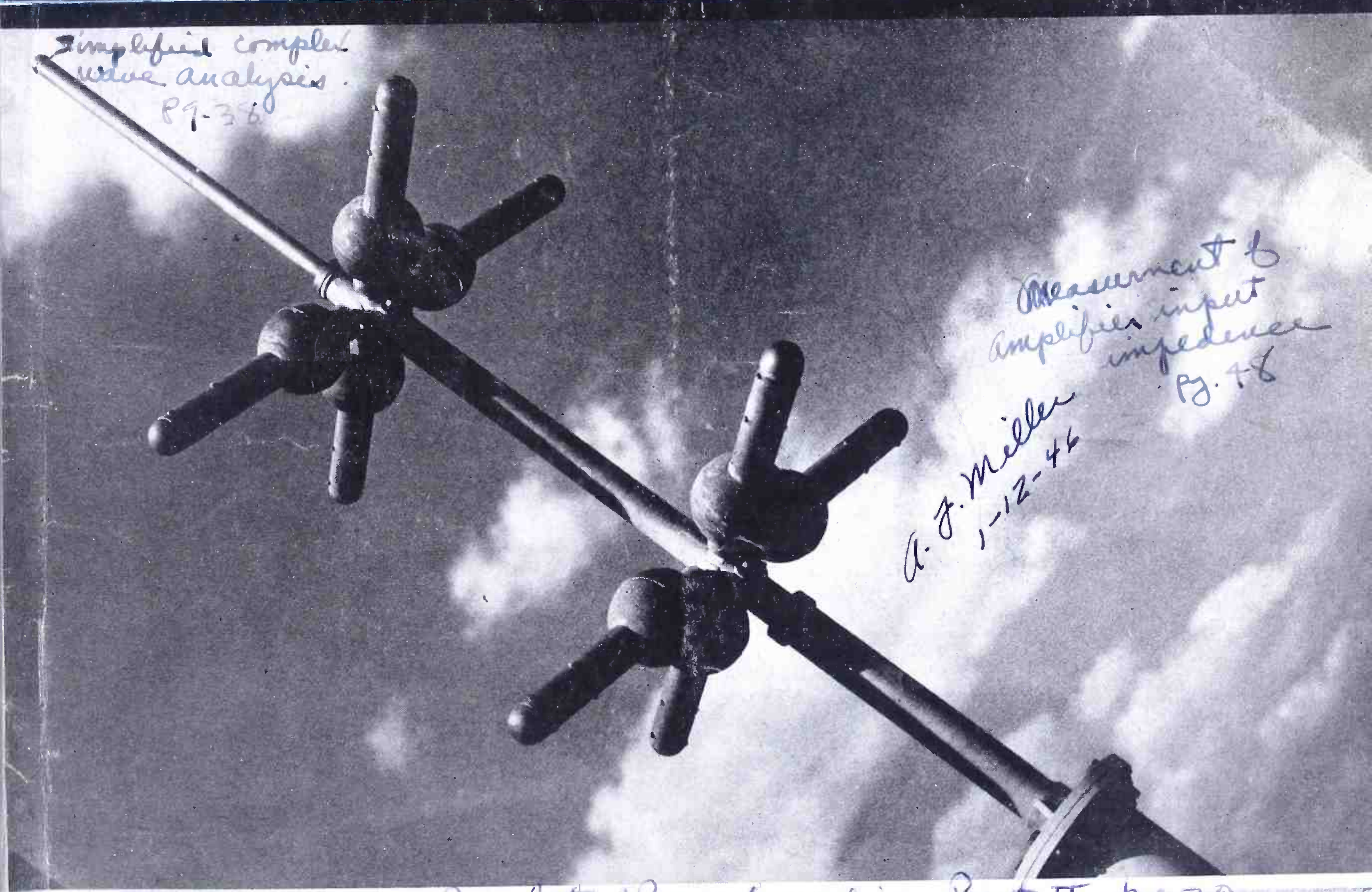
COMMUNICATIONS



Simplified complex wave analysis. Pg-38

Measurement of amplifier input impedance Pg. 48

A. J. Miller 1-12-46

Voltage Regulated Power Supplies Part II pg 70

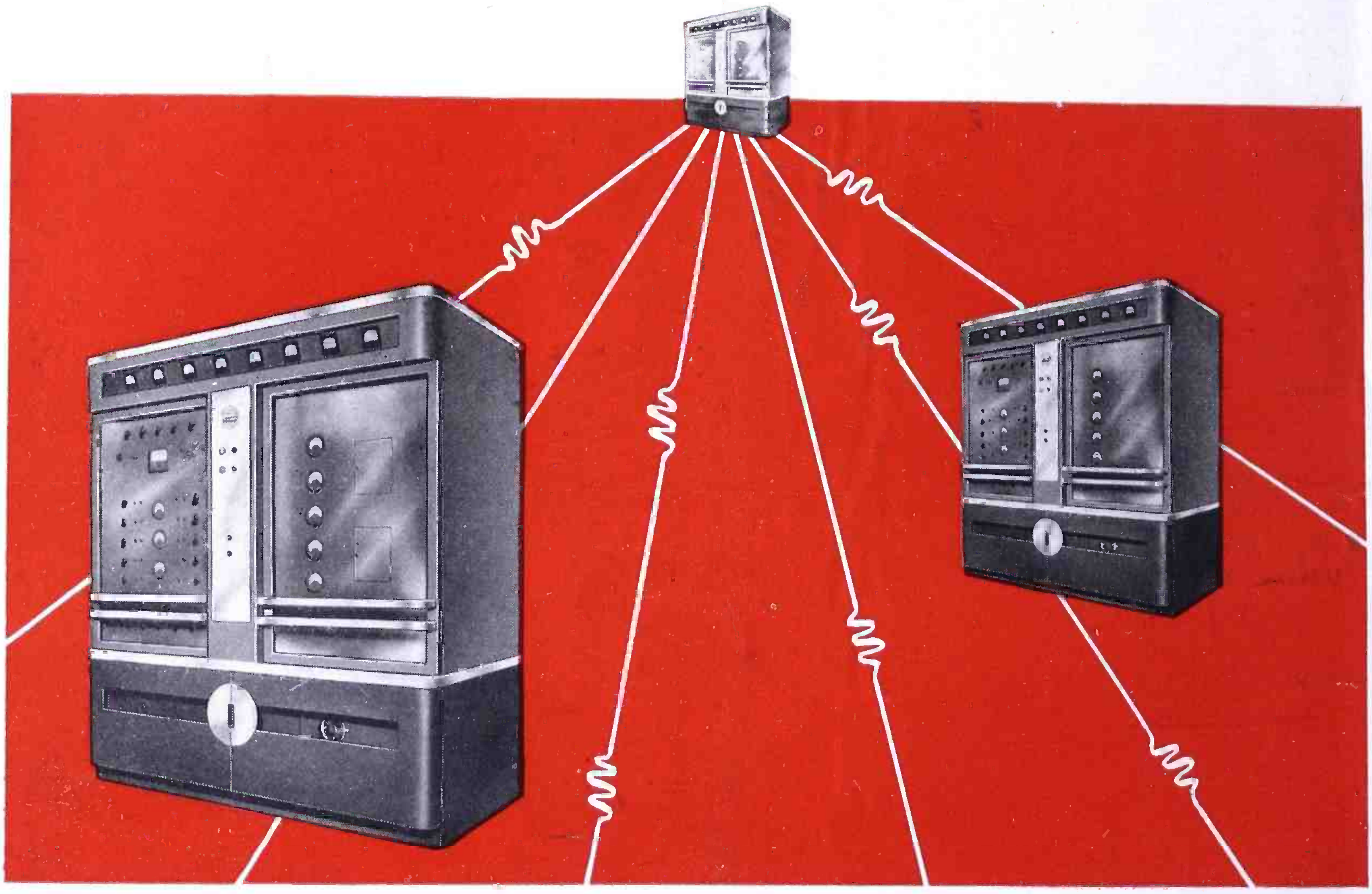
DECEMBER

★ RADIO ENGINEERING
★ STEPPING UP FROM ¼ KW TO 5 KW
★ REPORT ON IRE FALL MEETING
★ AERONAUTICAL COMMUNICATIONS
★ AMPLIFIER INPUT IMPEDANCE MEASUREMENT
★ TELEVISION ENGINEERING

1945

INDEX-1945-Pg 72

250 AND 1000 WATT FM BROADCAST TRANSMITTERS ARE *On The Way . . .*



For many years, HARVEY OF CAMBRIDGE has built transmitters considered standards of quality and dependability. Yet, these new HAR-CAM FM Broadcast Transmitters that are about ready for release, will be far and away the finest ever to bear the HAR-CAM name.

Here's why:

As specialists in the manufacture and development of communications equipment, receivers as well as transmitters, for Commercial, Marine and Emergency use, we have gained a thorough knowledge and understanding of *all* phases of the industry. This sound background has been greatly enhanced by the additional skill and "know-how" gained through war work, particularly in the development and production of vital Loran Radar Transmitters and other important communications units. Add to this improved production facilities and advanced precision methods of manufacture and you can readily understand why HAR-CAM FM Broadcast Transmitters will provide the last word in efficient, dependable and economical transmission.

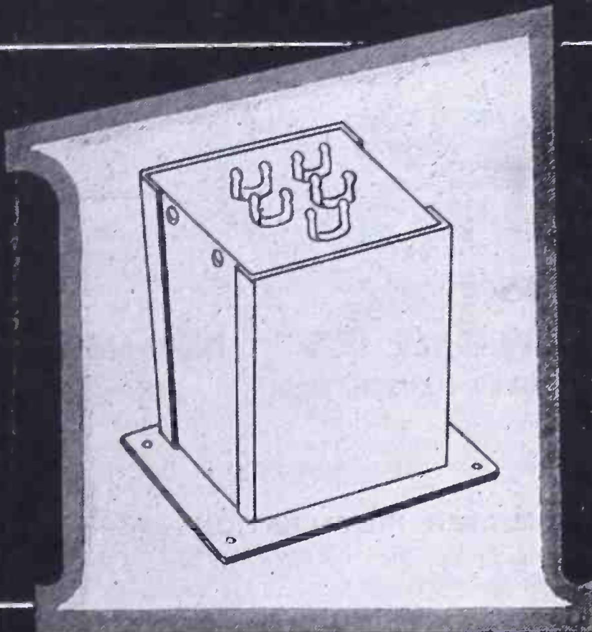
Now is the time to get the complete story on these new HAR-CAM 250 and 1000 watt FM Broadcast TRANSMITTERS.

HARVEY RADIO LABORATORIES, INC.

442 CONCORD AVENUE · CAMBRIDGE 38, MASSACHUSETTS

Now - 3 FERRANTI DIVISIONS OFFER

LOW COST PRODUCTS



FERRANTI HIGH QUALITY

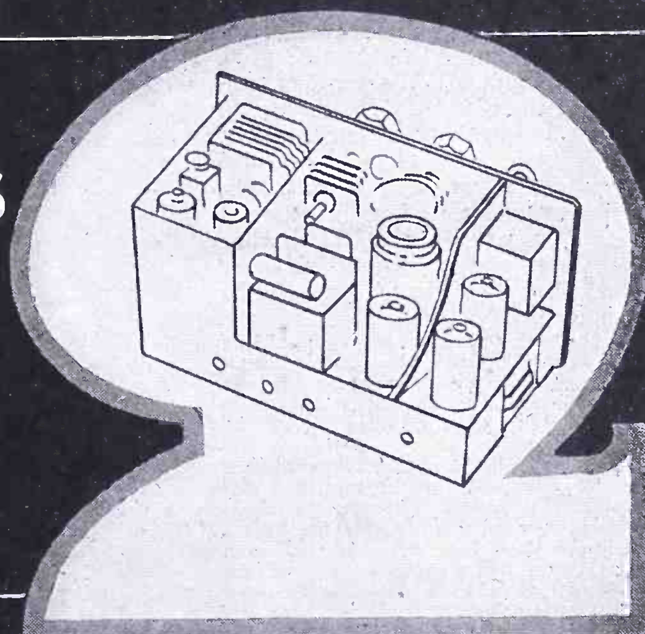
TRANSFORMERS

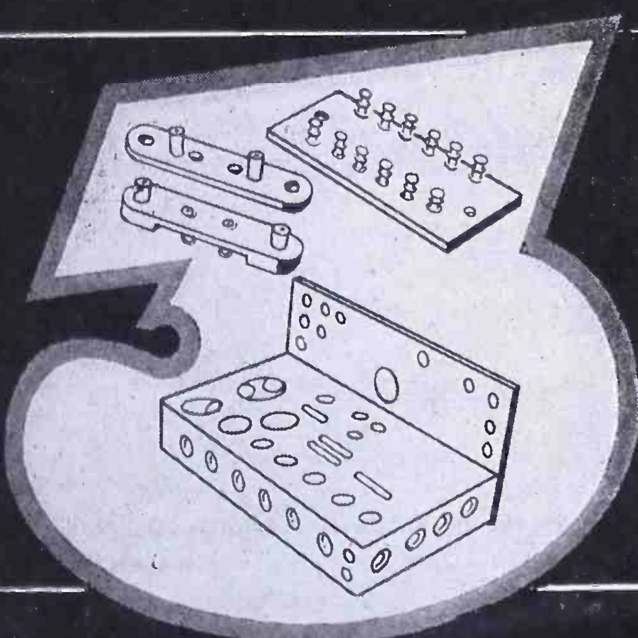
AUDIO AND POWER TRANSFORMERS
CHOKES · FILTERS · COILS · ETC. ETC.
STOCK UNITS
HERMETICALLY SEALED — CUSTOM BUILT
LARGE OR SMALL QUANTITIES

FERRANTI HIGH QUALITY

WIRING & ASSEMBLIES

ELECTRONIC AND MECHANICAL ASSEMBLIES
SUB-ASSEMBLIES · COMPONENT PARTS
FERRANTI NOW OFFERS
THE BENEFITS OF WAR-GAINED EXPERIENCE
ON ALL TYPES OF
ASSEMBLY JOBS — LARGE OR SMALL





FERRANTI HIGH QUALITY

SHEET METAL & BAKELITE FABRICATION

FROM SHEETS, RODS AND TUBES — PANELS
CASES, TERMINAL BOARDS, RACKS, CHASSIS, ETC.
CUT — PUNCHED — DRILLED — ENGRAVED
FINISHED TO SUIT YOUR NEEDS

QUALITY — AT LOW COST . . PROMPT DELIVERY

FERRANTI ELECTRIC, INC. • RCA BUILDING

NEW YORK 20, NEW YORK

SEND US YOUR SPECIFICATIONS FOR IMMEDIATE ATTENTION

LEWIS WINNER, Editor

F. WALEN, Assistant Editor

We See . . .

THE COMMUNICATIONS INDUSTRY is scheduled to initiate one of the most diversified and intensive development and production programs in its entire history during the coming twelve months of the New Year, 1946. Plans encompass new materials, components and equipments for the rapidly expanding transmission and reception fields . . . fields which will include train radio; municipal and state police, fire and forestry systems; all forms of mobile operations for highway and local use; fixed and mobile relay systems; aviation; rural telephone exchanges; public utilities; geophysical services; amateurs; facsimile and a-m/f-m and p-t-m broadcasting, and television.

Striking evidence of this active interest appeared in a recent statement by the FCC, which disclosed that the FCC staff will have to be doubled and perhaps tripled to process the thousands of station applications already received and still pouring in. Over 700 applications for f-m broadcasting stations alone have already been sent in to Washington. Commissioner Paul A. Walker has predicted that at the close of 1946 there will be over 2000 f-m applications on file. Hundreds of television forms have also been received. Buses, trucks, railroads, rural independent telephone companies (of which there are over 6,000), harbor and lake craft, and a variety of other commercial activities have been filing station applications with the FCC.

The recent FCC television report providing extra channels in the nation's first 140 markets, which will eventually extend a chain of over 400 stations throughout the nation, has also emphasized the expansion possibilities of the industry.

Cost studies have disclosed that unprecedented peacetime budgets will be appropriated for communications equipment. The recent analysis of f-m station costs by the FCC for the Senate Small Business Committee revealed that even a 250-watt station will involve an expenditure of from $6,000 to $14,000 covering the cost of transmitters (including royalties), antenna (but not supporting structures), control consoles, remote pick-up (wire line), turntables and monitors. Other station costs revealed were: 1-kw station, $10,000 to $20,000; 3-kw station, $12,-000 to $24,000; 10-kw station, $22,000 to $34,-000; 50-kw station, $73,000 to $85,000 (all costs approximate). Incidentally, the survey revealed that deliveries of transmitters, ordered in November, will begin around April of 1946. Those ordered prior to November should come off the production line starting in January.

The extensive CAA u-h-f communications plans for private aircraft are also indicative of the bright prospects that fact the industry.

A tentative technical program has already been prepared providing the bases on which receiver and transmitter manufacturers may plan their postwar equipment. Extreme simplication is being fostered by the CAA to both expedite production and facilitate operation.

The wartime developments of radar, loran and shoran; the resnatron and sub-miniature tubes; laminated-phenolic speaker diaphrams, alnico V and processed resistor—capacitor ceramic-plate units, to mention a few, will serve as the basis of many a 1946 design, and provide an assortment of apparatus for a variety of new and unusual applications.

Looks like a banner year for *communications!*

OVER SIXTY PAPERS on all phases of communications will be presented at the postwar IRE Annual Winter Meeting to be held from January 23rd to 26th at the Hotel Astor in New York City. The meeting promises to be one of the most interesting ever held.

We urge you to attend.

CONGRATULATIONS TO JACK POPPELE on his reelection as president of the TBA. A just reward for his excellent work during the past year!

—L. W.

COMMUNICATIONS

Including Television Engineering, Radio Engineering, Communication & Broadcast Engineering, The Broadcast Engineer. Registered U. S. Patent Office.
Member of Audit Bureau of Circulations.

DECEMBER, 1945

VOLUME 25 NUMBER 12

COVER ILLUSTRATION

The two-layer turnstile 288-mc television antenna recently installed atop the Empire State Building. The antenna was designed and constructed at the RCA research laboratories in Princeton, N. J. *(Courtesy RCA)*

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

BRYAN S. DAVIS, President **F. WALEN, Secretary**

PAUL S. WEIL, Vice Pres.-Gen. Mgr. **A. GOEBEL, Circulation Mgr.**

Advertising and Editorial offices, 52 Vanderbilt Ave., New York 17, N. Y. Telephone, MUrray Hill 4-0170. Cleveland 6, Ohio: James C. Munn, 10515 Wilbur Ave.; Telephone, SWeetbriar 0052. Pacific Coast Representative: Brand & Brand, 1052 W. Sixth St., Los Angeles 14, Calif.; Telephone, Michigan 1732. Wellington, New Zealand: Te Aro Book Depot. Melbourne, Australia: McGill's Agency. Entered as second-class matter Oct. 1, 1937, at the Post Office at New York, N. Y., under the act of March 3, 1879. Yearly subscription rate: $2.00 in the United States and Canada; $3.00 in foreign countries. Single copies, twenty-five cents in United States and Canada; thirty-five cents in foreign countries.

CAPACITOR *Craftsmanship*

● With tiny silvered micas, it's precision: capacitance tolerances of 1%, with temperature coefficients and stability requirements to meet the highest characteristics requirements of JAN-C-S; excellent retrace characteristics; practically no capacitance drift with time; exceptionally high Q. Yes, Aerovox *specializes* in such precision capacitors.

And at the other extreme are giant Type 26 oil-filled capacitors for high-voltage requirements such as in X-ray equipment, high-voltage test and laboratory equipment, and for carrier-current coupling. Again, Aerovox *specializes* in high-voltage oil-impregnated, oil-filled capacitors.

But how, you ask, can one organization really *specialize* in such totally different products? The Aerovox answer:

The huge Aerovox plant is really *several* plants in one. Micas are made in the Mica Department, oils in the Oil Department, electrolytics in the Electrolytic Department, and so on. Each has its OWN engineers, supervisors, trained workers.

Thus you are assured of that *specialized* craftsmanship that insures the best in highly specialized products, along with the convenience, certainty and economy of ONE outstanding source of supply.

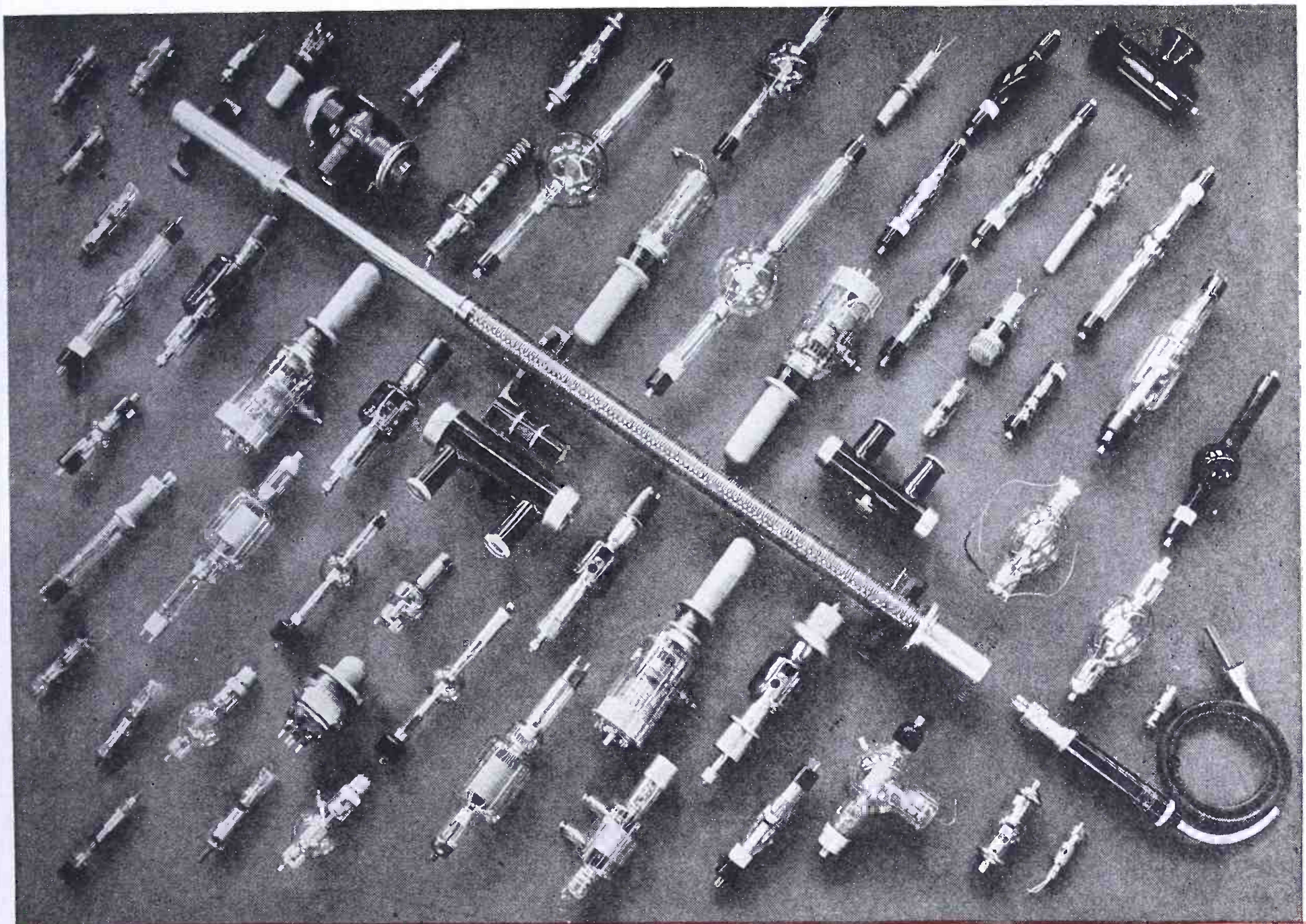
● ***Try us on that capacitance problem***

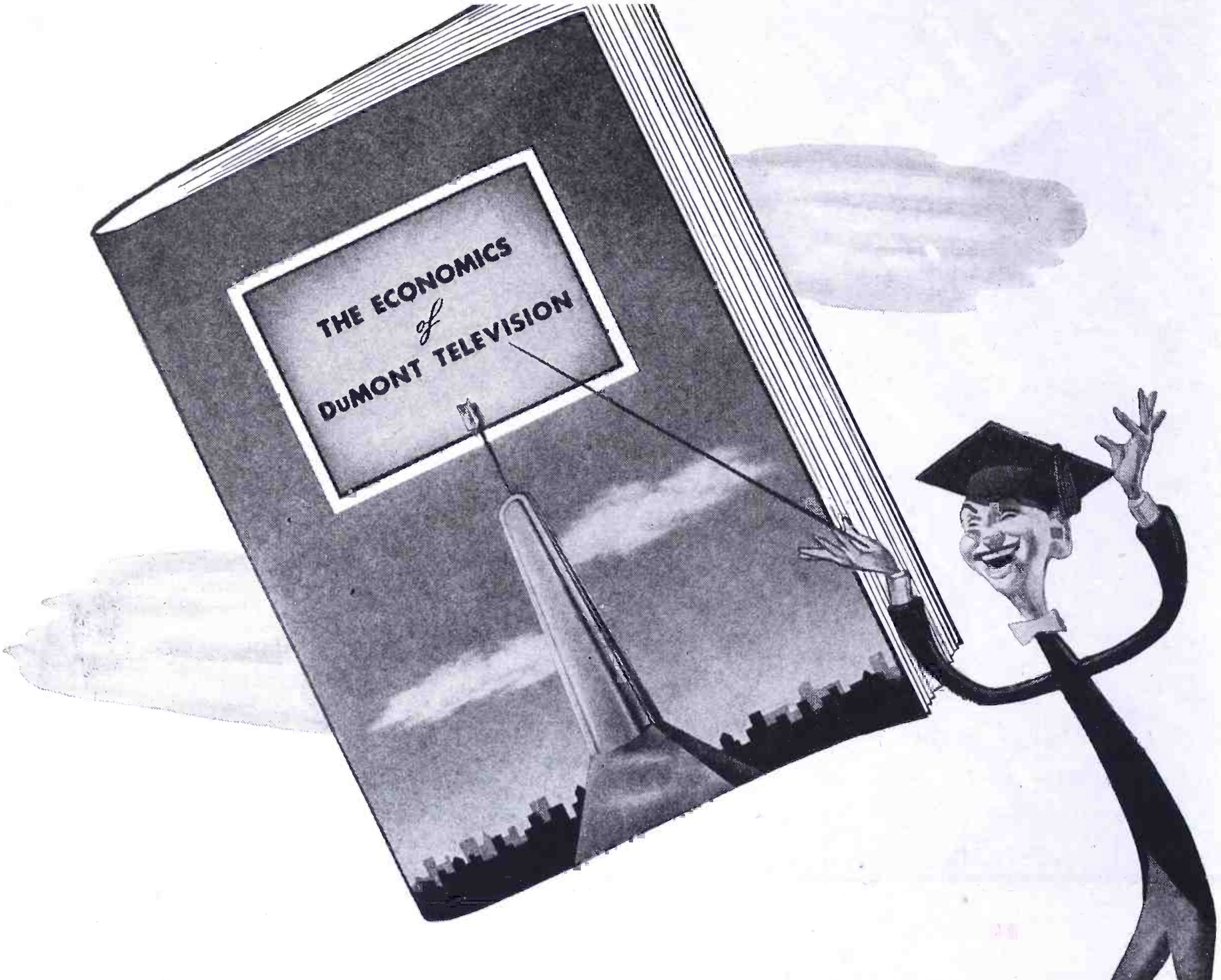
AEROVOX *Capacitors*

INDIVIDUALLY TESTED

AEROVOX CORPORATION, NEW BEDFORD MASS., U. S. A. • SALES OFFICES IN ALL PRINCIPAL CITIES

Export: 13 E. 40 ST., NEW YORK 16, N. Y. • Cable: 'ARLAB' • In Canada: AEROVOX CANADA LTD., HAMILTON, ONT.





Does Television Make Economic Sense?

What capital investment is required for a full-service television station? What will be its annual operating cost? What is the revenue expectancy from time sales? What is a fair tele-time rate? Shall rehearsal time be charged for? How will a network affiliation affect profits?

These hard-headed questions are boldly and frankly answered with exciting facts and figures in DuMont's new booklet: "The Economics of Television"—just off the press!

DuMont's answers are backed by DuMont's extensive experience in developing television broadcasting equipment, in building more tele-stations than any other company, in designing and constructing DuMont's new John Wanamaker Studios, in operating its own tele-station since 1941, and by continuous laboratory, market and audience research.

Television experts generally are agreed that DuMont has the "tele-know-how" needed to set a pattern for profitable station management. This new booklet makes such a pattern available. Please request it on your firm letterhead.

DUMONT *Precision Electronics and Television*

ALLEN B. DuMONT LABORATORIES, INC., GENERAL OFFICES AND PLANT, 2 MAIN AVENUE, PASSAIC, N. J.
TELEVISION STUDIOS AND STATION WABD, 515 MADISON AVENUE, NEW YORK 22, NEW YORK

RECEIVER MANUFACTURERS:

RCA TEST EQUIPMENT

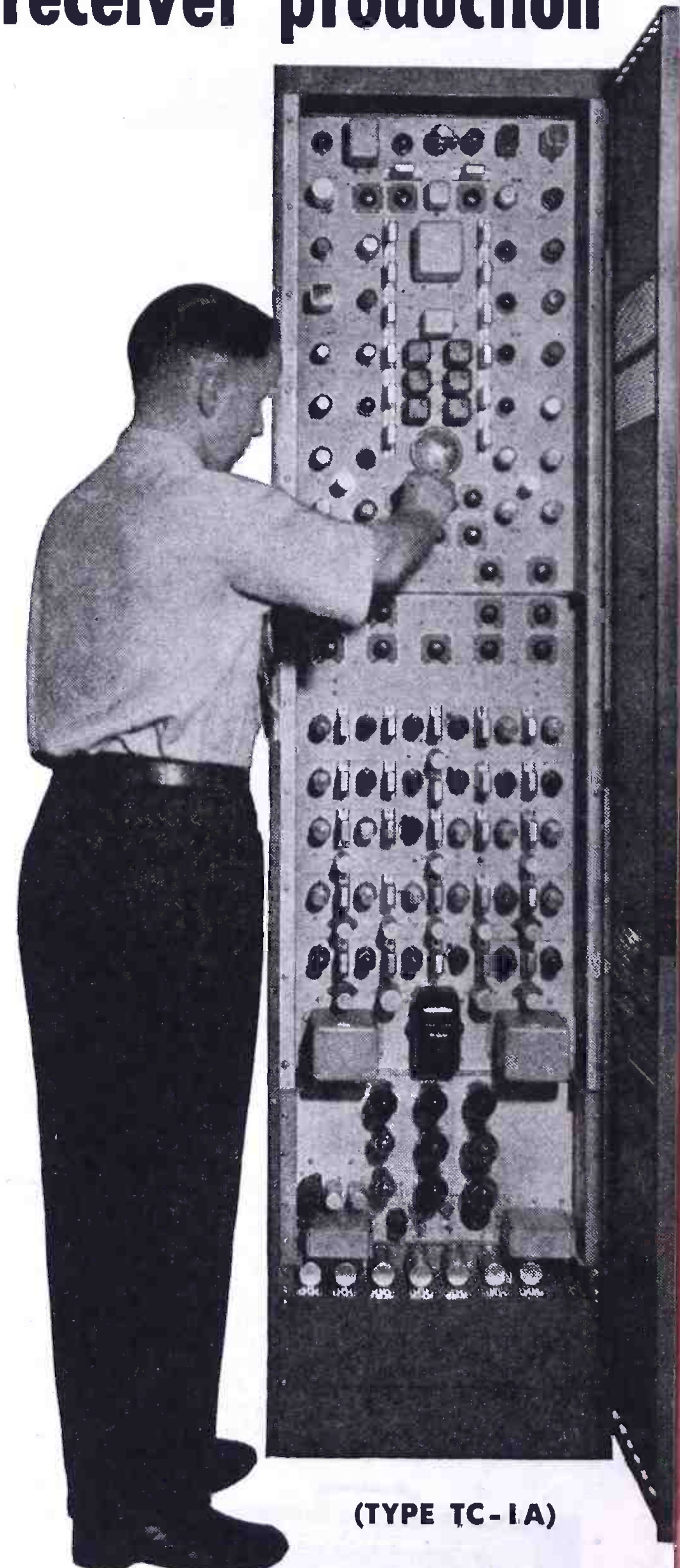
to help speed your television-receiver production

IF your television-receiver program has been held up because of inadequate test and measuring equipment, here's the answer. RCA will begin to deliver the instruments shown here in 60 to 90 days. They are not experimental or first post-war models, but service-tested equipment—developed before the war and perfected as a result of RCA's extensive television research and manufacturing work during the war for the armed forces.

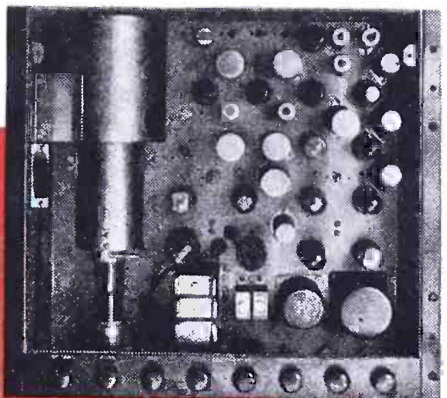
With items 1 through 4, a complete video signal can be produced, making it possible to measure and adjust accurately the focus, contrast, resolution, and scanning linearity of your television receivers.

Items 5 through 8 are other instruments we believe you will also find useful in easing your laboratory and testing problems.

An early indication from you of your test and measuring requirements will assure prompt delivery of this hard-to-get equipment.

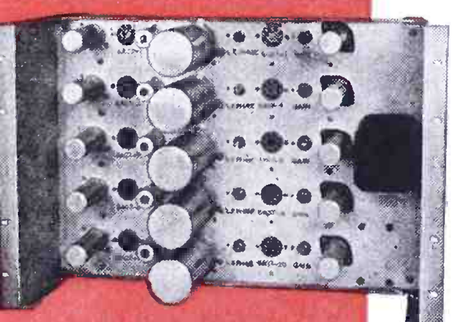


(TYPE TC-1A)



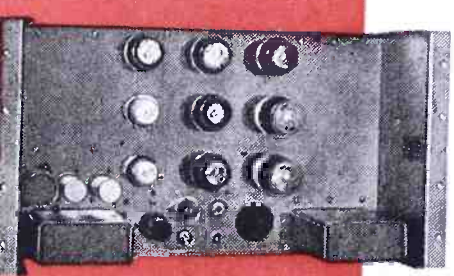
1 MONOSCOPE CAMERA

Produces a fixed television signal for aligning and testing equipment such as television receivers, transmitters, and monitors. The signal is produced by scanning a stationary pattern mounted permanently inside the monoscope tube. It is designed for rack mounting for use with items 2 and 4. The filament supply is self-contained, but a separate regulated plate supply is required. The 580-C unit (item 3) is ideal for this purpose.



2 DISTRIBUTION AMPLIFIER (TYPE TA-1A)

For use with the synchronizing generator and monoscope camera. Applications include: transmission over coaxial lines of pictures and synchronizing signals to various locations, feeding signals from program line to monitors, for isolating distributed pulses, as a mixer to combine synchronizing with picture signals to form the complete video signal. Requires a regulated plate supply.



3 REGULATED POWER SUPPLY (TYPE 580-C)

For supplying the plate power required by the monoscope camera and distribution amplifier. Regulation is better than .25 per cent over the range between 50 and 400 milliamperes; output voltage is adjustable between 250 and 300 volts; output ripple is lower than .012 per cent of the d-c output voltage. This unit may also be used for general-purpose work.

4 SYNCHRONIZING GENERATOR

Ideal for design and production testing of television receivers, and for application work in experimental laboratories engaged in television work. Provides "synchronizing" pulses of suitable wave shape and frequency for the production, in conjunction with camera equipment, of 525-line interlaced television signals. It keys together the scanning beams of the camera Iconoscope and the receiver Kinescope to form a perfectly synchronized picture.

AVAILABLE SOON

5 VIDEO SWEEP GENERATOR (TYPE 711-A)

A quick, accurate, convenient means of testing and adjusting wide-band video amplifiers. When this generator is connected to the input of a video amplifier and the output of the amplifier is connected to an oscilloscope, a trace is produced on the screen that accurately shows the amplifier's dynamic-frequency characteristic. The lower-output-frequency limit of this unit is normally set at 100 kc, and the high frequency at 8 mc (but the latter can be easily adjusted to any frequency between 2 and 9 mc). The sweep to high frequency and return is smoothly accomplished in one cycle of the power-line frequency.

6 HIGH-FREQUENCY, WIDE-BAND SWEEP GENERATOR (TYPE 709-B)

When used in conjunction with an oscilloscope, this instrument will help you save time in accurately aligning the i-f and r-f stages of wide-band receivers. Stage-by-stage alignment is practical as the generator output voltage is continuously variable between .001 and .4 volts RMS over the entire frequency range. A calibration marker permits constant checking of band-width characteristics.

7 U-H-F SIGNAL GENERATOR (TYPE 710-A)

Provides an r-f signal of a known frequency and amplitude for easily obtaining the data needed to check the performance of high-frequency devices. This instrument provides smooth and complete attenuation throughout its range, plus precision frequency control. Output frequencies from 370 to 560 mc—just right for citizens' radio-phone and other development work within these bands.

8 LABORATORY-TYPE OSCILLOSCOPE (TYPE 715-B)

Especially designed to permit close examination of extremely short, sharp-fronted pulses and other unusual wave forms. Produces steady, clear traces even with random recurrence of signal. Some of its advantages for modern development work include: Extended range (flat to 11 megacycles), triggered sweep (individually triggered by each signal), time-base marker (one microsecond intervals), input calibration meter (to permit direct determination of amplitude of any voltage component in signal), and many other new features.

HERE'S A QUICK WAY TO GET DETAILS

Radio Corporation of America
Test and Measuring Equipment Section
Box T-9083B, Camden, N. J.

Please send me complete data on the RCA products corresponding to the numbers circled:

1 2 3 4 5 6 7 8

Name__________ Title__________

Company__________

Address__________

City__________ Zone___ State______

RCA TEST AND MEASURING EQUIPMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DIVISION, CAMDEN, N.J.

Medium Duty Power Switches

BUILT to meet the exacting standards set up by Old Man Centralab . . . these already famous Medium Duty Power Switches are now available at your jobbers in single or multiple sections up to 6 sections.

Ideal for transmitters, power supply converters and special industrial and electronic uses. Rated at 7½ amperes at 60 cycles, 115 volts. 3 pole, 5 positions . . . or 1 pole, 17 positions or 18 positions continuous rotation . . . shorting or non-shorting contacts.

