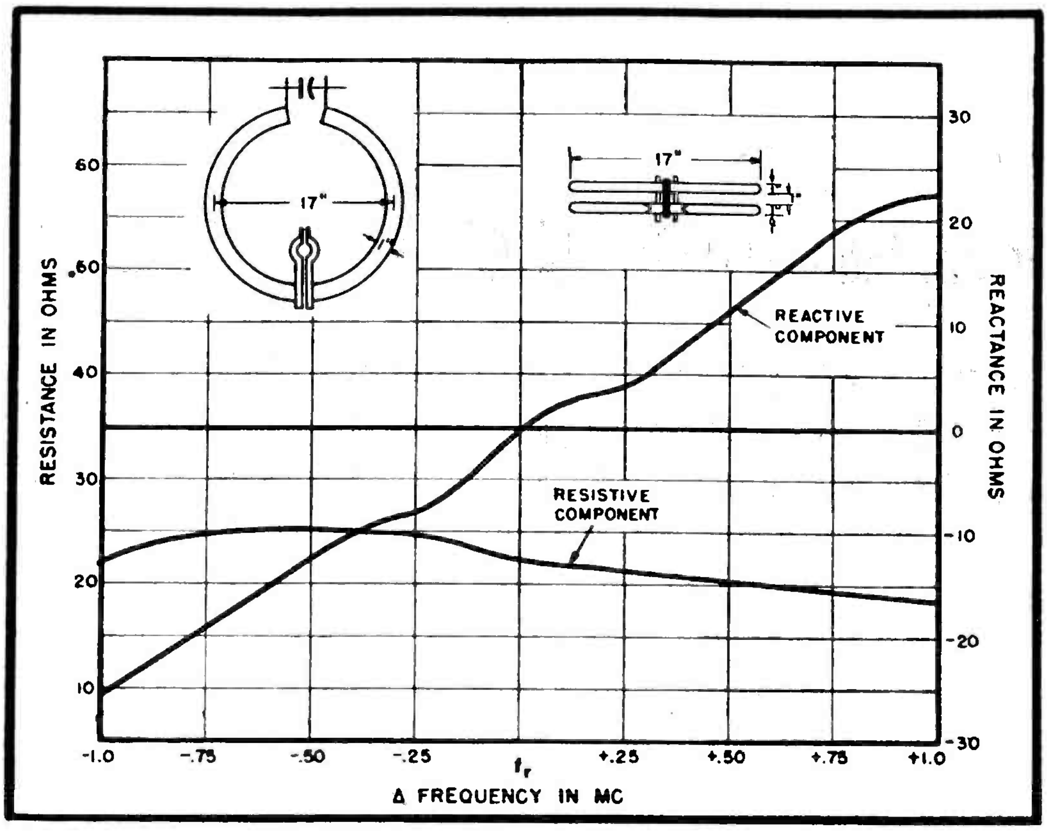
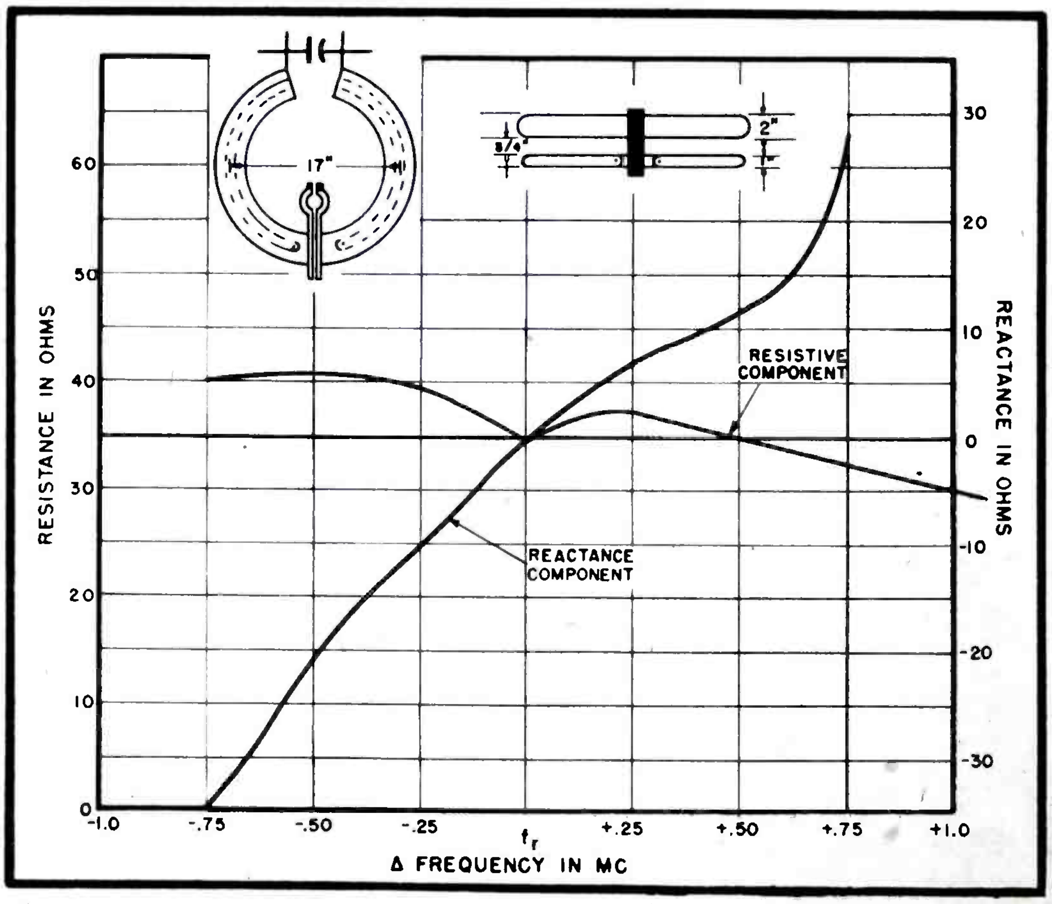



Figure 6a
Electrical characteristics of doughnut-antenna folded-dipole with 1" elements.

Figure 6b
Electrical characteristics of doughnut antenna using different element diameters.




THE METHOD FOR EVALUATING the complex nature of transmission line loads, outlined in previous installments of this series[4], applies to the measurement of h-f antenna systems. In this discussion appears a general consideration of antenna problems, with certain basic systems which have proven satisfactory. Offered are data of actual measured results.

In television service two separate transmitting systems are required, video and sound. Since the frequencies involved are quite close, care must be taken to keep the energy at one source from filtering into the other due to intermodulation and cross-modulation. Two methods are currently available: (*1*) Sharply-tuned rejection circuits; (*2*) antennas which have small mutual relations with respect to each other. The latter case will be discussed.

### Sound Antenna

The maximum frequency deviation for the f-m sound signal is ± 40 kc. From the viewpoint of bandwidth practically any antenna, tuned to resonance at the high frequncies will be satisfactory. A circular *doughnut* antenna such as shown in Figure 6*a* and *b*, satisfies the requirement for a minimum mutual and produces an almost circular pattern. (The electrical characteristics of the two antennae are shown.) It will be noted that the antenna in Figure 6*b* uses elements of a different cross-sectional area. When the feeding element is the smaller of the two the impedance goes up, the impedance ratio being approximately equal to the square root of the diameter ratio. This step up in impedance also makes the matching problem easier.

The quarter-wave transformer is one of the most useful devices for obtaining a match between the transmission line and the antenna. Referring to equation (*20*)

$$Z = \frac{Z_0 (Z_r + jZ_0 \tan\beta d)}{Z_0 + jZ_r \tan\beta d} \qquad (20)$$

[4]COMMUNICATIONS; January and February, 1947.

## Concluding Installment Offers a Discussion of Impedance Characteristics, and Phasing and Matching Methods for Television Transmitting Antennas. Measurement Problems Often Encountered Are Also Analyzed.

**by G. EDWARD HAMILTON and RUSSELL K. OLSEN**

**Senior Engineers, Development Section**
**Allen B. Du Mont Laboratories**

where: $Z$ = impedance looking into a section of line
$Z_o$ = characteristic impedance of the line
$Z_r$ = load impedance
$\beta d$ = electrical length of line

Making the length $\lambda/4 = \beta d = \pi/2$, the foregoing expression is reduced to

$$Z = \frac{Z_o\,(Z_r + jZ_o \tan \pi/2)}{Z_o + jZ_r \tan \pi/2} \text{ (indeterminate)}$$

However, if divided by $\tan \pi/2$

$$Z = \frac{Z_o\left(\dfrac{Z_r}{\tan \pi/2} + j\,Z_o\right)}{\dfrac{Z_o}{\tan \pi/2} + j\,Z_r} = \frac{Z_o^2}{Z_r}$$

$$\text{or } Z_o = \sqrt{Z_{in}\,Z_r} \qquad (30)$$

where $Z_o$ is the required impedance of the quarter-wave section to produce a match. The terminating impedance may be either higher or lower than the line impedance and a match will obtain.

Figure *7a* and *b* shows matching sections for two systems of feed. Careful installation of a system, as illustrated, can produce an impedance mismatch ratio of less than 1 to 1.1. Figure *7b* shows a method for going from unbalanced coaxial line to balanced antenna feed by use of the *bazooka*. The quarter-wave matching section is included inside the *bazooka*.

It is important to note that, with respect to this overall system, tuning of the antenna capacitor is *critical* and should be completed by means of slotted-line measurements or other accepted methods.

When it is desired to *stack* two such antennas, in order to increase the power gain, a unique method of phasing and feed, as shown in Figure 8, may be employed to give unbalanced to balanced characteristics, matching to a single standard 51-ohm transmission line and proper phase relations between the antennas.

### Video Antenna

Figure 9 shows the effect of element size for the simple dipole. It will be noted that the bandwidth over which it is resistive is quite narrow, but does increase with increase in the element diameter.

One method of increasing the non-reactive bandwidth is to use folded dipoles. Figure 10 shows the electrical characteristics of a two-element system using pipe diameters of 1½" with 3" spacing between centers. In addition to increased bandwidth, the impedance also rises. The impedance is increased as the square of the number of elements; at any instant the ends of a dipole are of opposite polarity. Since the potential across each element is the same, and the diameters are equal, the current in each element will be identical and traveling in the same direction. However, since the same power is radiated from the folded dipole, as from a standard dipole,

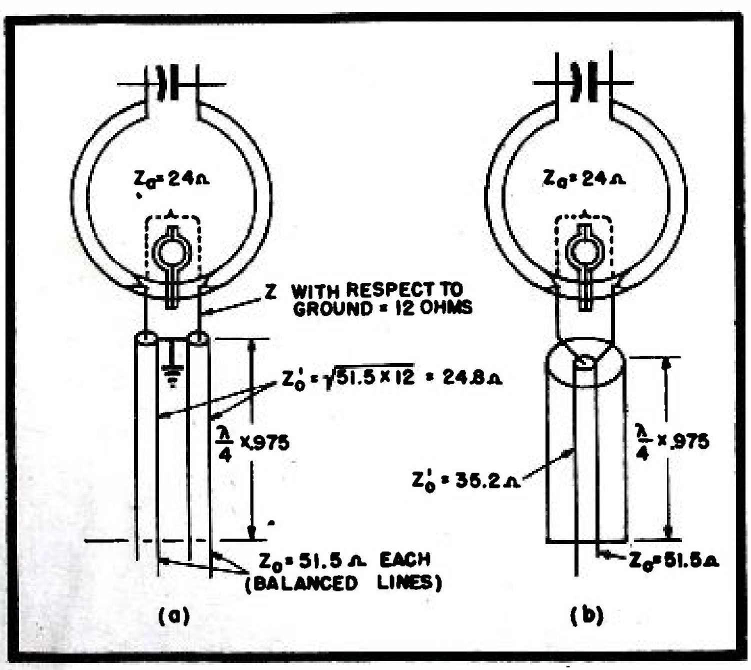
$$P = I^2 R_d$$

where: $P$ = constant value
$R_d$ = radiation resistance of a standard dipole
$R_f$ = radiation resistance of a folded dipole

The current in each folded dipole element will be half that in a standard dipole, or

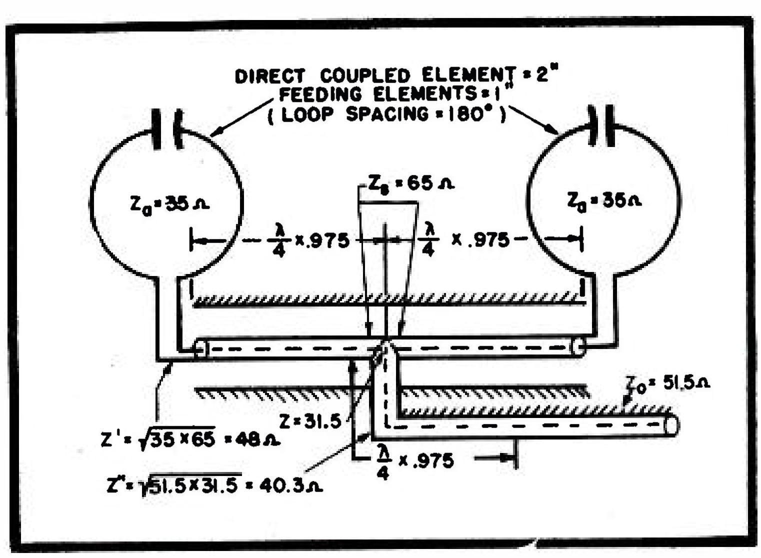
$$P = (I/2)^2 R_f$$
$$(I/2)^2 R_f = I^2 R_d$$
$$\frac{I^2}{4} R_f = I^2 R_d$$
$R_f = 4R_d$ or approximately 280 ohms, where $R_d = 70$ ohms

For a three-element folded unit the




Figures 7a and b (left)
Method of feeding doughnut antennas from balanced and unbalanced transmission lines. All outer conductors are at ground potential.

Figure 8
Simple method of stacking doughnut antennas with proper phase and measuring relations.



**FEDERAL COMMUNICATIONS COMMISSION**
WASHINGTON 25, D. C.

ADDRESS ALL
TO THE

# IS READY TO SERVE THE NATION

November 27, 1946

Mr. John Curtis, Manager
Mobile Communications Division
Farnsworth Television & Radio Corp.
Fort Wayne 1, Indiana

Dear Mr. Curtis:

I wish to thank you for your letter outlining the excellent progress which the Farnsworth Television and Radio Corporation has made in developing and producing various types of equipment for railroad radio communication. I was especially pleased to read that section of your report which quotes various railroad presidents who recognize that radio will enhance safety and efficiency in railway operations.

As you know, the Commission has been convinced for some time that a properly engineered railroad radio system will contribute to safety of life and property, both in preventing accidents and in reducing the seriousness of injury and damage after accidents. While safety is of paramount importance we also recognize and encourage the use of radio as a means of improving the overall efficiency of the railroads.

Sincerely yours,

E. K. Jett,
Commissioner

Commissioner Ewell K. Jett has been a motivating factor in the development of radio communications since the pioneering days of the early 20th Century. From 1911-1929 he participated in the development of the Navy's use of what was then a new communications art. Since 1929, Mr. Jett has been associated with the Federal Communications Commission and its predecessor, the Federal Radio Commission, first as Assistant Chief Engineer; then, since February 1, 1938, as Chief Engineer. On February 15, 1944, Mr. Jett was appointed Commissioner.

Throughout his career with the Navy and the Commission, Mr. Jett has been alert to the ever-increasing usefulness of radio in mobile operations. More recently, with the development of radio equipment for railway and highway services and Mr. Jett's origination of the Citizens' Radio Communication Service, his activities wth the Commission have taken on even more significance to American economy and well-being.

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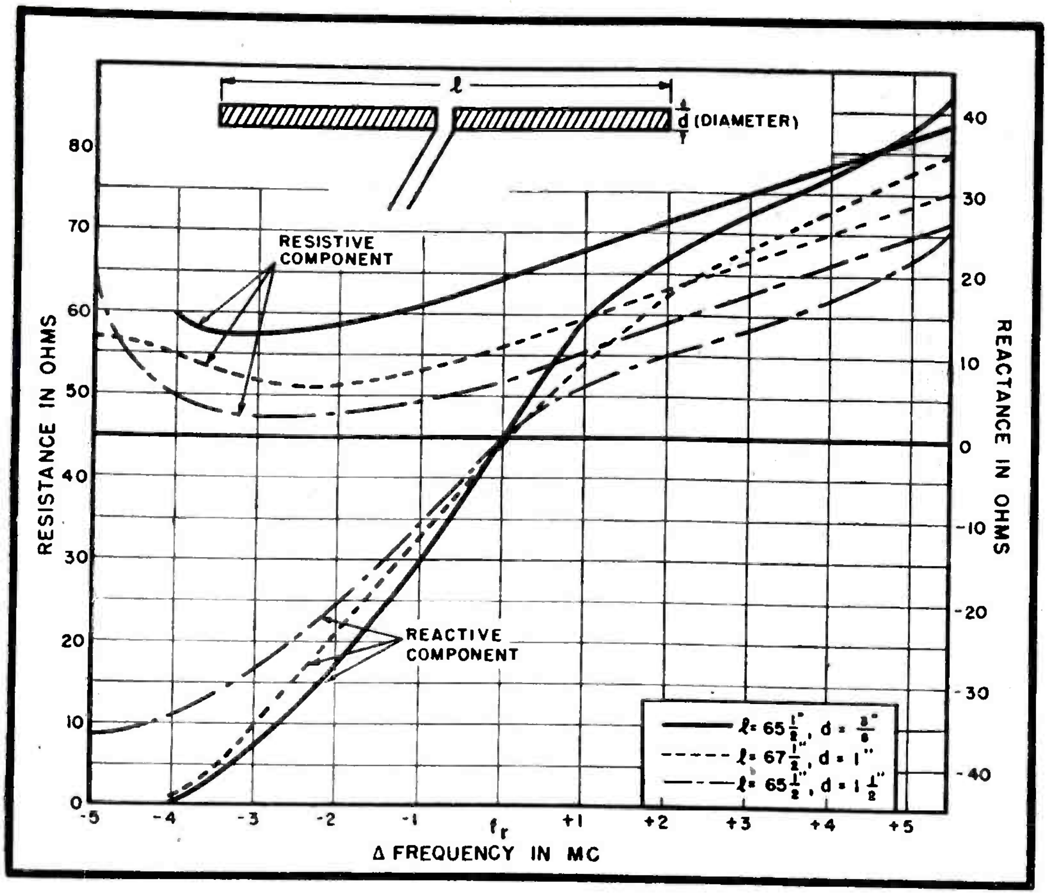
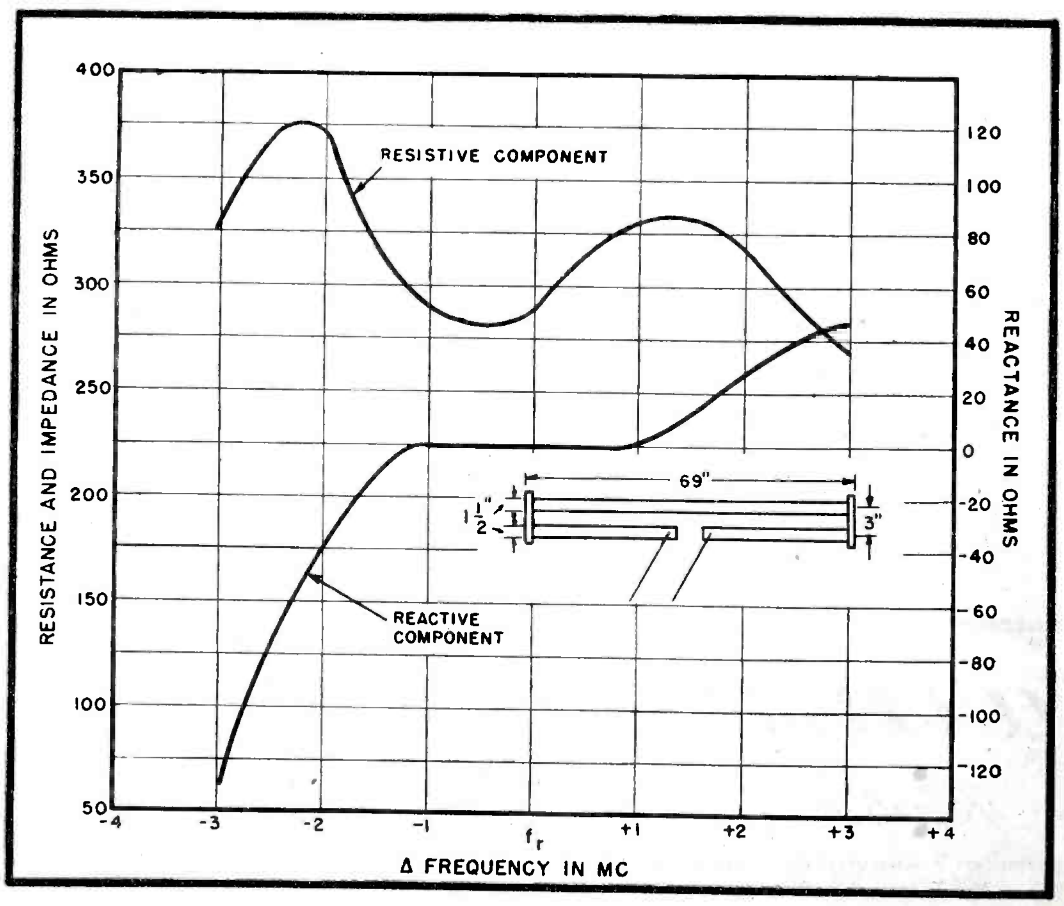



Figure 9

Measured characteristics of simple ½-wave dipoles.

Figure 10

Measured characteristics of double folded dipole adjusted to 79-mc resonance.




current in each element will be 1/3 that obtaining in a standard dipole. Therefore

$$P = I^2 R_d$$
$$P = (I/3)^2 R_f$$
$$R_f = 9R_d \text{ or approximately 630 ohms}$$

In general we may say that

$R_f = N^2 R_d$, where $N$ is the number of elements.

The use of folded dipoles offers the further advantage, therefore, of impedance transformation which gives additional flexibility in the design of a radiator system.

### Double-Folded System

Figure 11 shows a method of connecting a double folded system in turnstile. With respect to ground, the individual quadrature sections present an impedance of 140 ohms. Two coaxial phasing lines may be constructed, whose length is 90° and characteristic impedance is 140 ohms. Two adjacent sections of the turnstile are connected by means of the phasing sections, resulting in flat lines and the system is fed at any two elements 180° removed from each other. The feeding impedance, per line (for balanced lines), will be 70 ohms, which is most convenient, since matching transformers are not required. The overall bandwidth of such a system is in the order of 3 mc.

### Three-Element Dipoles

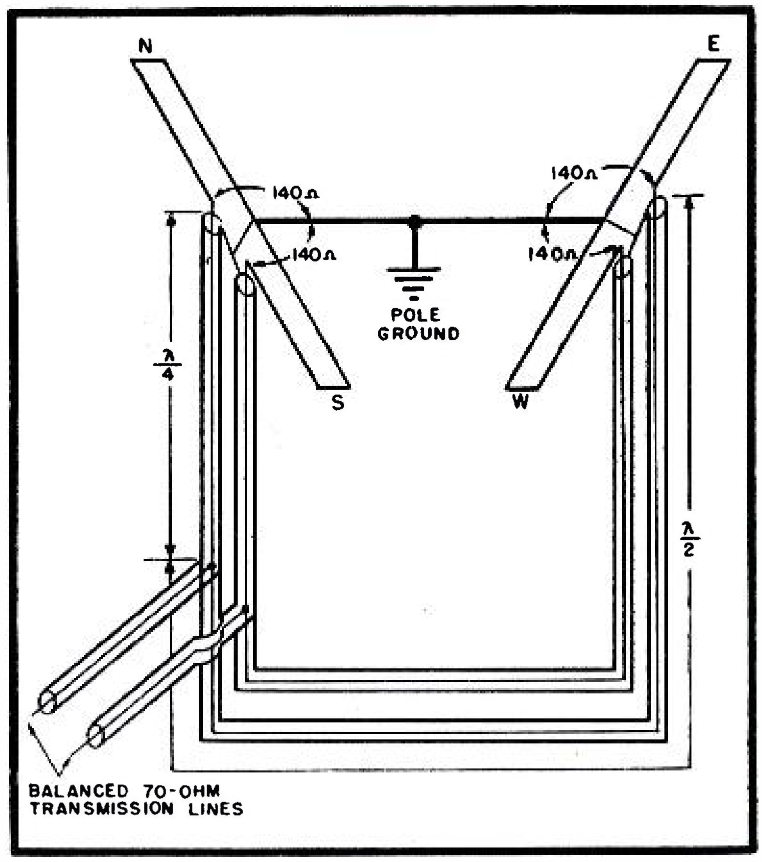
Three-element folded dipoles give a bandwidth of approximately 6 mc with a constant impedance over this range. Since the impedance of this system is quite high it may be connected in turnstile by the use of quarter-wave matching sections in the phasing line, resulting in a correct match to the transmission line. The line length between adjacent elements is ¾ wavelength, Figure 12.

### Other Configurations

It is possible to use many other antenna configurations that will give satisfactory results, the cone, sheet, slot triangle, and others. However in all cases design data must be substanti-

Figure 11 (right)

**Method of connecting turnstile folded dipoles for efficient matching, dipoles cut to the resonant frequency. With respect to ground, each element represents an impedance of 140 ohms. With the phasing sections $Z_0$ = 140 ohms a flat line between elements is produced. When connected as shown, the feed-line impedance, with respect to ground, is 70 ohms per pair of elements.**



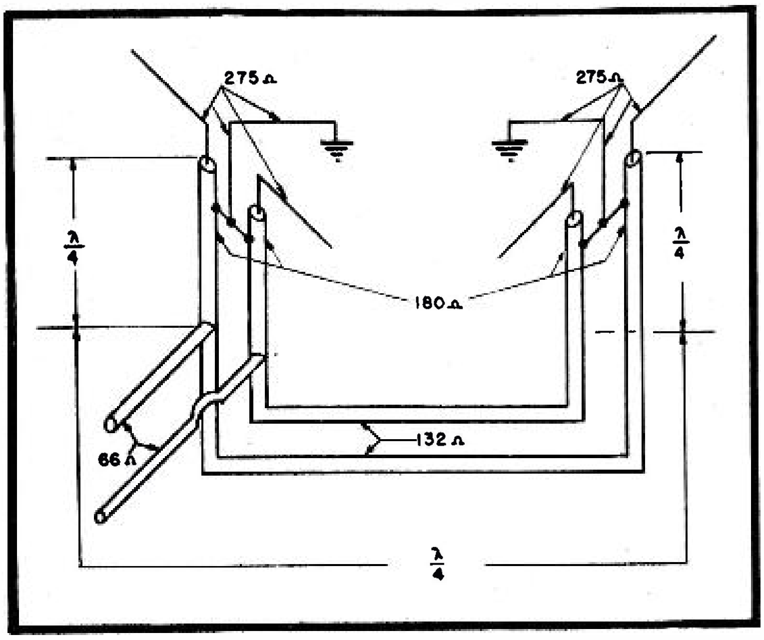




Figure 12 (above, left)

Turnstile phasing and matching system for high-impedance folded dipoles and quarter-wave transformers.

ated by actual measurement, since so many variables are presented.

#### Appendix

Where many measurements are required and the complex nature of the load must be plotted, it is suggested that transmission line charts be used to reduce the amount of calculation. Three common nomographs are:

*Chart for Transmission Line Measurements and Computations,* P. S. Carter, RCA Review; Jan. 1939.

*Practical Analysis of Ultra-High Frequency,* J. R. Meagher and H. J. Markley, RCA Service Company, Inc.

*Transmission Line Calculator,* P. H. Smith, Electronics; Jan. 1939.

#### Credits


The authors are grateful to Robert F. Wakeman of the R-F Telecasting Section, Allen B. DuMont Lab., for his valuable comments offered during the preparation of this paper.


#### References


F. E. Terman, *Radio Engineers Handbook,* McGraw-Hill Book Co.

R. W. P. King, H. R. Mimno and A. H. Wing, *Transmission Lines, Antennas, and Wave Guides,* McGraw-Hill Book Co.


| | |
|---|---|
| (*1*) Balanced 2-wire line: $V_{min}$ and $V_{max}$ do not appear at the same place on each line. | Indicates unbalance; may be either load or generator unbalance. This condition may be isolated by transposing generator leads. If originating in generator the positions will reverse on each line-adjust generator loading. If positions remain unchanged the load is (*a*) unsymmetrical; (*b*) beads bunched together; (*c*) poor transmission line connections; (*d*) solder shorting line, etc. |
| (*2*) Impedance measurements not logical, unreasonable by virtue of theoretical considerations or previous experience. | (*a*) Poor connections; (*b*) reflections from near objects, (antenna should be greater than one wavelength from conducting surfaces); (*c*) voltmeter may be non-linear (usually square law function). |
| (*3*) Body capacity affects measurements. | (*a*) Install reference plane close to transmission line being used for measurements; (*b*) bond coaxial line at frequent intervals; and (*c*) remove antenna from proximity of measurements. |
| (*4*) Frequency measurement methods. | (*a*) Precision secondary standard oscillator beating against test generator into receiver; (*b*) precision wavemeter; (*c*) lecher-wire method on transmission line |

***Measurement Pitfalls and Possible Corrections***

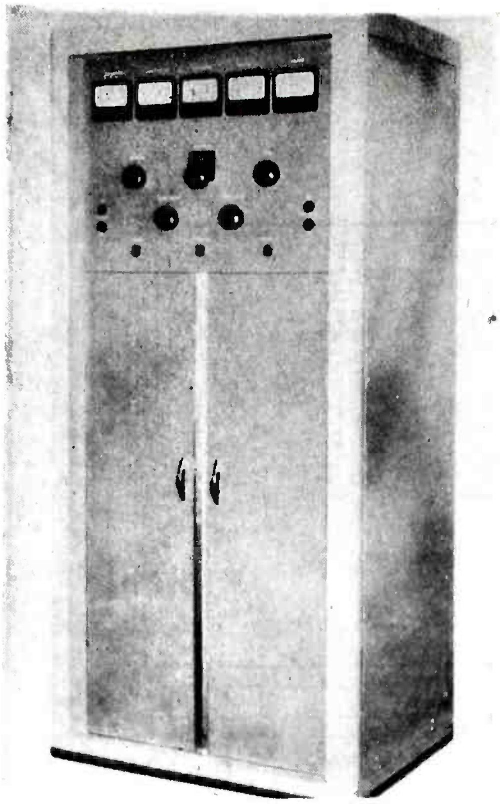


Figure 1 (left)
Front view of transmitter.