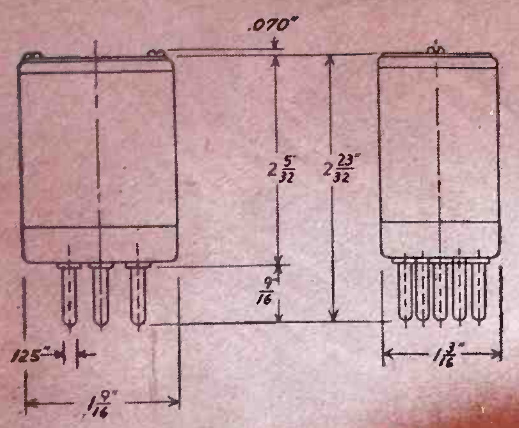
Producers of:
Variable Resistors •
Selector Switches •
Ceramic Capacitors, Fixed and Variable
Steatite Insulators and Silver Mica Button-type Capacitors.

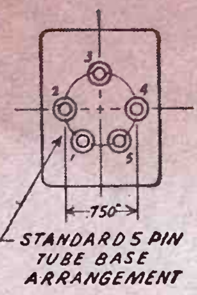
Write for Bulletin 815.

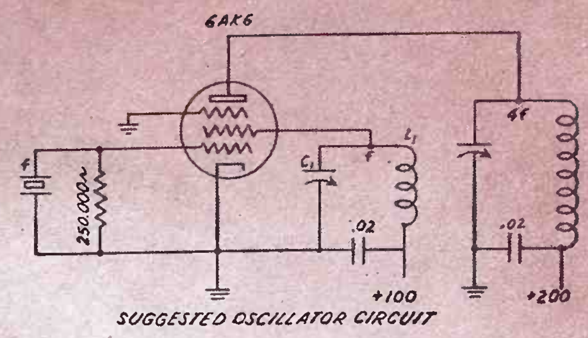
Centralab

CRL

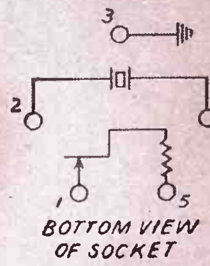
Division of GLOBE-UNION INC., Milwaukee

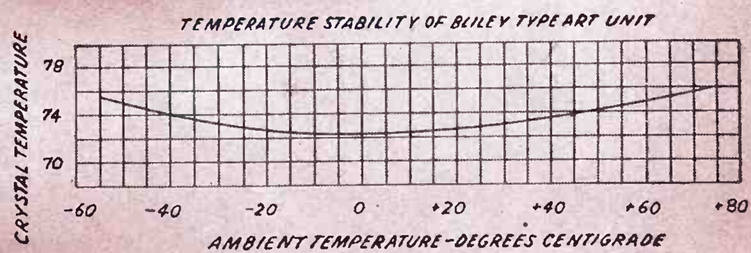




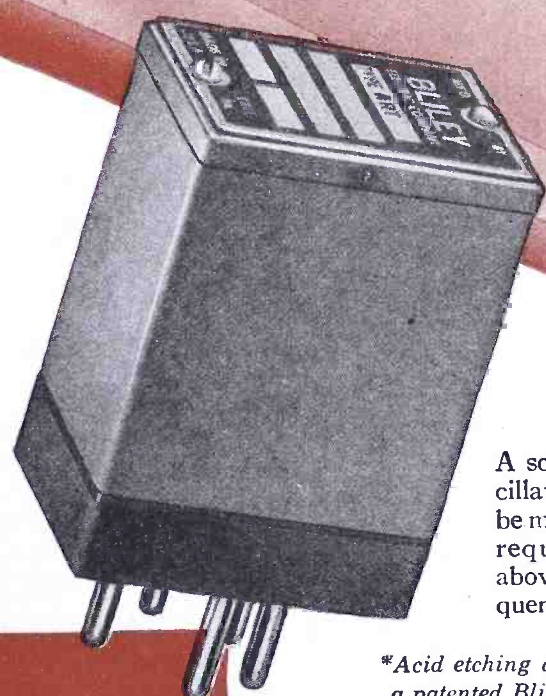


Announcing the BLILEY type ART crystal unit for maximum VHF stability





This new Type ART acid-etched*, crystal unit is another Bliley "first", designed for VHF services, such as police and railway communications, where frequency stability must be maintained over temperatures ranging from -55°C. to +75°C. With a built in heater operating on 6.3 V. at 1 amp. crystal temperature is held within ±2°C. The unit will maintain an overall frequency tolerance of ±.005% or better including variations due to temperature change and tolerances required for crystal production. This rugged, compact crystal assembly is available for any frequency between 3500 kc. and 11,000kc.



A schematic diagram of the oscillator circuit and tolerance to be maintained should accompany requests for quotations. See above design for efficient frequency multiplication.

Bliley CRYSTALS

**Acid etching quartz crystals to frequency is a patented Bliley process.*

Radio Engineers — write for temporary Bulletin CM-26

BLILEY ELECTRIC COMPANY • UNION STATION BUILDING, ERIE, PENNSYLVANIA

WAR DEVELOPED REMOTE CONTROLS NOW BEING APPLIED TO CIVILIAN NEEDS

Following typical controls can be operated by:

MULTICONDUCTOR CABLES, 2 WIRE SYSTEMS, OR WIRELESS

CONTINUOUSLY VARIABLE CONTROLS

provide a means of continuously positioning a remote load through one or many revolutions. The load may be moved forward, backward or stopped in any position with high accuracy. Any movement of the control knob results in a corresponding movement of the load. Types available include synchronous, non-synchronous, (with back indication), AC.-DC., low or high torque with or without automatic scanning. Accuracy to 1/100 of a degree is possible.

AUTOMATIC SELECTORS

make it possible to rotate a remote shaft to any one of six or more predetermined positions. Push button selection is provided for each position. Positions are easily adjustable to any desired location through the range of the unit. Selectors may be provided for 180° control range or for many revolutions. Accuracy of resetting may be as high as 1/100 of 1°.

DUAL CONTROLS

combine the features of the continuously variable control with those of the automatic selectors. The control head is provided with a knob for continuous positioning of the load. Any movement of the knob is followed by a corresponding movement of the load. In addition, a bank of push buttons permits automatic positioning of the load to a number of preset locations. These load positions may be easily adjusted and relocated to any point within the range of rotation.

Many Other Controls Are Being Developed

WHAT IS YOUR PROBLEM?

WE MAY HAVE THE SOLUTION TO YOUR REMOTE CONTROL PROBLEM

ELECTRICAL

REMOTE CONTROL

COMMUNICATION . . . INDUSTRIAL . . . AIRCRAFT . . . MARINE . . . TELEVISION . . . OPTICS, ETC.

ACCURATE POSITIONING by the YARDENY SYSTEM

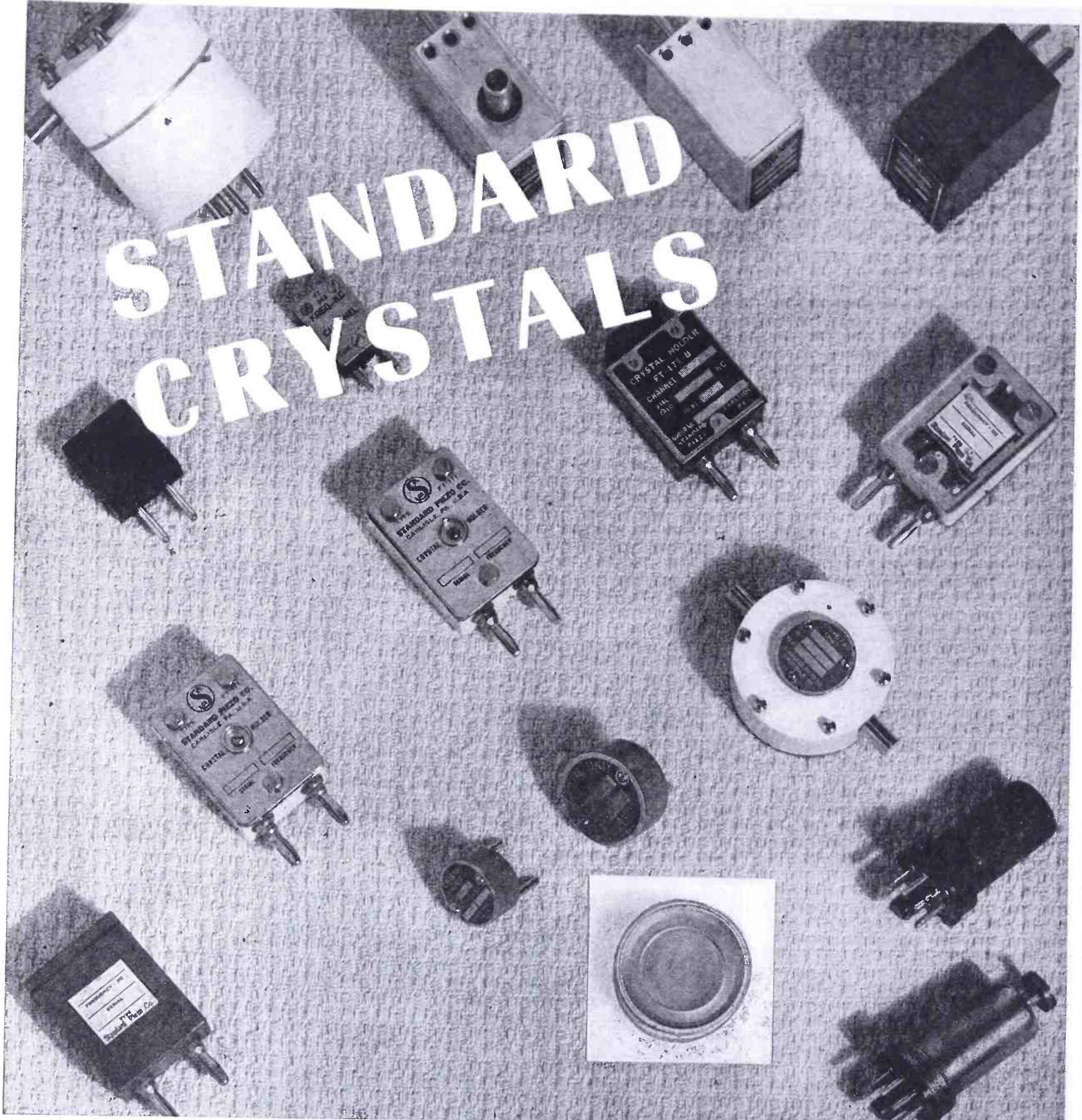
YARDENY precision remote controls provide a means of accurately positioning or moving a load which is remotely located from the operator. Positioning accuracies as high as one part in a million are attained. Although this remarkable accuracy is an outstanding feature of YARDENY controls, they are simple, rugged and dependable. All are practically immune to temperature change, extreme shock, vibration or severe usage—with dependability proved through extensive use by the Armed Forces.

Basic components of YARDENY systems are the torque-delivery unit—an electric motor—and a control head. These control devices are applicable to present standard equipment as accessories, or may be engineered into future plannings as an integral part of the assembly. Merely outline your specifications and required quantities for complete collaboration. Appointments or demonstrations are by request, and you incur no obligation.

YARDENY ENGINEERING CO.
105-107 CHAMBERS STREET, NEW YORK 7, N. Y.

YARDENY LICENSEES: SELF WINDING CLOCK COMPANY, INC., AMERICAN TYPE FOUNDERS, INC., MASTER CONTROLS, INC., C. D. & I., INC.

One of a series of advertising messages currently appearing nation-wide in trade publications, including ELECTRONICS, AERO-DIGEST, CHEMICAL & METALLURGICAL ENGINEERING, INSTRUMENTS, ELECTRONIC INDUSTRIES, ETC.



Every day more STANDARD crystals are being used for general *Airline, Police, Broadcast, Aircraft, Amateur* and *Commercial* uses.

Now the modern STANDARD *MIDGET* is available for your particular problem.

Write, wire or phone us your needs so our engineering group and production facilities can be placed at your disposal.

STANDARD's new, up-to-date catalogue is yours for the asking.

The inset STANDARD *MIDGET* is shown actual size. Background pictures other popular STANDARD types.

STANDARD PIEZO COMPANY

Established 1936

Quartz Crystals and Frequency Control Equipment

Office and Development Laboratory

SCRANTON, PA. CARLISLE, PA., P. O. Box 164 CARLISLE, PA.

Eimac TUBES — THE COUNTERSIGN OF DEPENDABILITY IN ANY ELECTRONIC EQUIPMENT

Tests Prove Eimac Vacuum Condensers Far Superior in Operating Efficiency

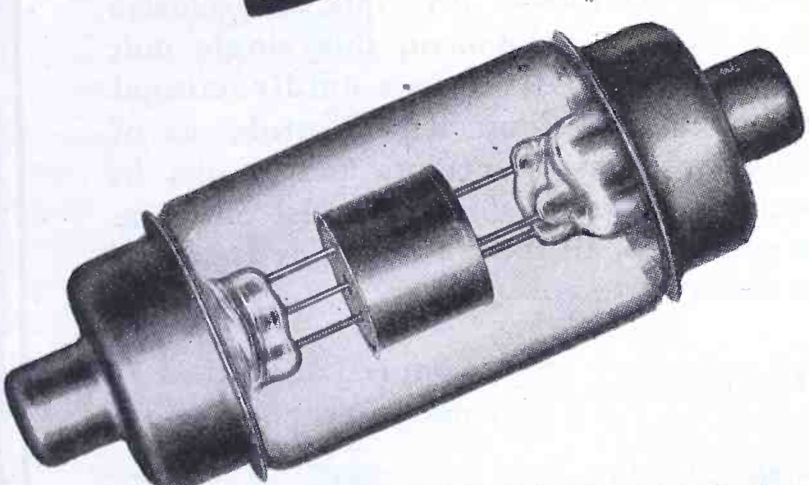
Ability to handle high current at high frequencies is the true measure of the performance of a capacitor. A high peak voltage rating based on low frequency measurements does not tell the whole story.

The chart on this page shows the results of tests at 50 Mc. conducted on a standard Eimac VC50-32 Vacuum Capacitor and three other 50 mmfd. vacuum capacitors, designated on the chart by "A," "B" and "C." At just over 17 amps. (approximately 1525 peak volts across the capacitor) Unit "A" (rated at many times the applied voltage) became sufficiently heated to melt the solder on the end caps. Under this same test, the Eimac VC50-32 operates at less than 70°.

Eimac introduced the vacuum capacitor in 1938. It is interesting to note that the original Eimac capacitor design is still outperforming all comers. Such outstanding performance is typical of all Eimac products, which is one of the reasons why they are first choice of leading electronic engineers throughout the world.

1113

Follow the leaders to Eimac REG. U.S. PAT. OFF. TUBES



EIMAC VACUUM CAPACITOR TYPE VC50-32
General Characteristics

Mechanical:

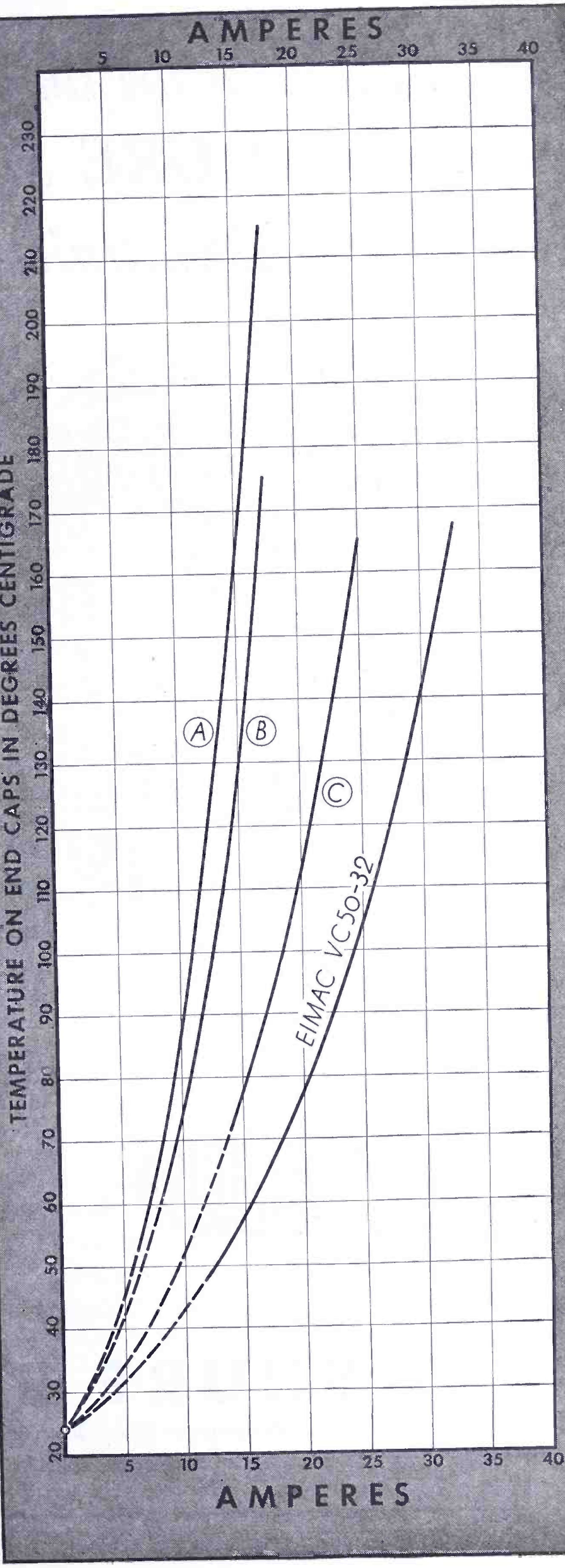
Maximum Overall Dimensions

Length	6.531 inches
Diameter	2.281 inches

Electrical:

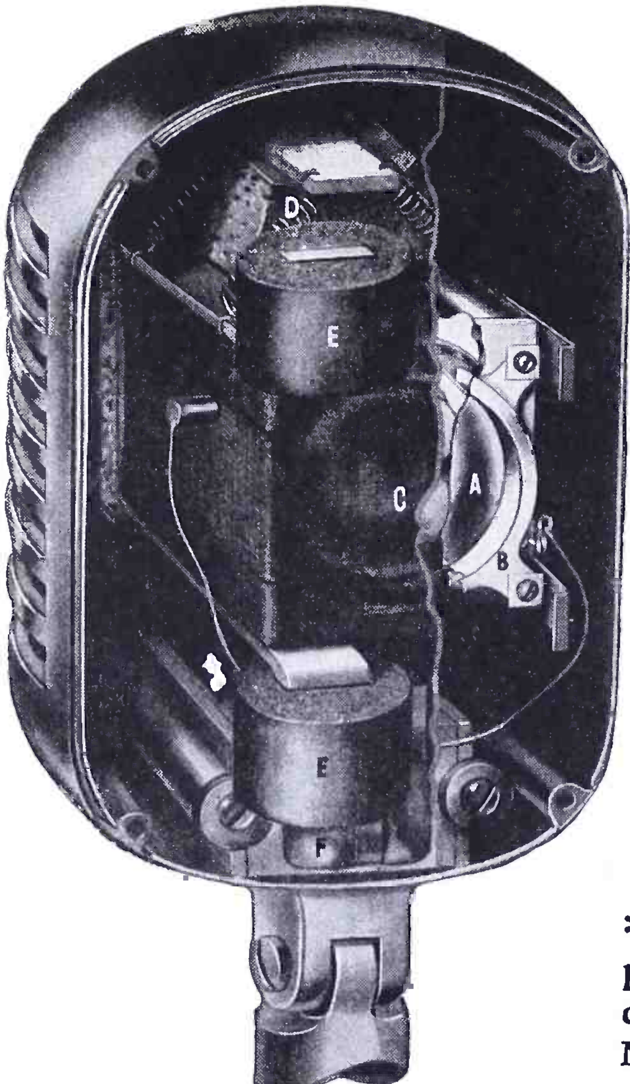
Maximum Peak Voltage	32,000 volts
Maximum RMS Current	28 amps.

EITEL-McCULLOUGH, INC., 1113 San Mateo Avenue, San Bruno, Calif.
Plants located at: San Bruno, California and Salt Lake City, Utah
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco 11, Calif., U. S. A.



. . . *this is the single unit* construction of*

SHURE Super-Cardioid Dynamic Microphones



(A) Single moving coil diaphragm.

(B) Rugged 4 point moving coil suspension.

(C) First wind and dust screen.

(D) Spring mounted mechanism.

(E) Shock absorbers.

(F) High fidelity transformer.

* Using the "Uniphase" principle, an exclusive patented Shure development, this single unit construction is possible in a unidirectional Microphone. This eliminates the problems of matching two dissimilar units and results in compactness and ruggedness. Because only one unit is employed, all these advantages are available at less cost to you.

SHURE
MICROPHONES

List Prices . . . Shure Super-Cardioid Dynamic Microphones

Models "556" Broadcast $82
Models "55" Unidyne . . . . . $51.45 to $54.20

SHURE BROTHERS

Designers and Manufacturers of Microphones and Acoustic Devices

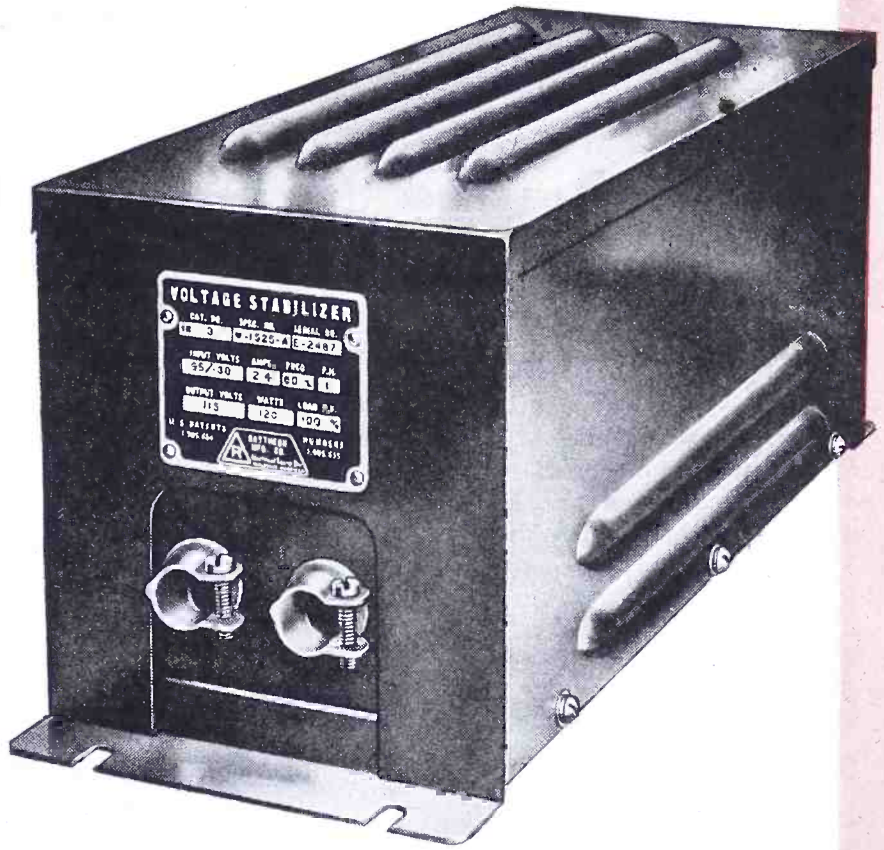
225 West Huron Street, Chicago 10, Illinois • Cable Address: SHUREMICRO

Boost the Performance

OF YOUR EQUIPMENT

with

RAYTHEON VOLTAGE STABILIZERS



THE PRECISION, accuracy and dependability of much electrical equipment are impaired by varying supply voltages.

If varying power supply handicaps your equipment why not install magnetic-type RAYTHEON VOLTAGE STABILIZERS? Long-proved, job-rated, and designed to meet practically any installation need, they are *boosting performance* in a wide variety of electrical equipment in many useful applications.

Get these principal operating advantages:

- **Control of output voltage to within ±½% of 115 or 230 V.**
- **Stabilization at any load within rated capacities.**
- **Quick response. Stabilizes varying input voltage within 1/20 second.**
- **Entirely automatic. No adjustments. No moving parts. No maintenance.**

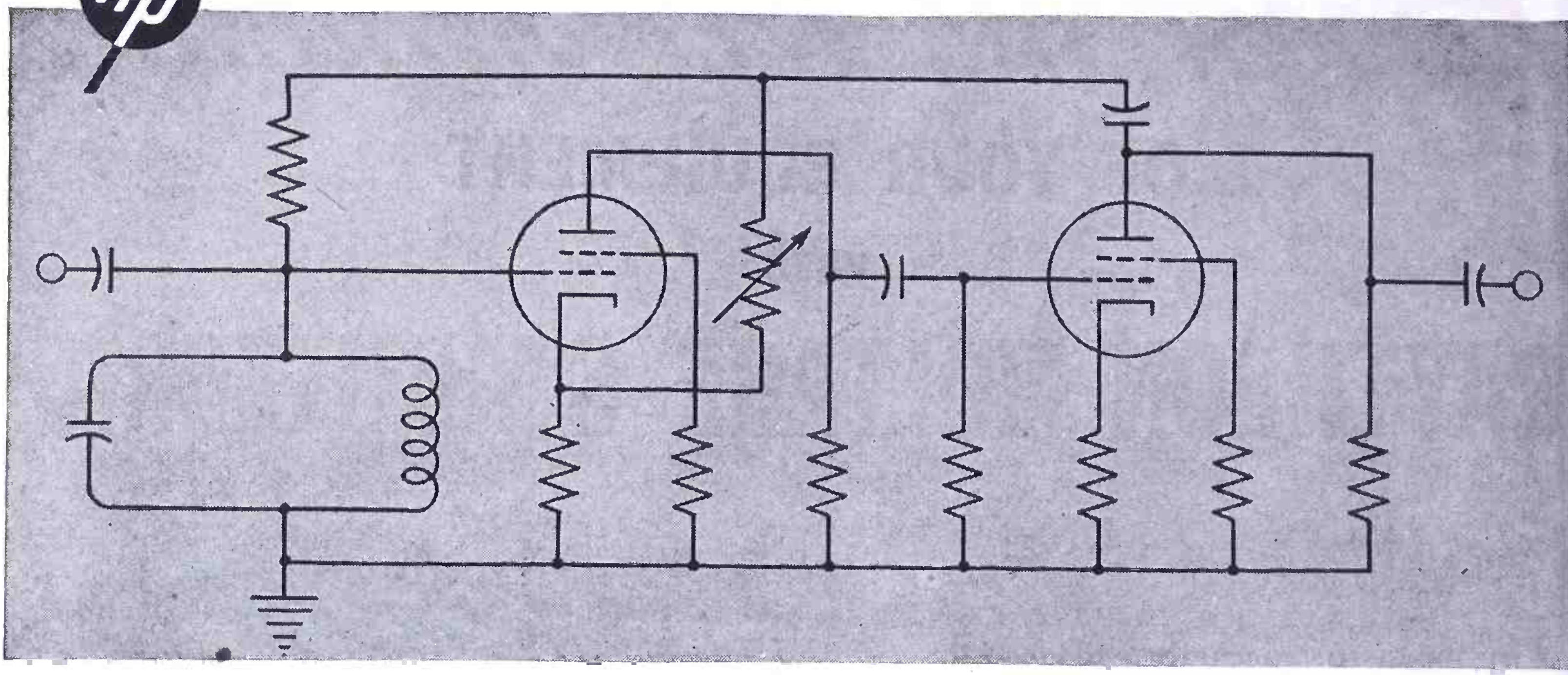
Read the complete story in our Bulletin DL48-537. Write for your copy today.

For Radio • Television • Communications Radar • Motion Pictures Sound Recording Electronic Devices • Constant Speed Motors Production Machinery • Signal Systems X-ray Equipment • Testing and Laboratory Equipment.

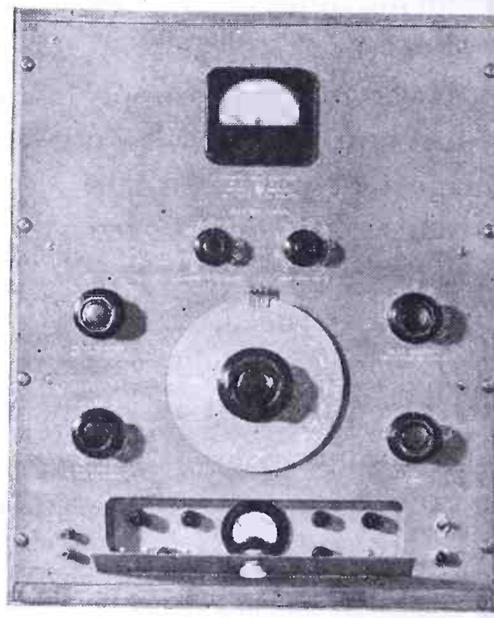
RAYTHEON
MANUFACTURING COMPANY
WALTHAM 54, MASS.

ELECTRICAL EQUIPMENT DIVISION
Excellence in Electronics

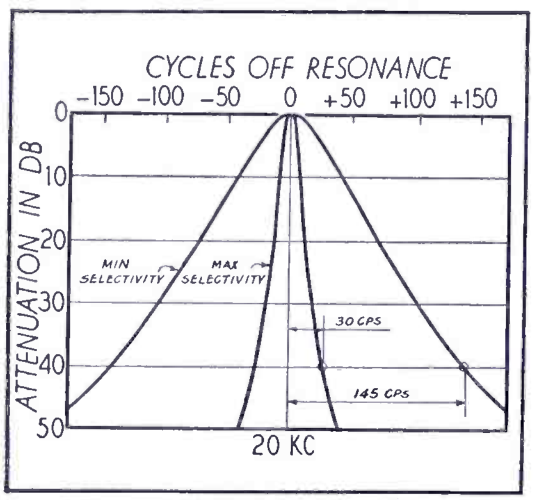
LABORATORY INSTRUMENTS FOR SPEED AND ACCURACY



The High—and Variable "Q" of This Circuit Means Rapid, Accurate Wave Analysis



This -*hp*- Harmonic Wave Analyzer measures the individual components of complex waves with speed and surety, because of the highly efficient composite circuit shown above. The variable selectivity of the amplifier is the factor which makes it especially useful for measurements at higher frequencies. Regeneration is used to give the amplifier a high effective "Q," and a degeneration control provides variable selectivity. The resulting performance of this circuit is shown in accompanying graph.



In practical terms, variable selectivity means no tedious "searching out" of the harmonics to be measured. Yet the finger-tip control is easy to manage. This characteristic makes the -*hp*- Harmonic Wave Analyzer useful for many applications where constant selectivity would be unsuitable. Variable selectivity is required in measuring distortion of sound on recorded film, disks and other cases where there may be a small amount of frequency modulation. It is also used in integrating the noise spectrum in acoustic measurements and elsewhere when a wider pass band gives a more representative integration.

The -*hp*- Harmonic Wave Analyzer covers the audio spectrum from 30 to 16,000 cps. There is likewise a wide voltage range; full scale voltmeter readings may be obtained with inputs of .001 to 500 volts. Thus the 300A may be used with equal success with low output recording devices and high power modulating amplifiers. Other features which make it unexcelled for both laboratory and production testing are the linear meter scale, fully protected against overloads, and the built-in calibrating system to standardize voltage measurements. With the stability, accuracy, flexibility and ease of operation of the Harmonic Wave Analyzer, Hewlett-Packard continues to set a new standard.

1119

These -hp- Representatives Are at Your Service

Eastern Representative:
Burlingame Associates, Ltd.
11 Park Place
New York 7, N. Y.—Worth 2-2171

Midwestern Representative:
Alfred Crossley
549 West Randolph Street
Chicago 6, Illinois—State 7444

Western Representative:
Norman B. Neely Enterprises
7422 Melrose Avenue
Hollywood 46, California—Whitney 1147

Canadian Representative:
Atlas Radio Corporation
560 King Street West
Toronto 2, Canada—Wa 4761

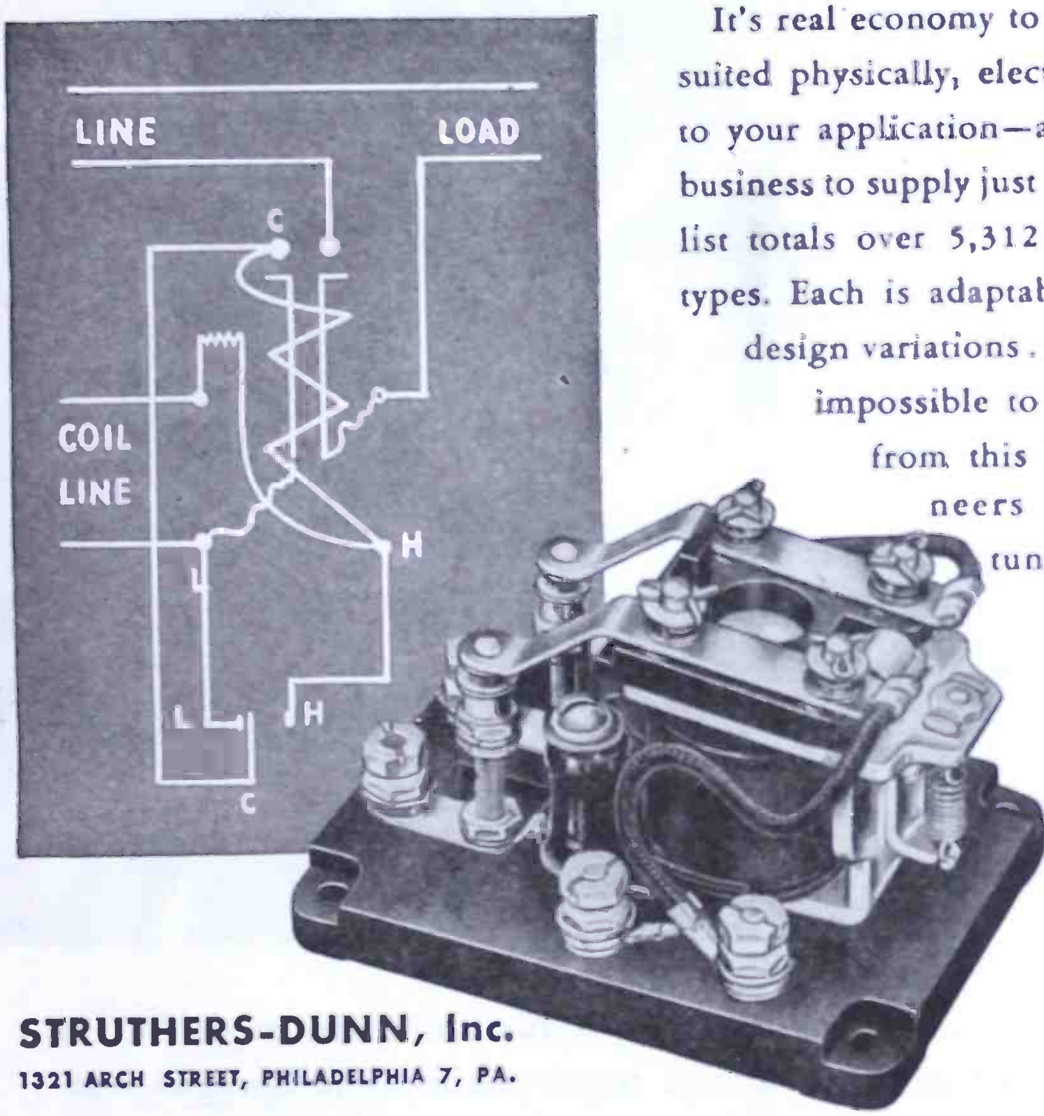
HEWLETT-PACKARD COMPANY

BOX 1119E • STATION A • PALO ALTO, CALIFORNIA

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

FIT THE RELAY TO THE JOB....

NOT THE JOB TO THE RELAY



It's real economy to use relays that are *exactly* suited physically, electrically, and mechanically to your application—and it is Struthers-Dunn's business to supply just the unit you need. Today's list totals over 5,312 standard Struthers-Dunn types. Each is adaptable to numerous coil and design variations . . . but, should it still prove impossible to match your specification from this list, Struthers-Dunn engineers welcome the opportunity to "tailor" a new relay type to your exact measure.

A typical application of the Struthers-Dunn Type 8BXX50 electrical lock-in relay used with a 3-wire "high-low" temperature control thermostat.

STRUTHERS-DUNN, Inc.
1321 ARCH STREET, PHILADELPHIA 7, PA.

STRUTHERS-DUNN

5,312 RELAY TYPES

DISTRICT ENGINEERING OFFICES: ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DALLAS • DENVER • DETROIT • HARTFORD • INDIANAPOLIS • LOS ANGELES • MINNEAPOLIS • MONTREAL • NEW YORK • PITTSBURGH • ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO

New!

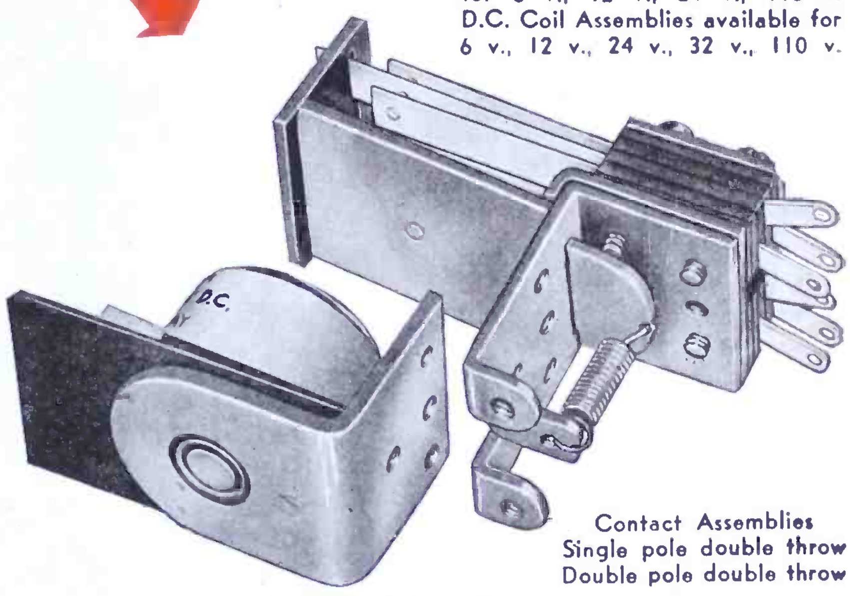
Series 200

A RELAY BY GUARDIAN with *Interchangeable Coils*

BUILT IN TWO PARTS

★ Two basic parts—a coil assembly and a contact assembly—comprise this simple, yet versatile relay. The coil assembly consists of the coil and field piece. The contact assembly consists of switch blades, armature, return spring, and mounting bracket. The coil and contact assembly are easily aligned by two locator pins on the back end of the contact assembly which fit into two holes on the coil assembly. They are then rigidly held together with the two screws and lock washers. Assembly takes only a few seconds and requires no adjustment on factory built units.