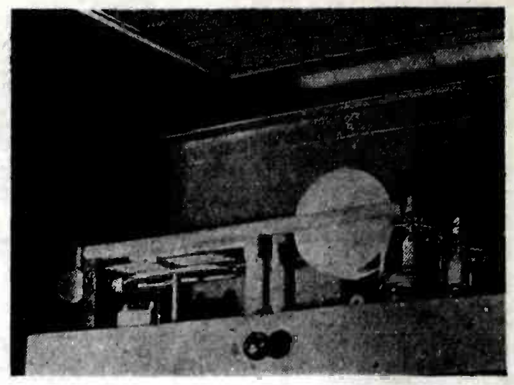


Figure 2
Final amplifier showing task-circuit construction and placement of 4-125A tubes.

# FCC Approved 88-108 MC $\frac{1}{4}$-KW F-M TRANSMITTER

## Broadcast Transmitter Can Be Used as a Basic Exciter for 1 or 3-Kw Amplifiers.

THIS TRANSMITTER[1] EMPLOYS the phase shift method of modulation affording direct crystal control of the carrier frequency. A two-stage amplifier (600-ohm audio-input impedance; approximately 0 db audio-input level) which also contains a pre-emphasis circuit is used to supply the audio power for modulation; frequency response is within ½ db of 75 microsecond pre-emphasis curve. Distortion, maximum 1½% at 50-100 cycles, less the 1% above 100 cycles. The audio-input level is relatively low so that if desired a fixed attenuator may be inserted to obtain accurate matching to auxiliary audio equipment having comparatively low-output level.

Two temperature-controlled crystals are provided, either selected by a switch, to generate and control the original frequency. This frequency is in the neighborhood of 200 kc and is fed to the modulator tube, modulated and then further increased to the carrier freqency by a series of multiplier stages. Following this is a driver amplifier that has ample output to drive the final r-f amplifier stage.

Indication of plate current in the low-powered stages is available on a

(Continued on page 36)

[1]Gates BF-250A.

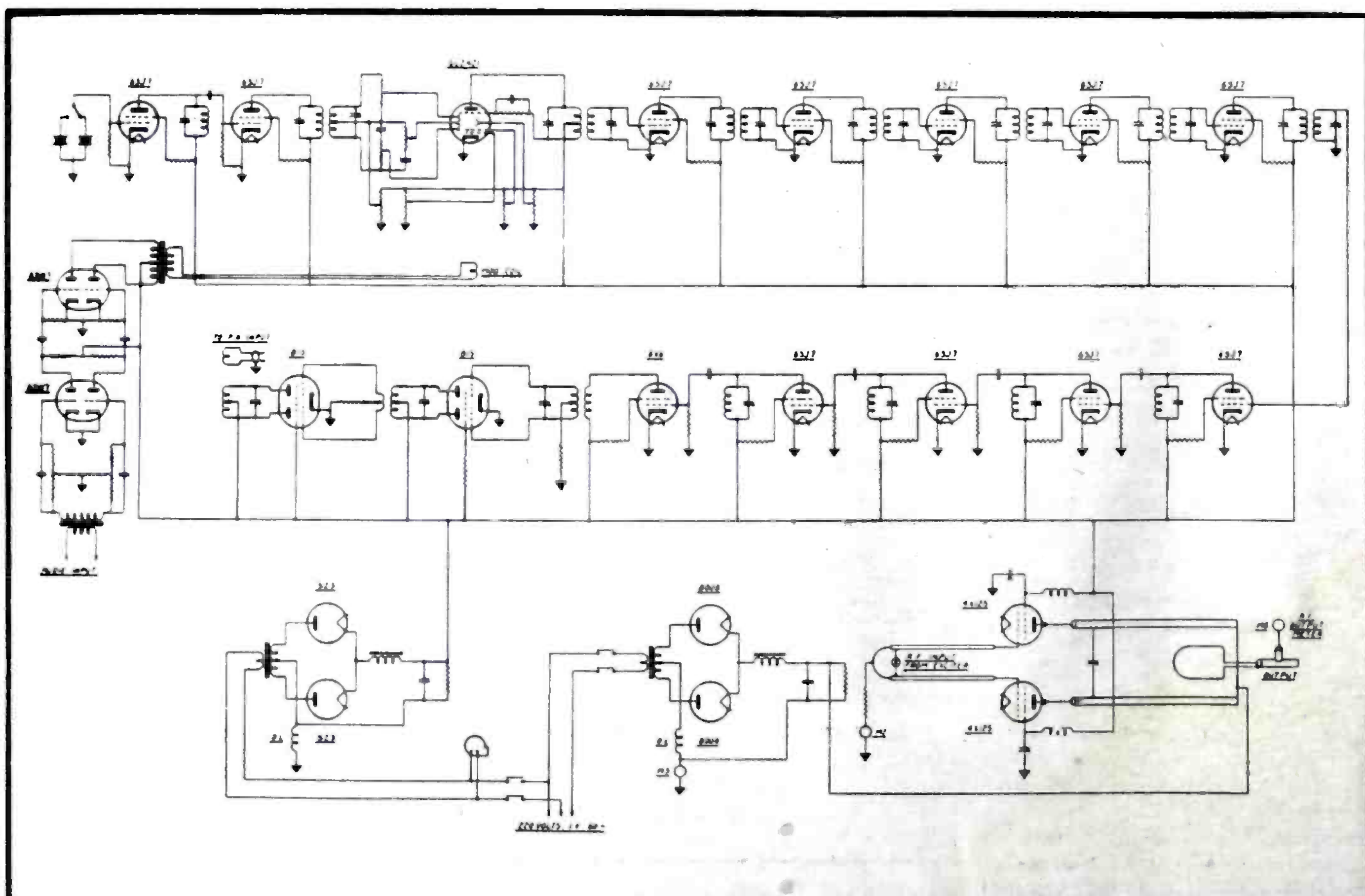


Figure 3
Schematic of the 250-watt f-m transmitter.

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# VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

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

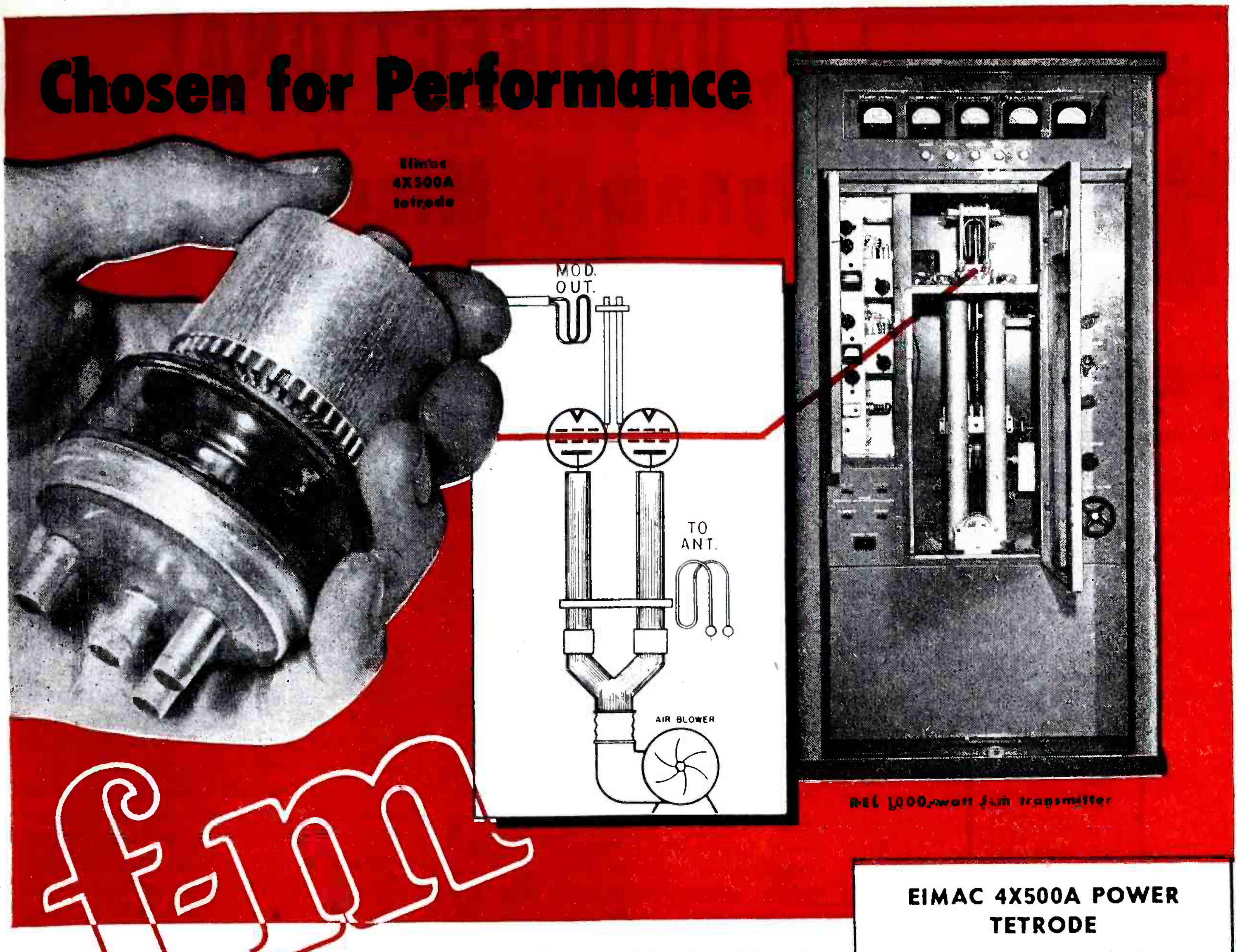
Above, front row, left to right: William C. Simon, who received a Marconi Memorial Medal of Merit; Arthur H. Lynch, who was awarded a Marconi Memorial Commemorative Medal; William A. Ready, president of National Company; W. J. McGonigle, and Wen Yuan Pan, U.N. Delegate of China to the Advisory Committee on Telecommunications. Rear, left to right: Gibson Parker (U.N. Telecom. Div.); Hans Van Steue (U.N. Telecom.); Hugh Williams (U.N. Telecom.) Brigadier J. G. Deedes (U.K. Delegate to U.N. Telecom.); V. Duckworth-Barker (U.N. Telecom.); Brigadier General Frank E. Stoner; Arthur J. Costigan, who became a VWOA life member; and Peter Aylan and C. Garcia Palacios (U.N. Telecom.)

## At the Twenty-Second N. Y. Annual Dinner-Cruise

Below, George Adair, FCC chief engineer, and Capt. Fred Muller, USNR, who received a Marconi Memorial Medal of Achievement. Above, Paul F. Godley, who received a Marconi Memorial Commemorative Medal for his transatlantic amateur radio work 20 years ago.

Below, left to right: W. J. McGonigle; Brigadier General Frank E. Stoner (Ret.), formerly Assistant Chief Signal Officer of the Army and now Chairman of the U.N. Advisory Committee on Telecommunications, who received a Marconi Memorial Medal of Service; George Bailey, assistant to VWOA prexy; E. K. Jett, FCC Commissioner, and Colonel Thompson H. Mitchell, executive vice-president, RCA Communications.

# Chosen for Performance




**REL** . . . the pioneer manufacturer of f-m transmitters, has been engineering gear around Eimac Tubes ever since 1939.

One of their latest designs is illustrated above at the right—the 1000-watt unit with Armstrong dual-channel direct-crystal-controlled frequency modulation. For the power amplifier, shown in the center, REL chose a pair of Eimac 4X500A tetrodes because of their remarkable power gain, stability to frequencies above 110 mc, and efficiency. Actually, 70 per cent of the input to the final amplifier is delivered to the load.

In the REL transmitter, less than 20 watts of drive produces the rated kilowatt. In fact, a pair of Eimac 4X500A's can deliver 1750 watts of useful output with only 25 watts of drive; while four tubes in push-pull parallel, taking 50 watts on the grids, put out 3500 watts.

Unwavering stability is achieved in these tubes by combination of exclusive Eimac emission-controlled grids and a concentric-ground-plane ring terminal for the screen grid. Visible in the accompanying illustration, this ring permits finger contact with chassis ground and effective isolation of input and output circuits. Self oscillation is minimized and neutralization, if necessary, is made simple.

### FURTHER POINTS

**GRIDS**...Special treatment suppresses primary emission and controls secondary emission to add efficiency to stability. One hundred per cent useful structure, without interfering supports, and precise alignment between control grid and screen give maximum plate efficiency and low grid current.

**FILAMENT**...Special thoriated tungsten provides high electron emission at low temperature.

### EIMAC 4X500A POWER TETRODE

**Electrical Characteristics**

| | |
|---|---|
| Filament: Thoriated tungsten | |
| Voltage | 5.0 v |
| Current | 13.5 amp |
| Direct Interelectrode Capacitances (Average) | |
| Grid-plate | 0.05 μμf |
| Input | 12.8 μμf |
| Output | 5.7 μμf |

**Maximum Ratings**

| | |
|---|---|
| Plate voltage, d-c | 4000 v |
| Plate current, d-c | 350 ma. |
| Plate dissipation | 500 w |

*Ask for full details on these and other Eimac tubes for f-m, a-m, television, and industrial applications in a comprehensive range of power and frequency capabilities.*

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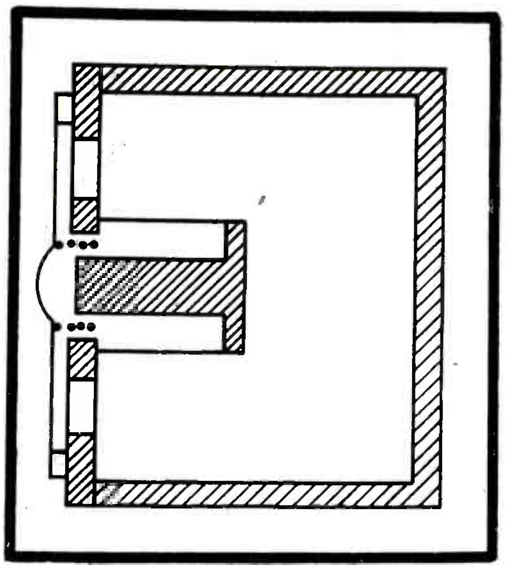


Figure 2
Conventional dynamic non-directional pressure microphone.