A.C. Coil Assemblies available for 6 v., 12 v., 24 v., 115 v. D.C. Coil Assemblies available for 6 v., 12 v., 24 v., 32 v., 110 v.



Contact Assemblies
Single pole double throw
Double pole double throw

SERIES 200 RELAY

On Sale at Your Nearest Jobber NOW!

See it today! . . . this amazing new relay with interchangeable coils. See how you can operate it on any of nine different a-c or d-c voltages—simply by changing the coil. Ideal for experimenters, inventors, engineers.

TWO CONTACT ASSEMBLIES

The Series 200 is available with a single pole double throw, or a double pole double throw contact assembly. In addition, a set of Series 200 Contact Switch Parts, which you can buy separately, enables you to build dozens of other combinations. Instructions in each box.

NINE COIL ASSEMBLIES

Four a-c coils and five d-c coils are available. Interchangeability of coils enables you to operate the Series 200 relay on one voltage or current and change it over to operate on another type simply by changing coils.

Your jobber has this sensational new relay on sale now. Ask him about it. Or write for descriptive bulletin.

GUARDIAN (G) ELECTRIC

1610 W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

THE *PROS* AND *CONS* OF HERMETIC SEALING

HERMETIC SEALING—A wondrous process which was a government "Must" when ordering Transformers and Reactors for war use. At that time we could take no chances on faulty equipment that might seriously hinder military operations and inadvertently cause unnecessary loss of life among our fighting men.

EXPENSIVE—yes, but added costs meant little when the only thing really important was winning the war.

IN PEACE—we at KENYON are of the opinion that such expense is not warranted. Past performance of ordinary transformers shows conclusively that sealing in a metal case with humidity proof compound along with proper mechanical design is sufficient. This conclusion is self-evident if you will weigh all cost factors involved.

SMALL AUDIO-COMPONENTS — KENYON has developed a range of case sizes (illustrated) which are adaptable to Hermetic Sealing and also to a new exclusive KENYON PROCESS. Despite the fact that the danger of moisture damage is greater in the small audio-component, we feel that our exclusive KENYON PROCESS is more than adequate. While it does not make 100% of the units proof against a five-cycle test, it does make all units impervious to salt water immersion over narrower temperature ranges —and is very much less expensive.

The saving involved by this new Process is so substantial that the cost of the few replacements that might be saved by Hermetic Sealing is more than offset by this much lower original cost.

The items illustrated are only a few of the many possibilities offered by KENYON. We will be more than happy to supply complete details on request.

Write Now For Illustrated Catalog

THE MARK OF EXCELLENCE

KENYON TRANSFORMER CO., Inc. 840 BARRY STREE[T] NEW YORK, U. S. A

Finer in Performance AND NOW – *Smarter in Appe*

INTERCHANGEABLE COLORED FL

ROUND OR SQUARE . . . AT NO EXTRA CHA

Marion Glass-to-Metal Truly Hermetically Se
2½" and 3½" Electrical Indicating Instrum

Smart styling, sleek lines, more color are invading the radio and electronic industry packaging and drab blacks and grays are no longer in step with the times . . . now takes equal rank with performance in consumer demand.

Sensing this important trend, we here at Marion present a "beauty treatment" for electronic equipment in our new and attractive interchangeable colored flanges. different iridescent shades, including blue, red, green, silver, gold and others—in and square shapes.

Manufacturers who specify Marion hermetically sealed instruments will find the appeal of these new flanges will give added sales value to their products. Am operators and experimenters will especially welcome the idea because the interch feature will help reduce instrument costs by permitting universal application "hermetics" when building or modernizing their equipment.

Marion "hermetics" sell for no more than most competitive unsealed instruments . . . and they're being delivered in ever-increasing quantities. Write for our 12 - page brochure.

MARION ELECTRICAL INSTRUMENT CO.
MANCHESTER, NEW HAMPSHIRE

EXPORT DIVISION 458 BROADWAY · NEW YORK 13, N. Y. U. S. A.
CABLE ADDRESS: MORHANEX

CONFIDENTIALLY,

WE'RE JUST A BUNCH OF HAMS AT HEART!

Frankly, the magic of Radio is still a lot of fun to us! We here at GATES—every one of us, right up to the top man—put the enthusiastic imagination of the youngest amateur into our products.

That enthusiasm, supported by a background of continuous experience since 1922—and backed up by engineering ability and real precision workmanship—is what gives GATES Products their dependable quality.

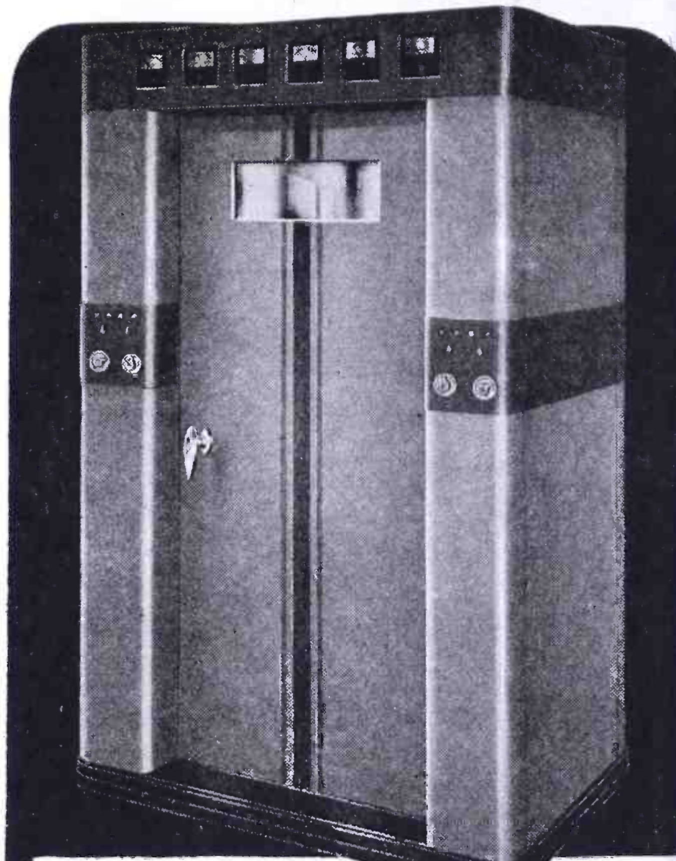
For good Transmitting Equipment — reasonably priced—for your needs today, tomorrow, or whenever—call on GATES! The GATES RADIO CO., Quincy, Ill., U.S.A.

Write for Details About the GATES Priority System for Prompt Post-War Delivery

GATES RADIO CO.

QUINCY, ILLINOIS

New York Office: 40 Exchange Place. Tel: HAnover 2-0198



GATES ONE KILOWATT BROADCAST TRANSMITTER

This GATES Transmitter embodies the latest in engineering developments — modernized and streamlined to bring efficiency *plus* good looks to the Post-War Broadcasting Station.

All parts are conveniently, accessibly located for simple operation; and the pressure-type cabinet assures dustless, cool performance. A Transmitter of extremely high fidelity.

Detailed Bulletin on the New GATES 1 KW Transmitter Will Soon Be Available

PROGRESS REPORT

GATES is now in full production on civilian equipment and can make prompt delivery on many popular items.

EXCLUSIVE MANUFACTURERS OF RADIO TRANSMITTING EQUIPMENT SINCE 1922

We grow up with electronics

Our engineers and executives grew up with Electronics. Before the war we manufactured commercial radio equipment. During the war we greatly expanded our engineering and research staff and did extensive work in advanced electronics for the Army and Navy. Our present engineering and research facilities occupy more than 30,000 square feet of space. Our current production program is centered on communications equipment for rail, air, highway, marine and commercial use. Other products, notably in the field of industrial electronics, are under development. Aireon's engineering and research staff will be glad to consult with you on your electronic problems. Your inquiry will have prompt attention.

Aireon

MANUFACTURING CORPORATION

Radio and Electronics • Engineered Power Controls

NEW YORK • GREENWICH • CHICAGO • KANSAS CITY • OKLAHOMA CITY • BURBANK • SAN FRANCISCO

CLAIM STAKING

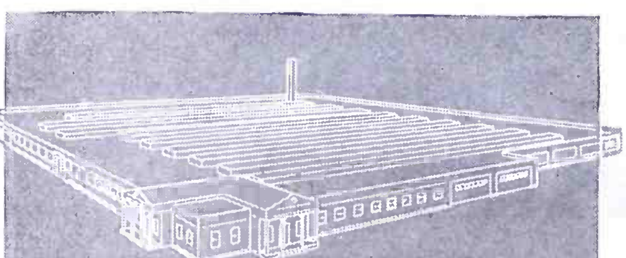
Hallicrafters and Very High Frequency

Based on the facts in the case, Hallicrafters can stake out a very strong claim to leadership in the very high frequency field. The facts include such things as the Model S-37, FM-AM receiver for very high frequency work. The Model S-37 operates from 130 to 210 Mc.—the highest frequency range of any general coverage commercial type receiver.

Hallicrafters further supports its claim to domination in the high frequency field with the Model S-36A, FM-AM-CW receiver. The 36A operates from 27.8 to 143 Mc., covers both old and new FM bands and is the only commercially built receiver covering this range.

Further developments in this direction can soon be revealed—adding further support to Hallicrafters claim to continued supremacy in the high frequency field.

HALLICRAFTERS NEW $600,000 HOME NOW UNDER CONSTRUCTION.



hallicrafters RADIO

THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT • CHICAGO 16, U. S. A.

LOOK FOR GREEN VITROHM RESISTORS

The Green Vitrohm Enamel used in the manufacture of all Ward Leonard Vitrohm Resistors and Rheostats is an exclusive development of Ward Leonard Laboratories — the result of more than 50 years of intensive research in resistor enamels.

Pick the Resistor with the Green Vitrohm Enamel and you pick the best. Now available at your Radio and Electronic parts distributor.

Write for your free copy of our Radio and Electronic Resistor Catalog.

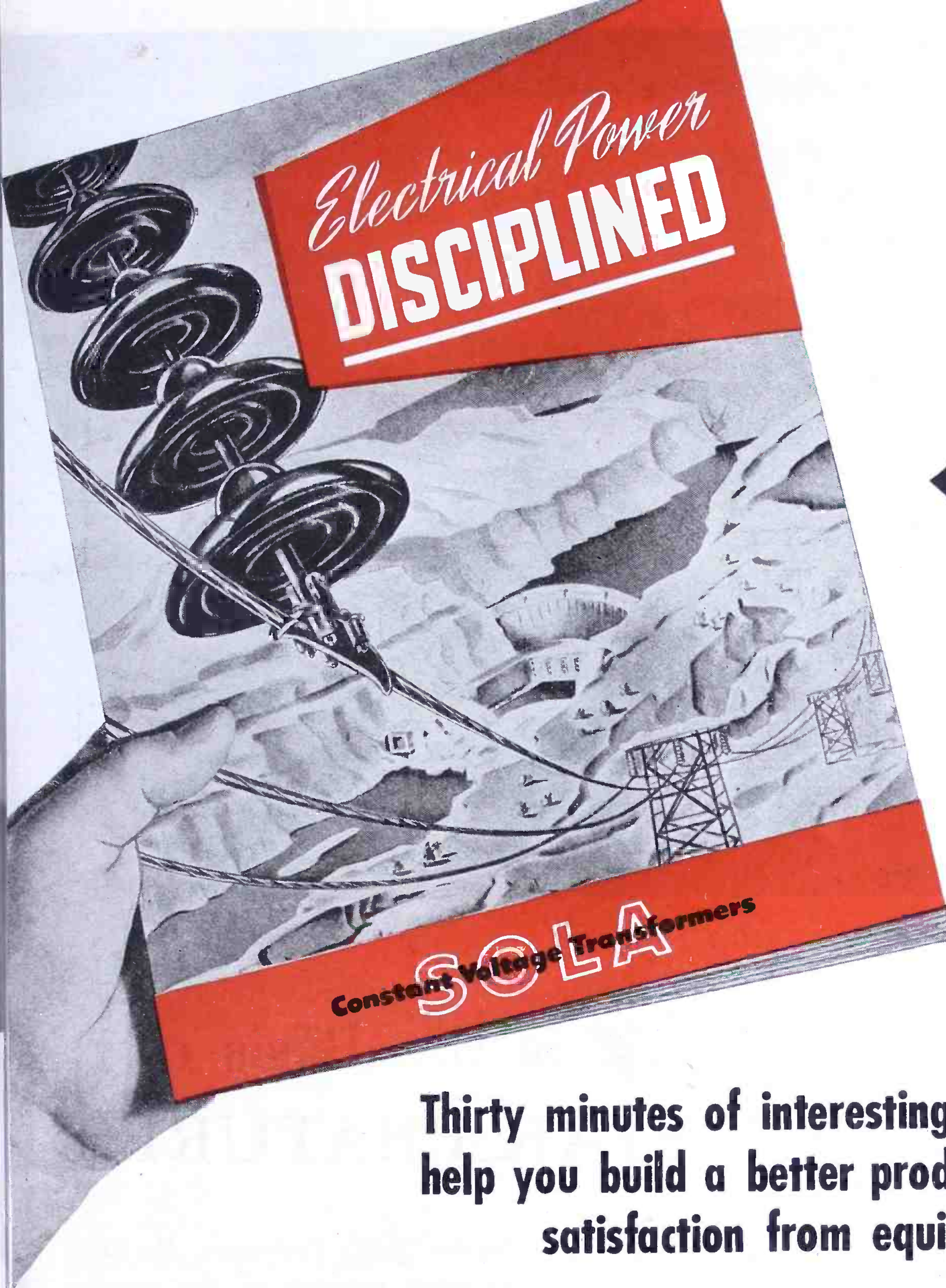
WARD LEONARD ELECTRIC CO.

Radio and Electronic Distributor Division

53 WEST JACKSON BLVD., CHICAGO, ILL.

WL WARD LEONARD
ACCEPTED MEASURE OF QUALITY

RESISTORS
RHEOSTATS
RELAYS



for:

designers

•

manufacturers

•

maintenance engineers

•

salesmen

•

users of electronic and electrically operated equipment

Thirty minutes of interesting reading that will help you build a better product or get greater satisfaction from equipment now in use

What is a Constant Voltage Transformer?—why is it necessary?—how does it operate?—where can it be used?—what new developments have resulted from its world-wide, war-time use?—

. . . these and many other important questions are fully answered in this new SOLA handbook.

The Constant Voltage Transformer is an exclusive SOLA product—the ONLY voltage regulating TRANSFORMER. In principle, design and construction it is different and should not be confused with ordinary types of voltage regulating networks.

It employs no tubes and has no moving parts. It is fully automatic in operation, it is not dependent on manual control or supervision and protects both itself and the equipment it serves against voltage surges or short circuit. It instantly corrects voltage fluctuations as great as 30% to within ±1% of rated value.

Your product will serve more people—*better*—with built-in Constant Voltage. There are SOLA units specially designed for that purpose—fully described in this new handbook.

SOLA Constant Voltage Transformers

Write for your copy

You will find in this handbook a final answer to the problem that confronts every manufacturer or user of electrically operated equipment.

Ask for Bulletin ECV-102

Transformers for: Constant Voltage • Cold Cathode Lighting • Mercury Lamps • Series Lighting • Fluorescent Lighting • X-Ray Equipment • Luminous Tube Signs Oil Burner Ignition • Radio • Power • Controls • Signal Systems • etc. **SOLA ELECTRIC COMPANY, 2525 Clybourn Avenue, Chicago 14, Illinois**

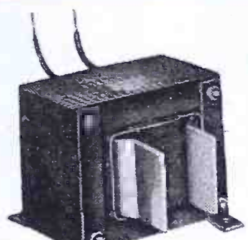
UNUSUAL DESIGNS AT UTC

RESONANT TRANSFORMERS

This high voltage application involved a minimum size requirement. For maximum compactness, the final transformer produced has a turns ratio of 115/5,800, but a voltage ratio due to resonance of 115/10,000 V.

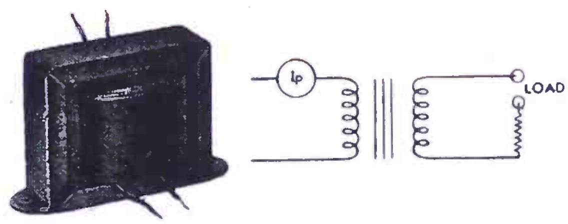
VARIABLE AC SATURATED INDUCTOR

This inductor is part of a voltage sensitive non-linear network. By adustment of the inductor with a specific capacitor, peak non-linearity can be adjusted over a substantial range in voltage.



CONDENSER – PULSE WELDING TRANSFORMER

This transformer is designed for a small precise spot welding set. For this type of application, design factors include High Q and maximum surge power transfer. The transformer shown is the equivalent of 100 VA in size, but handles 1,000 VA pulses.



SPECIAL CONTROL TRANSFORMER

In this odd application, the requirements were that the primary current go down with increase in load current. In actual practice, when normal load is placed on the secondary, the primary current drops 50%.

The UTC application engineering section is available for your problem.

United Transformer Corp.

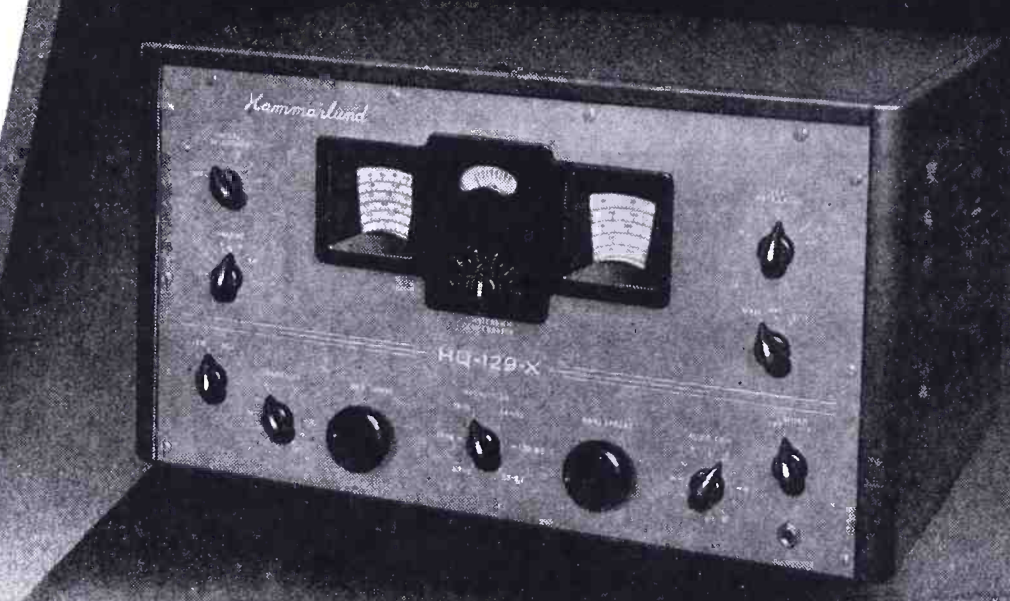
150 VARICK STREET • NEW YORK 13, N. Y.

EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y., CABLES: "ARLAB"

ALL PLANTS

Try it! Compare it!

HQ-129-X



$129* AMATEUR NET LESS SPEAKER

*Price subject to change without notice.

Frequency 31—.54 Megacycles

Try — then compare, and you'll agree that this professional receiver is an outstanding value. It is built by craftsmen who specialize in communication equipment. The HQ-129-X has endless improvements which are fully described in an eight-page booklet . . Write today for complete technical information.

THE SIGN OF QUALITY
ESTABLISHED 1910

HAMMARLUND

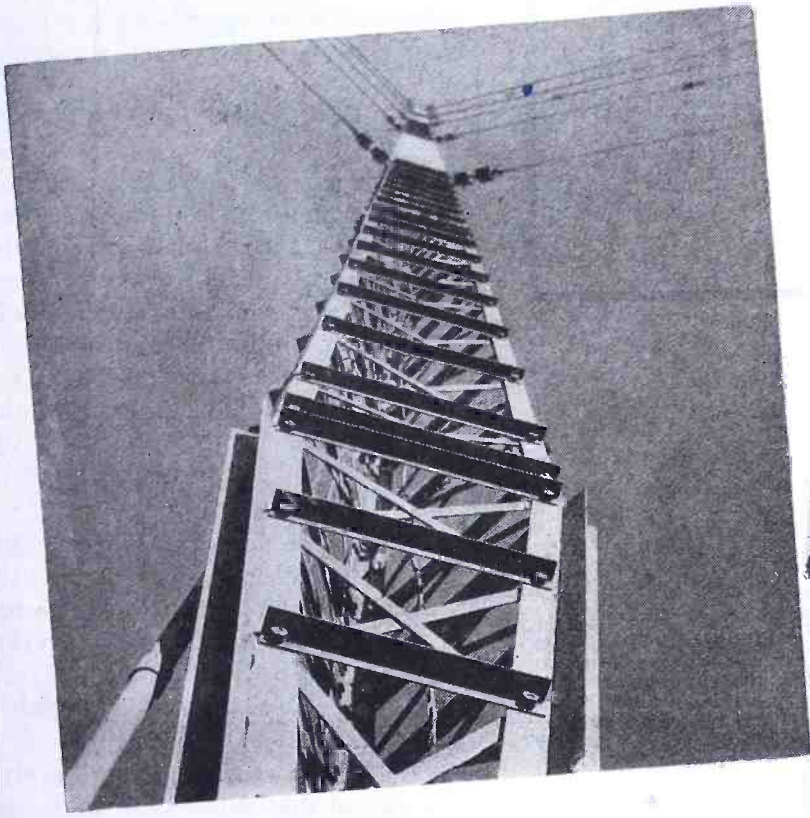
THE HAMMARLUND MFG. CO., INC., 460 W. 34TH ST., NEW YORK 1, N.Y.

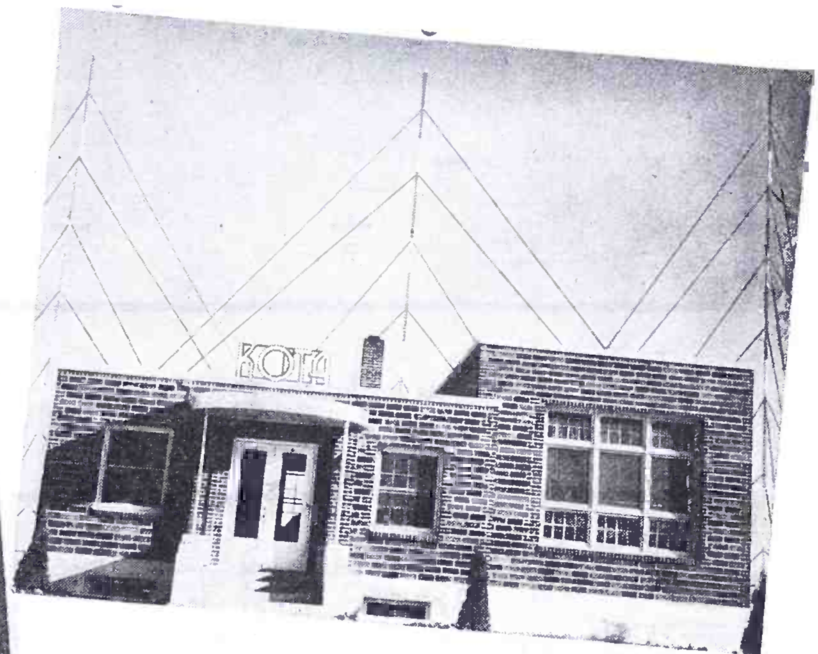
MANUFACTURERS OF PRECISION COMMUNICATIONS EQUIPMENT

COMMUNICATIONS

LEWIS WINNER, Editor

* * DECEMBER, 1945 * *





Figures 1 (left) and 2 (above)
Figure 1. One of the 300′ antenna towers now used at KOTA.
Figure 2. Front view of the new transmitter house.

STEPPING UP FROM 1/4 KW TO 5 KW

KOTA Higher Power and Directional Antenna System Installed to Provide Valley and Mountain Coverage In the Black Hills of South Dakota

by A. E. GRIFFITHS

Chief Engineer
Black Hills Broadcast Company

DURING the eight years of operation of KOBH (former call letters of KOTA) on 1370 and 1400 kc with 250 watts, many plans and applications had been initiated to secure an increase in power to adequately cover the trade area. We were especially interested in giving primary service to the rich mining districts located in the rugged mountainous terrain starting at our western city limits and extending approximately seventy-five miles to the north and south and fifty miles west. With these low powers it wasn't possible to service these areas and most Black Hills communities which are in deep narrow gulches with rock walls on either side extending a thousand feet upward at approximately sixty degrees.

We had proposed to use 5-kw on 610 kc. However it was not possible to secure this channel. We then requested 1,380 kc (DN) using 5 kw and on July 11, 1944, a conditional grant for this frequency and power was issued. This increase in power and new channel offered a solution to the balky service-area problem.

Then came the problem of equipment and installation. The conditional grant was followed by many sessions with the WPB. Shortly after these meetings we arranged for the purchase of a Western Electric transmitter from KFH, Witchita, Kansas, and the three 300′ towers from Wincharger.

During December, 1944, we completely rebuilt our studios in the Alex Johnson Hotel, utilizing the entire tenth floor for studios, programming, sales and management. Full floating floors and inner walls were used for

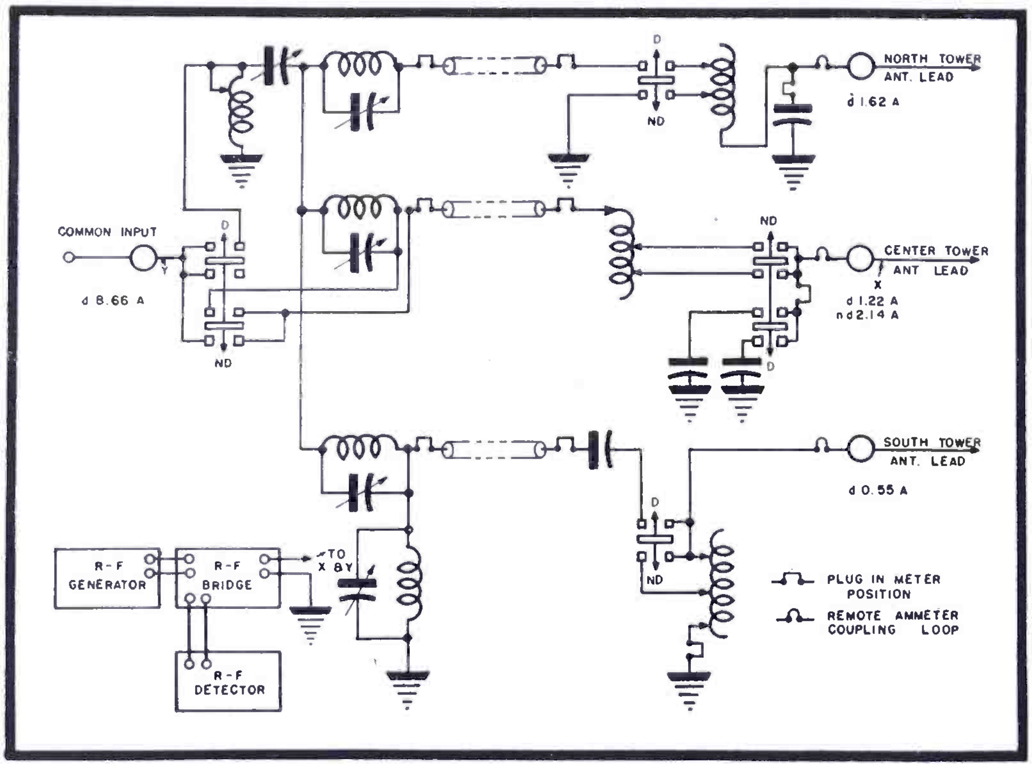


Figure 3
Schematic of the antenna coupling and phasing circuits of the 5000-watt KOTA transmitter.

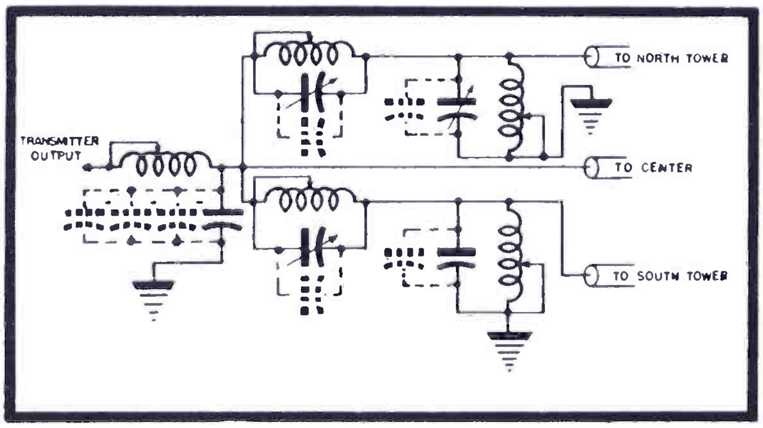


Figure 4
Original phasing circuit with an *L*-net in the end branches and nothing in the center because of the stronger field required at the center tower.

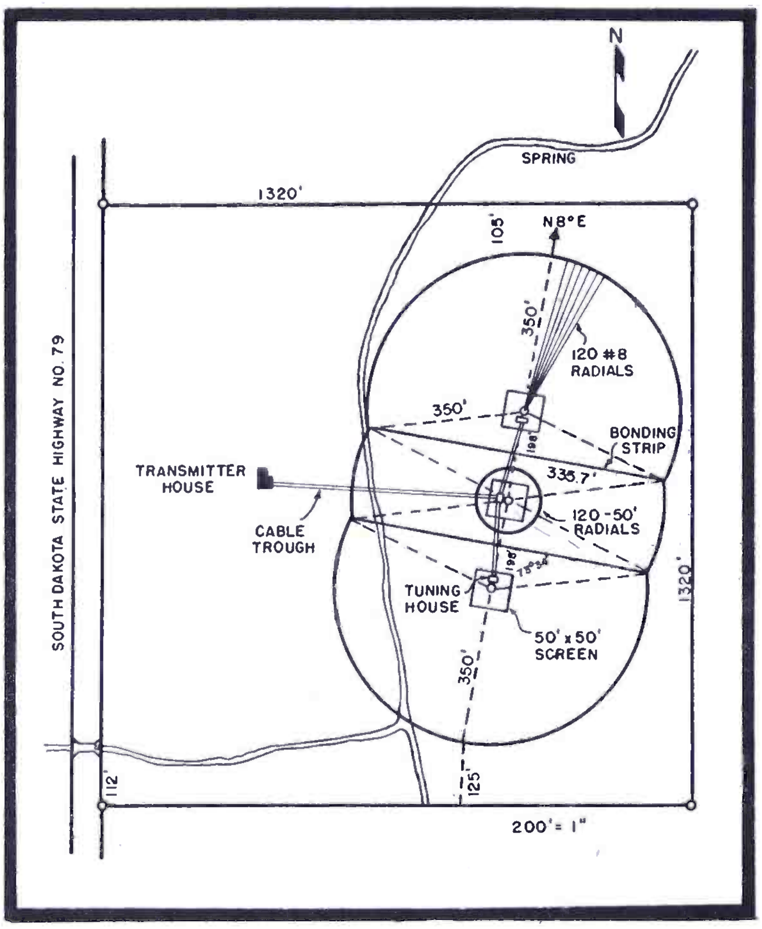


Figure 5
The ground system used at KOTA. There are one-hundred-twenty 350' radials from the base of each tower with an additional one-hundred-twenty 150' radials at the center alternating between the longer ones. At the base of each tower are also 50' matts of hardware cloth. The radials are interwoven with this cloth and bonded.

the control room and announce booth. One wall, one end floating, was used for the main studio. All except one end of the main studio were supplied with acoustic celotex spot glued to a thick soft building board. This provided the main studio with one live and one very dead end with a wide range in between. The new announce and control rooms were first completed in their new locations, then all of the equipment moved in over night and operation was continued from them, until the balance was completed.

The composite speech input control board and the badly worn turntables had been replaced with new Gates equipment previously during the summer. Only the chassis of the Gates 30-C input console was used, being installed in a custom-built console that fit diagonally across one corner of the control room so that the control operator could see well into either studio with a very slight turn of his head. This console arrangement brought the two transcription tables closer to the operator without interfering with the operation of either console of the turntables.

Although the new transmitter building, a 2-story unit, was started in October and the contractor expected to complete it within five to six weeks, it was not finished until late in March this year, because of material and labor problems.

The building was designed to utilize the material that came with the transmitter and all components were placed so there would be a saving in the amount of conduit, wire, copper pipe and tubing, etc., used. The original installation at KFH had all of the equipment installed on one floor, with separate rooms for the water-cooling and m-g sets, and the high-voltage transformers. However we placed the filament and bias motor-generator sets in the basement almost directly under the transmitter and the high-voltage transformers in a concrete vault directly under the high-voltage rectifier rack. Two square wiring ducts were run parallel under (and in line with) the transmitter near the basement ceiling, one for a-c and the other for d-c with short stubs of conduit extending up through the floor under each of the five-transmitter and the one-phasing units. This simplified the inter-unit wiring with quite a saving in material and gave us a much neater floor back of the transmitter.

The transmitter and rectifier room was made with a 12' ceiling while the rest of the building have 8' ceilings. The building is located on the edge of a small hill with the front of the main floor and the rear of the basement both

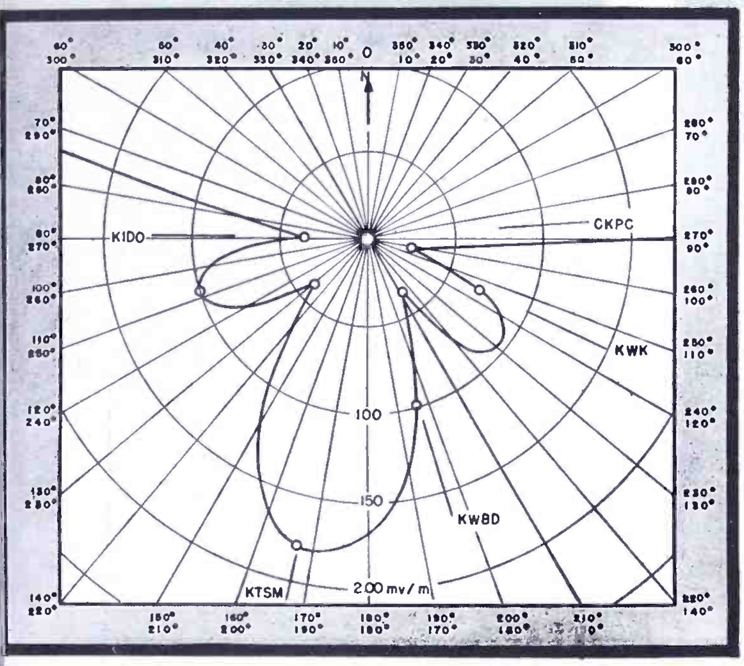
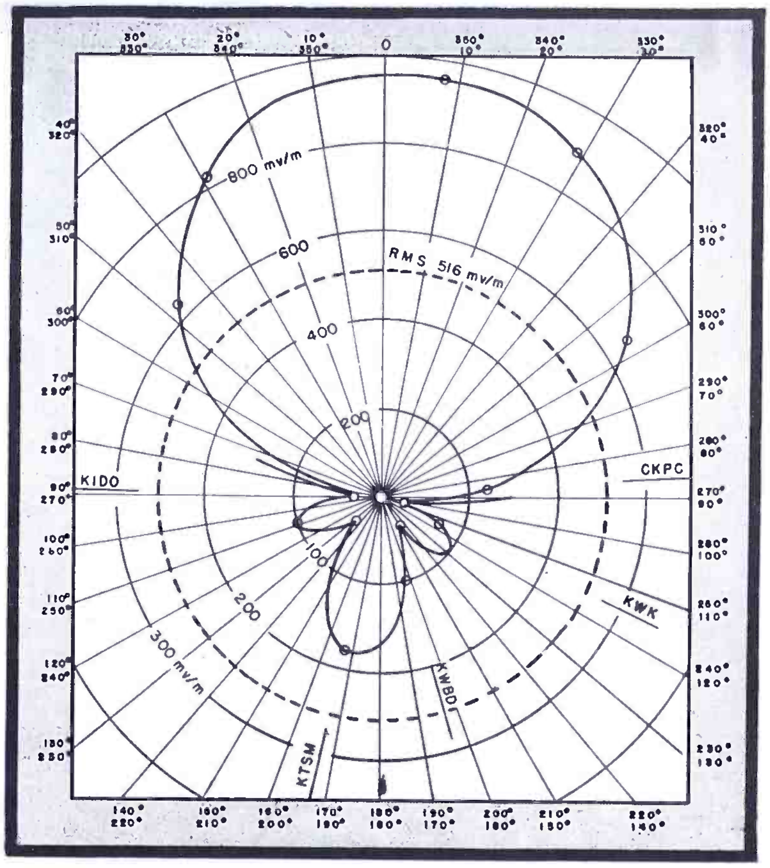


Figure 6
Null details of the measured horizontal radiation pattern.

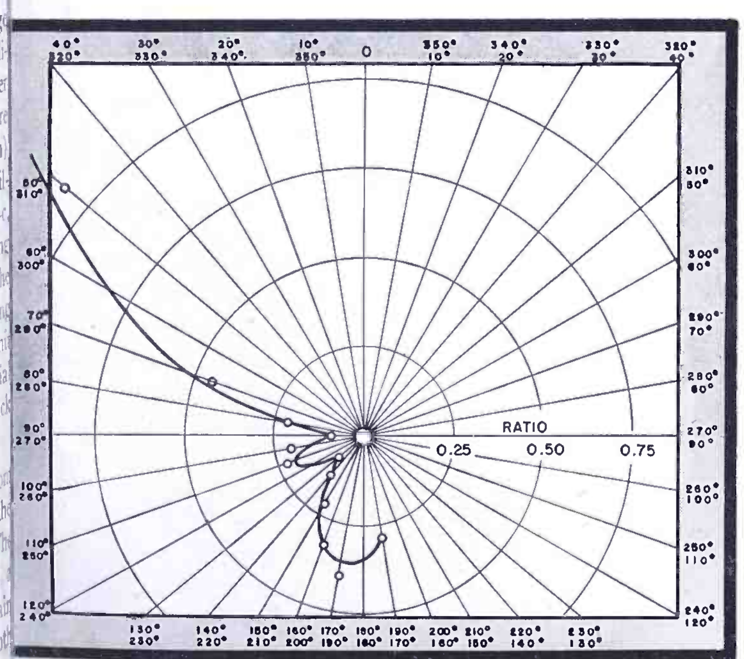


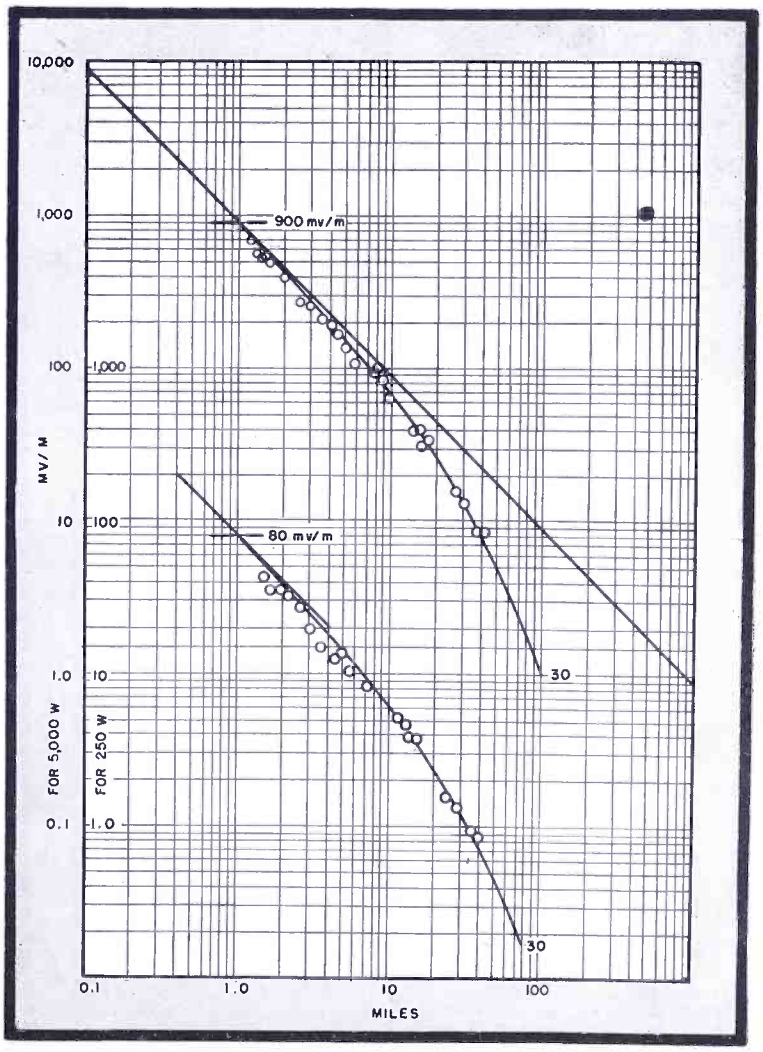
n ground levels, making it quite easy ɔ install and remove heavy equipment n either floor and providing a large nderground garage.

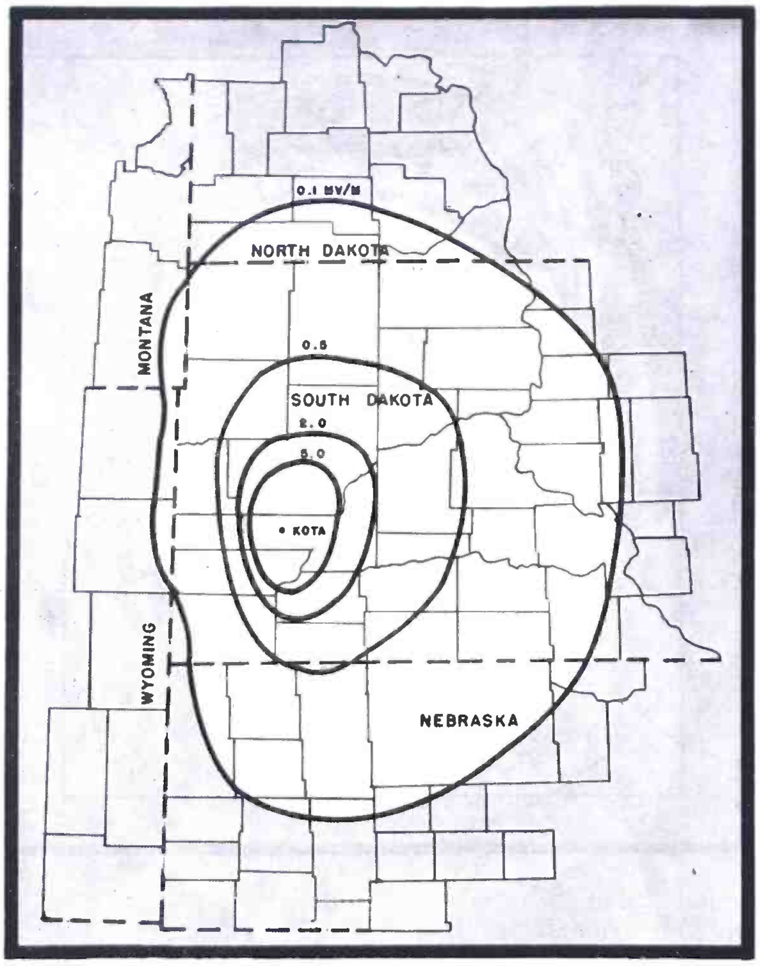
Desiring a *quieter-than-usual* water-ooling system and wishing to take dvantage of the heat dissipated by the ıree water-cooled tubes, a small sepa-ate room was built back of one end f the transmitter to house the distilled vater pump and the cooling system. 'he inner walls of this room (and all thers within the building) used pyro-ar sound absorbing blocks, plastered ith acoustic plaster. The two three-lade fans were removed from the ver-cal radiators and were replaced with large squirrel-cage air-conditioning pe blower. The two coils were ounted horizontally on a rack about high with the blower centered un-erneath. A cone shaped sheet metal duct (insulated for sound from the duct by a short canvas tube) distributes the air evenly to all sections of the coils. A flapper valve in this duct permits the diversion of all of the air through either or both of the coils. Another in the exhaust duct above the coils enables us to send the exhaust hot air either up through the roof or through a long duct to the opposite end

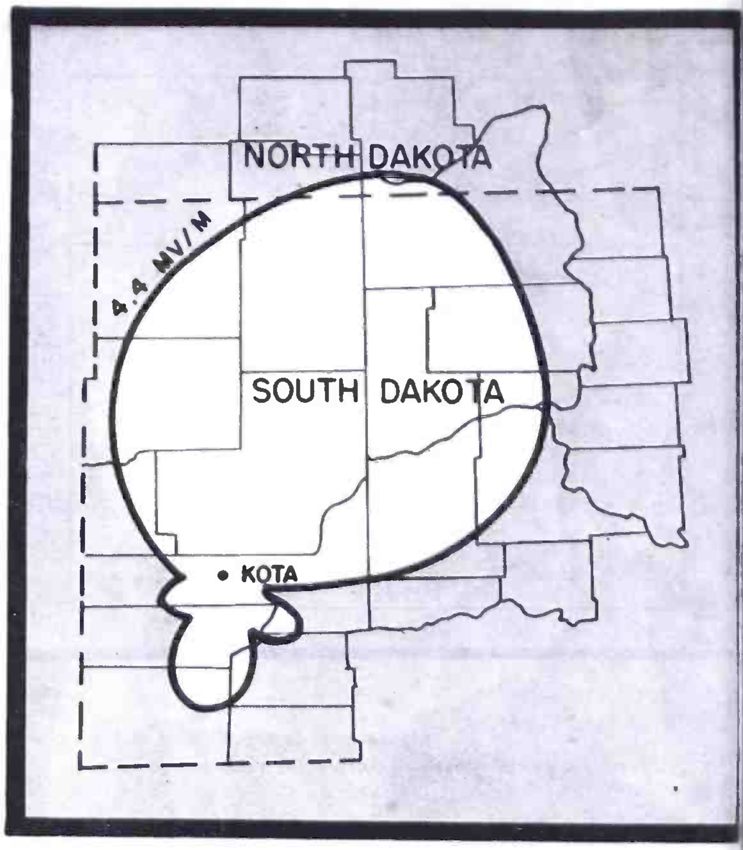
Figures 7 (above) and 8 (below)
In Figure 7 appears the measured horizontal plane of an unattenuated radiation pattern. Scale from 100° to 280° is twice that of the major lobe. Figure 8 illustrates two radiation patterns of radial *b*, N 29° *E*. Patterns cover radiation at 900 mv/m, conductivity 30; and at 80 mv/m, conductivity 30.

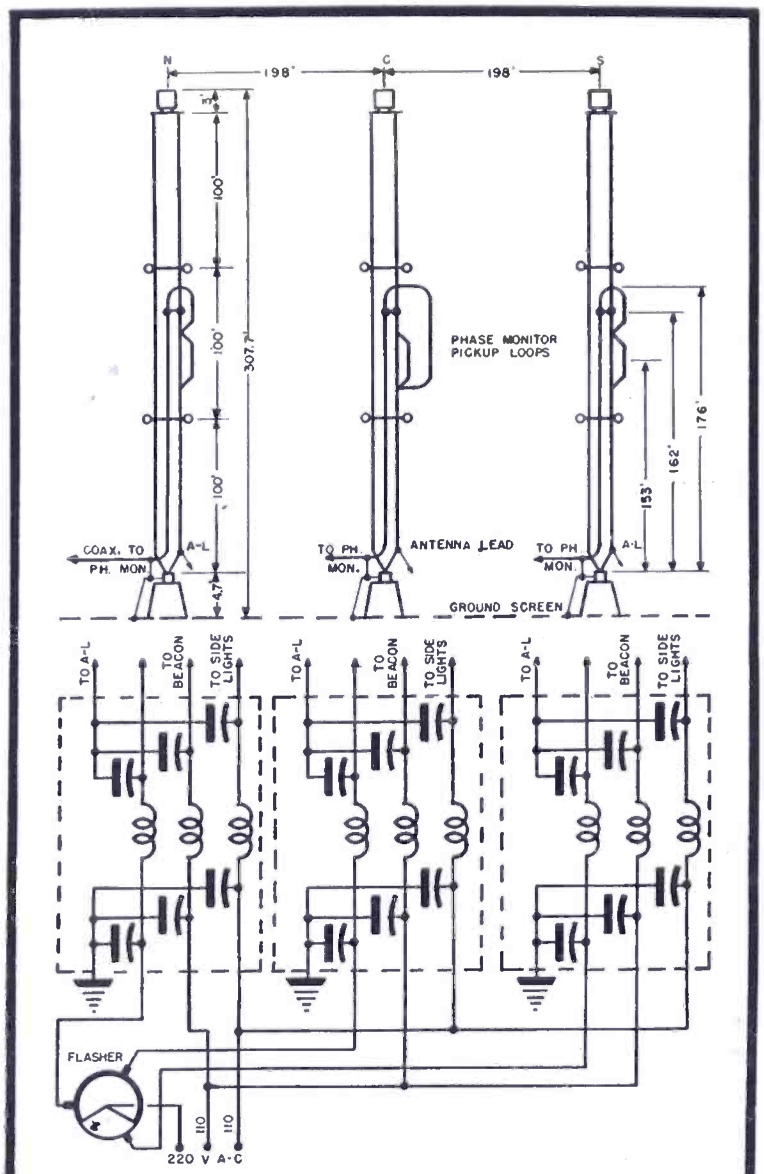
Figure 9 (below, left)
Measured ratios of directional to non-directional fields. Plotted points are measured; curve is calculated.











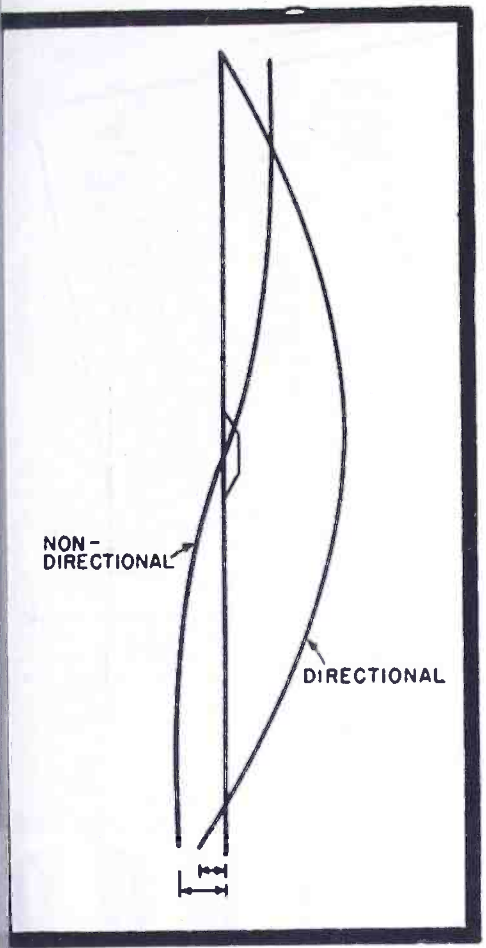
Figures 10 (above, left), 11 (above) and 12 (below, left)

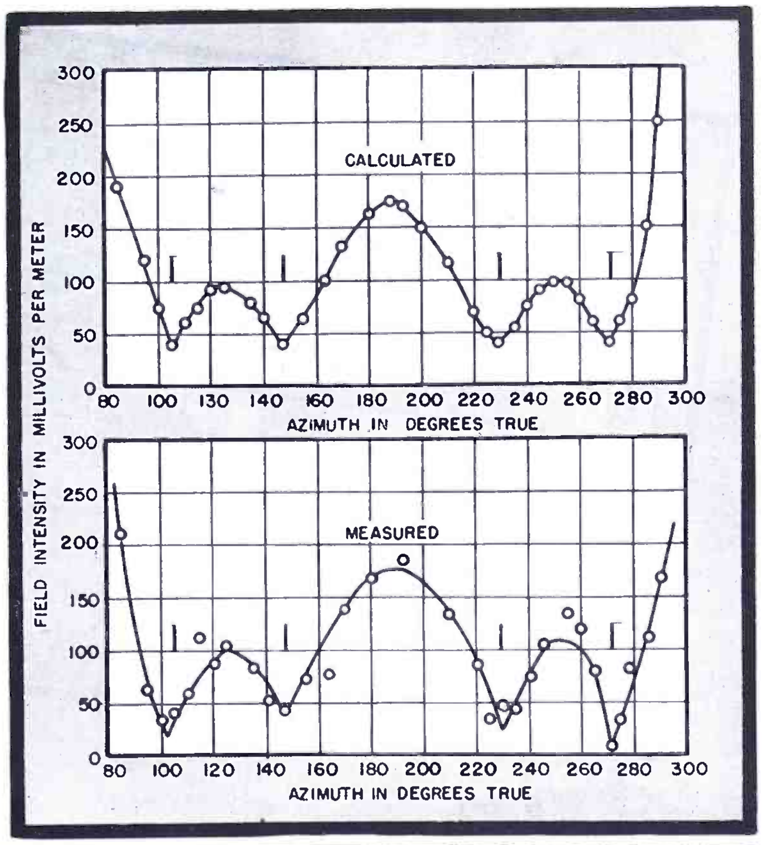
Figure 10 illustrates the daytime pattern. It is non-symmetrical due to the variance in ground conductivity. In Figure 11 appears the directional pattern for the nighttime coverage. This pattern covers the 4.4 mv/m contour only, the KOTA nighttime limitation. Figure 12 shows the tower light and phase monitor circuits, and tower details.

of the building for winter heat or chill mornings. There are also two larg vents protected with louvres in th walls of the cooling room with slidin covers so we may use the air from ou side or from within the building. Thi system has also been very satisfactor except that we found it necessary t install an exhaust fan near the ceilin of the transmitter room to remove th radiated heat during extreme h weather.

The three 300′ towers were als erected in December. They we spaced 198′ apart, in a line 8° east north. Three flashing beacons we mounted atop, controlled by a comm flasher unit in the center doghous This common flashing unit keeps tw beacons on and one off continuous making the load more constant. T current sampling loops were mount .21 wavelength (physically) dow from the top of each tower so th would be in the position of maximu current.

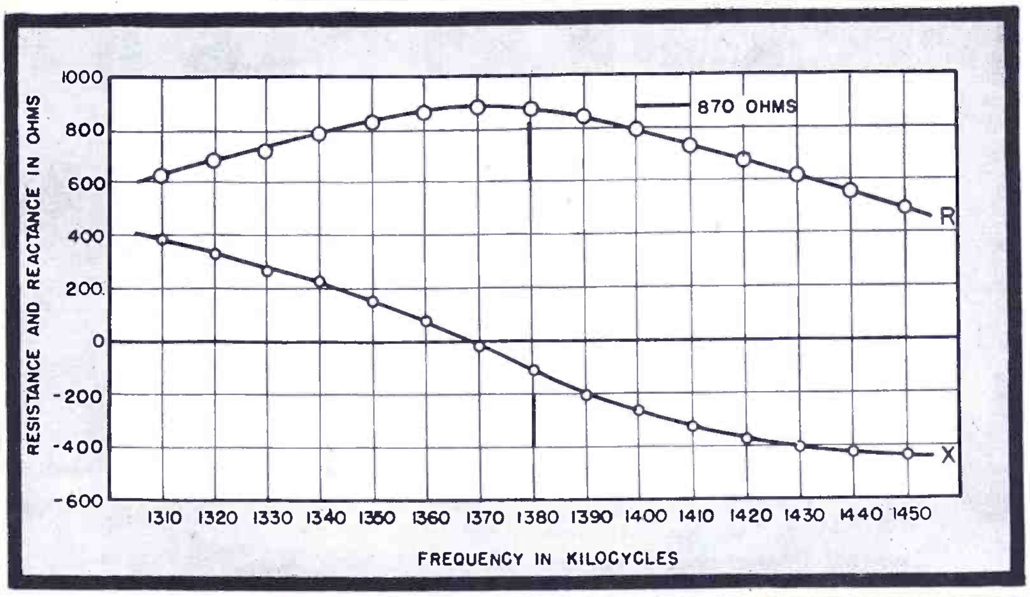
The ground system was conve tional, consisting of one hundr twenty 350′ radials from the base each tower with an additional one-hu dred-twenty 50′ radials at the cent tower alternating between the long ones, and 50′ square matts of hardwa cloth at the base of each tower throu which radials were interwoven a bonded. All radials were bonded heavy copper strips encircling the bas and four similar strips brought up ov to the concrete base tops and join under the insulator base. This poi is the common ground for each un The square matts were laid over a base of crushed rock (4″ of coa under two of fine), then covered w

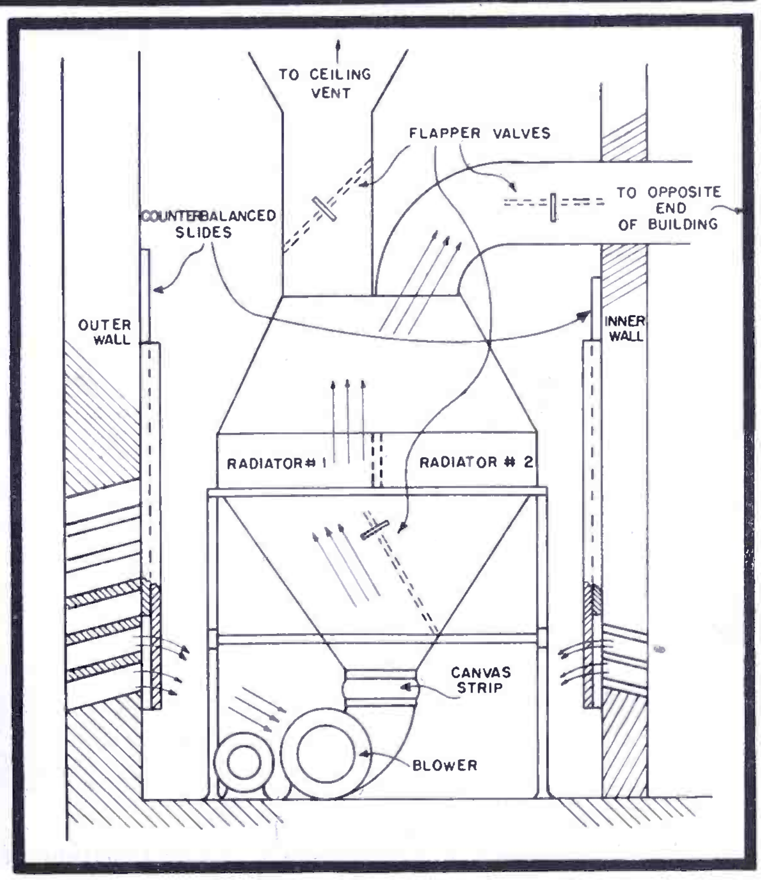




Figures 13 (left) and 14 (right)

In Figure 13 we have the approximate current distribution on the south tower of KOTA. Base current read: 1.1 amperes, (non-directional, detuned and receiving no power from transmitter); and .52 ampere (directional, receiving power from transmitter). Figure 14 shows the cross radial measurements of KOTA.





Figures 15 (above) and 16 (below right)

Figure 15 presents the resistance and reactance measurements of the center non-directional tower. The water-cooling distribution system is diagrammed in Figure 16.

nother 2″ of very fine rock after the onding had been completed. The eatherproof antenna coupling units vere mounted within 8′ square dog-ouses.

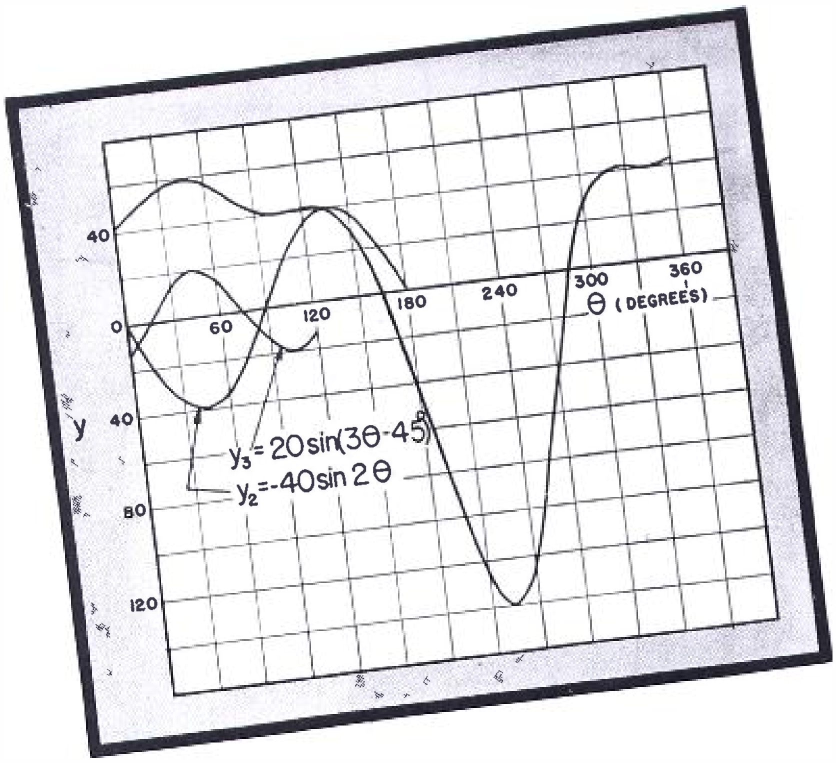
Enclosed wooden troughs, 1′ high nd wide, with removable covers were uilt (from the transmitter house 550′ the center and from there to each nd tower) to carry six coaxial cables nd wiring for the control, remote me-r and intercommunication systems. he troughs were made with 2″ plank ottoms on top of posts varying from ′ to 12′ high and spaced 12′ apart. ll of the coaxials and conduit were exibly bonded and connected to sepa-ate ground rods every 24′ down the roughs. The towers are in a low flat reek bed. The transmitter building is 20′ west on the side of a small hill bout 40′ above the tower bases.

The W. E. transmitter has a D-96020 -kw unit, and D-97712 5-kw amplifier, ach complete in itself with its own n-g sets for d-c filament and bias, and ube rectifiers for high-voltage supplies.

The 1-kw units have the following ube complement: Two 271As as sep-rate oscillators; a 271A as an oscil-ator buffer amplifier; a 276A first r-f mplifier; a 276A plate-modulated sec-nd r-f amplifier; a 212E class B third mplifier; a 228A water-cooled class *B* utput, and a 276A first audio resis-ance coupled to a 212E class A modu-ator. The 5-kw unit uses two 220Cs n parallel, class *B*.

The first power supply uses six 67Bs in 3-phase full wave with 2 kv

(*Continued on page* 81)



Θ°	y	Θ°	y
0	42.42	195	− 89.28
15	49.28	210	−126.06
30	56.78	225	−140.00
45	60.00	240	−126.06
60	56.78	255	− 89.28
75	49.28	270	− 42.42
90	42.42	285	0
105	40.00	300	28.06
120	41.22	315	40.00
135	40.00	330	41.22
150	28.06	345	40.00
165	0	360	42.42
180	−42.42	...	....

Figures 1 (left) and Table 1 (above)

Figure 1. A given complex wave with one cycle of second harmonic and one cycle of third harmonic as disclosed by analyses of Tables II and III (page 40). By inspection, $y_2 = -40 \sin 2\Theta$; $y_3 = 20 \sin(3\Theta - 45°)$. Table I provides data for the complex wave of Figure 1.

A SIMPLIFIED METHOD OF WAVE ANALYSIS

by **W. L. CASSELL**

Professor of Electrical Engineering
Iowa State College

MOST methods of analysis of complex waveforms are more or less tedious and laborious, particularly if no more than the presence or the absence of some particular harmonic is sought. An extension of the classical Fischer-Hinnen method of wave analysis makes possible a simplified procedure with the distinct advantage that the harmonic components are revealed directly as *waves* through the use of simple arithmetic. In addition a cathode-ray oscillograph may serve as a convenient aid if the order of accuracy required is not too high.

Mathematical Background

Let us consider the complex wave whose equation is:

$$y = A_1 \sin[\omega t + \Theta_1] + A_2 \sin[2\omega t + \Theta_2] + \ldots A_m \sin[m\omega t + \Theta_m] + \ldots A_n \sin[n\omega t + \Theta_n] + \ldots$$

where:

$\omega = 2\pi f$ = angular velocity of fundamental, in radians per second,

2ω, $m\omega$, $n\omega$ = angular velocity of harmonics, of frequency $2f$, mf and nf cycles per second, respectively,

A_1, A_2, A_m, A_n represent the maximum values of the respective periodic components of the complex wave,

Θ_1, Θ_2, Θ_m, Θ_n express the possibility that none of the periodic components may be instantaneously zero at time $t = 0$, from which time t is measured.

Let us assume that one complete cycle of the complex wave is to be broken up into m equal angular divisions. The limits of the divisions, in radians, are:

Division	Lower Limit	Upper Limit
1	0	$\frac{2\pi}{m}$
2	$\frac{2\pi}{m}$	$\frac{4\pi}{m}$
...		
m	$2\pi\frac{m-1}{m}$	2π

The equation of the portion of the complex wave within each division may be written as:

For *division 1*:

$$y_1 = A_1 \sin[\omega t + \Theta_1] + A_2 \sin[2\omega t + \Theta_2] + \ldots A_m \sin[m\omega t + \Theta_m] + \ldots A_n \sin[n\omega t + \Theta_n] + \ldots$$

For *division 2*:

$$y_2 = A_1 \sin\left[\omega t + \Theta_1 + \frac{2\pi}{m}\right] + A_2 \sin\left[2\omega t + \Theta_2 + \frac{4\pi}{m}\right] + \ldots A_m \sin[m\omega t + \Theta_m + 2\pi] + \ldots A_n \sin\left[n\omega t + \Theta_n + 2\pi\frac{n}{m}\right] + \ldots$$

For *division m*:

$$y_m = A_1 \sin\left[\omega t + \Theta_1 + 2\pi\frac{m-1}{m}\right]$$

Engineered

Especially for HEAVY DUTY Industrial Applications

This high power industrial tube built by Federal is the result of the widening use of induction heating for heavy applications...especially designed for the purpose...built to meet the exacting demands of severe operating conditions.

Federal's 9C23 is a tube that can stand the gaff...with extra ruggedness for stamina...heavy duty filament for long life and high power output . . . and with the inherent reliability and exceptional qualities that characterize every tube in the extensive Federal line.

Here is another instance where Federal's long experience and leadership in tube design and construction contribute to electronic progress. And it is a good reason to see Federal first for industrial power . . . rectifier . . . transmitting tubes.

Remember—"Federal Always Has Made Better Tubes."

Technical Data for Type 9C23
Maximum Ratings for Maximum Frequency of 20 Megacycles

D C Plate Voltage	15,000 volts
D C Plate Current	4.0 amperes
Plate Dissipation	25 kilowatts
Filament Voltage	22 volts
Filament Current	82 amperes
Overall Length	19¼ inches
Type of Cooling	water

ARMY NAVY E

FEDERAL TELEPHONE & RADIO FTR

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark 1, N.J.

Θ	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180°
Div. 1	42.42	49.28	56.78	60.00	56.78	49.28	42.42	40.00	41.22	40.00	28.06	0	–42.42
Div. 2	–42.42	–89.28	–126.06	–140.00	–126.06	–89.28	–42.42	0	28.06	40.00	41.22	40.00	42.42
$2y_2$	0	–40.00	–69.28	–80.00	–69.28	–40.00	0	40.00	69.28	80.00	69.28	40.00	0
y_2	0	–20.00	–34.64	–40.00	–34.64	–20.00	0	20.00	34.64	40.00	34.64	20.00	0

Table II
Analysis for second harmonic

$$+ A_2 \sin \left[2\omega t + \Theta_2 + 4\pi \frac{m-1}{m} \right]$$

$$+ \ldots A_m \sin [m\omega t + \Theta_m + 2\pi (m-1)]$$

$$+ \ldots$$

$$A_n \sin \left[n\omega t + \Theta_n + 2\pi (m-1) \frac{n}{m} \right]$$

$$+ \ldots$$

If the m divisions are superposed and added, the resultant wave will possess the equation:

$$y_r = y_1 + y_2 + \ldots y_m$$

$$= A_1 \sin [\omega t + \Theta_1]$$

$$+ A_1 \sin \left[\omega t + \Theta_1 + \frac{2\pi}{m} \right]$$

$$+ \ldots A_1 \sin \left[\omega t + \Theta_1 + 2\pi \frac{m-1}{m} \right]$$

$$+ A_2 \sin [2\omega t + \Theta_2]$$

$$+ A_2 \sin \left[2\omega t + \Theta_2 + \frac{4\pi}{m} \right]$$

$$+ \ldots A_2 \sin \left[2\omega t + \Theta_2 + 4\pi \frac{m-1}{m} \right]$$

$$+ A_m \sin [m\omega t + \Theta_m]$$

$$+ A_m \sin [m\omega t + \Theta_m + 2\pi]$$

$$+ \ldots A_m \sin [m\omega t + \Theta_m + 2\pi (m-1)]$$

$$+ A_n \sin [n\omega t + \Theta_n]$$

$$+ A_n \sin \left[n\omega t + \Theta_n + 2\pi \frac{n}{m} \right]$$

$$+ \ldots A_n \sin \left[n\omega t + \Theta_n + 2\pi (m-1) \frac{n}{m} \right]$$

$$+ \ldots$$

All components of the resultant wave with the exception of the *mth* harmonic and integral multiples of the *mth* harmonic ($n/m = 2, 3, 4$, etc.), vanish in the above summation, since p equal sine waves displaced from one another by $2\pi/p$ radians add to zero. On the contrary, the *mth* harmonic and integral multiples of the *mth* harmonic consist, respectively, of m equal sine waves in phase with one another. The equation of the resultant wave, therefore, simplifies into:

$$y_r = mA_m \sin [m\omega t + \Theta_m] + mA_n \sin [n\omega t + \Theta_n]$$

If the complex wave possesses no harmonic integrally related to m, the component of frequency n disappears, leaving:

$$y_r = mA_m \sin [m\omega t + \Theta_m].$$

In this case, the resultant wave is in all respects the equivalent of the *mth* harmonic of the complex wave, with the important exception that the maximum value of the resultant wave is m times that of the *mth* harmonic.

Steps in Wave Analysis

The foregoing mathematical background suggests the following steps in the analysis of a complex wave:

(*1*)—Division of one cycle of the complex wave into equal angular divisions, equivalent in number to the order of the harmonic sought.

(*2*)—Superposition of the wave-divisions in (1).

(*3*)—Addition of ordinates of the superposed wave-divisions in (2).

(*4*)—Interpretation of the resultant wave obtained by the addition of ordinates in (3). The following possibilities exist:

a. The resultant wave is a straight line (coincident with the angular axis, in the absence of a steady component in the complex wave). Conclusion . . . absence of the harmonic sought.

b. The resultant wave is a complex wave. Conclusion . . . integral multiple or multiples of the harmonic sought are present. Division into a larger number of divisions and isolation of the highest integral multiple is indicated.

c. The resultant is a sine wave. Conclusion . . . division of each resultant ordinate by the number of wave-divisions discloses the harmonic sought, in full detail.

Example

Let us consider the complex wave of Figure 1, the ordinates of which are tabulated in Table I.

Analysis for the second harmonic is performed in Table II by superposing two wave-divisions, adding ordinates of the superposed waves, and dividing each resultant ordinate by 2. The values of y_2 in the last row of the table comprise one complete cycle of the second harmonic, as plotted in Figure 1. Obviously, the second harmonic is represented by

$$y_2 = -40 \sin 2\Theta.$$

In a similar manner, Table III discloses the third harmonic, possessing the equation

$$y_3 = 20 \sin (3\Theta - 45°).$$

As a matter of interest, superposing five wave-divisions and adding ordinates results in a straight line coincident with the Θ axis, indicating the absence of the fifth harmonic. Since analysis for the second harmonic results in a sine wave, integral multiples of the second harmonic are absent in the complex wave.

Use of Cathode-Ray Oscillograph

The production of a desired number of superposed wave-divisions may be accomplished by proper adjustment of the linear sweep frequency of the cathode-ray oscillograph. For example, Figure 2 represents one cycle of the exciting current of a small filament transformer, while Figure 3 shows three superposed wave-divisions

(*Continued on page* 103)

Θ	0°	15°	30°	45°	60°	75°	90°	105°	120°
Division 1	42.42	49.28	56.78	60.00	56.78	49.28	42.42	40.00	41.22
Division 2	41.22	40.00	28.06	0	–42.42	–89.28	–126.06	–140.00	–126.06
Division 3	–126.06	–89.28	–42.42	0	28.06	40.00	41.22	40.00	42.42
$3y_3$	–42.42	0	42.42	60.00	42.42	0	–42.42	–60.00	–42.42
y_3	–14.14	0	14.14	20.00	14.14	0	–14.14	–20.00	–14.14

Table III
Analysis for third harmonic

KEEP that designation in mind—FF-55. You will need it when you redesign a lot of your electrical apparatus for genuine postwar efficiency.

It represents the newest and best in laminated electrical insulation—a new product produced with a new fibre base—Glass Cloth—and a recently perfected synthetic resin—Melamine.

While retaining the easy machinability and workability that makes rapid production possible, it offers in combination many qualities that previously could be had separately only in much less adaptable insulating materials.

It has very high strength—tensile, compressive and flexural. It stands up to 440 degrees Fahrenheit for short periods, more heat than any previous laminated grade. It also stands arcing for longer periods.

As there is no cellulose in its composition, it resists fungus growth in the tropics. And moisture absorption is so low, and has so little effect on it, that its stability of dimensions and electrical characteristics is equally unusual.

Other materials with glass fibre bases, and new and useful characteristics are also now available.

You will certainly find use for it. Remember the name, Formica FF-55!

Engineering test data is yours for the asking.

FORMICA

THE FORMICA INSULATION COMPANY, 4635 SPRING GROVE AVENUE, CINCINNATI 32, OHIO

A REPORT ON THE 1945

A Coaxial Modification of the Butterfly Circuit

E. E. GROSS
General Radio Company

THE extensive use of u-h-f equipment during the war presented quite a series of problems for the laboratory instrument design engineer, particularly in the development of variable oscillators. Effective units were built, but because of their specific applications, they were not adaptable for general laboratory use. As a result fixed-frequency or limited-range oscillators were being used as an expedient. However development work on wide-range oscillators was not halted. One such development project proved quite sucessful, providing the tuning unit familiarly known as the coaxial butterfly.

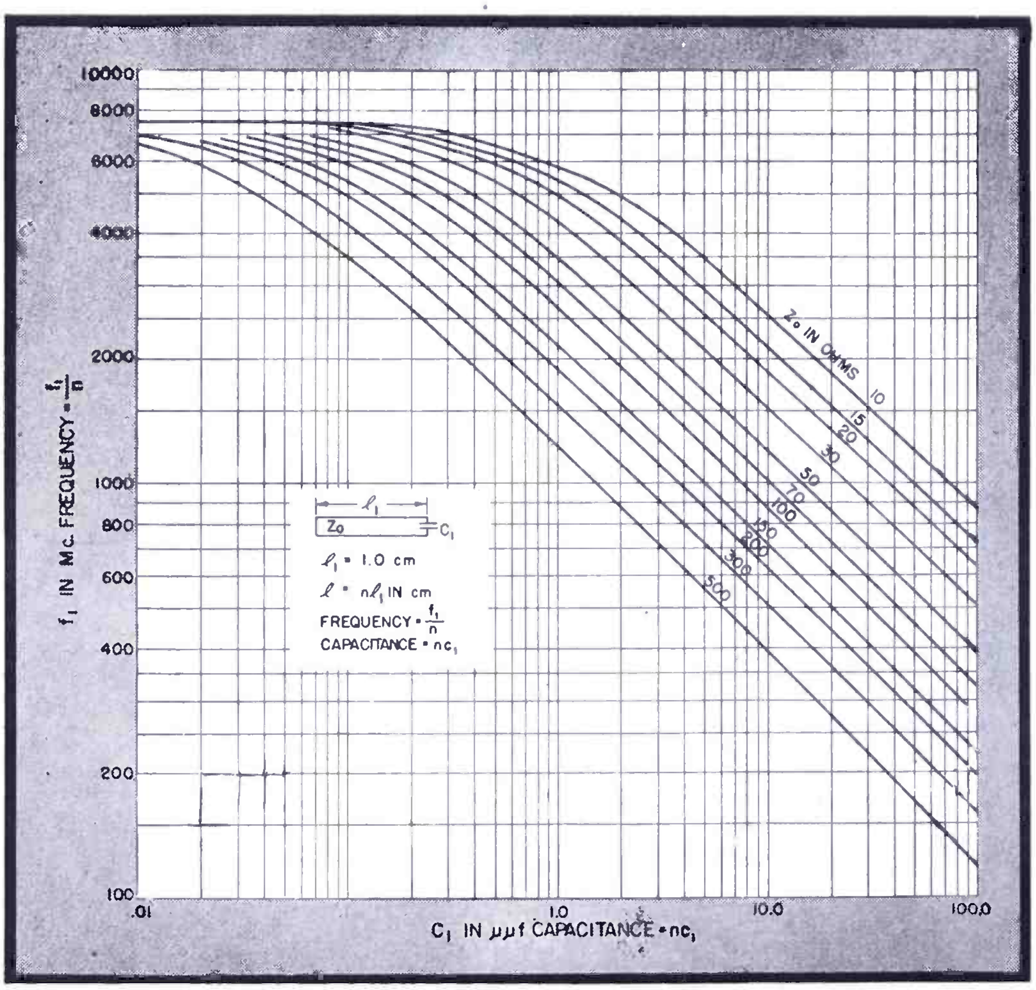
An interesting analysis of the development which led up to the design of this unit, and a discussion of the unit was offered by Mr. Gross.