# A UNIDIRECTIONAL Dynamic Microphone

**Microphone, Using Mechanophase Principle to Achieve Unidirectivity, is a Combination Non-Directional Pressure Microphone and Bi-Directional Pressure-Gradient Microphone, But With One Transducer.**


**by A. M. WIGGINS**

**Research Director**

**Electro-Voice, Inc.**

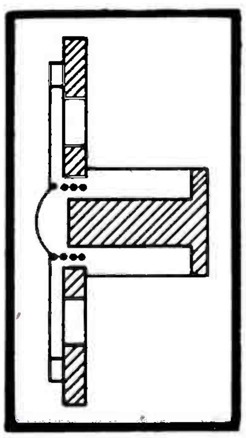
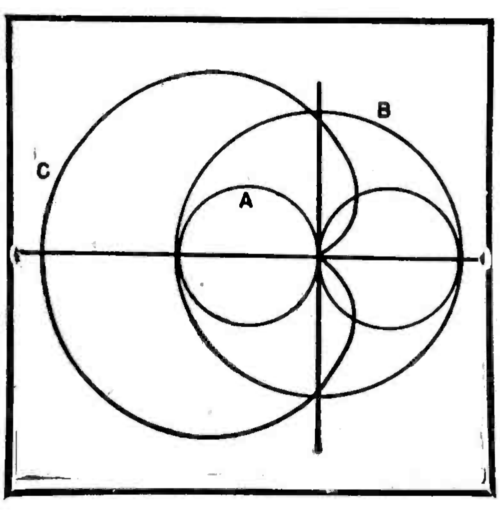



Figure 1 (above)
Dynamic bi-directional pressure-gradient microphone with part of the magnetic structure removed.

Figure 3
Polar response of: (*a*), bi-directional microphone; (*b*), non-directional microphone; and (*c*), combination of bi-directional and non-directional microphone.




THE COMBINATION OF A NON-DIRECTIONAL pressure microphone with a bi-directional pressure gradient microphone to produce a unidirectional microphone was first conceived by Weinberger, Olson, and Massa.[1] The first type employed a pressure gradient ribbon and a pressure ribbon which was terminated in an acoustic resistance in the form of a labyrinth. The two ribbons were suspended in the same magnetic structure. This development led to the design of various types of unidirectional microphones employing dynamic,[2], condenser,[3] and crystal[4] generating systems. A new approach to this problem which considerably simplified the design of unidirectional microphones was first made by Von Braunmuel and Weber[5] who employed a mechanical impedance in the form of a diaphragm over the back of a condenser microphone to produce unidirectivity in a single transducer. A single transducer unidirectional microphone utilizing an acoustic phase shifting network was later made by Bauer.[6]

Recently a unidirectional crystal microphone[7] was developed utilizing a combination of non-directional pressure microphone and bi-directional pressure gradient microphone, but employing only one transducer. The term *mechanophase* has been applied to this method of achieving unidirectivity. This method is not limited to any one type of generating system, but may be used with a crystal, ribbon, dynamic, condenser, carbon, etc., generating systems. Due to the different types of controlling mechanical impedance necessary for the various methods of generation, the microphone may take different forms depending on the generating system used.

### Pressure and Pressure Gradient Microphones

In Figure 1 appears a dynamic bi-directional pressure gradient microphone which has part of the magnetic structure removed for clarity. Both sides of the diaphragm are open, and the diaphragm responds to a difference in pressure between the two sides. If the source is located at right angles to the axis of the microphone the two sound pressures are equal and in phase resulting in no force on the diaphragm. The force available for actuating the diaphragm is proportional to the cosine of the angle of incidence. In this type of microphone the mechanical impedance looking into the back is zero, and the microphone is bi-directional.

Figure 2 shows a conventional dynamic pressure microphone. The back of the microphone is completely enclosed by the case which presents an infinite impedance to sound. The microphone is non-directional except at the higher frequencies where diffraction around the case becomes a factor. The volume of air enclosing the back must be expanded and compressed as the diaphragm moves, so it adds its stiffness to the stiffness of the diaphragm.

[1]Weinberger, Olson & Massa, *Journal of the Acoustical Society*; October 1933.
[2]Marshall and Harry, *Journal of the Acoustical Society*; April 1941.
[3]Patents 2,093,664, 2,126,437.
[4]Patent 2,184,247.
[5]Patent 2,179,361.
[6]Bauer, *Journal of the Acoustical Society*; July 1941.
[7]Wiggins, COMMUNICATIONS; January 1946.

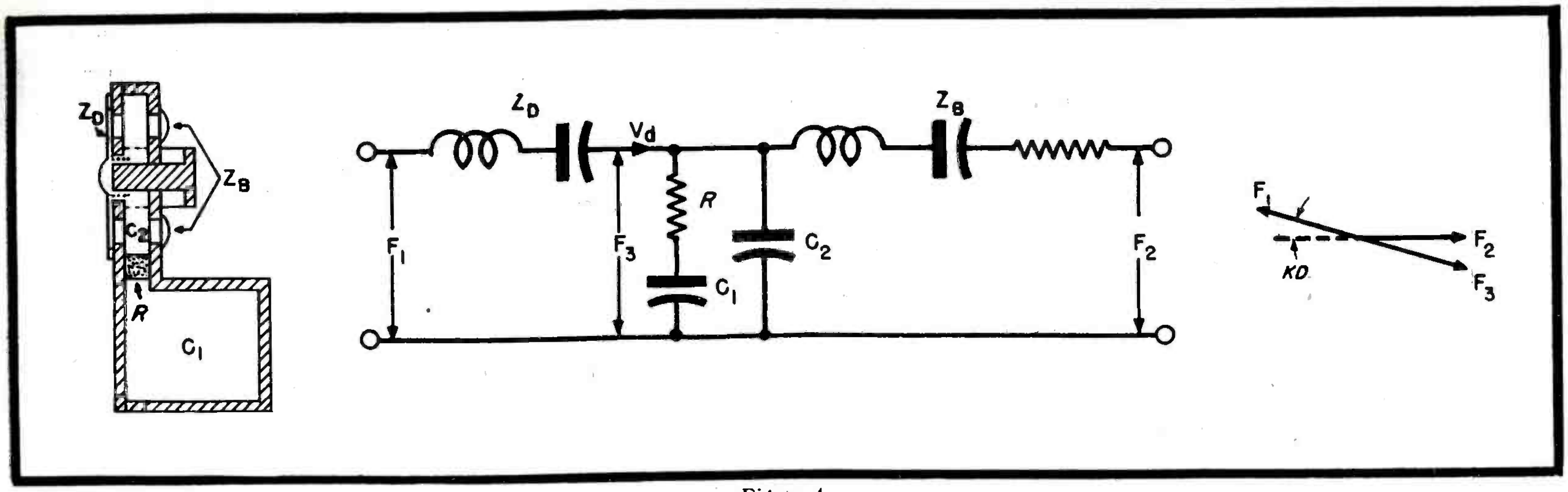



**Figure 4**
Unidirectional microphone employing the mechanophase principle, with its equivalent circuit and vector diagram.

Figure 3 shows the polar response of these two types of microphones and the polar response of a microphone which would result if the two outputs were added in equal amounts. Now since in the pressure gradient microphone the mechanical impedance looking into the back of the diaphragm is zero, and in the pressure microphone it is infinity, if a microphone were designed with a mechanical impedance of the right value imposed over the back of the diaphragm, a combination of the characteristics of pressure and pressure gradient microphones would result giving the polar response shown in *C* of Figure 3. This is accomplished as shown in Figure 4. The volume back of the diaphragm has been moved from its conventional position to enable the placement of two diaphragms of the correct mechanical impedance to produce unidirectivity. If the openings which the two diaphragms cover are completely closed the microphone becomes non-directional; if the diaphragms are removed and the sound has free access to the back of the diaphragm the microphone becomes bidirectional, but if the mechanical impedances of the two diaphragms are of the right value the microphone becomes unidirectional.

Use is made of the equivalent mechanical circuit, as shown in Figure 4, to calculate the correct mechanical impedance which will produce unidirectivity. $Z_D$ is the mechanical impedance of the voice coil and diaphragm, $Z_B$ is the equivalent mechanical impedance of the back diaphragms, $R$ is the damping resistance, $C_1$ the compliance of the large volume back of the diaphragm and $C_2$ the small volume between the front and back diaphragms, $F_1$ the force on the front of the front diaphragm, $F_2$ the force on the back diaphragm, $F_3$ the force on the back of the front diaphragm, and $V_d$ the velocity of the diaphragm and voice coil. The volume, $C_2$, is quite small so the effect of this compliance will be negligible except at the very high frequencies. These values of mass, compliance, and resistance must be referred to one of the parameters. For convenience they may be referred to the back diaphragm. The vector diaphragm of the forces acting on this microphone for sounds arriving axially from the rear is also shown in Figure 4. $F_2$ is the force on the live diaphragm, $F_1$ the force on the front of the live diaphragm which acts in the opposite direction and is displaced by an angle, *KD,* where $K$ is $\frac{2\pi}{\lambda}$, $\lambda$ the wavelength, and $D$ is the acoustic distance between the two diaphragms. $F_3$ is the force on the back of the front diaphragm which must be equal and opposite to $F_1$ if the microphone is not to respond to sounds arriving axially from the rear. In this case it can be seen that the velocity of the voice coil $Vd$ will be zero. Referring all parameters to the total area of the back diaphragms the ratio of the forces acting on the front diaphragms may be written

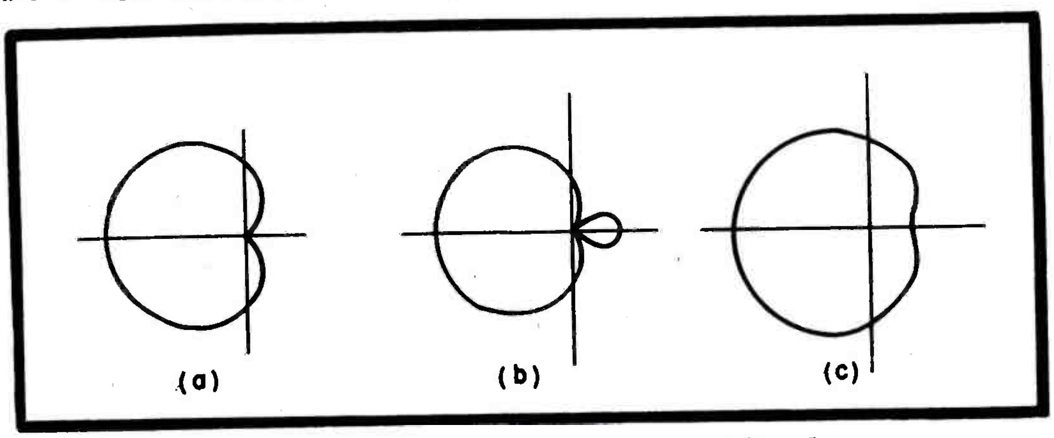


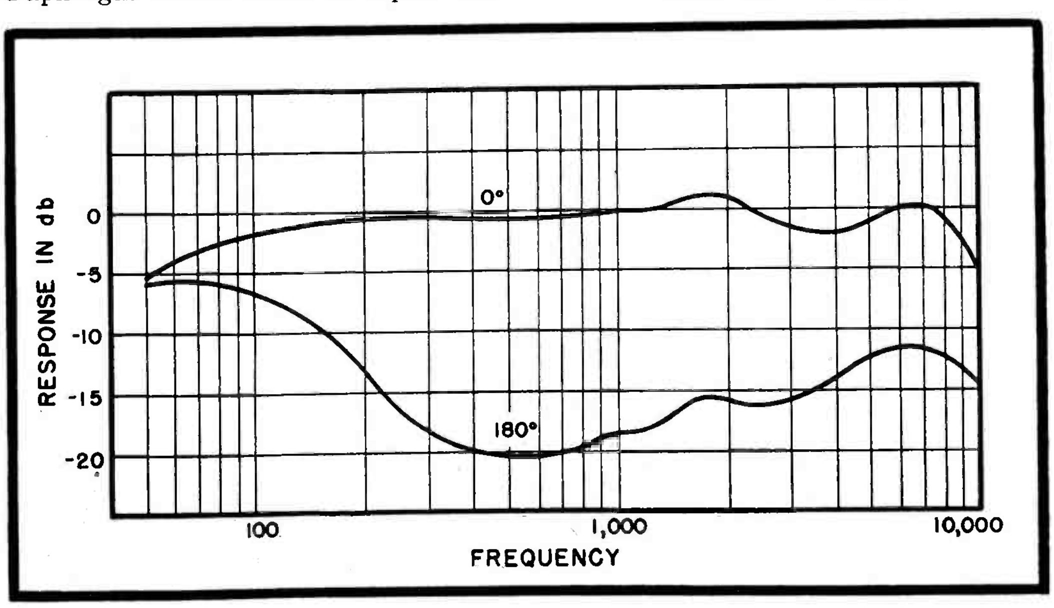

**Figure 5**
Various types of polar curves obtainable.

$$\frac{F_2}{F_3} = \frac{Z_B + R + \dfrac{1}{j\omega C_1}}{R + \dfrac{1}{j\omega C_1}} \qquad (1)$$

The phase displacement between $F_1$

(*Continued on page* 38)

**Figure 6**
Front and back response.



# THE INDUSTRY OFFERS . . .

### RCA 16-MM TELEVISION FILM PROJECTOR

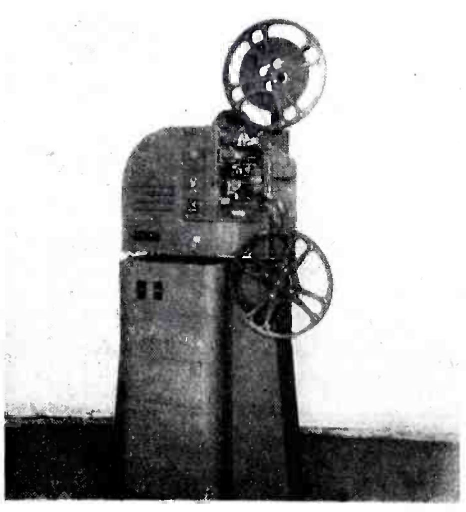
A 16-mm film projector, TP-16A, for operation with a television camera has been announced by the RCA engineering products department.

The projector, an adaptation of the RCA 16-mm sound motion picture projector, has been modified to project motion pictures onto the mosaic of a pickup tube.

Conversion from the 24- to 30-frame rate is done by scanning the first frame twice, second frame three times, third twice, fourth three times, etc. The average rate, 2½ scannings per frame, which, at a film speed of 24 frames per second, provides 60 scanned fields per second.

To employ the 2-3-2-3 scanning sequence, the pull-down time (time required to pull a new frame into place) must be shorter than that employed in standard projectors. The pull-down interval in a standard projector is about one-sixth the total frame cycle. If this interval were used for television projection, alternate pull-downs would slightly overlap the scanning cycle and would cause travel ghosts. To avoid this, spur gears ordinarily used have been replaced with a set of elliptical gears, which cause the claw mechanism to travel about fifty per cent faster in the downward direction. As a result the pull-down time is reduced to about one-eighth the frame cycle, the film remains in the film gate for seven-eighths of the cycle, and the pull-down cannot coincide with the projection interval.

The optical projection system consists of a 1,000-watt air-blast-cooled incandescent lamp, silver coated pyrex glass reflector, two-element aspheric condenser lens, and a coated 3½" F.2 projection lens.



* * *

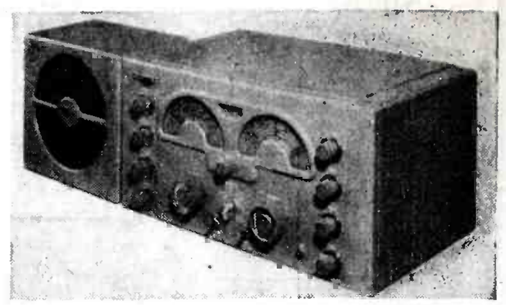
### NATIONAL COMMUNICATIONS RECEIVER

A 13-tube communications (phone and c-w) model with a calibrated band spread covering the 6-, 10-11-, 20-, 40- and 80-meter amateur bands, NC-173, has been developed by the National Company, Inc., of Malden, Mass. Frequency range extends from 540 to 31,000 and from 48,000 to 56,000 kc.

Receiver features an adjustable threshold noise limiter for phone and code use.

Circuit employed consists of one stage of r-f amplification, first detector and separate stabilized high frequency oscillator, two i-f amplification stages, a diode-type second detector, audio limiter, a high-gain audio stage and an audio output stage. Receiver also features avc, beat-frequency oscillator, voltage regulator and rectifier circuits. A crystal filter is connected between the first diode detector and the first i-f stages.

An r-f trimmer panel control is provided so that any sort of antenna, from single-wire affair to a coaxial feed-line can be employed.



* * *

### CLARE D-C RELAY

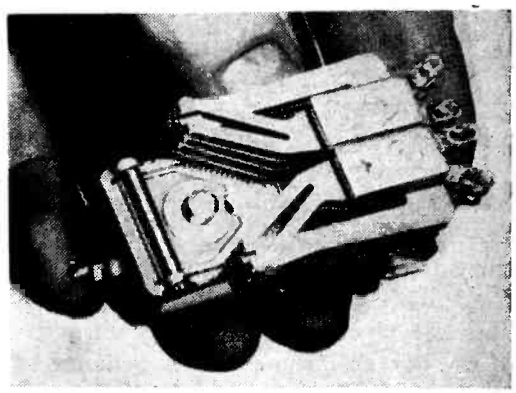
A 2¼" long d-c relay, type J, has been announced by C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois.

Relay features independent twin contacts; long, flexible contact fingers of the bifurcated stationary springs allow twin palladium contacts to operate independently of each other so that one will close even if the other should be blocked by presence of dirt or grit.

Twin points have a rated current carrying capacity of 4 amperes, 150 watts.

Other features include a hinge-type armature. Pivot pin turns in a cylinder of a different metal which extends the full length of the heel-piece.

Relay is said to be designed for extremely fast operation—a minimum of one to two milliseconds. Available in both single- and double-arm types. Maximum of ten springs on a single-arm relay, 20 on a double-arm relay.

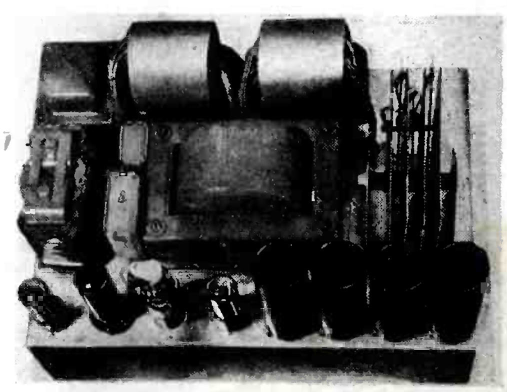


* * *

### SORENSEN VOLTAGE REGULATOR UNITS

A line of voltage regulation units, Nobatrons, has been announced by Sorensen & Company, Inc., 375 Fairfield Avenue, Stamford, Connecticut.

Available in six models, units operate on a 95-125-volt a-c source and provide amperages of 5, 10 or 15 with output voltages of 6, 12 or 28 respectively. Regulation accuracy is said to be ½ of 1%, maximum ripple voltage (rms) of 1%, and recovery time 1/5 second.



* * *

### ELECTRO-VOICE CRYSTAL MICROPHONE

A crystal microphone, 905, employing a high-capacity, moisture-sealed crystal, has been announced by Electro-Voice, Inc., Buchanan, Michigan.

Frequency response is said to be substantially flat from 50-7,500 cps; output level, —54 db.

Polar pattern is non-directional at low frequencies becoming directional at higher fre-

(Continued on page 34)

## THE INDUSTRY OFFERS . . .

(*Continued from page 32.*)

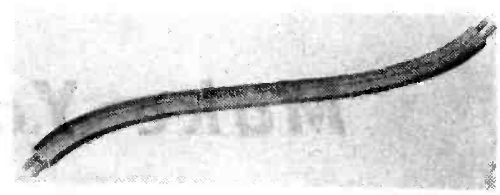
quencies. High impedance. Head at fixed tilt of 22°. Built-in cable connector. Standard 5/8"-27 thread for stand mounting; equipped with 8' or 20' shielded cable.

* * *

### AMPHENOL TWIN-LEAD TRANSMISSION LINK

A twin-conductor 75-ohm transmission line featuring polyethylene insulation, has been announced by American Phenolic Corp., Chicago 50, Illinois.

Two conductors in heavy-duty line are said to be spaced near enough to eliminate radiation as a loss factor up to several hundred mc; individual conductors are seven strands of No. 21 copper.



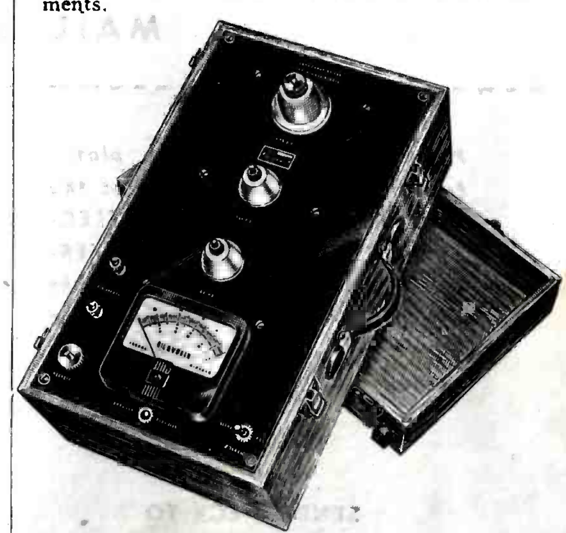
* * *

### SHALLCROSS KILOVOLTMETERS

A series of eight portable kilovoltmeters has been announced by the Shallcross Manufacturing Company, Collingdale, Pa.

A typical unit, the 760-A, has three scales of 5, 10 and 20 kv with a sensitivity of 10,000 ohms per volt.

Kilovoltmeters are of d-c and a-c/d-c types. Multiplier sections are insulated from panels by ceramic insulators. Accuracy is said to be 2% for d-c measurements and 5% for a-c measurements.



* * *

### FERRANTI CLIP-ON VOLT-AMMETER

A 7-range clip-on volt-ammeter featuring a rectifier-type moving coil instrument, with 5 current ranges (0-10-25-100-250-1,000 amps) and 2 voltage ranges (0-150-600) has been announced by Ferranti Electric, Inc.

Unit consists of a current transformer and

2½" dial-type instrum... in a bakelite case with a selector ...

The magnetic joints ... ore are self-aligning under influence ... powerful spring and the limbs of the ... protected by a covering of moulded in... aterial.

The instrument will ... es up to 2¼" diameter.

Volt-ammeter can be u... are conductors up to 600 volts a-c.

• • •

### G.E. L AND T PADS

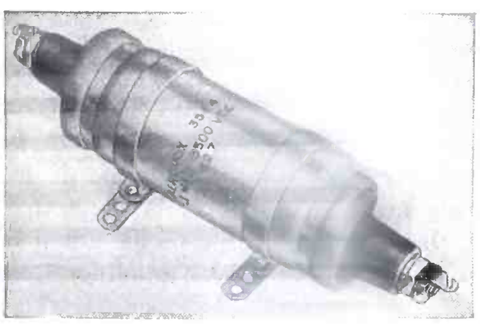
Wire-wound L and T pads (6 ... 1000 ohms) have been announced by G. E.

Rated at a maximum power di...pation of 2.5 watts, the units have a continuous range of from 0.5 to 30 db attenuation in ...% of rotation.

• • •

### AEROVOX TELEVISION CAPACITORS

Voltage ratings of several standard paper and oil-filled capacitor types have been extended by Aerovox Corp., New Bedford, Mass., to meet elevated voltages encountered in television receivers as well as in c-r oscillographs. Tubular paper capacitors, series 84, are now made in ratings up to 10,000 volts dew. Midget-can series 89 and the round-can series 2 and 14 are available in voltage ratings from 500 to 7,500. Series 14 is available in the double-ended design or with pillar terminals at either end and with two adjustable ring mountings.



• • •

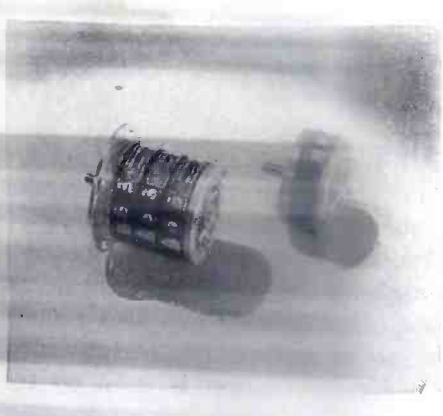
### FAIRCHILD LINEAR GANGED POTENTIOMETER

A linear, wire-wound potentiometer in single or ganged units on one shaft to provide independent voltage outputs for seve... related variables, has been developed by Fairchild Camera and Instrument Corporation, Ja...a, N. Y.

Two sizes available; $2\frac{3}{32}$" (7... ohms) and $3\frac{3}{32}$" (100,000 ohms).

Linearity is said to be .15% an... %, respec-

(*Continued on page* ...)



# THE INDUSTRY OFFERS . . .

(Continued from page 32.)

quencies. High impedance. Head at fixed tilt of 22°. Built-in cable connector. Standard ⅝"-27 thread for stand mounting; equipped with 6' or 20' shielded cable.

* * *

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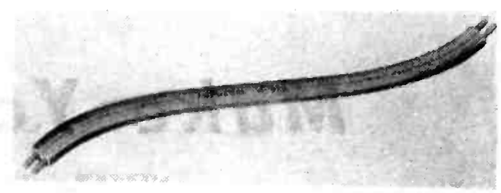

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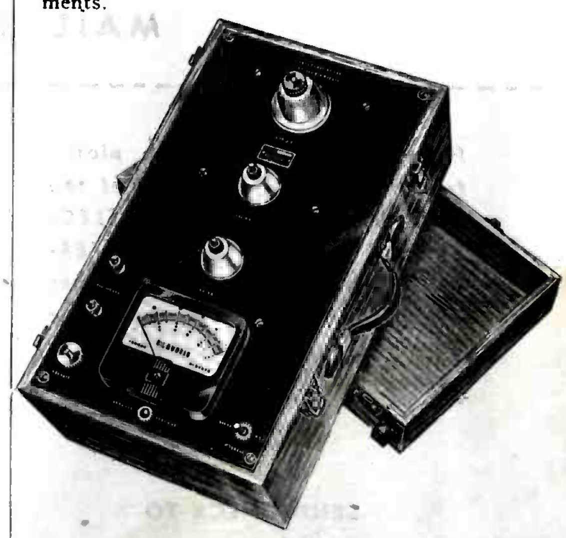

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A 7-range clip-on volt-ammeter featuring a rectifier-type moving coil instrument, with 5 current ranges (0-10-25-100-250-1,000 amps) and 2 voltage ranges (0-150-600) has been announced by Ferranti Electric, Inc.

Unit consists of a current transformer and

2½" dial-type instrument housed in a bakelite case with a selector switch.

The magnetic joints in the core are self-aligning under influence of a powerful spring and the limbs of the core are protected by a covering of moulded insulating material.

The instrument will take cables up to 2¼" diameter.

Volt-ammeter can be used on bare conductors up to 600 volts a-c.

* * *

### G. E. L AND T PADS

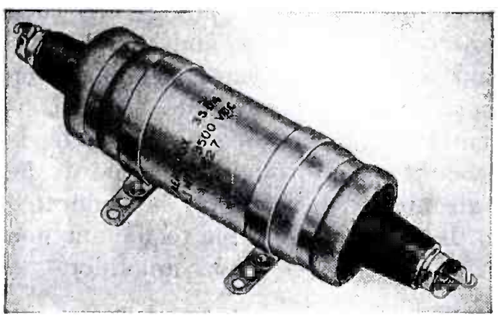
Wire-wound L and T pads (6 to 800 ohms) have been announced by G. E.

Rated at a maximum power dissipation of 2.5 watts, the units have a continuous range of from 0.5 to 30 db attenuation in 90° of rotation.

* * *

### AEROVOX TELEVISION CAPACITORS

Voltage ratings of several standard paper and oil-filled capacitor types have been extended by Aerovox Corp., New Bedford, Mass., to meet elevated voltages encountered in television receivers as well as in c-r oscillographs. Tubular paper capacitors, series 84, are now made in ratings up to 10,000 volts dcw. Midget-can series 89 and the round-can series 12 and 14 are available in voltage ratings from 3,500 to 7,500. Series 14 is available in the double-ended design or with pillar terminals at either end and with two adjustable ring mountings.



* * *

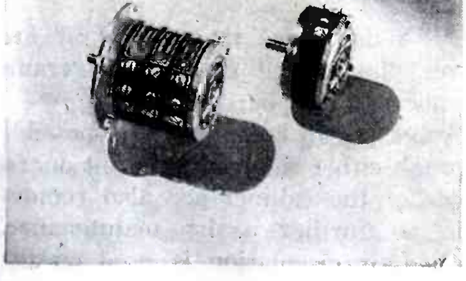
### FAIRCHILD LINEAR GANGED POTENTIOMETER

A linear, wire-wound potentiometer in single or ganged units on one shaft to provide independent voltage outputs for several related variables, has been developed by Fairchild Camera and Instrument Corporation, Jamaica, N. Y.

Two sizes available; $2\frac{3}{32}$" (75,000 ohms) and $3\frac{3}{32}$" (100,000 ohms).

Linearity is said to be .15% and .1%, respec-

(*Continued on page* 44)



## F-M TRANSMITTER

(*Continued from page 26*)

milliammeter which operates in conjunction with a selector switch to connect it in any desired amplifier stage. Tuning of each stage is done by observing indications of a vacuum-tube tuning meter when plugged into jacks directly adjacent to the stage under observation.