He pointed out while methods existed for constructing spot-frequency u-h-f oscillators using a variety of negative grid triodes, the problem of securing frequency coverage of the order of 2:1 with good output, single-dial control and no sliding contacts was only now being solved. In particular, circuits and mechanisms have been devised utilizing the capabilities of the 2C43 lighthouse tube as an u-h-f oscillator.

Simple oscillators using a single tuning unit, Mr. Gross explained, can be made to oscillate at frequencies approaching the resonant frequency of the tube if the tube has approximately equal grid-cathode and plate-cathode capacities. However, with practicable circuits, series lead inductance prevents satisfactory operation of conventional triode oscillators near their ultimate frequency limits, so that full advantage of their capabilities cannot be obtained. As an example of what can be done with conventional u-h-f triodes, the W.E. 703, a single-ended *doorknob,* which is self-resonant at 1700 mc, can be made to work in a transmission-line circuit up to 1500 mc, but it is considered mechanically impracticable to make the circuits variable over any appreciable frequency range. The same tube used in a butterfly circuit works well over the range of 220 to 1000 mc, but a final objection to this tube is that its filament should preferably be run from a well-regulated d-c source.

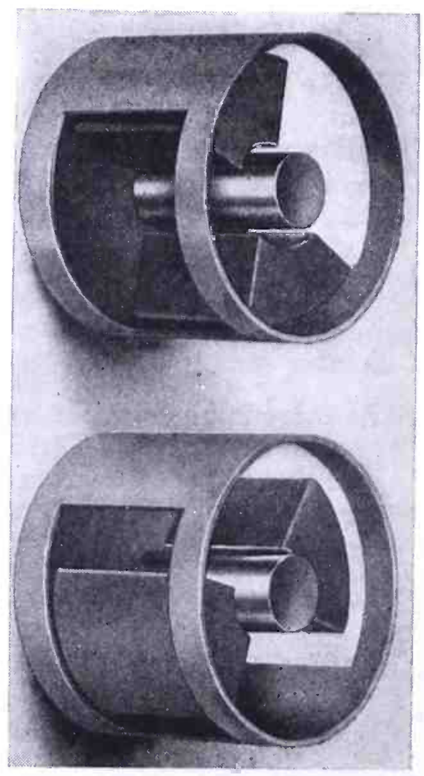
Of the available u-h-f triodes, continued Mr. Gross, the 2C43 lighthouse tube seemed to be the best suited if the proper tuning mechanisms could be made. Since this tube was designed to fit integrally into coaxial-line resonators, a tunable coaxial line was necessary. This was accomplished without sliding members by adapting the butterfly idea to the coaxial line, the result being called the *coaxial butterfly.*

The basic form of this tuning unit is shown in Figure 1, with the high-frequency position at the top and the low-frequency position on the bottom. The unit consists of a coaxial line shorted at one end and open at the other. The outer conductor is not a full cylinder but has two 105° sections cut away. Rotating between in-



Figures 1 (below) and 2 (left)

Figure 1. Basic form of tuning unit, with high-frequency position at top and low-frequency position at bottom. Figure 2. Possible range of tuning unit.



ROCHESTER FALL MEETING

Highlights of Papers Presented By E. E. Gross, L. C. Holmes, C. W. Carnahan, and J. Minter

by LEWIS WINNER
Editor

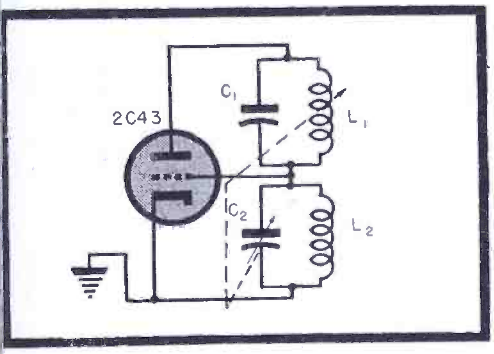


Figure 4
Circuit reduced to lumped parameters: C_1L_1 = inner *butterfly* coaxial; C_2L_2 = outer coaxial formed by outer conductor of butterfly plus cathode cylinder of tube as inner conductor with respect to outermost cylinder.

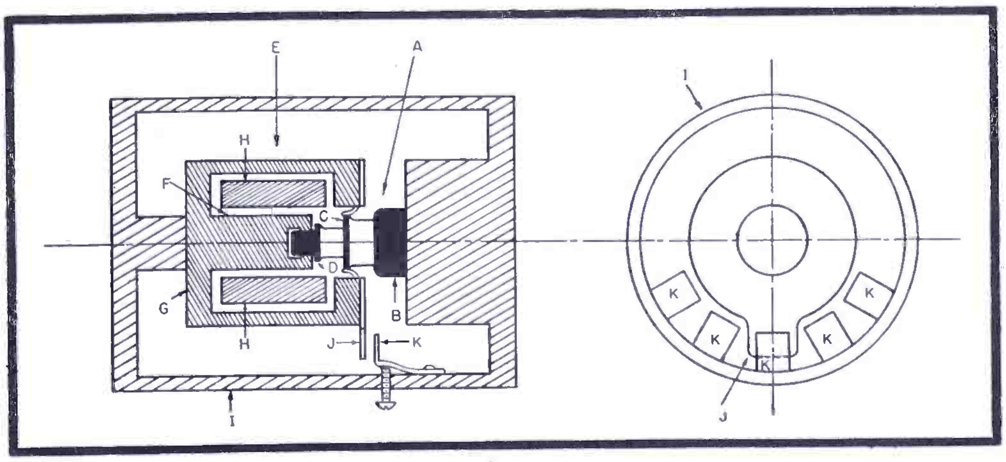


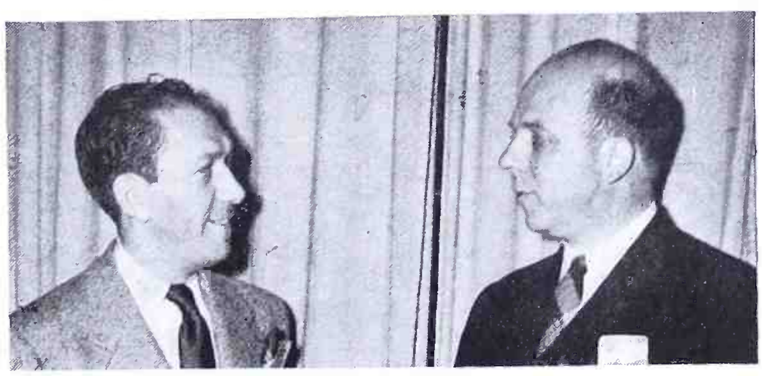
Figure 3
Cross-sectional view of coaxial system, prepared from data offered by Mr. Gross in his paper: A = 2C43 *lighthouse* tube; B = cathode terminal; C = grid terminal; D = plate terminal; E = coaxial butterfly circuit; F = inner conductor of butterfly; G = outer conductor of butterfly; H = butterfly sectors; L = outer conductor of outer coaxial line (grid-cathode line); J = grid loading capacitor tab; and K = cathode loading capacitor tube.

ner and outer conductors are two 75° sectors. In varying the frequency with these conductors, the tube is connected across the open end of the line. The tube's grid-plate capacity therefore loads the line so that the line is resonant at a frequency less than its quarter wavelength. As the inner sectors are rotated the characteristic impedance of the line changes, which means that the amount of line foreshortening caused by the grid-plate capacity of the tube changes. Hence the resonant frequency changes. In Figure 2 appears the possible ranges of this tuning unit. In this illustration, the resonant frequency, f_1, for tube loading capacity, C_1, is given for a line 1 cm long varying from 10 to 500 ohms in characteristic impedance. For a line n x 1 cm long we divide f_1 by n and multiply C_1 by n. Thus the line shown in Figure 1 can be varied from 30 to 150 ohms. If the line is 2 cm and the loading capacity is 4 mmfd, a frequency range of 800-1600 mc can be covered.

A circuit of this type connected between plate and grid of a lighthouse tube, Mr. Gross said, cannot oscillate well much beyond 700 mc because the plate-cathode to grid-cathode capacity of the tube ratio is not favorable for proper feedback beyond this point. To go higher in frequency it is necessary to connect an additional tuned line between grid and cathode and couple it to the plate-grid line. This, however, introduces another element which must be tuned. The cross-sectional drawing of Figure 3 illustrates how this difficulty was solved. The lighthouse tube was inserted into a coaxial butterfly, the plate terminal meshing with the inner conductor and the grid terminal with the outer conductor. In turn, the element formed by the outer conductor of the coaxial butterfly plus the cathode cylinder of the tube formed part of the inner conductor of a second coaxial line, the outer conductor of which is defined by the shell enclosing the cross-section. The second, or outer line was therefore connected between grid and cathode and its flux was linked with the flux of the inner butterfly coaxial through the butterfly openings. The dimensions of the outer line were fixed to resonate at the highest frequency. To keep this line in resonance, as the inner coaxial butterfly was rotated from the position of highest frequency to the position of lowest frequency, capacity was automatically added from grid to cathode by means of a series of adjustable padder tabs, one tab rotating with the butterfly and connected to the grid, and a series of tabs (adjustable from the outside) located around the inner wall of the outermost tube. Figure 4 shows the circuit reduced to lumped parameters.

As finally evolved, Mr. Gross stated, an oscillator of this type, with single-dial tuning and no sliding contacts, was constructed to cover the range 620-1340 mc. Power output over the range varied between 0.15 and 0.300 watts, and the maximum frequency change for a plate voltage change of 2:1 was 4000 parts per million.

Dr. W. L. Everitt (right), president of the IRE and head of the department of electrical engineering at the University of Illinois, discussing the Fall Meeting papers with ye editor at Rochester.



High Quality Sound Recording on Magnetic Wire

L. C. HOLMES

Stromberg-Carlson Company

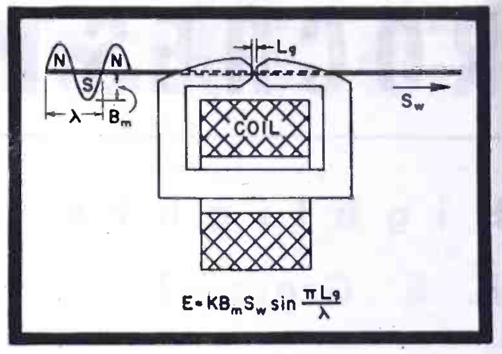


Figure 5
A typical wire recording-reproducing head.

WITH wire-recording interest growing daily, engineers have begun to study the various phases of quality control very carefully. Factors such as distortion, frequency response, signal-to-noise ratio and wow or flutter are being analyzed, and methods developed to provide improved fidelity.

Research of this nature has been conducted at Stromberg-Carlson for some time. And as a result, several high-quality wire-recording processes have been evolved. These methods and tests developed to check the results were discussed by Mr. Holmes.

Commenting on the quality factors, Mr. Holmes said that distortion demands exceedingly close scrutiny.

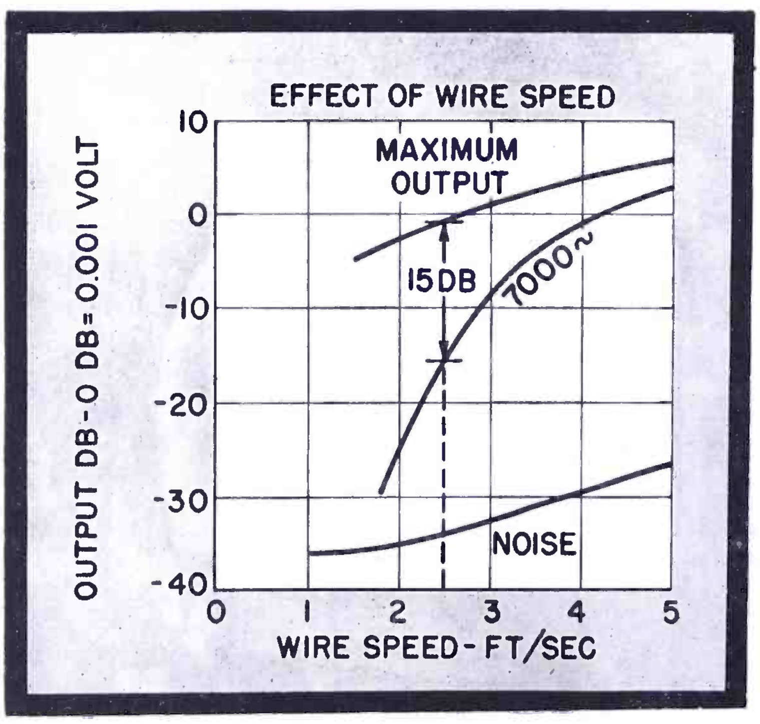
Distortion, Mr. Holmes pointed out, could occur in any part of the system.

The essential problem concerns distortion in the recording medium itself, all other distortions being held to a minimum. The problem then becomes one of being able to magnetize a wire or ribbon such that the surface density of lines of force along the medium is a linear function of the audio signal. The normal magnetization curves for ferro-magnetic materials, and more important for magnetic recording purposes the residual - flux - density magnetization curves, are far from linear. The curves must then be made linear by the use of some bias current before distortionless reproduction obtains. Previous methods have used direct-current bias, which affects linearity but decreases the dynamic range and the signal-to-noise ratio. The system described by Mr. Holmes uses a supersonic bias current mixed with the signal in the recording head. The supersonic current yields a nearly linear transfer characteristic and at the same time affords a demagnetized medium for passage through the recording. Thus a wider dynamic range and lower noise level is possible. The peak value of supersonic current required for transfer linearity is that value corresponding to the magnetizing force obtained by extending the straight-line portion of the residual magnetization down the point of intersection with the X-axis. The supersonic frequency is not critical, values from 30 to 100 kc having been found satisfactory.

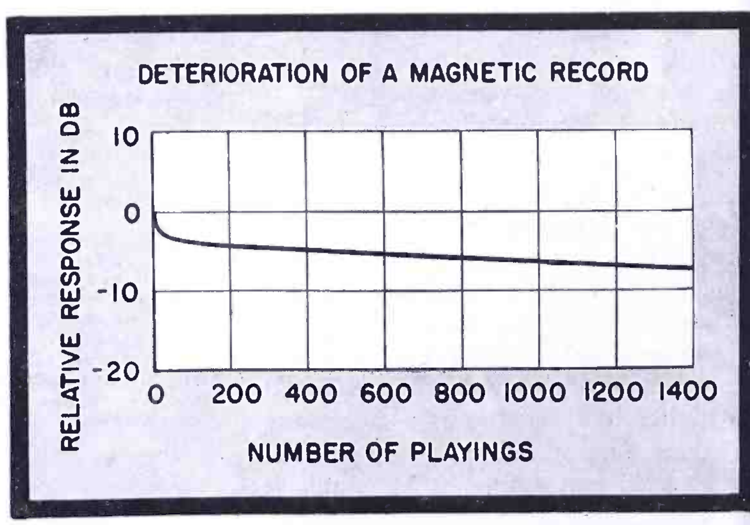
The factors affecting the frequency response of a reproducing head, Mr. Holmes continued, are related by the equation (Figure 5):

$$E = KB_mS_w \sin \frac{\pi L_g}{\lambda}$$

where: E = output voltage; K = a constant depending on the material and configuration of the reproducing head, on the units and the coupling between the recording medium and the head; B_m = maximum instantaneous flux density along the surface of the medium; S_w = wire speed; L_g = effective length of the air gap and λ = wavelength of the signal recorded on the medium, and is equal to the wire speed divided by the frequency. The most important of these factors in limiting the high-frequency response is B_m, the maximum instantaneous flux density along the surface of the medium. For a given wire, speed and head configuration, B_m is limited by the phenomenon of self-demagnetization. The magnetic record consists of a series of small bar magnets laid end-to-end along the medium. The magnets alternate in polarity and decrease in length with increasing frequency. The demagnetizing forces set up increase as the magnets become shorter. The resistance to demagnetization is a function of the coercive force of the medium, so that, other things being equal, high-frequency response is improved in media having high coercive force. Further, the effects of demagnetization may be limited by not allowing the magnets to become too short. For example, the magnet length for an 8-



Figures 6 (left) and 7 (below)
Figure 6 shows three curves as a function of speed: lower curve is the noise voltage; middle one is output at 7 kc; upper curve gives output at frequency of maximum response. Figure 7 provides results of wire-recording life test.



We recommend these *Gammatrons* for the new amateur bands

In answer to many requests for our recommendations as to the Gammatrons which will give peak performance on the bands released to amateurs on November 15, we have been commenting as follows:

HK-24 and HK-24G "These triodes fill the bill for operation up to and including the 205 megacycle band. Your mechanical arrangement will largely determine your choice. We give the nod to the 24-G for top performance at 205."

HK-54 "Excellent up to 148 megacycles. Just the thing for the chap who wants 300 to 350 watts output from a pair on 28 megs—plate modulated."

HK-254 "If you want to put out a half kilowatt on 54 megacycles, use this big brother of the HK-54 in pushpull. Ratings decrease above this frequency to approximately 280 watts input to one tube at 200 mc."

HK-257B "Don't overlook this beam pentode for your bandswitching job. It requires practically no driving power. A couple of receiving tubes, such as 6V6's, will take you in a hurry from a 3.5 mc. crystal to 28 megs where pushpull 257-Bs will give you up to 400 watts out."

HK-454 "This is the tube for the man who wants a full kilowatt output on 28 megacycles. It's also excellent on 54 megs."

Additional data on Gammatron tubes appears in "The Radio Amateur's Handbook" and in "The Radio Handbook." Data sheets on individual types will be sent on request, and our engineering department will gladly provide special information or advice on your particular applications. You can now obtain Gammatrons at stores handling amateur components.

HEINTZ AND KAUFMAN LTD.
SOUTH SAN FRANCISCO · CALIFORNIA
Export Agents: M. Simon & Son
25 Warren Street, New York City, U. S. A.

kc signal at a wire speed of 2′ per second is .0015″. If the wire diameter is .004″, the ratio of the magnet length to diameter is only about ⅓ and is approximately a current limiting value.

Considering the problem of equalization and signal-to-noise ratio, Mr. Holmes stated that proper choice of equalization directly affects noise. Let us assume that orchestral music must be recorded flat to 7 kc. Previous data show that the most probable maximum level at 7 kc is 15 db down from the level at 250 cps. Hence a maximum pre-emphasis of 15 db may be used at 7 kc in recording the music. The improvement at high frequency is obtained without increasing the noise, as would occur in post-emphasis methods. The preceding data are also useful in finding the optimum speed for a given system. Figure 6 shows three curves as a function of speed. The lower curve is the noise voltage, the middle curve is the output at 7 kc and the upper curve is the output at the frequency of maximum response. Both output curves were obtained using equal constant current in the head. At the speed of 2.5′ per second there is just 15 db between the maximum output and the output at 7 kc. This represents the lowest speed at which maximum signal-to-noise ratio is obtained for the given system. At lower speed the ratio decreases, while at higher speeds there is no sensible increase.

Much interest has been expressed, Mr. Holmes said, in the permanency of magnetic recordings. Accordingly life tests have been made using an endless loop of wire impressed with a sinusoidal signal. The tests show (Figure 7) a total drop in response of 7 or 8 db after 1400 playings of the loop. It was further stated that most of the drop occurred during the first few playings.

Figures 8 (above) and 8*a* (below, left)
Figure 8. Equipment used to demonstrate pre- and post-equalization in wire-recording reproduction. Figure 8*a*. Profile of terrain between Richfield, Wis., and Deerfield, Ill., area used to make 45.5- and 91-mc tests.

Field Intensities Beyond Line of Sight at 45.5 and 91 Mc

C. W. CARNAHAN
Zenith Radio Corporation

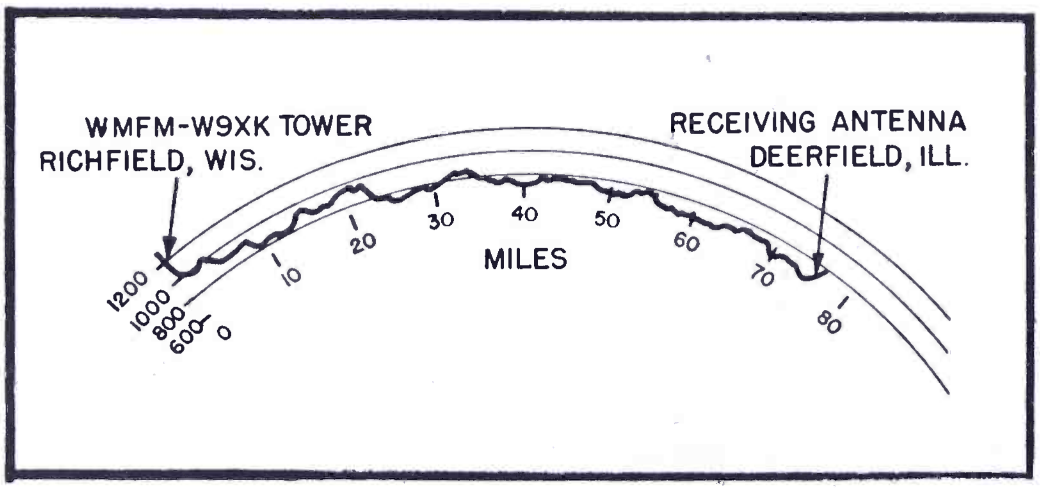
WHEN the FCC published the allocations for the v-h-f bands last summer, they stated that it would be wise to run a series of tests to evaluate the effectiveness of the 45.5 and the then-proposed 91-mc bands for f-m. With the war drawing to a close and the *increasing* need for a final allocation program to minimize industry production delays, the FCC decided to issue final f-m channels. And thus, a few weeks after the proposed program appeared, the final f-m bands at the higher frequencies were issued by the FCC. However the originally proposed tests were not discarded and several were run off. The preliminary results of one of these tests, run between July 20 and September 21, 1945, were disclosed at Rochester by Zenith engineers.

The tests were conducted between Richfield, Wis., and Deerfield, Ill., a distance of 76 miles. A profile of the terrain between these points is shown in Figure 8*a*. The transmitters, located at Richfield, comprised WMFM, the f-m station of the Milwaukee Journal, operating on 45.5 mc, and W9XK, an experimental 91-mc station whose antenna was mounted on WMFM's tower. The 45.5-mc antenna was a two-bay turnstile with a power gain of 1.23, mounted on a tower 230′ high. The 91-mc antenna was a directional array employing a 60° corner reflector, having a power gain of about 10 towards the receiver and mounted about 40′ below the 45.5-mc antenna.

The receivers consisted of a Hallicrafters S-27 for 45.5-mc and a modified Hallicrafters S-36 for 91-mc. Both receivers were further fitted with an additional r-f stage with balanced input. Receiver output was continuously recorded with Esterline Angus instruments, while Ferris 18C signal generators were used for receiver calibration. All equipment was supplied from voltage regulators. The receiving antennas were horizontal half-wave folded dipoles mounted 30′ above ground on towers 20′ apart. The antennas were connected to the receivers with straight runs of 300-ohm Amphenol *dumbbell* cable.

The recorded tape data was rendered into field strength by finding the factor necessary to multiply the signal-generators' output. This was accomplished by setting up an oscillator some distance away from the receiver antennas and measuring the field in terms of recorder-signal generator microvolts. The receiver antennas were then replaced by the antenna of a field strength meter and the field strength measured directly. Independent measurements were made by W. K. Roberts of FCC and by Stuart Bailey and Philip Laeser of station WTMJ. The average of these results was the multiplication factor used.

Since the power output for both transmitters was not the same, it was necessary to reduce the data to an equal power basis. The 45.5-mc output was known to be 35 kw. The 91-mc output toward Deerfield was measured directly by Major Armstrong and C. M. Jansky using a current indicator at the center of a dipole two wavelengths from the radiator. By means of this measurement, and a monitoring diode calibrated in field intensity, it was possible to obtain the effective radiated power as function of power input to the transmitter. This



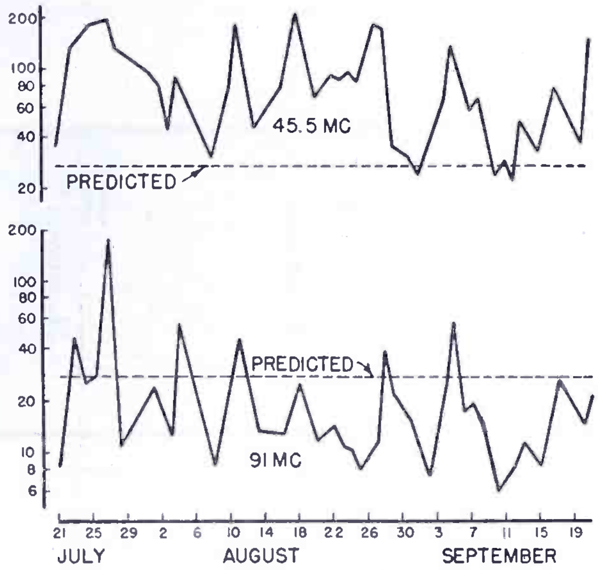


Figure 9
Daily average field intensities, μ v/m.

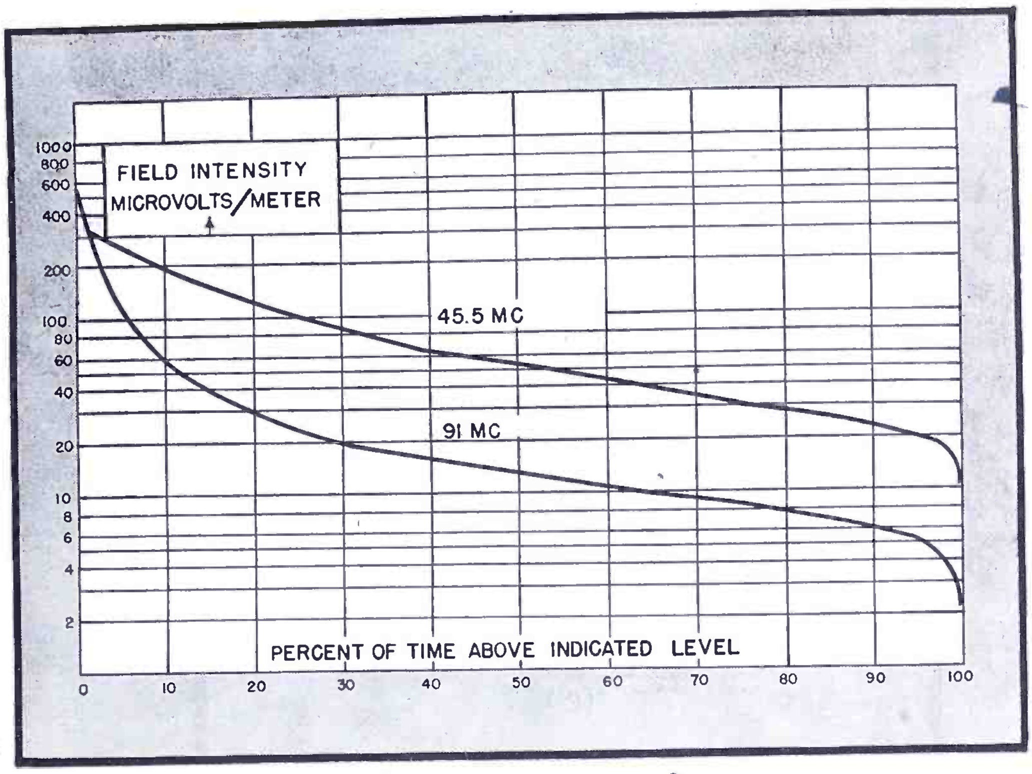


Figure 10
Plot of percentage of time signals exceed level indicated on the ordinates.

elation was then used to derive a mul- plying factor for each day's opera- ion.

The accumulated data was summar- zed by charts, such as appears in igure 9. These show the daily aver- ge field intensity in microvolts-per- neter together with the field intensi- ies predicted by FCC computations dotted lines). It is seen that the con- ours of both curves are approximately he same, but that the measured field ntensity of the 45.5-signal is consis- ently higher than that of the 91-mc ignal. In Figure 10, the data are lotted to show the percentage of time he signal exceeds the level indicated on the ordinates. Assuming signals of 10 microvolts-per-meter required for modern receivers, these curves show that the 45.5-mc signal met the condition 100% of the time while the 91-mc signal met it only 65% of the time.

The principal claims made by Zenith on the basis their data were: (*1*)—The average observed 45.5-mc signal was about twice as strong and the 91-mc signal about half as strong as FCC predicted values; (*2*)—interference at the distance used at 91-mc due to fading below usable level exceeds sporadic E interference on 45.5-mc at the same distance; and (*3*)—as a result, rural coverage will be decreased on 91-mc as against 45.5-mc.

FCC Report

In a report issued in Washington, the FCC claimed that their tests at Laurel, Maryland, proved that the 45.5-mc band was inferior to the 91-mc band.

The report stated that field intensity measurements of a low-band f-m station and a high-band f-m station, of comparable power, both located in Washington, D. C., showed negligible difference in signal strength at the FCC laboratory, a distance of approximately 20 miles in spite of the fact that the low-band station W3XO (43.2-mc) enjoyed the distinct advantage of having an antenna more than 200′ higher above sea level than

(*Continued on page* 92)

Comments on Existing Television Systems from a Measurement Viewpoint

J. MINTER
Measurements Corp.

CHANGES in the present standard television receiver selectivity characteristics, with a view toward simplifying the alignment problem, were proposed by Mr. Minter.

Present standard practice calls for the television transmitter output to be of the form shown in the upper half of Figure 11. The use of filters in the transmitter results in the partial sup-

(*Continued on page* 78)

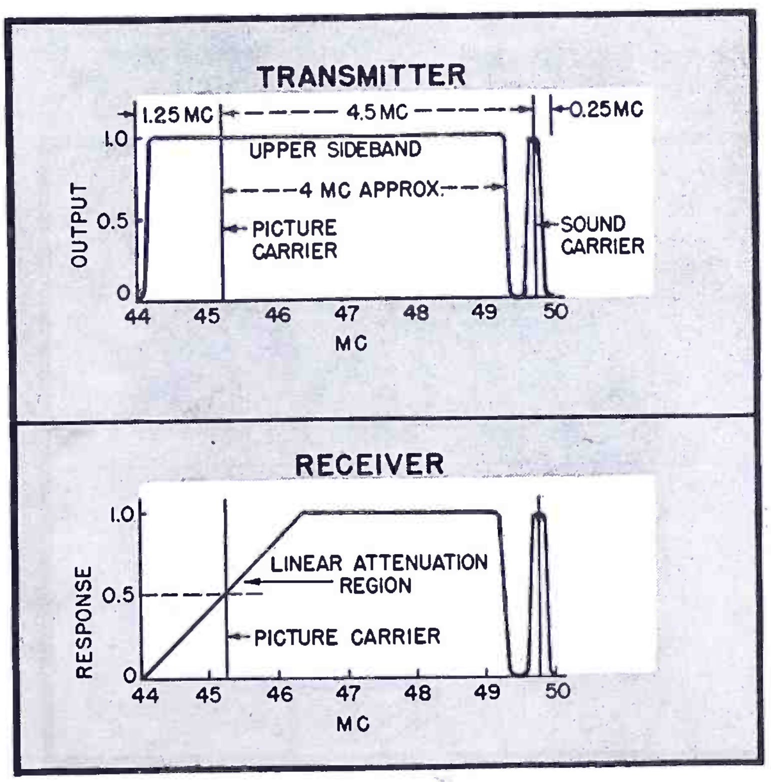


Figure 11
Present television standards, providing partial suppression of one side band by transmitter. Receiver designed to partially attenuate carrier will, theoretically restore normal modulation depth and avoid picture distortion.

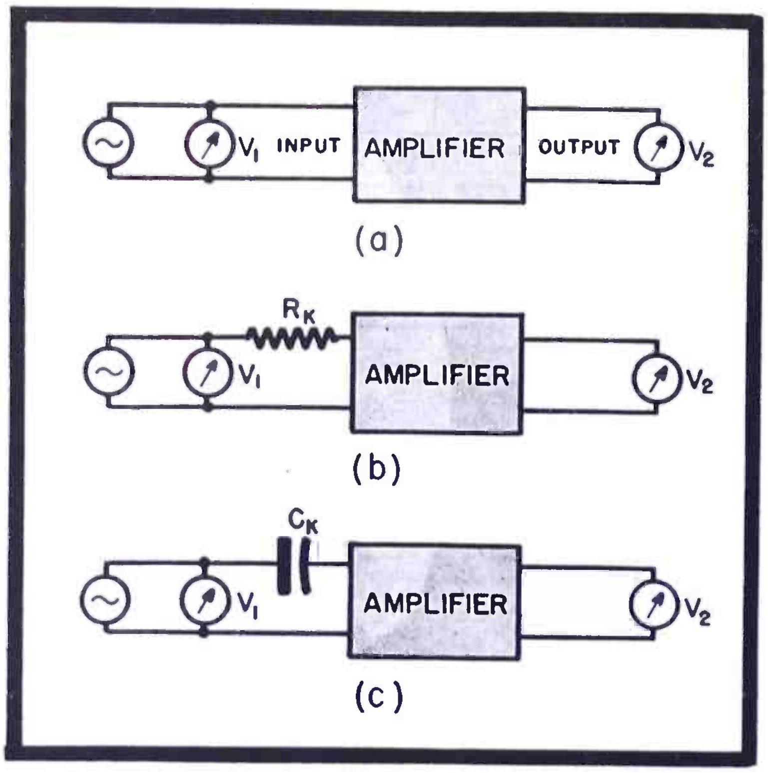


Figure 1 (left)
Shematic circuits of method for measuring amplifier input impedance.

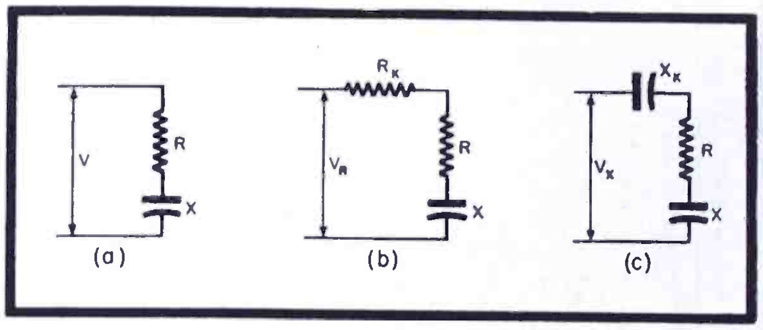


Figure 2 (above)
Equivalent circuits corresponding to the circuits of Figure 1.

MEASUREMENT OF AMPLIFIER INPUT IMPEDANCE

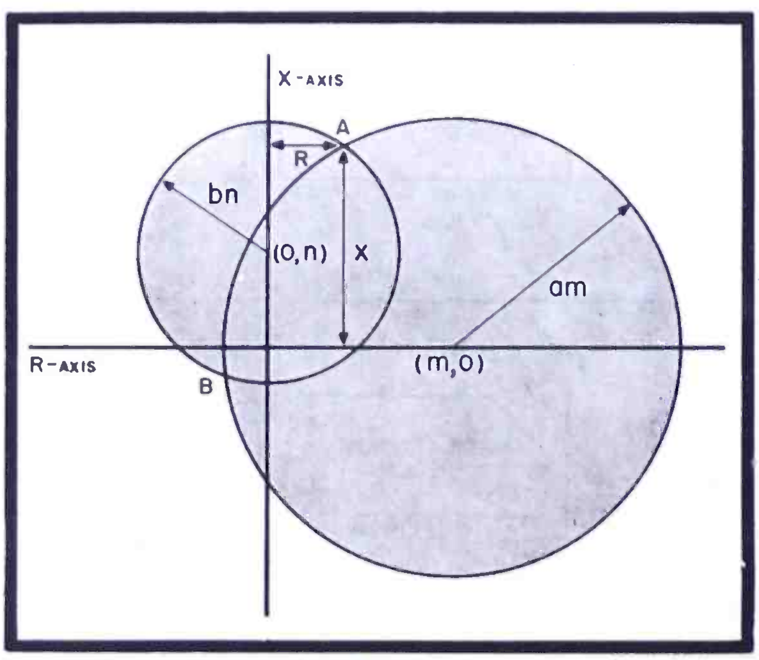
by D. L. WAIDELICH
Naval Ordnance Laboratory
Washington, D. C.

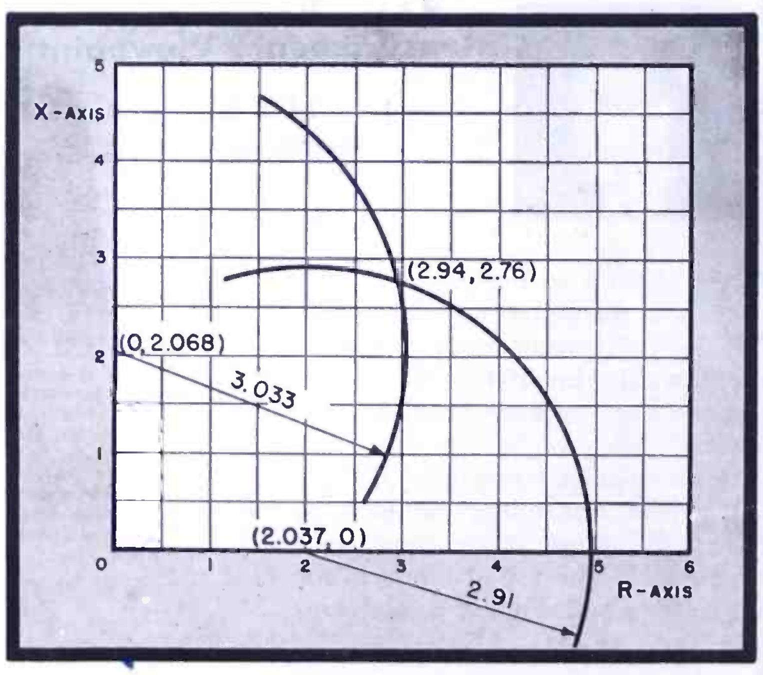
THE measurement of the input impedance of amplifiers is important particularly in determining how much the amplifier loads the device which supplies the voltage to be amplified. A bridge method of measurement might be used, but it has two disadvantages: (*1*)—The impedances are so high that the bridge balance is quite insensitive; and (*2*)—since the input impedance of an amplifier changes radically with the amount of the applied signal because of grid current flowing and feedback present in the amplifier, the impedance should be measured at the signal level desired. This is difficult to do with a bridge circuit.