#### Power Amplifier

A short length of concentric transmission line is used to carry power from the driver stage to the grid circuit of two power-amplifier tubes. They are connected in push-pull, using as a tank circuit a single-turn inductance actually composed of two metallic tubes mounted parallel to each other, one end of each being connected to the plates of the tubes and the other ends shorted together by a movable bar. The bar may be placed in a position suitable for obtaining approximate resonance of the tank circuit. Fine adjustments are secured by spacing of the round plates located near the open end of the tank inductance. One of these is positioned by a control knob on the front panel. Power is taken from the final amplifier by means of a small loop located just below the plate inductance. An electrostatic shield is placed between it and the plate inductance to balance loading on each power-amplifier tube and thereby obtain optimum efficiency. The pickup loop feeds the power into a ⅞" concentric transmission line which is brought out through the top of the transmitter where it may be connected to the transmission line to the antenna or to a successive power amplifier.

#### Tubes Used

Two 4-125As are used as final amplifiers; one 815 intermediate-power amplifier; one 815 frequency multiplier; one 6V6 frequency multiplier; nine 6SJ7 frequency multipliers and amplifiers; one GL2H21 modulator; one 6SJ7 buffer amplifier; one 6SJ7 oscillator; two 6SN7 audio amplifiers; two 8008 rectifiers; and two 5Z3 rectifiers.

#### Construction

All inductances that carry r-f are silver plated, and chassis and frame members are copper plated.

Access to all components is possible through either the back or front doors. Sides of the cabinet are also removable to further assist maintenance. Forced-air circulation is used on the power-amplifier stage. Blower noise is inaudible a short distance from the transmitter facilitating the use of announcing provisions in the same room if desirable.

Push-button stations are located on the front panel for application of filament and plate voltages, with indicators that light when the filament, low voltage and high voltage supplies are operating. Three rheostats controlled from the front panel adjust filament and plate and allow the power output to be varied from approximately 50 to 320 watts. Power amplifier grid and plate tuning controls are also located on the front panel. The plate tuning control is associated with a counter that shows the setting within one part in three hundred.

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## 2-CONTROL TRANSMITTER

*(Continued from page 13)*

*voltage;* (6) *r-f line current;* and (7) *antenna current.*

Appearing on the center horizontal front panel of the transmitter are, reading from left to right: (1) *test* meter switch; (2) *filament start-stop* buttons; (3) *plate start-stop* buttons; (4) *line volage variac;* (5) *final plate tuning;* (6) *final plate loading;* and (7) *crystal heat* pilot lamp. In the center of the panel, above the variac control, are located all necessary fuses; two a-c line fuses, crystal heat fuse, filament fuse, and plate fuse. Above each fuse is located a neon lamp, connected in parallel with the fuse, to indicate burnouts.

The audio system runs vertically up the right wall of the cabinet. The modulation transformer is near the bottom, and approximately one foot above this is the input transformer for the 2A3s, followed by the 2A3 tubes, the 805 grid transformer, and the 805 modulators.

The transmitter cabinet was sprayed with automobile body lacquer, using standard auto body shop procedures. A smooth, easily-cleaned surface was thus obtained. Large panels were painted dark maroon, and a contrasting pale blue was used on the control and meter panels. Chromium trim strips and door handles were employed.

***Acknowledgment***

Actual construction of the transmitter was done by Phil Hatfield and Walt Newman of WBOW, working under the engineering supervision of personnel of Electronics Research, Inc.

## Dynamic Microphone

(*Continued from page 31*)

and $F_3$ is $KD$.

$$F_2 = F_3 e^{jKD} \qquad (2)$$

and equation (*1*) reduces to

$$e^{jKD} = \frac{Z_B + R + \frac{1}{j\omega C_1}}{R + \frac{1}{j\omega C_1}} \qquad (3)$$

If the stiffness of the back diaphragms is neglected

$$Z_B = R_B + j\omega M_B \qquad (4)$$

Where $R_B$ is the resistance associated with the back diaphragms and $M_B$ the effective mass of the back diaphragms, equation (*3*) becomes

$$e^{jKD} = \frac{R_B + R + \frac{1}{j\omega C_1} + j\omega M_B}{R + \frac{1}{j\omega C_1}} \qquad (5)$$

The unit vector may also be written in the form

$$\cos KD + j \sin KD = \frac{R_B R + \frac{1}{j\omega C_1} + j\omega M_B}{R + \frac{1}{j\omega C_1}} \qquad (6)$$

Since $K = c$ where $c$ is the velocity of sound, and for small angles $\sin KD = KD$ and $\cos KD = 1 - \frac{K^2 D^2}{2}$, equation (*6*) may be written as

$$1 - \frac{\omega^2 D^2}{2c^2} + \frac{j\omega D}{c} = \frac{R_B + R + \frac{1}{j\omega C_1} + j\omega M_B}{R + \frac{1}{j\omega C_1}} \qquad (7)$$

For low frequencies the mechanical impedance of the back diaphragms is essentially a resistance, $R_B$, and the impedance of the cavity, $C$, becomes large in comparison to the resistance, $R$. Under these conditions $R_B$ may be determined from equation (*7*) by separating imaginary from real quantities.

$$R_B = \frac{D}{c\,C_1} \qquad (8)$$

For high frequencies the mechanical impedance of the back diaphragm will be predominately mass reactive while the impedance of the cavity will be negligible compared to the resistance, *R*. Under these conditions $M_s$ may be determined from equation (7) to be

$$M_s = \frac{DR}{c} \qquad (9)$$

The directional response of the microphone will be a cardioid of revolution, as shown in Figure 5(*a*), if the mass and resistance of the back diaphragms are of the above values. The polar equation of the cardioid is $\frac{1}{2} + \frac{1}{2} \cos \theta$. A more general equation of the polar response of a microphone of this type is $a + b \cos \theta$. If the above conditions are met $a$ becomes ½ and $b$ ½. If, however, the values of the mass and resistance are less than that given in (*8*) and (*9*), $a$ becomes less than ½ and $b$ more than ½, and the polar response takes the form similar to that shown in Figure 5 (*b*). Conversely if the mass and resistance are greater then that expressed in (*8*) and (*9*), $a$ becomes greater than ½ and $b$ less than ½ and the polar response resembles that shown in Figure 5 (*c*).

#### Construction

Diaphragms of very low stiffness and of the correct mass are used over the back of the microphone. The inherent resistance of the material used in the back diaphragm is enough to produce the correct value of resistance. Since the force available for actuating the diaphragm is the resultant of the two forces whose phase displacement is proportional to frequency, the force on the diaphragm and voice coil is approximately proportional to frequency. This means that the diaphragm and voice coil must be mass controlled. At the very low frequencies the stiffness of the back diaphragms becomes a factor causing an attenuation in the force on the back of the front diaphragm. This causes the microphone to act similar to a pressure microphone, and the very low frequencies below the resonance of the front diaphragm are fully reproduced, but at a sacrifice of unidirectivity. At the extreme high frequency end of the spectrum an extended range is obtained by employing a helmholtz resonator in front of the diaphragm which also serves to protect the diaphragm. The front and back response are shown in Figure 6. The rise in the back response at the very low frequencies is due to the stiffness of the back diaphragms. The action of the microphone approaches the action of a pressure microphone at the extreme low frequencies allowing a flat response below the resonance of the diaphragm and voice coil.

## IRE REPORT

(*Continued from page 18*)

of the importance of eliminating resonances in the pickup itself. This problem was solved by use of a small coil mounted on the vibrating platform of the shaker, and surrounded, by a permanent magnet from a small dynamic speaker. There was no mechanical coupling between the magnet and the coil, so that no resonances were introduced.

In a study of the subminiature triode, it was found that there was a mount resonance at 240 cycles and filament resonances at 5,000 and 10,000 cycles corresponding to the fundamental and second harmonic of the filament vibration.

In some tubes studied a *hash* was found superimposed on the sinusoidal output. This occurred at various frequencies in the range 700-7,000 cps. The spikey type of output was studied in some detail, because of its importance in one of our applications. By examining the output in the oscilloscope using a high fidelity video amplifier and the output well synchronized with the sweep it was observed that the hash was composed of sharp spike pulses occurring once each cycle.

Microphonic effects due to fluctuating electrical leakage were observed in certain tubes by operating them cold, and applying a d-c voltage between the various electrodes. The presence of leakage

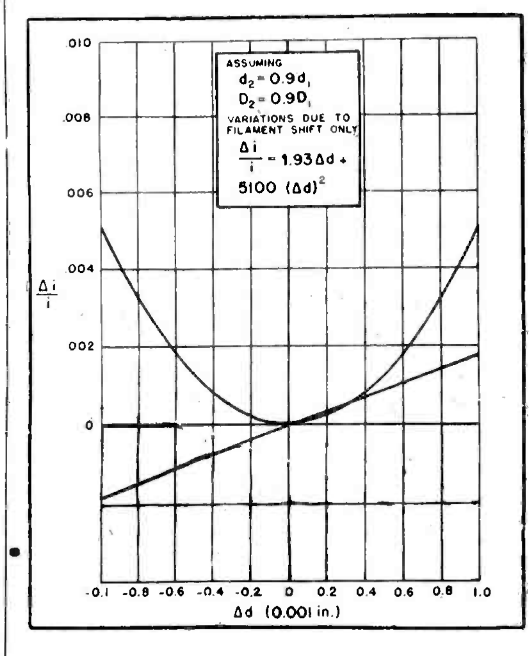
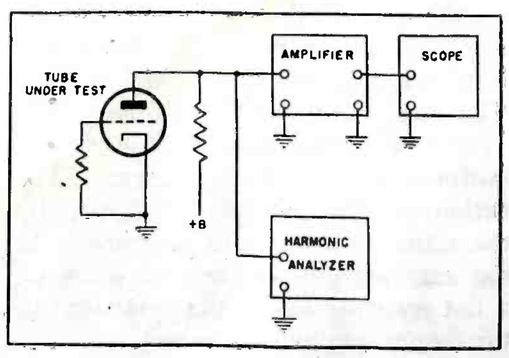



**Figure 10 (Cohen-Bloom paper)**

**First and second order output variation resulting from a filament shift in a triode.**

**Figure 11 (Cohen-Bloom paper)**

**Block diagram of a test circuit used to study tube vibration.**



was detected by the presence of leakage current of a very random nature, which will appear as a fine hash on an oscilloscope.

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## MULTIPLEX EMPLOYING PULSE TIME AND PULSED F-M MODULATION

***Harry Goldberg and Carl C. Bath***

***Bendix Radio***

THE MICROWAVE PORTION of the spectrum has been opened to the communications engineer by the developments of the war. A great deal of work is now being carried out to utilize this portion of the spectrum for point-to-point communication and long-distance relaying. Since the techniques of this part of the spectrum naturally lend themselves to broad-band systems, the efficient utilization of these broad-band channels is of primary concern. Pulse techniques developed for radar have been applied to time-division multiplexing. It has been found possible by means of these techniques, to transmit as many as 24 phone channels simultaneously over a single carrier. Goldberg and Bath reported that the utilization of the carrier, however, is still poor in comparison with frequency multiplex techniques used at lower frequencies. The minimum theoretical bandwidth required to transmit twenty-four 3-kc channels is 72 kc. Utilization approaching this figure has been demonstrated on coaxial carrier equipment. The pulse time, time-division system used to transmit 24 channels, however, requires a bandwith of at least 3 or 4 mc. The discrepancy is only partly alleviated by the advantages relative to cross talk and distortion peculiar to time division, time-modulation systems.

The investigation described in this paper was carried out to determine whether or not it was possible to employ a triple modulation system, still applicable to time-division methods, to increase the possible channel utilization of microwave communications equipment.

In pulse-time modulation, a double modulation system is used. That is, the intelligence is carried by modulating the time intervals between pulses, the pulse train being considered a sub-carrier, with the final space transmission being carried out by pulse modulating a microwave carrier. At the receiver, the first demodulation recovers the pulse train and a second demodulation, the transmitted intelligence. The proposal investigated was the addition, to pulse-time modulation, of frequency modulation of the microwave carrier during the pulses according to some other intelligence. This system, a triple modulation system, is still capable of time-division multiplexing. Advantages said to be possible with this method of modulation were:

(1) The number of separate channels that may be transmitted with a given type of pulse train, repetition rate, duty cycle, and average transmitter power is doubled.

(2) The ultimate number of channels of a given bandwidth that may be transmitted over a single carrier with a given signal to noise ratio is twice the number possible with pulse-time modulation alone.

(3) For any given number of channels over a single carrier, the signal-to-noise ratio possible on the pulse time channels is 6 db better than for a system giving the same number of channels using only pulse time modulation.

(4) For a given number of channels over a single carrier, the amount of synchroniz-

(*Continued on page* 42)

# IRE REPORT

(Continued from page 41)

ing equipment is decreased over that of a system employing pulse-time modulation only.

A system was investigated for a single pulse time channel and single pulsed f-m channel, with the transmitter operating in the 3,000-mc region at about 1-watt peak and modulated by a one microsecond rectangular pulse. The receiver used a crystal mixer, an 8-mc wide i-f, and the appropriate demodulators. Through the use of techniques developed for the purpose, Golderberg and Bath said that it was possible to transmit separate conversations via the two modulation systems with satisfactory cross-talk and signal-to-noise performance. Cross-talk characteristics of the system actually improve when time-division is employed to increase the number of channels transmitted. The Goldberg-Bath tests indicated that the triple modulation system is a practical method for increasing channel utilization.

## PULSE MODULATION NOISE SUPPRESSION CHARACTERISTICS

**S. Moskowitz and D. D. Grieg**
**Federal Telecommunications Lab.**

An analysis of the PTM improvement in signal-to-noise ratio over that obtained by the common a-m of either continuous or pulsed waves was offered in this presentation, Moskowitz citing that the improvement was proportional to the r-f bandwidth used in the transmission link. In terms of the pulses, he said that the improvement was proportional to the time modulation displacement and inversely proportional to the build-up or decay time, whichever is the smaller.

A main measure of protection against noise interference offered by time modulated pulses is due to the high ratio of peak-to-average power used. The threshold of improvement is reached when the peak pulse amplitude is about twice the effective noise peaks. Hence, devices such as limiters may be used to considerable advantage. The effectiveness of various noise suppression devices such as limiters, differentiators, and multivibrators was demonstrated by experimental data.

Moskowitz stated that the greatest degree of noise suppression is obtained when successive stages of limiting, and differentiation are incorporated in the receiver. This result may be understood by considering the manner in which noise can enter the pulse system, noise entering in the following ways:

(1) Amplitude modulation of the pulses.
(2) Width modulation of the pulses.
(3) Noise occurrence between pulses.
(4) Displacement in time of the leading or trailing edge of the pulses.

Noise entering by amplitude modulation of the pulses and between the pulses, may be removed by proper limiting providing the input signal to noise ratio is greater than 6 db. Following this stage a differentiator serves to extract the proper pulse edge, thus removing width modulation noise. However, since some edge slope variation may be introduced by noise, the output of the differentiator may again contain some amplitude and width noise. Such secondary noise modulations may be further suppressed by successive stages of limiting, and differentiation. These operations may also be obtained by the action of a multivibrator.

Noise entering by displacement in time of the leading or trailing edge of the pulse is of the same form as the modulating signal and is inherent in the system of modulation. However, the noise displacement may be reduced by decreasing the build-up or decay time of the pulses; i.e., increasing the bandwith of the system.

In a similar manner, impulse noise, such as that derived from electrical machinery, automobile ignition, and interfering pulse communications systems may be suppressed. The degree of suppression is usually greater than that obtained with random noise.

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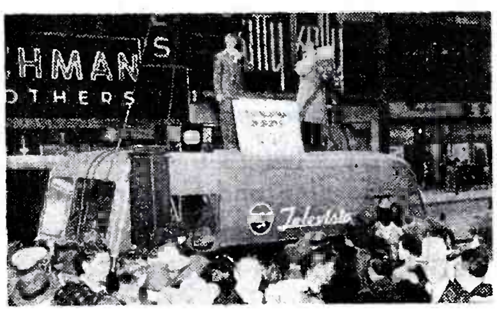
### FIELD TELEVISION

Above, image-orthicon setup at the Plaza Mexico, 60,000-seat bullring in Mexico City. Below, mobile television unit at the recent NAB convention in Chicago. (*Courtesy RCA*)



Below, tv monitor setup during a football game at the Yankee Stadium, New York.

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### CORRECTION

Circuit of the mobile f-m transmitter described by N. Marchand in the December (page 30) and January (page 25) issues of COMMUNICATIONS was a 30-watt unit. The 50-watt unit contains two RK 39 or 807 type tubes.

# THE INDUSTRY OFFERS . . . —

(*Continued from page 35*)

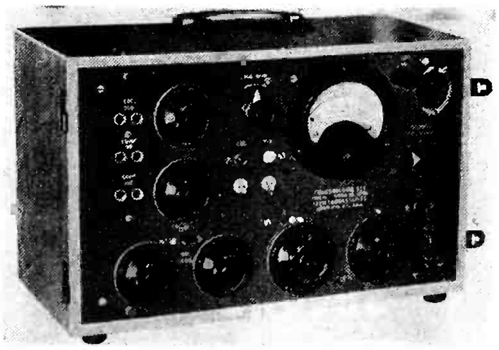
tively. Maximum thickness (single unit), 1.156". Additional thickness for each additional unit ganged, .594". Power dissipation for 2" type, 4 watts; 3" type, 5 watts.

* * *

### TECH LABS A-F TRANSMISSION MEASURING SET

A self-contained portable, a-c operated v-t-v-m unit for measuring of a-f gain or loss has been announced by Tech Laboratories, Inc., 337 Central Avenue, Jersey City 7, New Jersey.

Combines vacuum-tube voltmeter, audio oscillator with four fixed frequencies and a precision attenuator. Gain up to 80 db; loss 60 db maximum. Vacuum-tube voltmeter range, —40 to +40 db (1 mv. ref. level). Audio oscillator range, 100 to 10,000 cps. Precision attenuator is flat to 20 kc; 93 db in 1-db steps. Size, 10¼" x 16¼" x 8¾".



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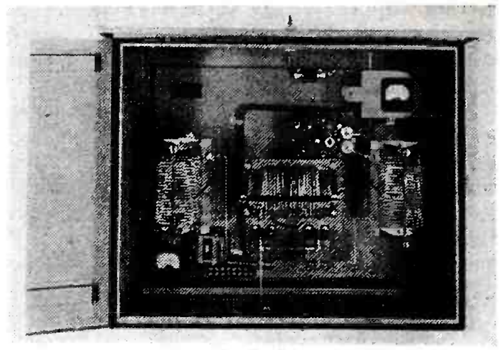
### RAYTHEON ANTENNA UNITS

Two antenna tuning units, the RT-1000, for 250- to 1,000-watt a-m stations, and the RT-5, for 5- to 10-kw a-m stations, have been developed by the broadcast equipment division of Raytheon Manufacturing Company, Chicago, Ill.

Both units are of the T type and are adaptable for use with directional antenna systems. The circuit consists primarily of a single T section low-pass filter network.



* * *

### SUPREME INSTRUMENT DESK TYPE 100-WATT A-M/F-M TRANSMITTER

A six-band 100-watt transmitter, model AF-100, housed in a metal cabinet measuring 29⅛" long, 11¾" wide, 18⅝" deep, and covering the 10, 11, 15, 20, 40 and 80 meter bands for cw, icw, and a-m and f-m 'phone transmission has been announced by Supreme Transmitter Corp., 280 Ninth Avenue, New York City. Frequency modulation available in the 27.185 to 27.455, and 29 to 29.7 mc ham bands. Transmitter is continuously tunable throughout the range of each band. Variable oscillator is followed by slug-tuned buffer and doubler stages, ganged to oscillator dial. Band changing is accomplished in exciter by a band selector switch and in the final stage by plugging in a coil for the particular band selected.

* * *

### TRANE TUBE COOLER

A tube cooler designed to lower the temperature of water used to cool transmitter tubes has been produced by The Trane Company, La Crosse, Wisconsin.

Outside air is brought into the unit by means of a fan. This air is forced over a coil in which the water being cooled is circulated. The cooled water is stored in a reservoir until needed.



## WHEN YOU CHANGE YOUR ADDRESS

**Be sure to notify the Subscription Department of COMMUNICATIONS, 52 Vanderbilt Avenue, New York 17, N. Y., giving the old as well as the new address, and do this at least four weeks in advance. The Post Office Department does not forward magazines unless you pay additional postage, and we cannot duplicate copies mailed to the old address. We ask your cooperation.**

# NEWS BRIEFS

### INDUSTRY ACTIVITIES

**Ohio has received a cp** for an experimental class 2 system, consisting of two land stations, at Ashtabula and near Ravenna, Ohio, and one mobile station with 1,000 units operating within the state. Stations will be used for the purpose of providing communications to operators of snow plows and other highway maintenance vehicles, looking toward the development of a highway maintenance class of station. Frequency, 31.54 mc, with the land stations using 150 watts and the mobile 75 watts.

**A dynamic noise suppressor** has been installed by WTMJ. Unit, developed by H. H. Scott, uses a gate circuit to eliminate needle hiss.

**Headquarters of the Raytheon** receiving tube Sales Department are now located at 445 Lake Shore Drive, Chicago.

All activities of the division, sales engineering and advertising and sale of radio receiving tubes to equipment manufacturers and distributor trade are under the direction of Ernest Kohler, Jr., sales manager.

Curtis R. Hammond has been appointed distributor sales manager in charge of renewal tube sales.

**XERF, Villa Acuna,** State of Coahuila, Mexico, is now operating with a 50-kw RCA transmitter. Station operates on 1,570 kc.

**Sylvania Electric** will produce, distribute and service commercial marine radar systems of their own design as well as those of A. C. Cossor, Ltd., London, with whom they became affiliated a year ago.

The first installation was made recently aboard the Queen Elizabeth.

Sir Robert Watson-Watt, of radar fame, recently retired as Vice Controller of Communications Equipment, British Ministry of Aircraft Production. to become scientific advisor for the Sylvania and Cossor Companies.

**Eitel-McCullough, Inc.,** 143 San Mateo Ave., San Bruno, California, plans to erect a 50-kw f-m transmitter. Equipment, which has already been designed, includes a pair of Eimac 3X10000A3 triodes in the final amplifier driven by two 3X2500A3 triodes which are in turn driven by four 4X500A tetrodes in push-pull parallel. Modulator is of the Armstrong dual-channel type.

Transmitter will be located on the 3,848' top of Mount Diablo, about 30 miles airline from San Francisco.

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### PERSONALS

**Dr. Albert Rose,** RCA Labs., has received the IRE award of the Morris Liebmann Memorial Prize for 1946. The Liebmann Prize for 1947 has been awarded to **J. R. Pierce,** member of the technical staff of Bell Telephone Labs.

**Dr. Lee deForest,** director of veterans' training at American Television, Inc., Chicago, has been elected to the board of directors of the Army Signal Association.

**Kenneth A. Norton** has been named chief of the recently established Frequency Utilization Research Section of the Central Radio Propagation Laboratory of the National Bureau of Standards. Mr. Norton served during the war as a consultant in radio propagation to the Chief Signal Officer and as assistant director of Dr. W. L. Everitt's operational research group.

**Victor M. Harkavy** has joined the Insuline Corporation of America engineering staff, and will be in charge of new product development and design.

Mr. Harkavy was formerly assistant division chief of the Crystal Research Laboratories of Hartford, Conn.

**Ralph C. Blauvelt** has been appointed chief engineer of the Electronic Research and Manufacturing Corp., Cleveland, Ohio.

Mr. Blauvelt was formerly chief electronic engineer for Radiart Corp., and previously design engineer for Zenith.

**John H. Miller** has been named vice president and chief engineer of Weston Electrical Instrument Corporation, Newark, N. J. He succeeds W. N. Goodwin, Jr., who, although retired, has been retained as an engineering consultant.

*(Contined on page 46)*

# NEWS BRIEFS

*(Continued from page 45)*

**Albert C. Gable** has been appointed assistant engineer of the tube division of the G. E. electronics department.

**Arch Samuelson** is now sales manager of the commercial sound division of the Operadio Manufacturing Company.

**J. F. McCraigh,** formerly chief of Operadio's engineering department, has returned from an extended leave of absence to take the post of west coast district manager.

**Fred H. O'Kelley** of Atlanta, Ga., has been appointed southeastern district manager for Operadio.

**Fred E. Garner** is now in charge of sales in the middle west for Interstate Manufacturing Corporation, 125 Sussex Avenue, Newark, New Jersey. Mr. Garner will be located at 333 North Michigan Avenue, Chicago, Illinois.

**Daniel E. Noble,** general manager of the communications and electronics division of Motorola, has been appointed vice president in charge of that division.

**R. C. Walker,** formerly chairman, president and general manager of Aireon Manufacturing Corp., has resigned the latter two offices but will continue as chairman of the board.

**C. A. Priest,** manager of the G. E. transmitter division, has been elected chairman of a newly formed Syracuse, N. Y., section of the IRE. **E. M. Deerhake** has been elected vice chairman of the group. Post of secretary treasurer went to **R. E. Moe.**

**Samuel M. Thomas** has been named assistant chief engineer of RCA Communications, Inc.

**Leo L. Helterline, Jr.,** has been appointed chief engineer of Sorensen & Company, Inc.

* * *

**John J. Glauber** has been appointed chief engineer of United Electronics Co., in charge of engineering and development of radio transmitting tubes. He was formerly with Federal Telecommunications Laboratories of New York, in charge of design and development of u-h-f high-power pulse tubes.

* * *

**Stephen T. Van Esen** is now advertising manager of the Hammarlund Mfg. Co., Inc., 460 W. 34th St., N. Y. 1, N. Y.

**Russell B. Rennaker** has joined Collins Radio Company and will be in charge of the broadcast sales division. Mr. Rennaker was formerly with FTR.

* * *

**I. J. Youngblood** has become vice president in charge of sales of the Clarostat Mfg. Co., Inc., Brooklyn, N. Y.



**L. C. McCarthy** has been elected to the board of directors of Electronic Laboratories, Inc., Indianapolis. For the past 14 years McCarthy has been Chicago district rerpesentative for Electronic Lab.

**Robert E. Lamar** is now on the advertising staff of the radio tube division of Sylvania.

**Walter A. Weiss** has been named supervisor of quality control for the Sylvania radio tube unit.

**W. L. Rothenberger** is now manager of renewal sales in the RCA tube department. He succeeds David J. Finn, newly appointed general sales manager of the RCA Victor record department.

**Louis Martin,** formerly supervisor of the RCA tube department field engineering group, has been appointed supervisor of the equipment field force. **Robert L. Kelly,** formerly field engineer in the New York area, is now supervisor of application engineering service, equipment sales section. **Jack M. Sadowsky,** formerly a field engineer, has been named supervisor of electronic components sales, equipment sales section.

**L. C. Joralemon,** formerly field representative for Weston Electrical Instrument Corporation, Newark, N. J., has formed the firm of Joralemon, Craig & Company, 112 South 16th Street, Philadelphia 2.

Company will handle sales of Weston instruments in southern New Jersey, eastern Pennsylvania, the District of Columbia, Fairfax County, Virginia, and in Maryland, with the exception of Allegheny and Garrett Counties. Sales unit also acts as field representatives for American Transformer Company, Newark; Western Electro Mechanical Company, Oakland, Calif., and Radio Frequency Laboratories, Inc., Boonton, N. J.

**Paul D. Bezazian,** treasurer of the Aero Needle Company, Chicago, since its organization some years ago, has been elected general manager.

**Joseph Walschmidt,** formerly of the Bamberger Broadcasting Service, is now with E. C. Page, consulting engineers, Bond Building, Washington, D. C.

**John Ballantyne,** president of Philco Corporation, has received a Certificate of Appreciation for his wartime services in directing the development and production of radar for the armed forces.

**Howard K. Morgan,** chief development engineer of Bendix Radio, addressed the Montreal Section of IRE recently on "Air Navigation and Traffic Control."

* * *

### *LITERATURE*

**Radio City Products Company, Inc.,** 127 West 26th Street., New York City, has compiled a 24-page catalog, 129, describing RCP and Reiner test equipment and instruments.

RCP equipment described includes tube testers, multitesters, v-t-v-m and signal generators. Reiner instruments discussed include square-wave generators, volt-milli-ammeters, etc.

**Cannon Electric Development Company,** 3209 Humboldt Street, Los Angeles 31, Cal., have released a 4-page bulletin describing X-L plugs and receptacles for low-level sound transmission circuits.

**The G.E. electronics department have published** a 156-page receiving tube brochures, Recommended Types (ETR-19), for equipment, designers and radio set manufacturers.

Covering the complete G. E. and Ken-Rad receiving tube line, the new publication lists tube types in numerical order by sections. Each section includes a typical circuit, complete ratings, curves and companion technical data for each tube type.

Distribution of the brochure will be made to receiver manufacturers, designers, and engineers. Requests should be sent to W. Hayes Clarke, sales manager of receiving tubes, G. E. electronics department's tube division, Schenectady, N. Y.

**Sound Apparatus Co.,** 233 Broadway, New York, 7, N. Y., has released a 4-page technical bulletin, "Sound Advances," describing a new graphic recorder, twin recorder, and a new regulated power supply.

**Clarostat Mfg. Co., Inc.,** 130 Clinton St., Brooklyn 2, N. Y., has compiled a volume control cross-index guide consisting of a set of cards printed on both sides with cross-index of corresponding type numbers of four leading volume control manufacturers, arranged in numerical order. May be had free of charge.

**P. R. Mallory & Co., Inc.,** 3029 E. Washington St., Indianapolis 6, Ind., have published an engineering data folder, VER-1146, describing vitreous enamel fixed and adjustable power resistors (fixed tab, adjustable and ferrule construction in commercial types, and type RN fixed resistors in tab construction which meet Joint Army-Navy Specification R-26, Grade 1, Class 1).

**The RCA tube** department has issued a 16-page booklet "Receiving Tubes for Television, FM, and Standard Broadcast."

Booklet charts the characteristics and socket connections of receiving tubes including projection and directly viewed kinesopes for television picture reproduction. All types are listed in numerical-alphabetical sequence of type designations for the convenience of the user. Metal and miniature types are identified. Information on discontinued types has been included.