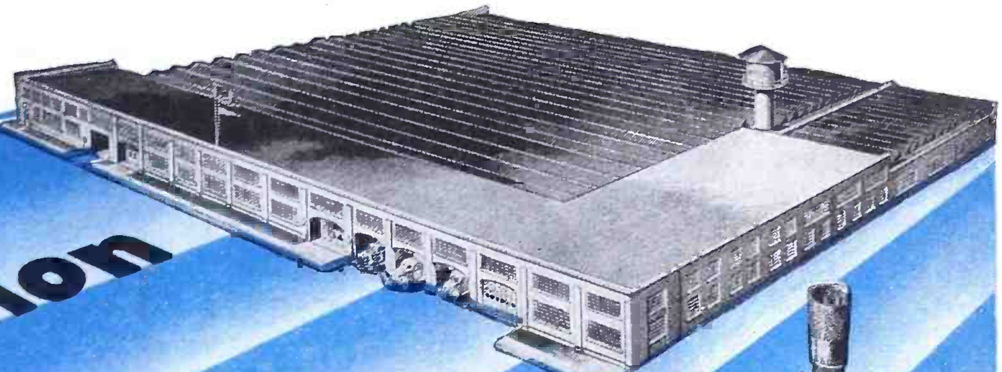
These disadvantages have been eliminated by the method outlined in Figure 1, involving the use of a known resistor R_k, and a known capacitor, C_k. The input to the amplifier from a sine-wave generator *G* is measured by voltmeter, V_1, and the output of the amplifier is measured by voltmeter V_2. Throughout a measurement the voltmeter reading, V_2, is kept constant so that the signal level in the amplifier and the input impedance of the amplifier is kept constant. In the first step it is necessary to measure the input voltage, *V*, to the amplifier with the desired output voltage, V_2, as shown at *a* in Figure 1. Next the input voltage, V_R, is measured with the resistance, R_k, in series with the amplifier input. This is shown in *b* of Figure 1. The output of the generator *G* must be in-

(*Continued on page* 96)

Figures 3 (left, below) and 4 (right, below)
Figure 3. Graphical method of solving for the input impedance. Figure 4. Example of graphical method of solution.







In Production at AMPHENOL

Radio's Most Extensive Line of Accessories and Replacement Parts

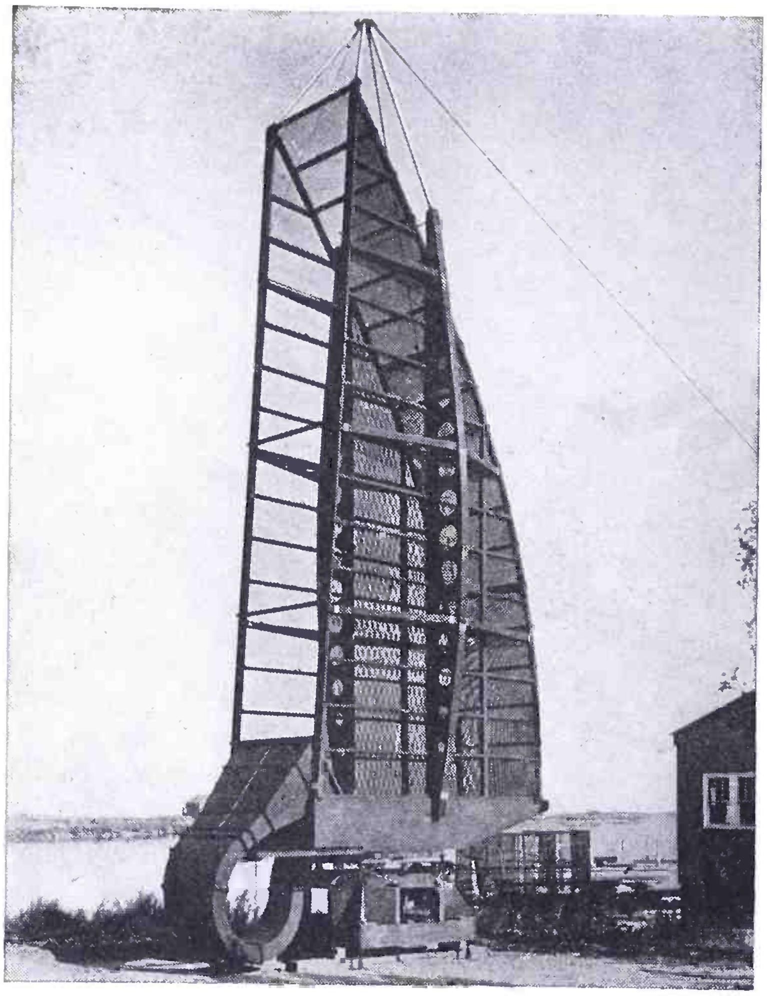
- Amphenol's newly developed and efficient Antennas for F-M and Television.
- Extruded Copolene Twin Line Cable.
- Many new Sockets, Plugs, Connectors and Fittings.
- The most complete range of Coaxial (RG Type) Cables.
- Plastic Components for all types of Radio and Electronic Applications.

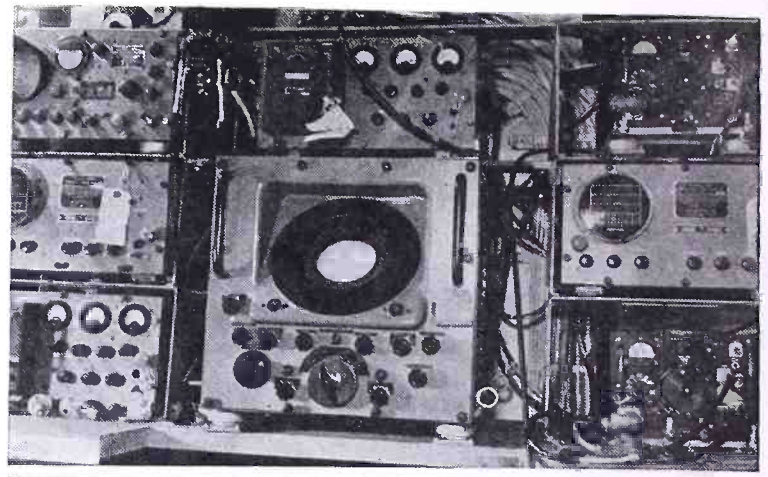
Yesterday's previews of future developments become today's realities as Amphenol swings into full production to meet the accumulated needs of the nation's radio market. Amphenol offers many new and interesting items along with its established line of standard components. All carry the familiar Amphenol trade-mark. *It pays to watch Amphenol*—the line with a future.

Write for Catalog No. 72. It tells vital facts about Amphenol and Amphenol products.

Depend upon AMPHENOL *Quality*

AMERICAN PHENOLIC CORPORATION
Chicago 50, Illinois
In Canada • Amphenol Limited • Toronto





Figures 1 (above, left), 2 (top, right) and 3 (above, right)
Figure 1. *Half-cheese* antenna (reflector, excited by waveguide and horn at base) used in a radar jammer by the RAF to protect their flyers by blinding radar eyes of the German night fighters. Antennas provided a beam that was very sharp in the vertical plane and relatively broad in the horizontal plane. Figure 2. U. S. Navy countermeasure equipment; radar scope (center), receiver that picked up beam (above scope), and receivers to analyze and visually display enemy radar signals (upper left). Figure 3. Typical radio jamming transmitter used in jamming early-warning and gun-laying radars.

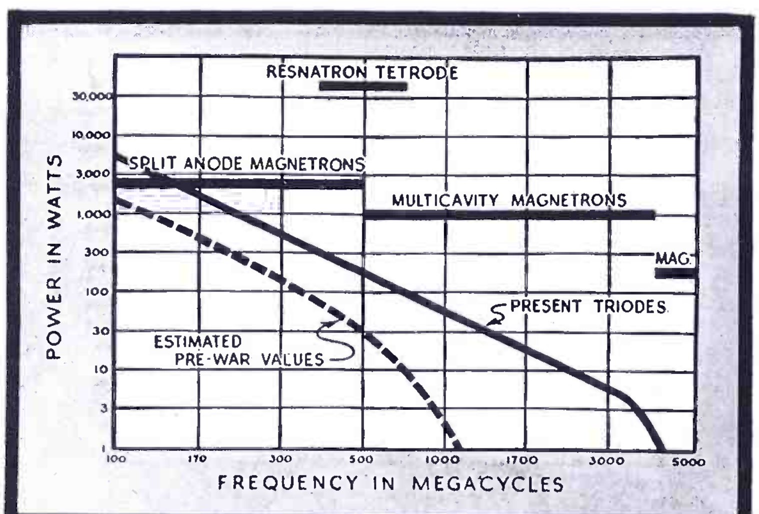
RADAR COUNTERMEASURES

—by RALPH G. PETERS—

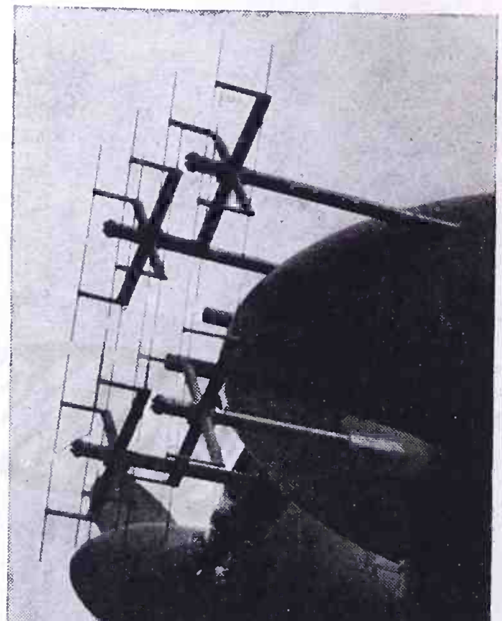
RADAR'S role during the war is by now well known to professional and layman alike. Not so well known though just as important, and until several weeks ago a deeper secret than radar itself, has been the work of those charged with rendering ineffective the military utility of enemy radar with a series of countermeasures. While the peacetime uses of radar are more obvious, some of the equipment and techniques devised for radar countermeasures, especially in the field of continuous power generation and broad-band antennas from 100 mc up will eventually prove exceptionally valuable to communications engineers.

Organization of Countermeasure Work

In this country countermeasure work was under the general direction of the Radio Research Laboratory, headed by Dr. Frederick E. Terman. Because of the peculiar military nature of the assignment, this activity achieved a degree of immediate tactical liason with the fighting fronts which exceeded almost any other phase of technical war operations. Enemy use of radar had to be fought on the basis of immediate tactical changes in the campaigns on both sides. Thus RRL maintained field laboratories in Britain and sent its technical representatives to every land, sea and air front. Introduction of new enemy equipment required immediate countermeasure steps, so that practically all of the work was



Figures 3 (left) and 4 (right)
Figure 3 shows the c-w power levels obtained with various types of tubes operating over the 100 to 5,000-mc range. The *resnatron tetrode* specially developed for high power s-h-f radio jammers has interesting postwar possibilities. Figure 4. Radar end of a German night fighter.



on a *crash* basis, equipment being designed and produced as needed in record time.

The Military Problem

Radar eventually came to be used by the enemy and the allies in the form of early warning for aircraft, ship surface search, gun laying and searchlight control, ground control interception and night fighting aircraft. Our countermeasures group had to prepare for and put into use means for destroying enemy radar intelligence, confusing it for tactical purposes and making enemy radar itself a means for supplying information for our own offensive actions.

The means used were search, direction finding and jamming. A variety of air- and ship-borne receivers covering the enemy radar bands were designed. Each of these receivers covered a continuous wide frequency band and were arranged for manual tuning, continuous motor-driven tuning with either aural or unattended continuous signal recording, or visual panoramic display. A particular radar signal could be analyzed by means of a pulse analyzer to give its pulse width and repetition rate. Thus *search* was effected. An enemy radar concentration could then be located by means of highly refined direction finders using rapidly rotating antennas which displayed the direction of the enemy signal as the direction taken by the spot on a c-r tube.

On the basis of this information together with information from captured equipment, appropriate jamming measures could be planned. Such information could be obtained by planes or ships

(*Continued on page* 85)

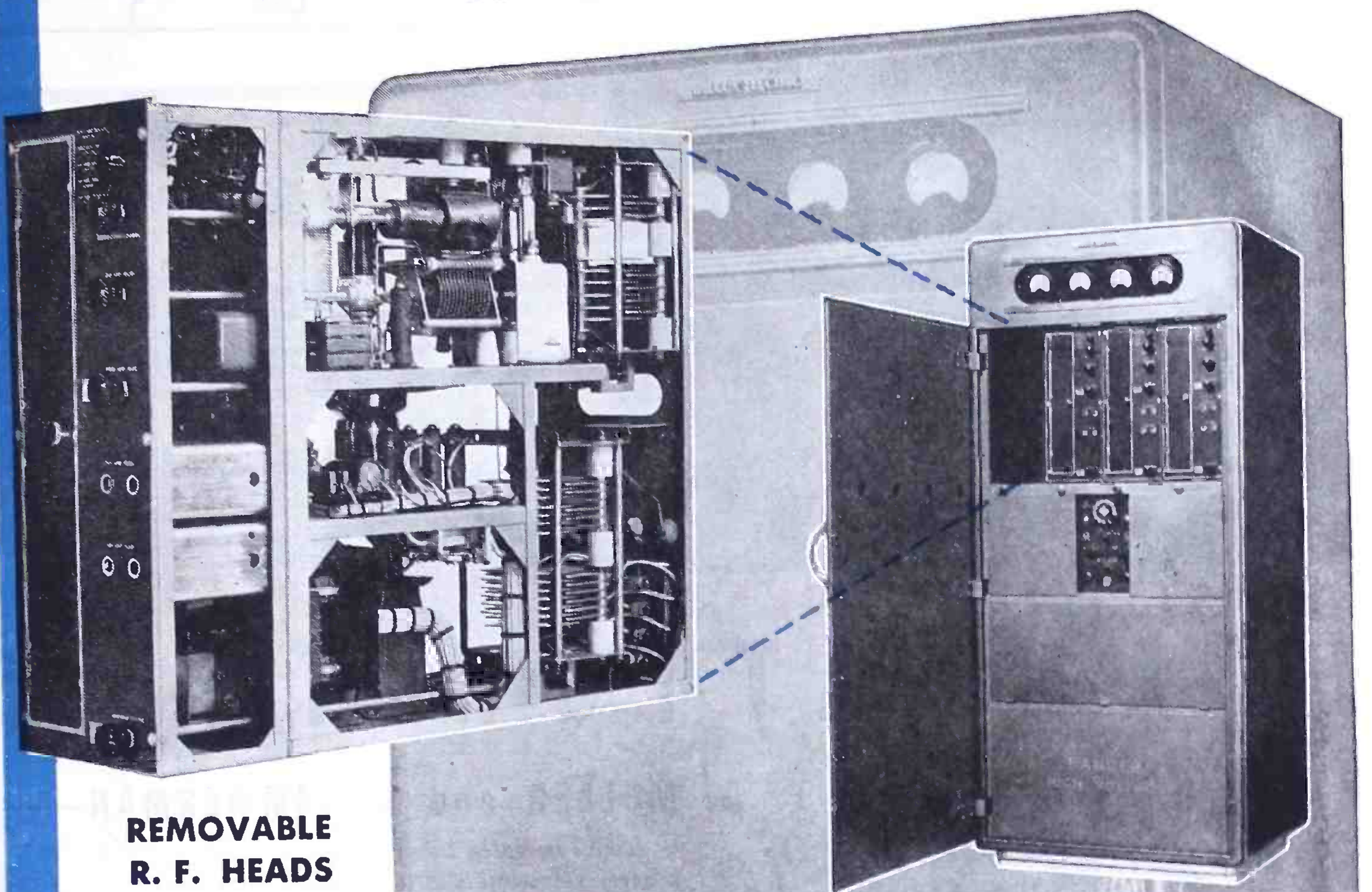
Frequency Range (mc)	Carrier Power Out (watts)	Band-width (mc)	Sideband Power (watts)	Input Power a-c (watts)	Input Power d-c (watts)	Comments
			Jamming Transmitters			
25- 100	All power in sidebands	.150	40-20	275	..	Single sideband suppressed carrier-noise transmitter single dial tunable over any 5 mc. Used against German EW, Jap GL and SLC.
85- 150	12-9	3	3- 2	280	..	Grid modulated mopa. Used again German EW.
90- 220	All power in sidebands	6	15- 8	250	..	Single sideband suppressed carrier-noise transmitter. Used against German EW, Jap GL and SLC.
200- 550	20-5.5	7	5-1.25	400	28	Modulated-line oscillator using doorknob tubes. Used against German coast watching radar, Japanese torpedo planes.
450- 720	8-3	7	1.6-.6	265	28	Modulated-line oscillator using doorknob tubes. Used against German GL radar *Wurzburg*.
475- 585	20	7	5	400	28	Modulated parallel-plate oscillator using 8012 tubes. Single dial tuning. Used against German GL radar *Wurzburg*.
350-1200	30-5	2.5-3.0	..	500	35	Modulated lighthouse-cavity oscillator. Single dial tuning. Used against German GL radar *Wurzburg*.
150- 780	150	7-10	..	1500	150	Current-modulated magnetron oscillator. Single dial tuning. Used against German GL radar *Wurzburg*.
300-2500	25-10	2-8	10-3	350	50	Modulated oil-can cavity oscillator. Single dial tuning.
2230-4030	25-50	..	..	550	..	Modulated tunable magnetron jammer. Single dial tuning. 4 heads to cover frequency range.
			Amplifiers			
26- 105	200-100	4	Depends on driver	600	..	Push pull amplifier.
85- 150	115-140	3 1.5	Depends on driver	550	..	Push pull amplifier.
140- 210	50	5	Depends on driver	550	..	Push pull amplifier.

Note: EW, Early Warning; GL, Gun Laying; SLC—Search Light Control.

Figures 5 (above) and 6 (below)
In Figure 5 appears data on jamming transmitters and amplifiers. Figure 6 provides data on receivers and direction finders used in jamming.

Frequency Range (mc)	Type of Circuit	Input Power a-c (watts)	Input Power d-c (watts)	Comments
				Receivers
25- 100	Superheterodyne	75	..	Tuned electronically to same frequency as transmitter.
40-3000	Superheterodyne	90	9	Single dial tuning radar search set used in Europe and the Pacific; 4 heads cover the frequency range. Bandwith 4 mc or .5 mc.
1000-3100	Superheterodyne	150	25	The original microwave search set used in Europe and the Pacific. Cavity oscillator, crystal mixer. Coaxial antenna input.
3000-6000	Superheterodyne	150	25	Same set as above, but special mixer operates on oscillator harmonies waveguide input.
4 or 10	Motor driven; panoramic adaptor	75	..	Used in connection with any receiver with 30 mc i-f as tuning aid.
				Direction Finders
100-450 in 3 Heads	Remotely controlled rotating antennas	1	..	Adcock antenna used for vertical polarization. Dipole antenna used for horizontal polarization. Equipment used as a null system in conjunction with search receiver. Remote bearing indication by selsyns. Set widely used in radar search in Europe and the Pacific.
300-1000	Whirling antenna with cathode-ray presentation	125	50	This is a visual presentation automatic direction finder comprising a whirling antenna having an essentially undirectional pattern and a synchronized circular sweep on a cathode-ray tube. The set works on the maximum of the antenna pattern. The shipborne version is similar to the airborne set in principle. A number of antennas exist for other frequency ranges. The set can be used with any appropriate search receiver.

Wilcox Type 99A Transmitter



REMOVABLE R. F. HEADS

All radio frequency circuits are included in the 2–20 Mc. R.F. head shown above. All connections to the transmitter cabinet are by means of plugs and receptacles.

A medium power transmitter, designed particularly for aeronautical service. Equally adaptable to other fixed services. Check these features for their application to your communication problems:

★ Four transmitting channels, in the following frequency ranges:
125–525 Kc. Low Frequency.
2– 20 Mc. High Frequency.
100–160 Mc. Very High Frequency.
Other frequencies by special order.

★ Simultaneous channel operation, in following maximum combinations:
3 Channels telegraph.
2 Channels telephone.
1 Channel telephone, 2 Channels telegraph.

★ Complete remote control by a single telephone pair per operator.

★ 400 Watt plus carrier power.

★ Low first cost. Removable radio frequency heads are your protection against frequency obsolesence.

★ Reliability backed by two years of engineering research, one year of actual field operation.

★ Available with all-steel, or wood pre-fabricated transmitter house complete with primary power, antenna, and ventilation fittings.

★ Not a "post-war plan," but a field-tested transmitter now in production.

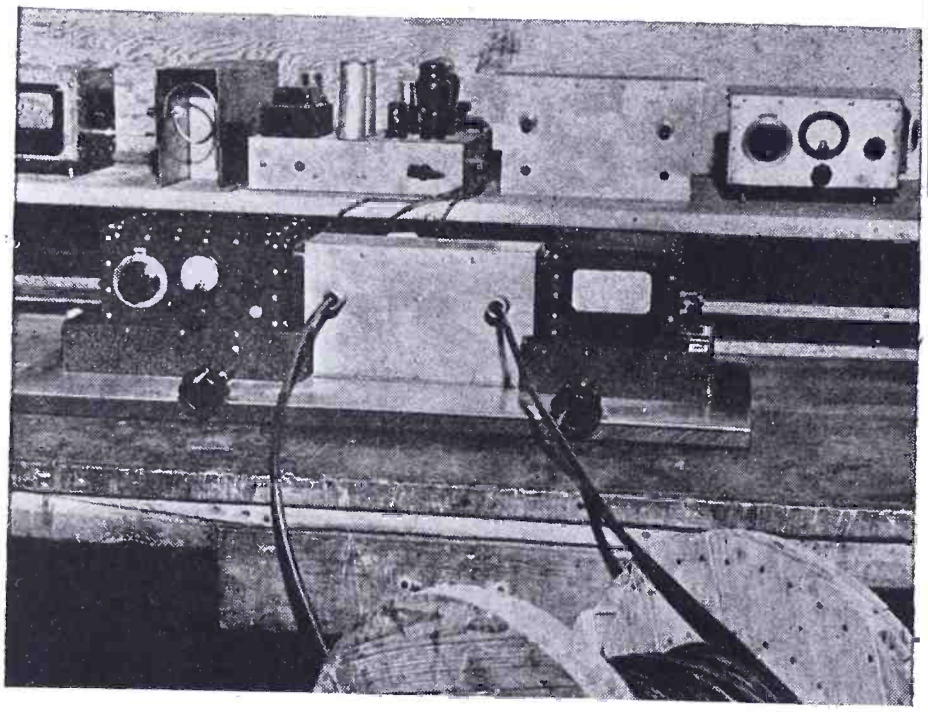
An inquiry on your letterhead outlining your requirements will bring you complete data.

WILCOX ELECTRIC COMPANY, INC.

Manufacturers of Radio Equipment

Fourteenth and Chestnut **Kansas City, Missouri**

Figure 1
High-frequency attenuation test equipment developed for mass production processing of v-h-f cable.



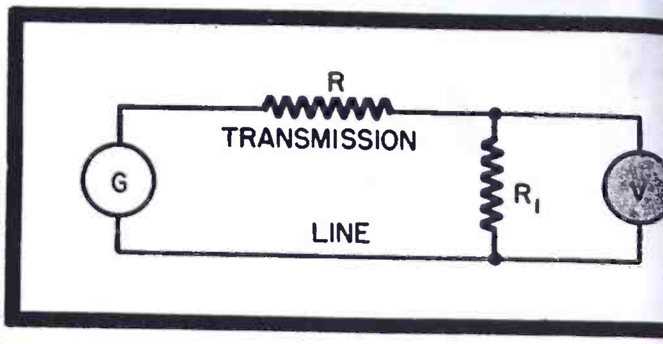


Figure 1a
Simplified schematic of a possible low-frequency attenuation test setup. $R_1 = R$ (R and R_1) between the output and input impedances respectively of the generator and vacuum-tube voltmeter.

ATTENUATION TEST

—by F. A. MULLER and K. ZIMMERMAN—

Intelin Research Laboratories
Federal Telephone and Radio Corp.

THE trend toward the use of higher frequencies has accentuated the need for low attenuation high-frequency cables. For instance, in some prewar television receiver installations 50% of the power picked up was lost in the leadin wire between antenna and receiver. This would represent an intolerable condition in present day equipment. If a low attenuation high-frequency cable had not been developed the use of high frequencies might not have expanded to its present-day proportions.

The development of this low attenuation cable was the result of teamwork of laboratory and production engineers. First, new techniques and materials were developed in the laboratory by research engineers and then the production engineer devised a system that duplicated the laboratory result on a mass production basis. Laboratory precision instruments that lend themselves to mass production methods also had to be developed so that the characteristics of the product obtained in the factory could be checked continuously.

The design of u-h-f test equipment is invariably difficult because of the critical nature of the test conditions necessary for accurate results. Also, the equipment designed usually involves procedures that are time-consuming and can be performed only by skilled personnel. Such equipment is obviously not adaptable to mass production methods which require accurate results rapidly obtainable by unskilled personnel. It thus became necessary to develop special test equipment that permitted rapid yet accurate testing, and with a minimum of operations. One of the instruments developed for such mass production processing is shown in Figure 1. A 100 to 400-mc attenuation meter, it can be operated by unskilled personnel, providing direct readings in db.

The Design Problem

In measuring attenuation a known amount of power is usually fed into a transmission line and then the power delivered by the line is measured. Knowing the ratio of these two values the attenuation can easily be calculated by use of the equation:

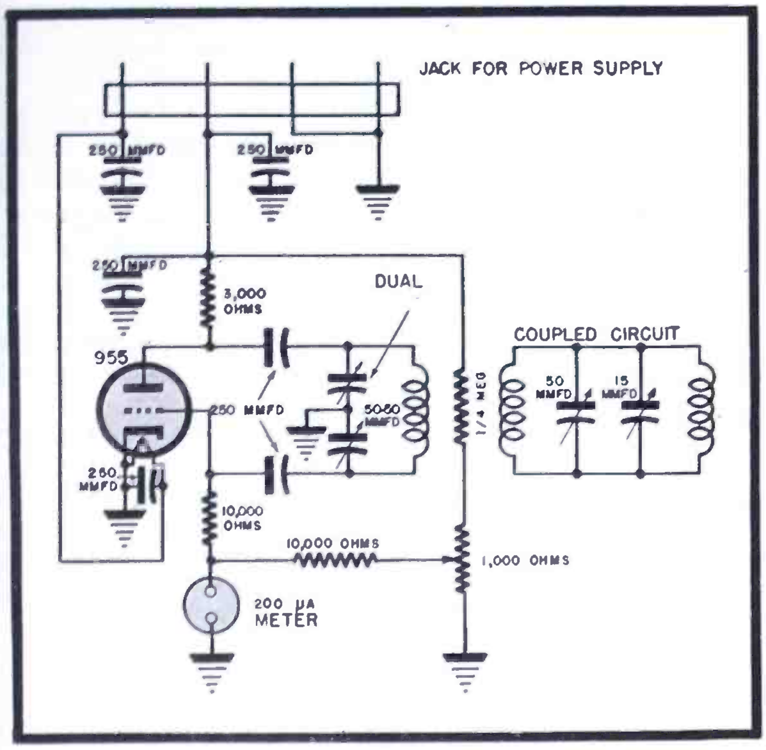
$$A\ (db) = 10 \log \frac{P_{in}}{P_{out}}$$

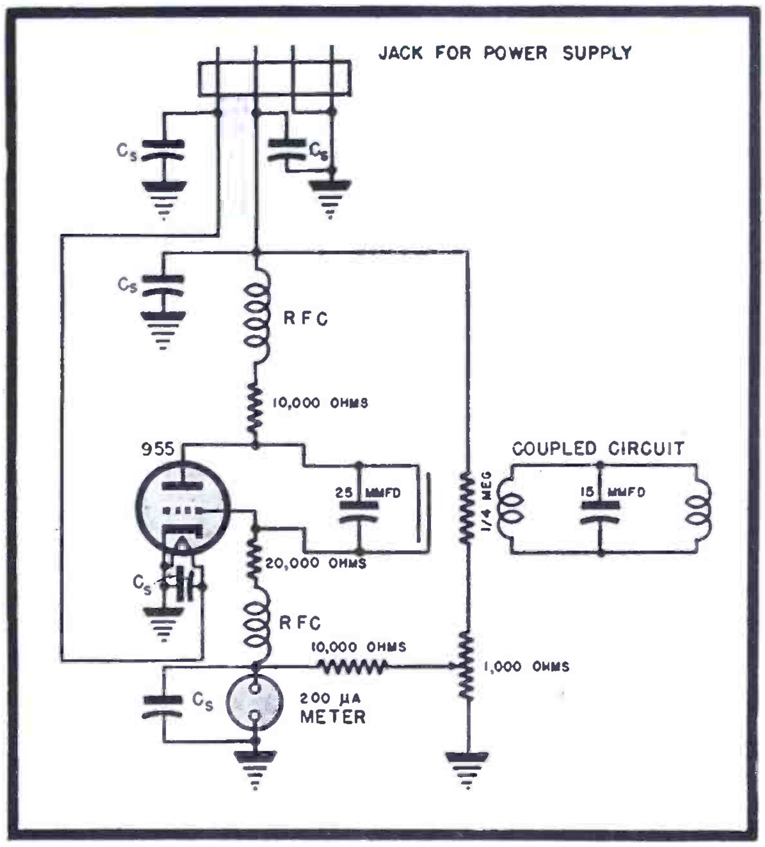
Since power varies directly with the square of the voltage, it may be determined by measuring the voltage across the line. The attenuation is then calculated from

$$A\ (db) = 20 \log \frac{V_{in}}{V_{out}}$$

At low frequencies this can be achieved quite readily. A simplified schematic of a possible set-up is shown in Figure 1*a*. $R = R_1$ (R and R_1 being the output and the input impedances respectively of the generator and vacuum-tube voltmeter) and is chosen for maximum power transfer. V_{in} is measured by directly coupling the generator output to the vacuum-tube voltmeter. V_{out} is the reading obtained by transmitting the same generator output through a known length of transmission line.

This procedure becomes more complicated when high frequencies are used. This is mainly due to the difficulty of effecting an impedance match. Unless a transmission line is terminated in a pure resistance equal to its characteristic impedance, reflection occurs, causing standing waves and an incorrect reading of attenuation. Hence the transmission line must be properly terminated. Furthermore, the generator must be matched to the transmission line, to insure the delivery of the same generator output when coupled directly to the voltmeter as when coupled through the transmission line. Two impedance matches are therefore nec-





Figures 2 (above) and 3 (right)
Figure 2. A 100 to 200-mc oscillator with coupled circuit. Figure 3 illustrates a 300 to 400-mc oscillator with a coupled circuit. C_s = special capacitor.

EQUIPMENT FOR V-H-F TRANMISSION LINES

essary before accurate results can be obtained.

Much of the original circuit work was done at the Naval Research Laboratories and appears in their report on *Methods of Measuring the Electrical Characteristics of Transmission Lines at U-H-F.*

Generator Circuit

Two oscillator circuits are used. One is for the 100 to 200-mc range and the other for the 300 to 400-mc range (Figures 2 and 3). Both oscillator circuits are designed for a high degree of frequency and power output stability. The circuit is carefully shielded to prevent signals other than those carried by the transmission line from reaching the vacuum-tube voltmeter. The coupling coil is almost completely external to the shield, just enough of it extending within the shield to provide loose coupling with the tank circuit. To keep this coupling inductive, a perforated copper sheet is mounted between the tank circuit and the coupling coil. The whole set-up can be considered as a constant series electromotive force driving a tuned circuit. The tuned circuit is in turn coupled to the transmission line; Figure 4 is a simplified schematic representation of this circuit. As indicated in the equivalent circuit, Figure 5, the presence of the transmission line (L_1, C_4, R_2) places, in effect, a series resistance in the generator coupling loop circuit whose value is

$$R_R = \frac{\omega^2 M^2}{R_3}$$

The magnitude of this reflected resistance is controlled by varying *M*, the mutual inductance. Figure 6 shows L_3, C_3 and R_R replaced by an equivalent impedance consisting of a capacitance in series with a resistance R_1. Since C_2 is adjusted to resonate the loop circuit the total reactance in the circuit of Figure 6 is zero and this circuit thus becomes identical to Figure 1. Thus, by varying the coupling between the two circuits an impedance match can be achieved which is the point of critical coupling. This occurs when

$$R = R_1$$

and is indicated by a maximum reading on the vacuum-tube voltmeter at the far end of the line.

Figure 4 applies to both the factory and laboratory equipment. The only difference between the two is the method of varying the coupling between two units. In the laboratory apparatus the coupling is varied manually by moving one piece of apparatus toward the other until a maximum reading is obtained on the vacuum-tube voltmeter. The factory apparatus simplifies the required technique and minimizes the possibility of errors of manipulation by placing the equipment on tracks so that the coils are positioned at right angles to each other. In addition the movement of the units is accomplished by means of a gear mechanism so adjusted that a complete revolution of the gear moves the unit only a fraction of an inch. Thus, the critical point can be approached very slowly without depending on manual dexterity and only one reading is sufficient. The entire operation requires less than a minute.

Transmission Line Match

By a similar process it is possible to terminate the transmission line in a pure resistance equal to its characteristic impedance. In Figure 7 appears a simplified schematic of the transmission line-voltmeter circuit. Here again the impedance match is accomplished by varying the coupling between the two units until a maximum reading is obtained on the vacuum-tube voltmeter. Two vacuum-tube voltmeters are used; one for the 100 to 200-mc range and the other for the 300 to 400-mc range (Figures 8 and 9). As in the generator circuit the factory method provides an accurate and rapid mechanical arrangement for determining the coupling that will provide maximum power transfer.

Coupling Loop Unit

Another unit which reduces a possible source of error and simplifies the operation in the factory equipment is the coupling unit. There are four coupling units for 100, 200, 300 and 400 megacycles. The coupling unit consists mainly of two non-reactive loops which are well shielded from each other and to which the ends of the transmission line are connected. One loop is coupled into the generator circuit, the other into the voltmeter circuit. These loops are carefully soldered in the unit and need not be retuned oftener than once a week. The transmission line is connected to the loops through a banana jack and a quick connecting braid clamp. A good contact is assured by means of a banana plug which is soldered to the center conductor. This job of soldering has been simplified and speeded up by providing a jig into which the banana plugs fit. Uniform heat throughout the plug when soldering is assured by means of a carbon arc. Thus, when the center conductor is placed in the plug a very clean uniform soldering job results (Figure 10). The whole operation can be performed in a matter of seconds. All the operator has to do is expose the center con-

(*Continued on page* 58)

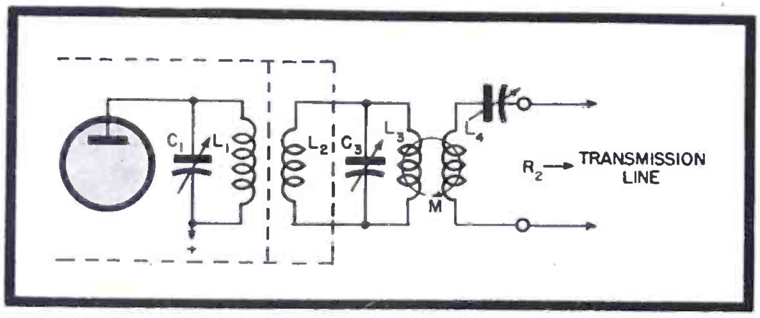


Figure 4
Generator coupling loop circuit.

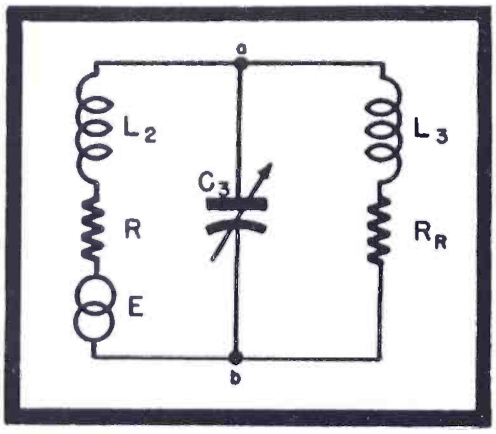


Figure 5
Equivalent of generator coupling circuit. $R_R = \frac{\omega^2 M^2}{R_2}$; where $\omega = 2\pi f$, M = mutual inductance between L_3 and L_4. R = resistance reflected into L_2 by tank coil L_1; E = voltage induced into L_a by L_1; and R_R = resistance reflected into L_3 by $L_4C_4R_2$ circuit.