The tube department has also published a 16-page booklet, "Power and Gas Tubes for Radio and for Industry."

Booklets are available from RCA tube distributors at 10c a copy, or 10c can be sent direct to commercial engineering, tube department, RCA, Harrison, N. J.

**Electronics Research Publishing Company,** 2 W. 46th St., N. Y. 19, N. Y., has prepared the 1947 issue of the Master Index with over 25,000 radio and electronic article entries. Will be published in the early spring.

An electronic-engineering patent index for 1946 with data on over 2000 inventions will also be published soon by Electronics Research.

**Simplex Wire and Cable Co.,** 79 Sidney Street, Cambridge 39, Mass., has compiled a 12-page report analyzing natural and synthetic rubber and its application as wire insulation.

**Electro-Voice, Inc.,** Buchanan, Mich., has compiled a 20-page catalog discussing cardiod, dynamic, crystal, carbon, velocity and differential microphones.

**Walker-Jimieson, Inc.,** 311 South Western Avenue, Chicago 12, Illinois, has prepared a 100-page buyers guide covering public address and inter-office communication systems, tubes, batteries, and electrical maintenance supplies.

**E. F. Johnson Co.,** Waseca, Minn., have prepared a 32-page tube socket guide with a tabulation of transmitting, control, regulator, rectifier and receiving tubes and required sockets.

**Leece-Neville Company,** 5363 Hamilton Avenue, N. E., Cleveland 14, Ohio, have prepared a 4-page bulletin describing an alternator system which includes alternator, rectifier and voltage regulator.

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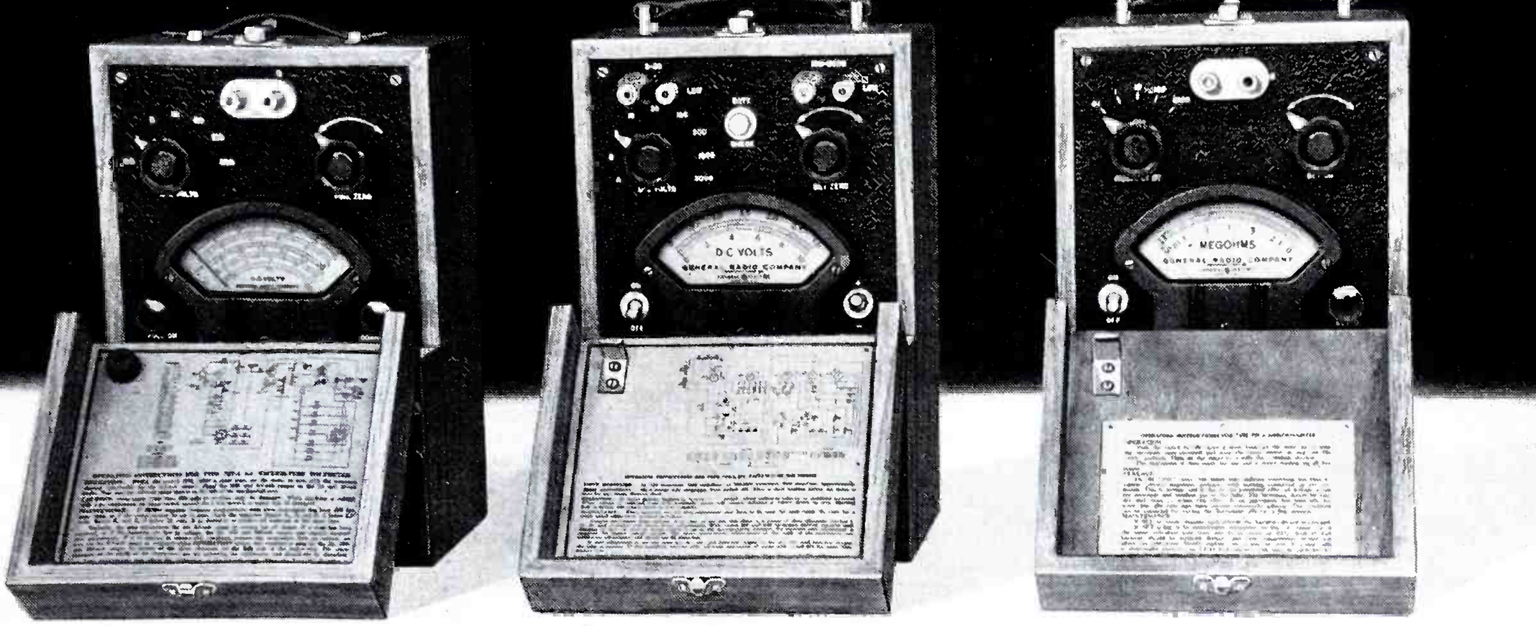
### *MARCHAND AND ROBINSON PAPERS TO APPEAR IN APRIL ISSUE*

The series of articles on f-m transmitter, receiver and accessory design and application by N. Marchand will be resumed in the April issue. W. H. Robinson's analysis of lateral recording, the first installment of which was presented in the February issue of COMMUNICATIONS, will be continued in the April issue.

# ADVERTISERS IN THIS ISSUE

## COMMUNICATIONS—MARCH, 1947

# METERS—by GR




### TYPE 727-A
### VACUUM-TUBE VOLTMETER

This general-purpose, battery-operated v-t voltmeter is for use at frequencies up to about 100 megacycles.

**RANGE** — 0.05 volt to 300 volts ac, in seven ranges (0.3, 1, 3, 10, 30, 100, 300 volts, full scale)

**ACCURACY** — With sinusoidal voltages applied, the accuracy is ±3% of full scale on the 0.3-volt range and ±2% of full scale on all other ranges. Periodic checking of the full-scale sensitivity will give corrections to be made to eliminate effects of aging on the higher voltage ranges.

**WAVEFORM ERROR** — On lowest ranges the instrument approximates a true square-law device. It is calibrated to read the r-m-s value of a sinusoidal voltage. On the higher voltage ranges it is essentially a peak-reading instrument calibrated to read 0.707 of the peak values and on distorted waveforms the percentage deviation from r-m-s values may be as large as the percentage of harmonics present.

**FREQUENCY ERROR** — Less than 1% between 20 cycles and 30 Mc. At 65 Mc the error is about ±5% and at 100 Mc about ±10%.

**INPUT IMPEDANCE** — The input capacitance is about 16 micromicrofarads. Parallel input resistance (at low frequencies) is about 5 megohms on the lower ranges and about 3 megohms on the upper.

**PRICE: $125***

### TYPE 728-A
### D-C VACUUM-TUBE VOLTMETER

This battery-operated v-t voltmeter is designed for measuring d-c voltages in low-power circuits where no appreciable power can be taken by the meter.

**RANGE** — 0.05 to 3000 volts in seven ranges (3, 10, 30, 100, 300, 1000, 3000 volts, full scale)

**ACCURACY**—Within ±3% of full scale on all ranges. If the full-scale sensitivity is checked occasionally the effect of aging, on the higher voltage ranges, can be eliminated

**INPUT RESISTANCE** — 1000 megohms on the ranges above 100 volts; greater than 5000 megohms on the lower

**TERMINALS** — Two sets of input terminals are provided; one for measurements at the 0 to 30 volts end of the range and the other for higher voltages

**POLARITY** — A reversing switch on the panel permits measurements with either the positive or the negative of the source grounded to the panel of the instrument.

**EFFECT OF A-C** — A superimposed a-c voltage of as high as 200 volts has negligible effect on meter indication

**PRICE: $125***

### TYPE 729-A
### MEGOHMMETER

This battery-operated megohmmeter is particularly useful where portability is required. It is well suited to field measurements of leakage resistance of cables and insulation.

**RANGE** — 2000 ohms to 50,000 megohms in five overlapping ranges

**SCALE** — Standard direct-reading ohmmeter calibration is used; center scale values are .1, 1, 10, 100 and 1000 megohms

**ACCURACY** — Within ±5% of the indicated value between 30,000 ohms and 3 megohms when the central decade of the scale is used; otherwise the error is increased because of the compressed scale

**TEMPERATURE AND HUMIDITY** — Effects of these are negligible over normal range of room conditions (65 to 95 deg. F.; 0 to 95% relative humidity)

**VOLTAGE ON UNKNOWN** — Voltage applied to the unknown does not exceed 22½ volts and varies with meter indication

**PRICE: $95***

**Plus 10% temporary price increase, due to greatly increased costs*

THESE three accurate, highly stable and portable meters are all battery-operated and completely self-contained. They are housed in identical walnut cabinets 11 inches by 6⅝ inches by 5⅞ inches in size. Their accuracy is sufficient for a wide variety of measurements both in the laboratory and in the field.

Other G-R meters include a portable a-c operated vacuum-tube voltmeter for audio and radio frequency measurements up to several hundred megacycles, a crystal galvanometer direct-reading in voltage between 30 and 1,000 megacycles, an a-c operated megohmmeter with a range of 2,000 ohms to 50,000 megohms, a counting rate meter for measuring random emanations from radio-active materials, three models of output-power meters, and an audio-frequency microvolter with an output voltage range of 0.1 microvolt to 1 volt.

G-R meters are carefully designed, correctly engineered, ruggedly constructed and accurately calibrated to insure many years of useful life.

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# GENERAL RADIO COMPANY

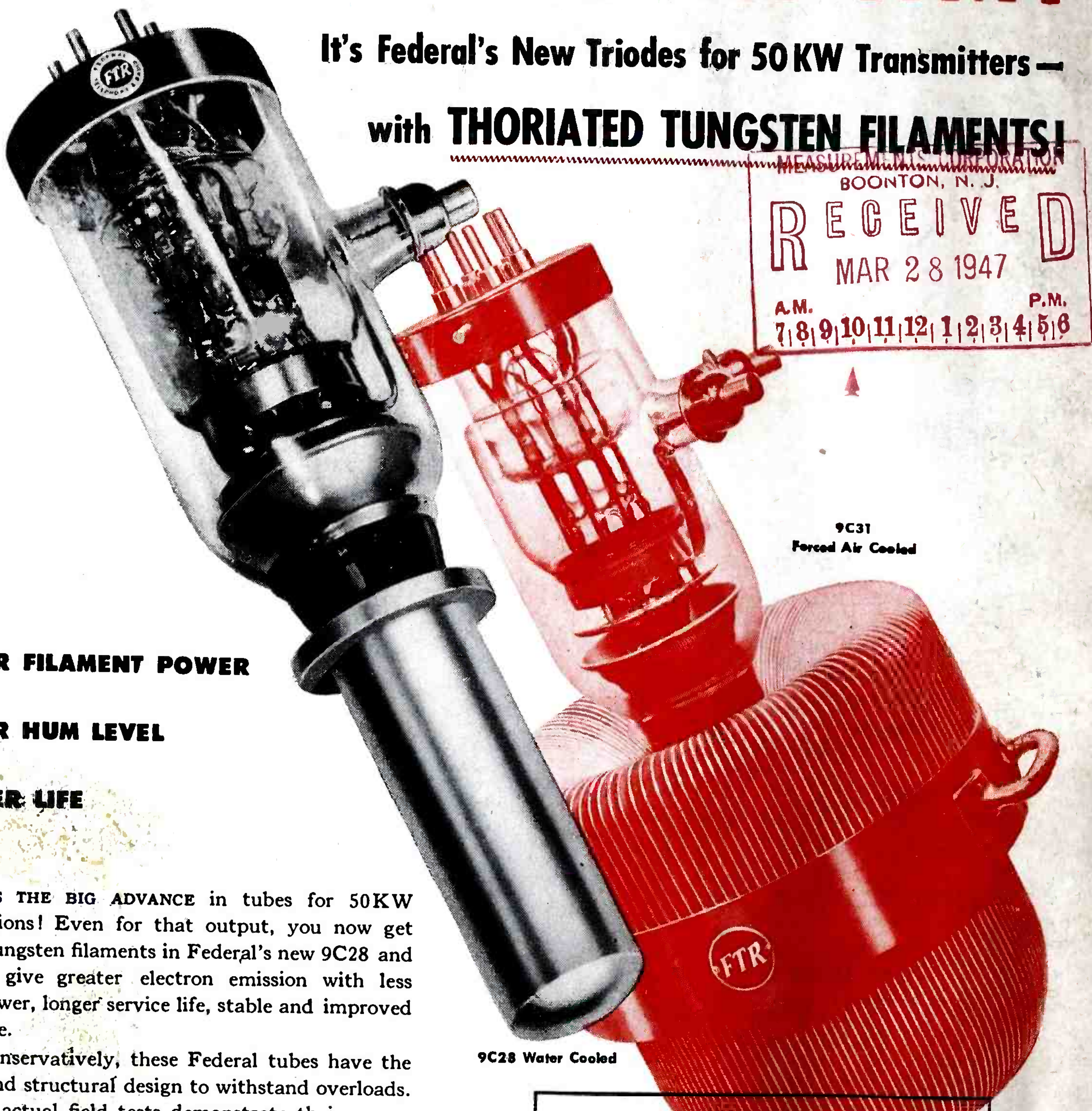
**Cambridge 39, Massachusetts**

**90 West St., New York 6** — **920 S. Michigan Ave., Chicago 5** — **950 N. Highland Ave., Los Angeles 38**

# BIGGEST NEWS IN AM!

**It's Federal's New Triodes for 50 KW Transmitters —**

**with THORIATED TUNGSTEN FILAMENTS!**




9C31 Forced Air Cooled

9C28 Water Cooled

- **LOWER FILAMENT POWER**
- **LOWER HUM LEVEL**
- **LONGER LIFE**

HERE'S THE BIG ADVANCE in tubes for 50KW stations! Even for that output, you now get thoriated tungsten filaments in Federal's new 9C28 and 9C30 — to give greater electron emission with less filament power, longer service life, stable and improved performance.

Rated conservatively, these Federal tubes have the electrical and structural design to withstand overloads. Months of actual field tests demonstrate their exceptional durability. Both the 9C28 and 9C30 are water cooled for maximum output. Alternate types (9C29 and 9C31), with air cooling, are also available. In a pair of either type you'll find new operating economy and low tube costs.

Federal's 38 years of tube engineering and manufacture show up once more in this latest "first". No wonder Federal tubes have consistently set the standards for performance in AM broadcast service. We'll be glad to send you more data on these tubes. Write department K410.

**PARTIAL TECHNICAL DATA**

| | 9C28 | 9C30 |
|---|---|---|
| Filament voltage | 15 v. | 15 v. |
| Filament current | 135 amp. | 135 amp. |
| *Maximum Ratings* | | |
| Plate Voltage | 12,000 v. | 15,000 v. |
| Plate Current | 10 amp. | 8 amp. |
| Plate Input | 100 kw. | 120 kw. |
| Plate Dissipation | 40 kw. | 40 kw. |

## *Federal Telephone and Radio Corporation*

In Canada: — Federal Electric Manufacturing Company, Ltd., Montreal.
Export Distributors: — International Standard Electric Corp. 67 Broad St., N. Y.

AN IT&T ASSOCIATE

100 Kingsland Road, Clifton, New Jersey