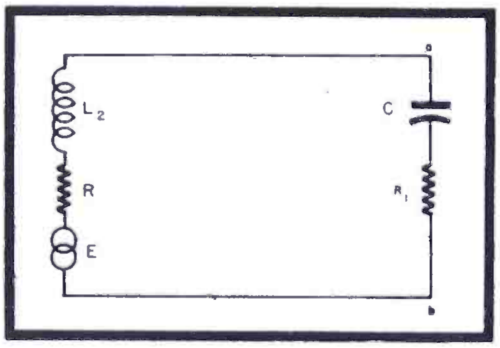
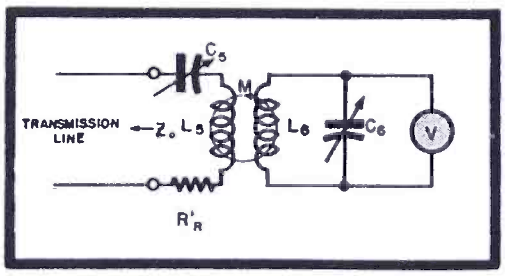
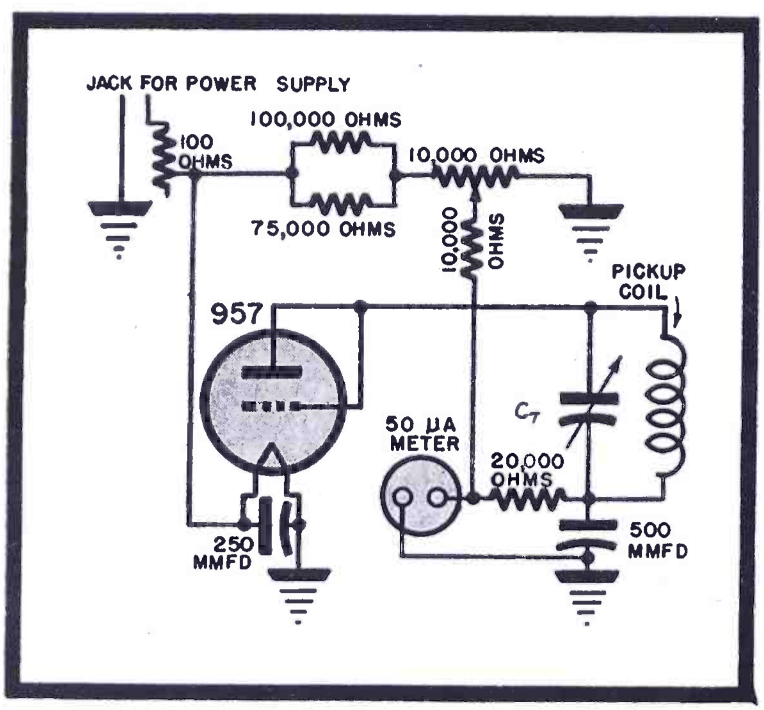


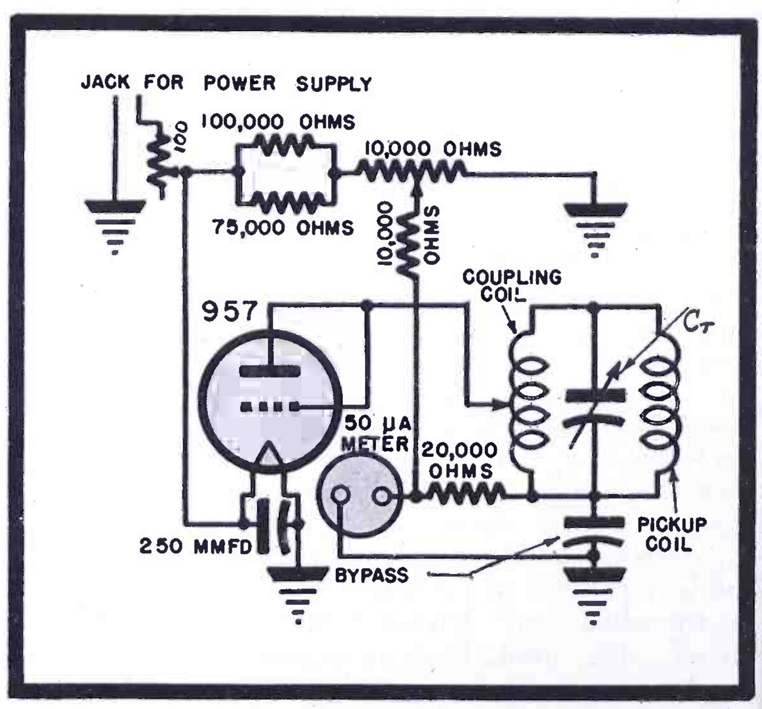
Figure 6
Equivalent of Figure 5. The impedance of C_3L_3 and R_R are replaced by an equivalent impedance consisting of a capacitance *C* in series with a resistance R_1.



Figures 7 (left), 8 (left below) and 9 (right below)

Figure 7. Vacuum-tube voltmeter coupling loop circuit. Maximum power transfer occurs when the reflected resistance R'_R is made equal to Z_0. **Figure 8.** Circuit of 100 to 200-mc vacuum-tube voltmeter. **Figure 9.** Circuit of a 300 to 400-mc vacuum-tube voltmeter. C_T = tuning capacitor.





V-H-F ATTENUATION TEST EQUIPMENT

(Continued from page 56)

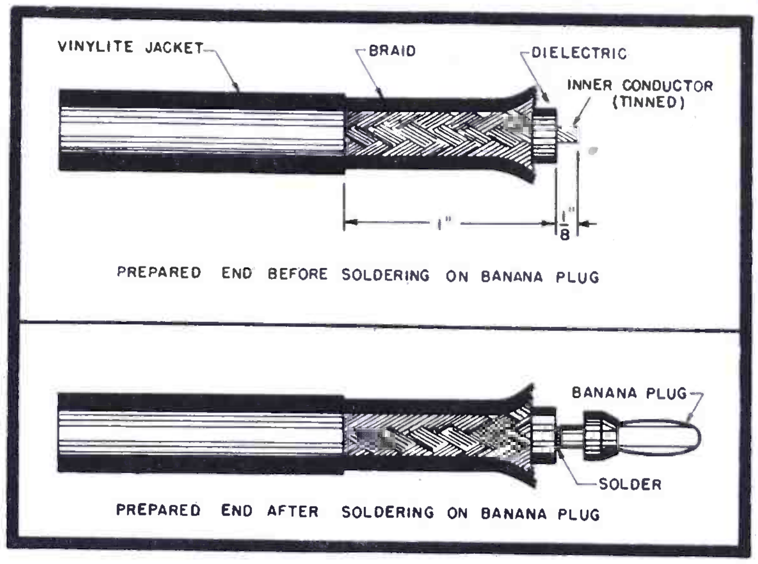


Figure 10
Preparation of ends of transmission lines. Transmission line is connected to loops of attenuation test unit through a banana jack and a quick connecting braid clamp. Good contact is assured by a banana plug which is soldered to center conductor.

ductor, solder the connectors, plug the line into the instrument and start measuring.

Laboratory Method

The laboratory method requires a more complicated procedure. The non-reactive loops have to be soldered on to the transmission line and then soldered to a ground plate. Obviously this is a difficult time-consuming job requiring a considerable amount of skill. In addition, because of continuous soldering and unsoldering, the capacitor often becomes loose and the loop must then be carefully tuned before each use.

To measure the attenuation of balanced lines a special coupling loop unit is provided. Since there are two inner conductors in this type of a cable, two receptacles are needed for each end of the line. Special connectors are used into which both conductors are clamped. The only change in the circuit is in the non-reactive coupling loops of the coupling unit which use two identical capacitors, Figure 11.

Power Supply

The power supply (Figure 12) contains several features which are required to maintain a high degree of accuracy in the equipment. The voltage supplied to the oscillator remains constant despite variations in the load, thus assuring a constant power output. The voltage, however, can be varied by turning the *voltage control* knob on the front panel of the power supply, thus enabling the operator to control the power output of the oscillator.

Voltage Regulator

Another feature is the voltage regulator circuit that supplies filament voltage to the vacuum-tube voltmeter. It is of course necessary that this voltage be kept constant within a very narrow range. This is done by cascading two voltage regulator tubes and thus obtaining a high degree of voltage stability.

Operation of the Equipment

The vacuum-tube voltmeter is calibrated to read directly in db. First the attenuation of a 2′ cable is measured and then that of a 102′ cable. The difference between these two readings represents the attenuation of 100′ of cable. If the attenuation of a 2′ line is set at zero, the reading obtained for the 102′ line will be a direct measure of the attenuation of 100′ of the cable. Thus once the meter is adjusted to zero (by varying the *voltage control* knob on the power supply) with a standard 2′ cable, it will then give direct readings of the attenuation of the test cables. It is not necessary to adjust the meter to zero after every test as long as the same type of cable is used. Usually the zero reading is checked every 8 to 10 readings. These readings require little time, for the only operation necessary is to plug the cable into the meter and then vary the coupling for maximum voltage. It is desirable to select a length of line whose attenuation is about 5 db, as at this reading the scale is almost arithmetically linear (Figure 13).

Initial Setup Procedure

To set up the equipment for the first time a lengthier and more skilled procedure is of course required. First the frequency at which the attenuation is desired must be determined. Then the appropriate oscillator, vacuum-tube voltmeter, and coupling unit must be selected and slipped into the place provided for them on a base containing two side carriages. The power supply is then placed in a convenient position so that its outlets can be plugged into the oscillator and vacuum-tube voltmeter. The cable is then plugged in (Figure 14), the oscillator is tuned to the desired frequency after which the oscillator coupling circuit, the two non-reactive loops, and finally the voltmeter circuit, are tuned in the order named. Once this is done the operator follows the procedure previously indicated. The non-reactive loops need but infrequent retuning, while the oscillator and voltmeter tuning is done only for the first reading obtained that day.

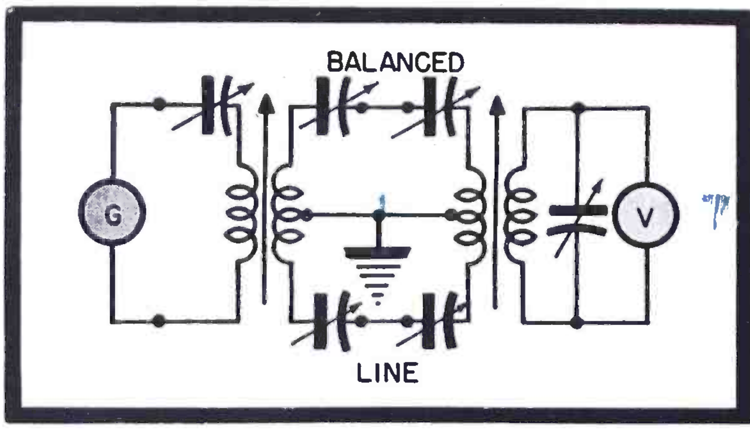
Measuring Highly Reactive Lines

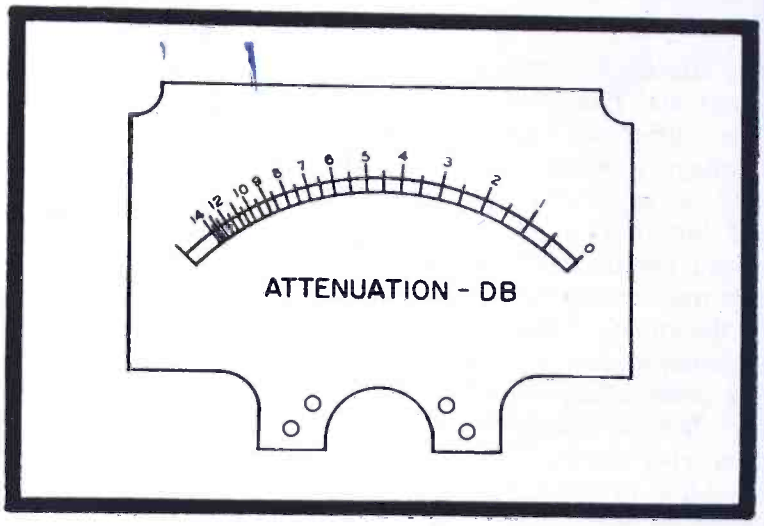
Lines of highly reactive characteristic impedance may be measured on

(*Continued on page* 60)

V-H-F ATTENUATION TEST EQUIPMENT

(*Continued from page 59*)





Figures 11 (above) and 13 (right)
Circuit for measurement of balanced lines, with a special coupling loop unit. The loops are non-reactive. Two identical capacitors are used. Figure 13. The db dial used on the vacuum-tube voltmeter. In calibrating, the attenuation of a 2′ cable is measured and then a 102′ cable is measured. The difference between these two readings represents attenuation of 100′ of cable. If attenuation of a 2′ line is set at zero, the reading obtained for the 102′ line will be a direct measure of the attenuation of 100′ of cable.

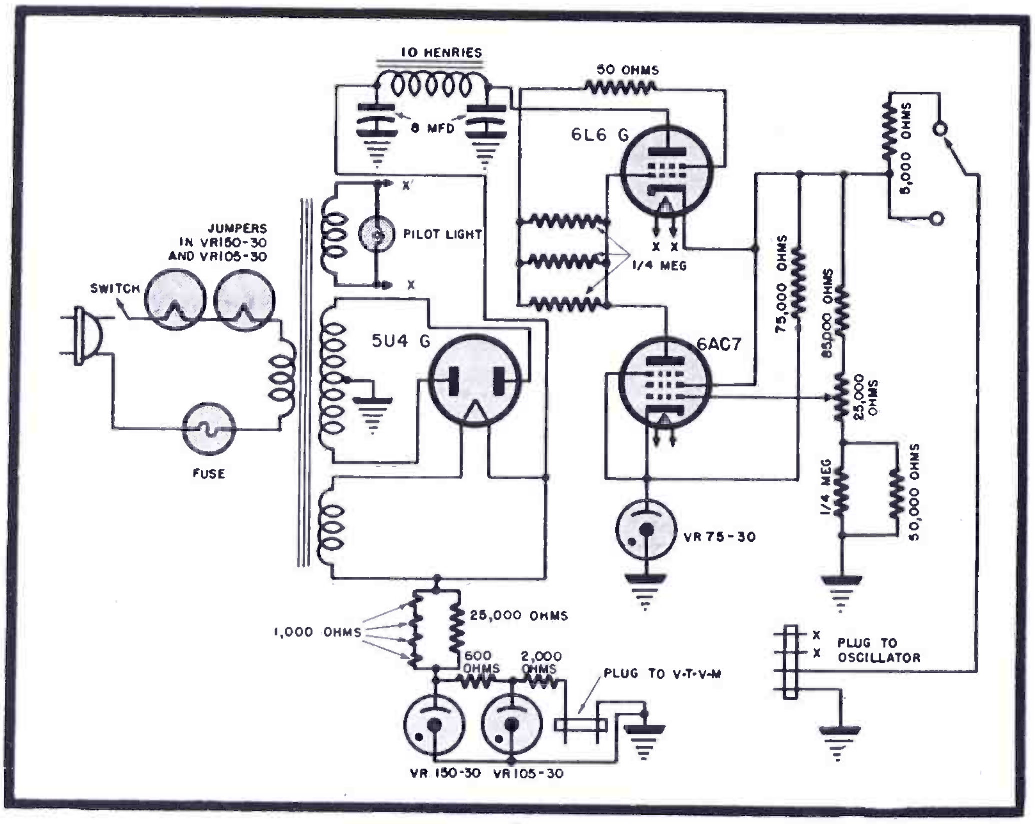
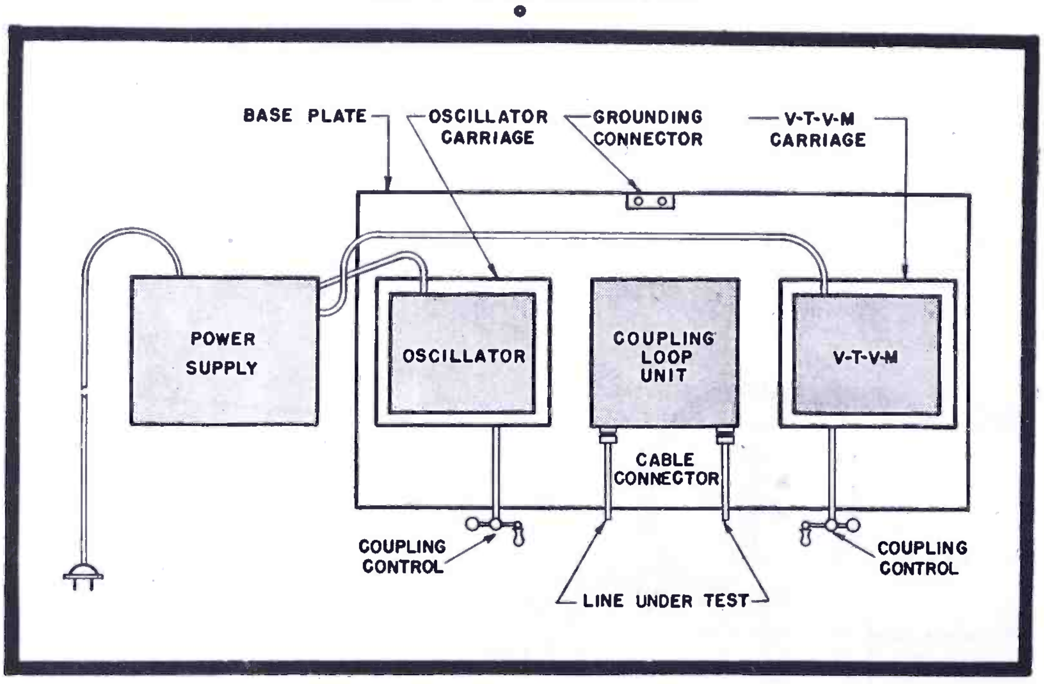
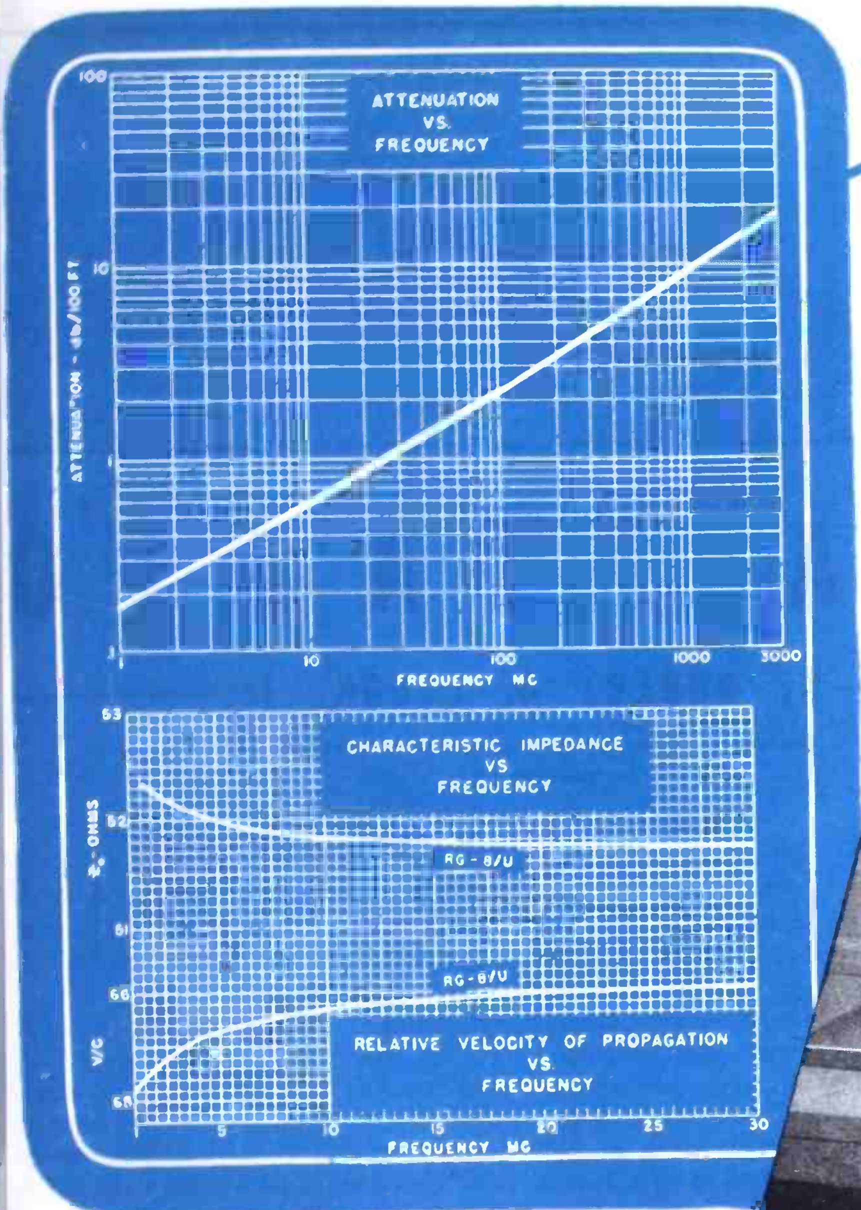


Figure 12 (left)
Circuit of regulated power supply. Two voltage regulator tubes are cascaded to obtain a high degree of voltage stability. The voltage to the oscillator remains constant despite variations in the load, thus assuring a constant power output. The voltage can be varied by turning a voltage control knob on the front panel.

Figure 14 (below)
Setup for attenuation measurements. In use, the cable is plugged in, the oscillator is tuned to the desired frequency, after which the oscillator coupling circuit, the two non-reactive loops and finally the voltmeter circuit are tuned. The non-reactive loops require infrequent tuning, while the oscillator and voltmeter tuning is done only for the first reading the day the tests are made.



this apparatus by applying a slightly different technique. After the line has been plugged in, and the vacuum-tube voltmeter and oscillator coupling circuit tuned, both non-reactive loops are tuned for minimum attenuation reading on the db-calibrated vacuum-tube voltmeter. Then, in the order named, the following are adjusted for minimum attenuation reading: Oscillator tuning, vacuum-tube voltmeter tuning, oscillator coupling and vacuum-tube voltmeter coupling. When the system is so adjusted that any change in tuning or coupling will cause a rise in the attenuation reading, the system is properly adjusted for this type of measurement. A standard 2′ cable of this type is used to set the vacuum-tube voltmeter at zero decibels. The procedure is then the same as for other cable types.



HERE'S PROOF...

How Federal H-F Cable Quality is Controlled by *Actual Test*

Precision engineering—plus careful control of all manufacturing operations . . . from raw materials to finished product—mean complete reproducibility in any given Intelin Cable type . . . and overall superior cables.

Take Intelin RG-8/U for instance . . . general purpose "work-horse" of high-frequency cables. Its characteristics are shown in curves obtained—not from nominal design values—but from thousands of actual measurements on cable samples, with special equipment developed and used exclusively by Federal's Intelin Product Line.

Intelin's Attenuation Meter is an example of such equipment. It's a precision instrument . . . accurate to .1 db . . . developed by Intelin to provide a constant check on production quality and "measured" data for the equipment designer.

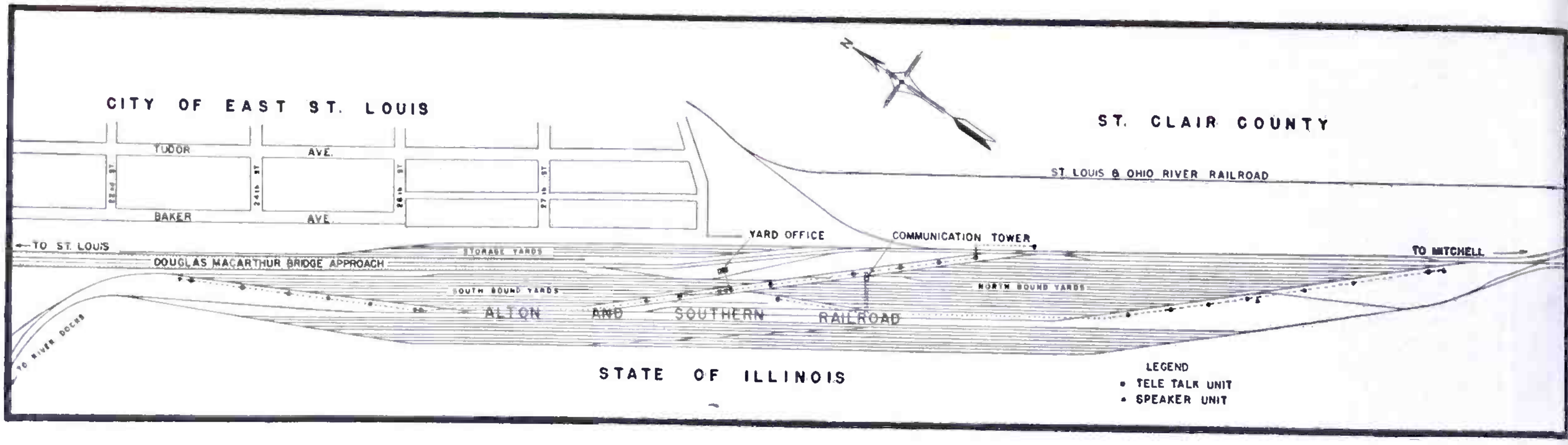
For additional information regarding Intelin RG-8/U . . . write *today* for Report E-53 —and for cable you can count on . . . *always* specify INTELIN.

FEDERAL TELEPHONE & RADIO FTR

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark 1, N. J.



RAILROAD RADIO

by ROBERT A. CLARK, Jr.
Communication Equipment and Engineering Co.
Chicago, Ill.

RAILROAD radio received its first effective demonstration over forty years ago; about 1914. In general the railroads were not too enthusiastic about this means of improving safety and speeding up train operations. While of course some of the tests indicated that radio could be used, there were many difficulties in establishing satisfactory communications and there are still many problems to be solved. Until the advent of u-h-f the problem seemed almost insurmountable. For example, the qualifying of each conductor and engineer on a railroad to meet the FCC requirements had been a serious problem. Also with the limited number of frequencies available the FCC had been rather reticent in allotting bands.

There are today two types of train operations with which radio is concerned. One involves the movement of cars in yards and around large cities, the latter known as terminal operation, and the second calls for the movement of trains on the main tracks between cities.

Trains are made up in yards. A typical yard layout is shown in Figure 1. The tracks vary in number depending on the size of the yard. Often the yard is divided into two sections; for example, a northbound yard and a southbound yard. Communications are usually required to all points in the yard and in many modern yards a loudspeaker system is arranged for this purpose. In fact some railroads prefer the loudspeaker installation to radio which would normally be from the yardmaster to the engines only. A typical yardmaster's office where all movements are coordinated appears in Figure 2. In this installation, the yardmaster can talk to the engine via radio.

Terminal operation involves the picking up of a few cars from one yard and transferring them to another. Generally the yards are on the edge of a large city. Thus the yardmaster finds it necessary to keep in touch with his engines when they are out picking up cars from other yards as well as when they are in his own yard. When a train is made up, particularly freight trains, it moves out onto the main line and then comes under the jurisdiction of a train dispatcher. The train dispatcher has control over many miles of main line track ranging from around fifty to several hundred miles. The length of line over which one dispatcher has jurisdiction depends pri-

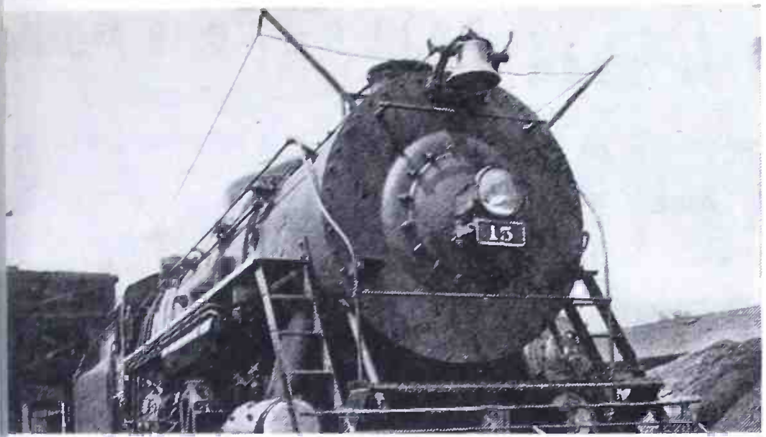
*Based on a paper presented before the Chicago section of the IRE, specially prepared for COMMUNICATIONS by the author.

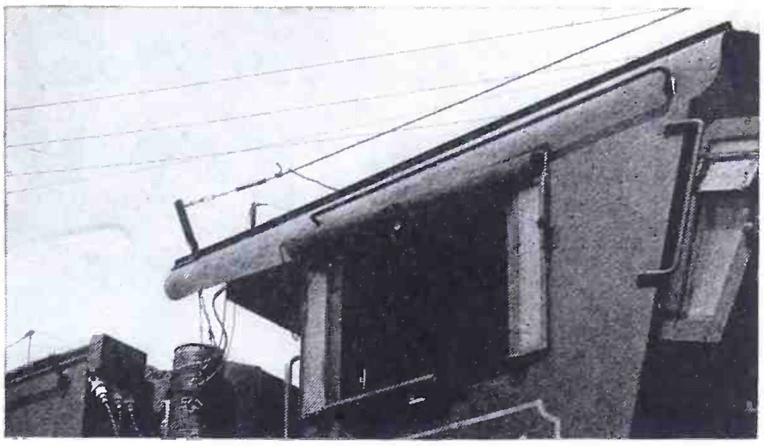
Figures 1 (above) and 2 (right, below)

Figure 1. Communications system at the Davis yards of the Alton and Southern R.R. of East St. Louis, Illinois. Figure 2. Radio setup in the yardmaster's office of the Blue Island freight yards of the Rock Island Lines. At microphone is yardmaster Clyde Emmert. J. D. Farrington, chief executive officer, is looking on.

Figure 3 (left)

Rock Island emergency radio unit used to bridge gaps in telephone line breaks. C. O. Ellis, superintendent of communications, is at telephone.





COMMUNICATIONS*

marily on the number of trains moving.

There are several methods of handling train movements along main line trackage. The simplest system and one which is still used on many railroads, where the train movements are not extremely heavy, is known as operation by time-table and train orders. All trains move under direction of the dispatcher by means of written orders delivered to the conductor and engineer of each train. Trains operating on schedule run in accordance with the timetables except in emergency. Trains can be stopped only by means of signals operated at depots attended by operators. The second type of operation involves the use of automatic block signal systems in addition to the timetable and train orders. This obviously provides more protection and is used in general on most heavily loaded lines. A modification of this system which was placed in effect on a few sections of railroads several years ago included cab signals and automatic train control, whereby if a train entered a block to which the signals showed red or stop the power was automatically shut off and braking applied. This system has not proved very practical and is used to a very limited extent today.

The third system of train control is known as the centralized traffic control or c-t-c system . With this method the dispatcher has control of all signals throughout his territory and can throw siding switches at will. The trains run without orders moving entirely by the wayside signals. This system is very expensive and while it speeds up train movements it has been applied only where the traffic density is very high. In all of the systems described the dispatcher's communication to each station along the line and unattended sidings where trains may stop, is generally by telephone. At such locations there is a booth telephone whereby the conductor or engineer can talk to the dispatcher and obtain instructions.

Types of Communications Facilities

In yard operation the yardmaster need talk only a few miles, that is from one end of the yard to the other. This is not very difficult using u-h-f as the yard is generally free from obstructions and it is easy to install a directional antenna which will cover the yard quite completely. Terminal operation is much more difficult as the communication will often extend over a radius as great as twenty or twenty-five miles. It may be that a number of fixed stations will be required to cover an area, each of which will be tied into the yardmaster by means of a telephone circuit. On main line train movements we have communications from the dispatcher to the conductors on the trains, communications from the conductor of one train to the engineer of that train and also communications between conductors on trains near each other. As mentioned before the dispatcher often has one hundred or two hundred miles of track under his jurisdiction and we are confronted with the problem of

Figure 4 (above, left) and 5 (above, right)
Figure 4. Locomotive equipped with carrier communications antenna. Figure 5. Antenna wires terminating on cab and fed to a junction box where the antenna and power circuits are carried to the equipment located on the tender.

Figure 6 (below)
Figure 6. Railroad radio equipment in a steel cabinet on the tender. This location is better than in the cab, since the vibration is less.

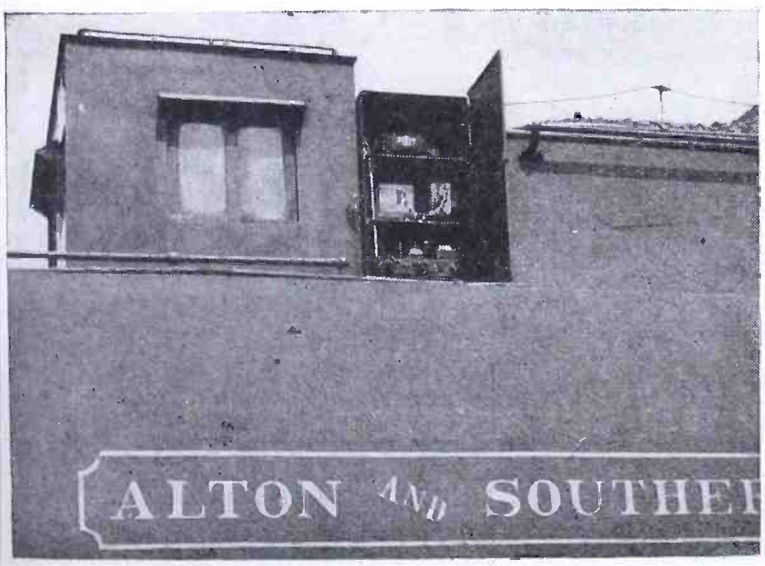


Figure 7 (above)
Dispatcher with two speakers, one for main telephone operation and another for communications with trains.

RAILROAD RADIO

(Continued from page 63)

talking over fairly long distances. Here again it will probably be necessary for the dispatcher to use a telephone circuit and communicate via radio over relatively short distances. It is also desirable that two trains be able to communicate with each other over a distance up to around five miles. Front to rear will range up to a mile and a quarter.

There are a few other uses of radio in railroad operation. One of them is the emergency radio system which can be taken out and installed at the ends of a wire line prostration, such as caused by tornado or sleet storm. The distance over which such a system should be able to work will range up to about twenty-five or thirty miles. In Figure 3 we see a typical emergency unit suitable for bridging wire breaks. This particular set operates in the 30-40 megacycle band and should work quite well up to twenty miles. It is a two-frequency duplex system equipped with hybrid coils so that it can be used as part of the telephone circuit.

A warning system for employees is also needed. This would be used by section gangs and work crews to indicate the approach of a train.

We come now to the problem as to how best to apply radio to the railroad communication problem. There are two systems proposed. One is the inductive carrier system employing frequencies ranging from about 50 to 200 kc. In fact one system employes frequencies as low as about 7,000 cycles.

The carrier system requires a wire of some kind along the right-of-way within about 100′ to 150′ of the track over which the train travels. A carrier system operates under the so-called low power radio formula; $D = \frac{157,000}{F}$ $\left(\frac{\lambda}{2\pi}\right)$ signal not to exceed 15 μv/m

By exceeding this formula bit it is possible to install wires along the side of a yard and obtain quite satisfactory communication throughout the area. In typical right-of-way systems the telegraph line in general will not be more than 40′ of 50′ away. Often the telephone line stops and goes into an underground cable. Here the carrier system runs into difficulty. In cities the tracks oftentimes go down the streets and through locations where wires can be maintained only with great difficulty and in some cases not at all. As a result the carrier system as definite limitations. Through owns where the wires take cable, there nay be sections of lines which cannot e used with the carrier system except y running special wires oftentimes at onsiderable expense.

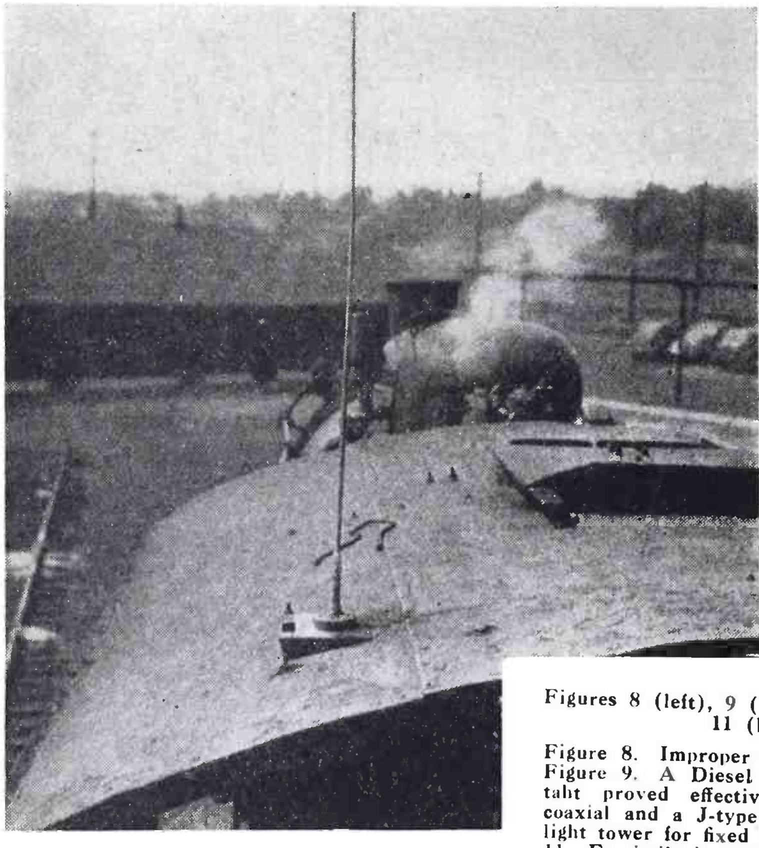
The carrier system may be either -m or f-m. Recent tests seem to in- icate that f-m using a deviation ratio f about 1:1 gives a better signal-to- oise ratio than the a-m system. Tests have made indicate that an a-m sys- em will operate over distances rang- ng up to fifty miles providing the vires are not more than fifty feet away rom the track.

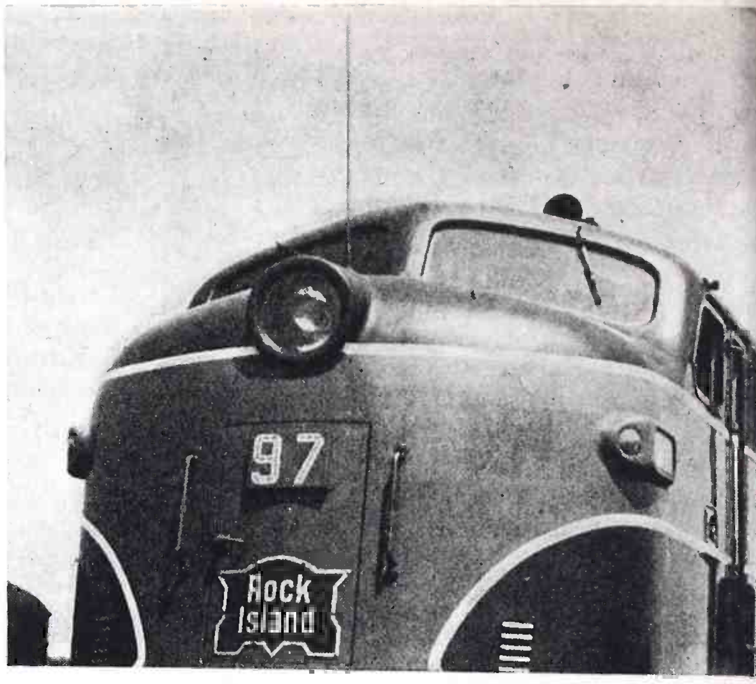
During the last year radio tests have een made using frequencies ranging rom 30 to over 2,000 mc. Both a-m nd f-m have been tried for yard and erminal operation. Satisfactory re- ults have been obtained in all the fre- uency bands. Very little work has een done on main line operation ex- ept at carrier frequencies. There has een a considerable amount of front to ear testing.

The 150-mc band appears to be quite satisfactory for this operation. However most tests indicate that about en miles is the maximum distance that atisfactory communication will be ob- ained. The tests at 2,000-mc have been very encouraging. F-m was used t this frequency and communications rom the engine to the caboose were ound to be very satisfactory regard- ess of the territory. The variation in ignal is very great due apparently to eflection and as a result f-m appeared o be better than a-m. The 2,000-mc requency was the only one that had provided satisfactory communications through the Moffett Tunnel. General- y the 150-mc frequency has proved satisfactory for front to rear com- munication. Here again, however, here is a violent fluctuation in signal strength and some difficulty has been experienced with a-m sets. The varia- tion in signal results in the flutter effect depending on the speed of the train.

The anetnna problem is not too seri- us on a caboose. However, the loco- motive installation presents problems. In Figure 8 the wrong way to mount an antenna on a locomotive is shown. Large locomotives do not have more than 10″ of 15″ clearance in many cases. As a result the problem of getting a good radiator is very dif- ficult. Figure 9 shows an antenna on the front of a Diesel. Here again there is a clearance problem although it is believed that this installation worked quite well. Figure 10 shows fixed antennas mounted on lighting towers in a yard. Most yards are

(*Continued on page* 66)





Figures 8 (left), 9 (right), 10 (left center) and 11 (below, left)

Figure 8. Improper way to mount an antenna. Figure 9. A Diesel engine antenna installation taht proved effective. Figure 10. A 40-mc coaxial and a J-type 157-mc antenna on a 150′ light tower for fixed antenna application. Figure 11. Facsimile installation in the caboose, recently installed by Rock Island. (*Courtesy Acme*)

•

equipped with towers of this type averaging about 75′ in height. There is generally adequate room for all equipment in the Diesel. In the steam locomotives the problem is somewhat more difficult.

Power Problems

Steam locomotives have a 32-volt d-c power source. The generators generally are only 400-watt capacity and with the present lighting load we generally find them well loaded up to capacity. This means that an additional source of power must be provided on the locomotives for the radio equipment. The Rock Island Railroad has standardized on a 110 volt a-c generator to be driven with a steam turbine. There is some question as to whether this is the best system. It may be possible to develop 32-volt equipment which will be more efficient and operate from the available source. In fact, some railroads are planning on using this voltage. Most cabooses at the present time have no power available. Several railroads have experimented with an axle-driven generator together with a storage battery. The Rock Island Railroad has installed a gasoline engine generator from the top of the caboose.

Railroad radio equipment must be made very rugged for the vibration and shock is extremely high. Shock will range up to as high as 50G, although it is not practical to design equipment for this high a value. At least 10G should be sufficient. Standard type airplane shock mounts have worked out quite well.

There is a possibility that facsimile can be used to advantage in the transmission of train orders. Rock Island has made several satisfactory tests.

Demand for Equipment

An estimate of the essential demand for radio equipment, based on the number of engines, cabooses and miles of track, is shown in Figure 12. This represents my best guess as to the total amount of equipment required *if all railroads were to use it*. It was brought out at the FCC hearing that about 66% of the railroads were interested in radio. However, it is doubtful whether some railroads would equip all of their lines and for this reason the figures are undoubtedly high. I would expect that if radio communication proved satisfactory we might see 30 or 40% of the quantities cited installed within the next five years.

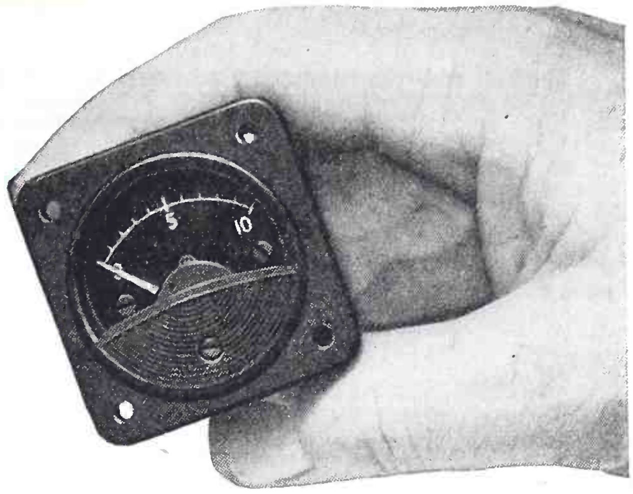
The FCC in its preliminary allocation report for frequencies above 30 megacycles has recognized the need for radio in railroad operation and has allotted channels in the vicinity of 150 mg. Allocations have been made also in the vicinity of 2,600 mc. The road is now clear for railroads to proceed with the development of moving train radio communications, and it now remains for them to proceed as fast as equipment can be made available.

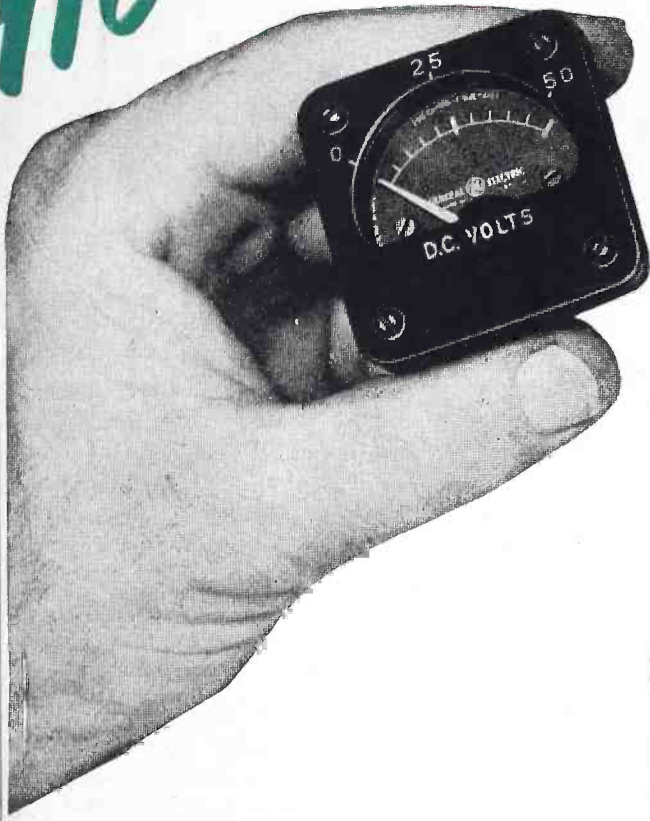
•

Figure 12
Estimate of potential demands for radio equipment used in railroad operation.

Fixed Stations	4,000
Engines	40,000
Cabooses	20,000
Passenger Cars	10,000
Total Fixed Stations	4,000
Total Mobile Stations	70,000
Total Portable Stations	30,000

Here They Are!





The New 1½ INCH

G-E PANEL INSTRUMENTS

To meet the need for compactness, especially in electronic and communication devices for combat, they have a body diameter of only 1½ inches, are less than 1 inch deep, and weigh only 3 ounces. They are accurate to within ±2 per cent.

These instruments are of the internal-pivot construction, and in addition to small size and light weight, they have all the other desirable features associated with this unique G-E design.

Because of its high torque and large-radius pivots, the element (which is common to both instruments) is well able to withstand vibration. High torque combined with a lightweight moving element results in fast response. Good damping makes for ease and accuracy of reading. Large clearances help to insure reliable operation.

All these features add up to a high factor of merit and all-round excellent performance.

For advance information, ask the nearest G-E office for Booklet GEA-4380, or write to General Electric Co., Schenectady 5, N.Y.

WATERTIGHT

TYPES DN-1, -2, -3
(Left hand, above)

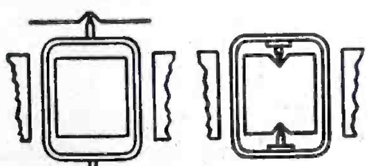
● For applications where equipment may be used in an extremely humid atmosphere, exposed to rain, or accidentally submerged in water. Available for direct-current (DN-1), radio-frequency (DN-2), and audio-frequency (DN-3) service.

CONVENTIONAL

TYPES DN-4, -5, -6
(Right hand, above)

● For use on aircraft and on communications or electronic devices where the instrument is protected. Available for direct-current (DN-4), radio-frequency (DN-5), and audio-frequency (DN-6) service.

THEY'RE G-E INTERNAL-PIVOT INSTRUMENTS



External-pivot   Internal-pivot

One advantage of the internal-pivot design is compactness. Armature, core, control springs, pivots, jewels, balance weights, and pointer form a single, self-contained unit, all parts of which are supported by a castcomol magnet.

HEADQUARTERS FOR ELECTRICAL MEASUREMENT

Buy all the Bonds you can—*and keep all you buy*

GENERAL ELECTRIC

602-83-6200

Radio Pioneers Party

VWOA was a guest association at the Radio Pioneer's Party of the New York Section of the IRE held in New York City recently. Dr. William Everitt, IRE president, was toastmaster, and Louis Pacent, VWOA life member, was general chairman. Ed Content of WOR, VWOA veteran member, served as treasurer.

We presented Sgt. Irving Strobing, Army radio operator, who sent the last message from Corregidor, with a VWOA scholarship during the evening. The scholarship, covering a course at the Capitol Radio Engineering Institute, was offered through the cooperation of E. H. Rietzke, CREI president.

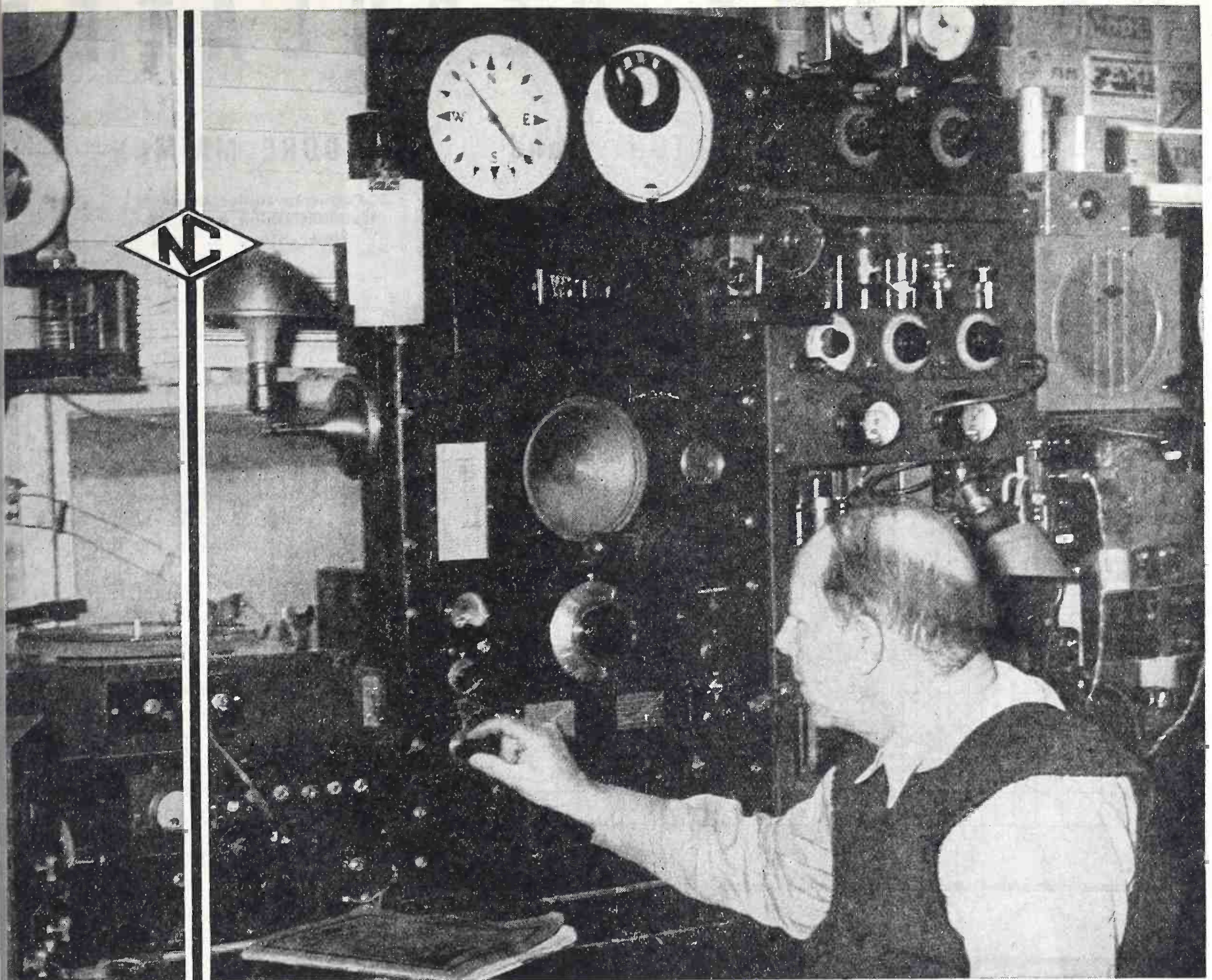
We were also able to offer a door prize, a National 240C communications type receiver, thanks to W. A. Ready, National Company president, and Arthur H. Lynch, New York manager for National.

Among those who attended as guests of VWOA was Major General J. O. Mauborgne, former Chief Signal Officer of the Army. Other VWOA members who attended were: C. D. Guthrie, VWOA director; George Clark, VWOA secretary, and director of the party; Bill Simon, treasurer; W. T. Marshall of the New York Telephone Company radio department; Mr. Carruthers of the War Shipping Administration; George McEwen of RCAC; Lewis Winner, editor of COMMUNICATIONS and VWOA life member; E. J. Girard of the Federal Telephone and Radio Corporation; Rear Admiral Joseph R. Redman, VWOA honorary member; Major General Harry C. Ingles, VWOA honorary member; Frank Orth of CBS; Jack Poppele, chief engineer of WOR and chairman of the VWOA scholarship committee; W. J. McGonigle, VWOA prexy, and George W. Bailey, assistant to the president of VWOA, and now doing a grand job as executive secretary of the IRE. Unfortunately, Bob Mariott was unable to attend. He has been an honorary member of VWOA for years and was first president of the IRE.

Sergeant Irving Strobing, U. S. Army radio operator who sent the ast message from Corregidor, receiving VWOA scholarship for training at Capitol Radio Engineering Institute, from W. J. McGonigle, VWOA president. Looking on, at extreme left, Major E. H. Armstrong; next to Sgt. Strobing, George Bailey; and at extreme right, Dr. W. Everitt.

Personals

THE 1946 Year Book will not be ready for mailing until after our Twenty-First Anniversary dinner-cruise at the Hotel Astor on Saturday evening, Februay 16, 1946. They will be mailed to those who have paid for their copies as soon as available. . . . Welcome to Bill Gillule, one of the pioneers in radio, and now with Mackay. . . . Eric L. Bisbee is back with the N. Y. Police Department. His experiences cover trips aboard the *SS Munplace,* the *Tiger* and the *Empire Arrow,* in 1923. He was with the New York Police Department radio division from 1932 to 1944. During '44 and '45 he served with the U. S. Maritime Service. . . . Stanley Wolff is now traffic chief of the AP at their North Castle radio station in Connecticut. Stanley was in the Army as a radio man from 1927 to 1932. He then went aboard ship for two years and served successively with Hearst Radio, RCA Communications, Globe Wireless, Macaky Radio and the *Herald Tribune*. . . . Glad to have Don A. Harris of Globe Wireless join our ranks. . . . From Buchans, Newfoundland, has come an application from G. C. Coffin of the Canadian Department of Transport. . . . N. E. Blackie of Redondo Beach, Calif., a real oldtimer, would like to hear from T. M. Stevens, George McEwen of RCA Communications, and Doc Forsyth. By the way why not drop Doc Forsyth a line at Sailor's Snug Harbor, Staten Island, N. Y. He is completely blind now but his *leader* will read letters to him. . . . Capt. E. H. Dodd, U.S.N. (Ret.) now resides at Oakland, Calif. . . . Hal Styles is reactivating the Los Angeles-Hollywood chapter of VWOA with the aid of his old co-partner in VWOA affairs, Leroy Bremer. . . . E. E. Rackle keeps up with VWOA down New Orleans way. . . . Dr. Lee de Forest, honorary president of VWOA, is now a consultant for the Mexican government, setting up television stations. Best of luck, Doc. . . . E. G. Raser is one of the earliest of oldtimers in Trenton, N. J. . . . Carl Coleman, who during the war years served as radio chief for the Arnessen Electric Company, has joined Tropical Radio. . . . Ben Wolf, in charge of the FCC monitoring station at Grand Island, Nebraska, could tell some good stories, if he would. Let's hear from you, Ben. . . . R. T. Willey has moved to Roselle Park, N. J. . . . Lt. Col. V. A. Kamin, long a VWOA member, is now located at Noroton Heights, Conn. . . . Brock Angle, Coast Guard Chief Radioman, expects to rejoin Tropical Radio in the near future. . . . Lt. Col. W. S. Marks has been transferred from the Signal Corps Laboratory at Red Bank, N. J., to Fort Bragg, N. C. . . . Ed Bennett of Norfolk, Va., saw service during World War II as a U.S.N.R. Lt. Commander. . . . By the way, James Gregory, son of Mr. and Mrs. William J. McGonigle, was born on November 17. Now there are four McGonigles. . . . W. Butterworth, with the Boston office of FCC, is active in VWOA affairs in the Hub city. . . . A. H. Waite, who was a communications expert for the Army, as a civilian, has quite a story to tell. We hope to have it soon. . . . A note from R. P. Herzig states that he has left the Navy where he served as a Radioman, First Class. . . . Radioman First Class W. Bacon is now stationed at the Naval Receiving station in Boston. . . . Commander Fred Muller U.S.N.R., was erroneously reported as being a former VWOA director, last month. FM is still a director.



CAPTAIN HORACE L. HALL, U.S. Merchant Marine, retired, at his home in Springfield, L.I., N.Y., made daily recordings of transmissions from Australia, for more than four years, missing but four days. The apparently harmless news broadcasts kept the Australian Government in New York and Washington informed of every phase of the progress of the war, by a pre-arranged code.

The National HRO, used for this remarkable accomplishment is the first ever to have been shipped into the New York area and is over ten years old.

NATIONAL COMPANY INC., MALDEN, MASS.

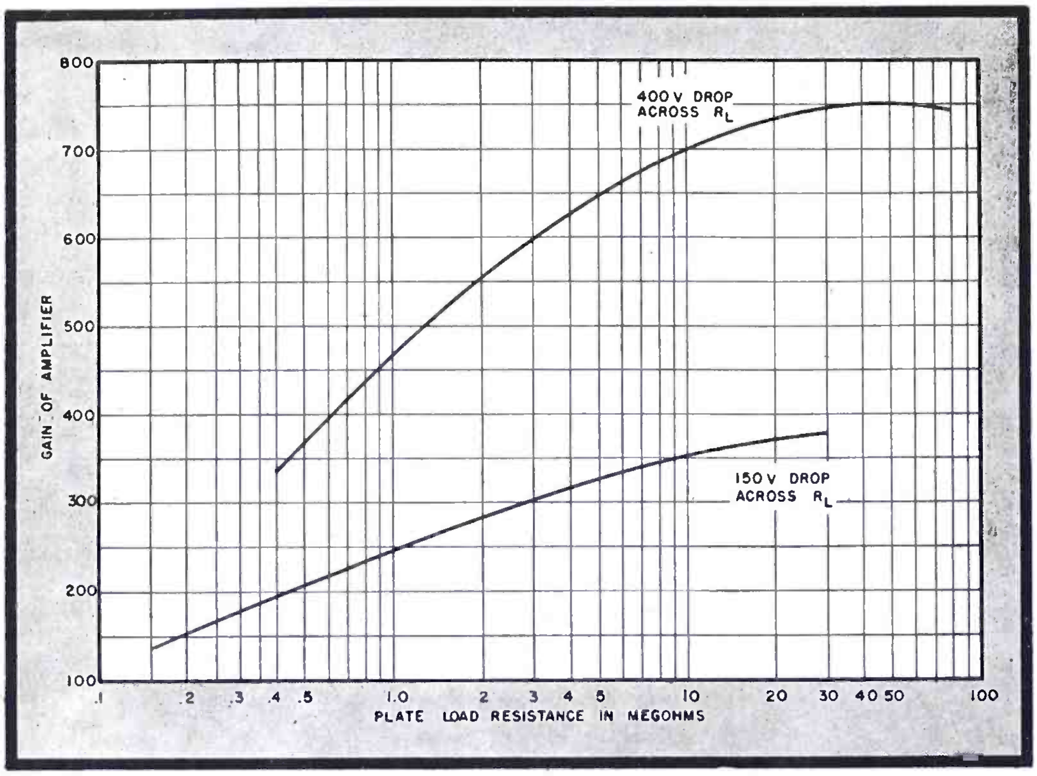
VOLTAGE-REGULATED

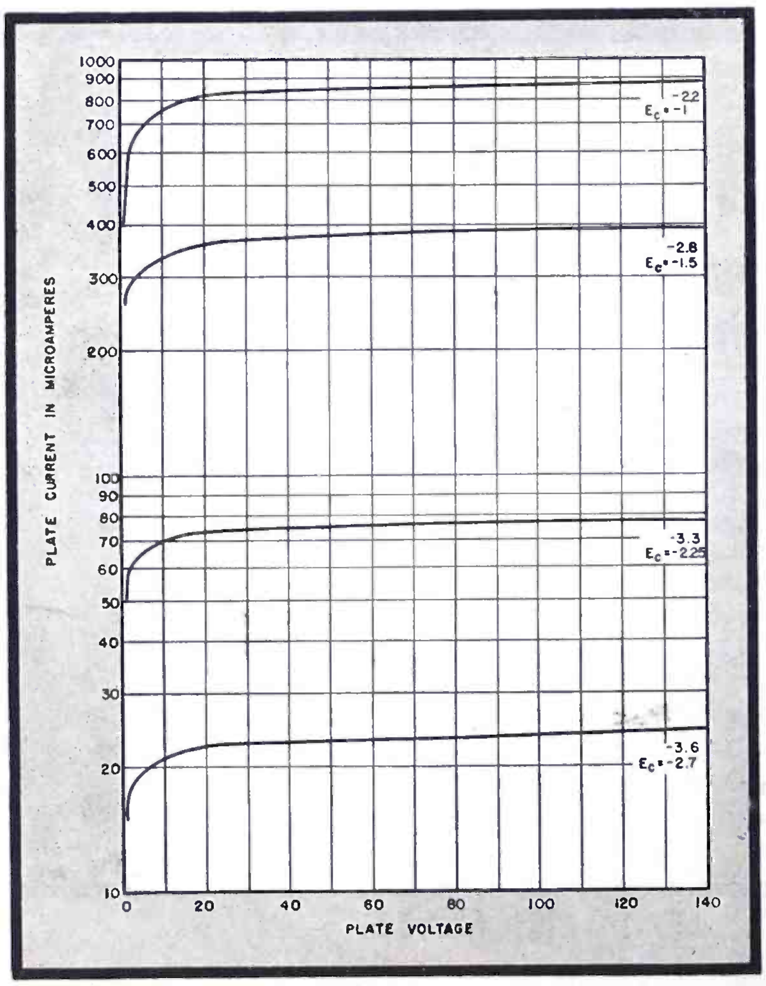
[*Part II*]

by G. EDWARD HAMILTON and THEODORE MAIMAN

Senior Engineer
Test Equipment Division
National Union Radio Corp.

Formerly Junior Engineer
National Union Radio Corp.
Now with U. S. Navy





Figures 8 (above) and 9 (left)

In Figure 8 we have a plot showing the variation of amplifier gain versus plate-load resistance in megohms. Figure 9 provides the plate family characteristics of a 6SJ7 at low values of plate current; Es = 100 v, Es = 50 v.

In designing a typical voltage-regulated power supply capable of good stability from zero to maximum output voltage, the following procedure may be applied.

$E_o = 0$ to 400 volts, I_o (max) = 100 ma.

(*1*)—Voltage drop across $T_1 = E_{p1}$ but $E_{p1} = E_i - E_o$. E_{p1} will vary between the limits E_i and $E_i - E_o$ (max). In practice it has been found advisable to make E_i about 100 volts higher than E_o (max). Therefore for this example E_{p1} will vary from 500 to 100 volts.

(*2*)—The passing tubes must be capable of a plate dissipation of $500 \times .1 = 50$ watts. Three 6L6 tubes, triode connected, will be satisfactory with a wide margin of safety. Type 6SJ7 has been found well suited as a control tube since the μ and R_p are high.

(*3*)—It now becomes necessary to determine E_{c1}. From the plate family we find when $I_b = \frac{100}{3} = 33$ ma (for one tube), and $E_{p1} = 100$ volts, $E_{c1} = 5.5$ volts, and when $E_{p1} = 500$ volts, $E_{c1} = \frac{500}{\mu} = -62.5$ volts.

(*4*)—*For zero output voltage* $E_{c1} = -62.5$volts.

$$E_L = E_{p1} + | E_{c1} | = 500 + 62.5 = 562.5$$

(*5*)—Figure 8 shows that when R_L is increased above 10 megohms little additional gain is realized in the 6SJ7. Thus,

$$I_{b2} = \frac{E_L}{R_L} = \frac{562.0}{10 \times 10^6} = 56.2 \text{ microamperes}$$

(*6*)—To determine the *control* bleeder resistance ratio we must now find E_{c2} from the plate family characteristics shown in Figure 9, which have been obtained for the 6SJ7, operating at low values of plate current.

Case I

(*7*)—Output voltage = 0.

POWER SUPPLIES

(7a) $E_{c2} \cong -2.4$ volts.

$E_1 = V_2 - |E_{c2}| = 105 - 2.4 = 102.6$

$E_2 = E_o + E_1 + |E_{c2}|$
$= 0 + 105 + 2.4 = 107.4$

$$\frac{E_1}{E_2} = \frac{R_1}{R_2} = \frac{102.6}{107.4} = .933$$

Case II

(8)—Output = 400 volts.

$E_{c1} = 5.5$ volts

$E_L = E_{p1} + |E_{c1}|$
$= 100 + 5.5 = 105.5$ volts

(9) $$I_{b2} = \frac{E_L}{R_L} = \frac{105.5}{10 \times 10^6} = 10.6\ \mu a$$

(10) $E_{c2} \cong -3$ volts.

(11) $E_1 = V_2 - |E_{c2}| = 105 - 3 = 102$

$E_2 = E_o + V_1 + |E_{c2}| = 400 + 105 + 3 = 508$

$$\frac{E_1}{E_2} = \frac{R_1}{R_2} = \frac{102}{508} = .201$$

Case I

(12) $$\frac{R_B + R_C}{R_a} = \frac{R_1}{R_2} = .933 \qquad (1)$$

Case II

(13) $$\frac{R_C}{R_a + R_B} = \frac{R_1}{R_2} = .201 \qquad (2)$$

(14) Let $R_b = .5 \times 10^6$ ohms

From *1* and *2*

$$R_a = \frac{1.201}{.732} R_b = .82 \times 10^6 \text{ ohms}$$

$R_c = .265 \times 10^6$ ohms

For simplicity of explanation the control tube has been considered from a *triode* point of view. However, in application, high gain is desirable; therefore a pentode is the logical choice.

Figure 10 shows a complete voltage-stabilized power supply capable of meeting the following requirements:

- Output voltage of 0–500 volts
- Voltage ranges of 0–10, 0–50, 0–100, 0-500 volts
- Maximum output current of 300 ma
- Better than 1% regulation between 0–500 volts
- Ripple voltage approximately 10 mv

Fundamentally this circuit is the same as shown previously with the exception of certain minor refinements.

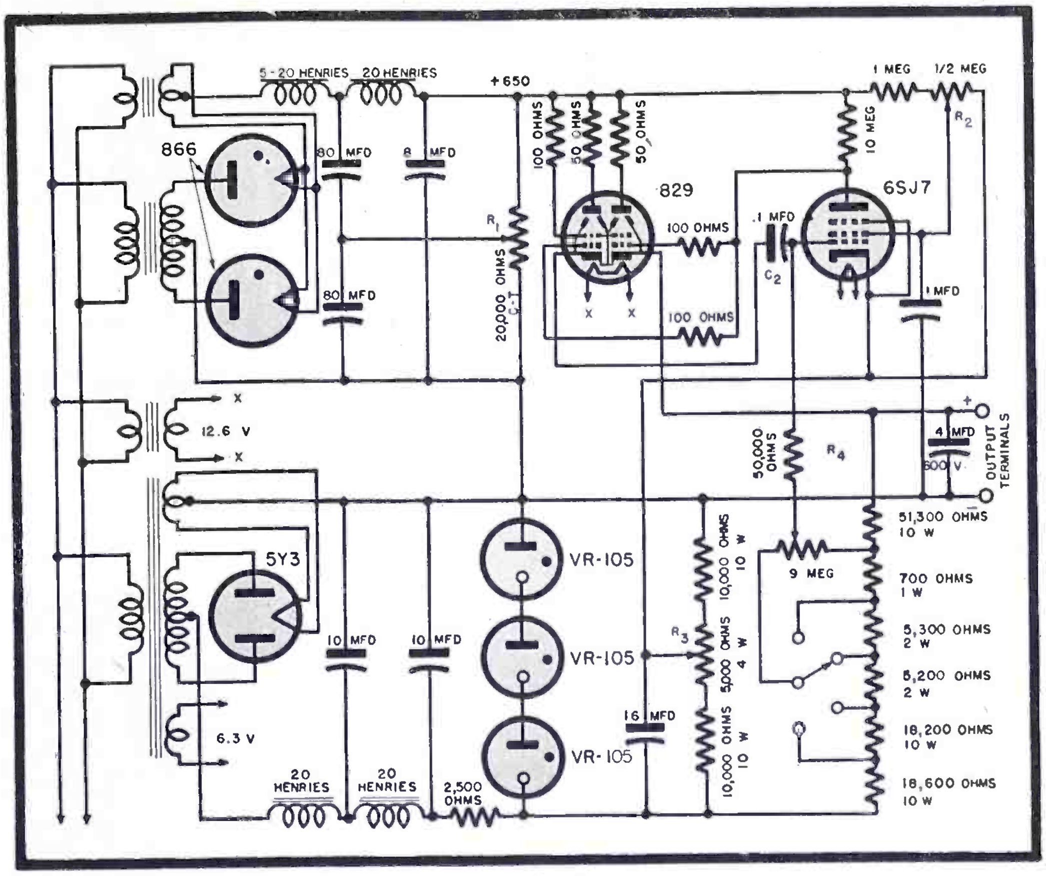


Figure 10
Voltage-stabilized power supply.

The cathode of the control tube has been returned to a potentiometer across the *bias* supply to provide for a fine zero output voltage control. The screen of the control tube has also been returned to a potentiometer.

This method of screen return can be adjusted to produce *negative* regulation; i.e., an increase of output voltage with an increased load, or a decrease in line voltage results in an increase in output voltage. It is this factor that makes possible the good regulation characteristic at low voltages. Both cathode and screen controls are screw driven adjustments.

Where tubes are to be operated in parallel it is most always advisable to include parasitic suppressor resistors in plate, screen and grid circuits, as shown in the figure. The purpose of R_4 and C_2 is to increase the feedback factor for fast changes of output voltage and hence reduction in ripple voltage. R_1 connected across the high-voltage supply serves the dual purpose of improved fundamental power supply regulation and voltage divider for the 80-mfd filter capacitors.

Adjustment of Power Supply

(*1*)—We first rotate the manual voltage control (R_4) to the zero output voltage position and adjust R_3 to give $E_o = 0$.

(*2*)—Then R_4 is rotated so that $E_o = 10$ volts. Then we apply approximately a 33-ohm load (to obtain a full load current of 300 ma).

(*3*)—If E_o decreases, R_2 should be adjusted so that a more positive voltage is applied to the screen; this adjustment is critical.

(*4*)—Then R_4 is again turned to zero position and R_3 is adjusted so that $E_o = 0$. This process is continued until the desired regulation is obtained; obviously if E_o increases at step *3* the reverse process is in order. When regulation is attained at low voltages, satisfactory regulation will obtain at the higher values.

While no difficulty has been encountered during tests and applications with grid emission or gas current in the control or passing tubes, care should be exercised in the choice of tubes since high impedance circuits are involved.

Bibliography

H. Reich, *Theory and Applications of Vacuum Tubes*
Radiotron Designers Handbook
F. V. Hunt and R. W. Hickman, Review of Scientific Instruments; Jan. 1939
F. E. Terman, *Radio Engineers Handbook*
H. Victor Heher and William H. Pickering, Review of Scientific Instruments; Feb. 1939
G. E. Hamilton, QST: August 1944

[*To Be Concluded in January*]

INDEX TO *COMMUNICATIONS,* 1945

•

CUMULATIVE INDEX ALPHABETICALLY ARRANGED FOR AUTHORS AND SUBJECTS

•

A

INDEX

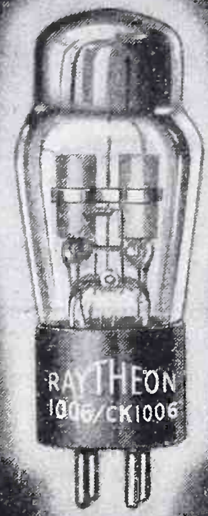
(Continued from page 73)

INDE

INDEX

(*Continued from page 75*)

TABLES & CHARTS



½ ACTUAL SIZE

RAYTHEON

TYPE 1006/CK1006 A HEAVY DUTY FULL-WAVE GAS RECTIFIER

TYPE 1006/CK1006 RATINGS
FULL-WAVE RECTIFIER SERVICE

	Ionically Heated	Heated Directly	
Filament Voltage	0	1.75	volts
Filament Current	0	2.00	amps
Maximum Peak Anode Voltage (per anode) no load	800	800	volts
Maximum Peak Inverse Voltage	1500	1600	volts
Average D.C. Voltage Drop	30	25	volts
Maximum D.C. Output Current	200	200	ma.
Minimum D.C. Output Current	70	0	ma.
Minimum Starting Peak Voltage (half wave or dc)	650	450	volts
Minimum Starting Peak Voltage (full wave)	550	420	volts
Maximum Steady State Peak Anode Current per anode	600	600	ma.

To supply the requirements of small transmitters or other equipment where rectification efficiency must be maintained at a high level, Raytheon engineers developed type 1006/CK1006.

Utilization of an inert gas enables this tube to perform its functions through a wide range of ambient temperatures. The cathode may be directly heated as shown in the ratings—or where greater efficiency is desired, ionic heating is possible provided the specified minimum load is maintained without rapid intermittent operation. The internal drop is low even during the time rated peak current is flowing.

A very important feature of the 1006/CK1006 is the fact that *no cathode preheating time is required*. Full load can be handled immediately and starting is practically instantaneous.

Obviously, the foregoing electrical characteristics are applicable to many types of mobile equipment. Structurally, too, the 1006/CK1006 fits well into such service because rugged design allows it to withstand considerable shock without change in characteristics.

Many thousands of Raytheon 1006/CK1006 tubes have individually given hundreds of hours of reliable service in equipment subjected to adverse conditions of temperature and vibration. Another convincing "exhibit" of evidence that Raytheon builds *fine* tubes . . . tubes well worth considering for your postwar products!

RAYTHEON
MANUFACTURING COMPANY

Excellence in Electronics

RADIO RECEIVING TUBE DIVISION
NEWTON, MASSACHUSETTS NEW YORK CHICAGO

BUY VICTORY BONDS

TELEVISION SYSTEMS AND MEASUREMENTS

[IRE FALL MEETING REPORT]

(*Continued from page 47*)

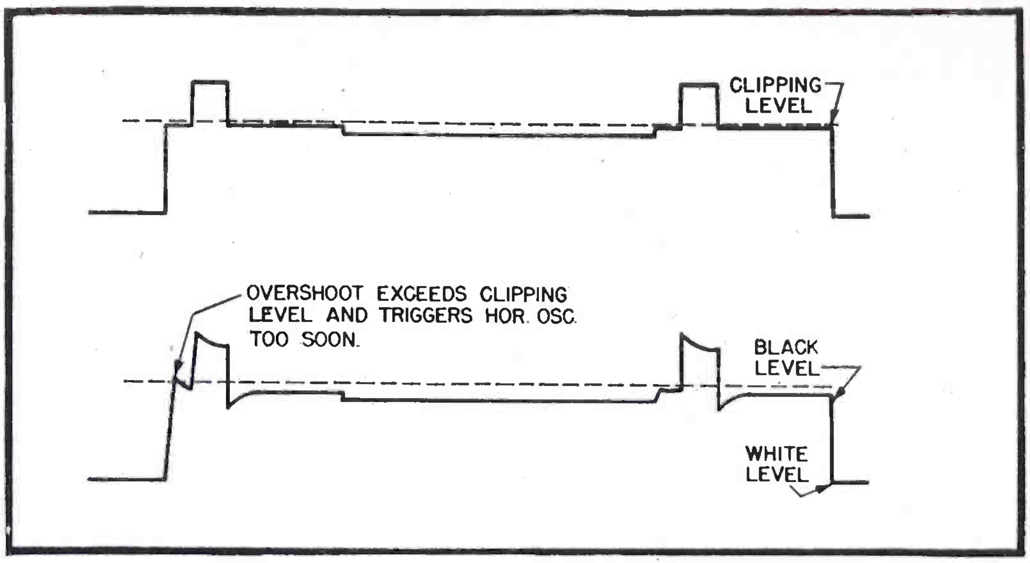


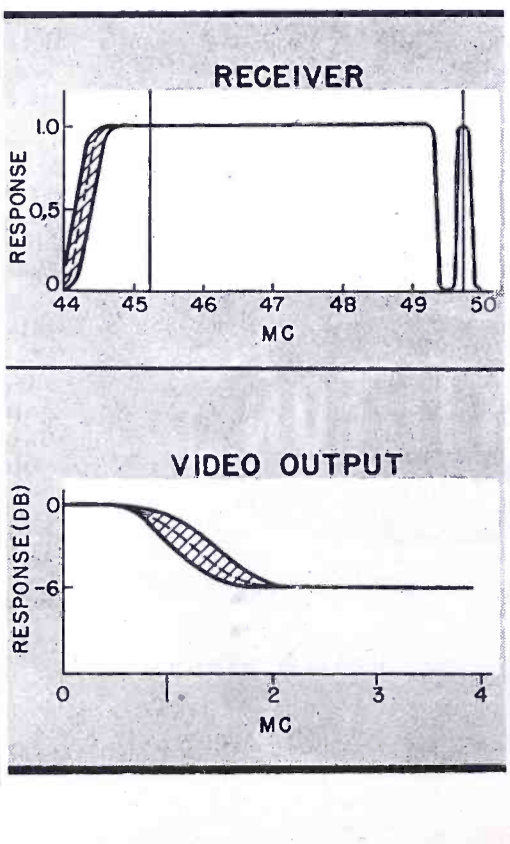
Figure 12
Non-linearity results. Upper diagram shows normal horizontal sync and blanking with a black and white line in succession. The lower diagram illustrates the effects of phase shift of the carrier with respect to most of the side band.

pression of the lower video sideband, while the linear attenuation region of the ideal receiver pass-band, shown in the lower half, completes the suppression without, in theory, seriously affecting image quality.

Actually, according to Mr. Minter, the tuning of a receiver to produce the recommended attenuation characteristic often does not result in optimum image resolution, and it is found that better resolution may be obtained by slight changes in tuning. Under these circumstances, however, the refined adjustment may give rise to phase shift causing *black and white following* and may be severe enough to cause cross talk between picture detail and synchronizing circuits.

The reason for this phenomenon lies in the fundamental limitations applying to networks commonly used for obtaining the ideal receiver response. A sharp change in amplitude transmission characteristic is accompanied by a gradual change in phase characteristic slope or a gradual change in time of transmission. Hence the cascading of many tuned circuits to obtain a constant amplitude transmission

Figure 13
Receiver and video response when the receiver alignment method used prior to 1941 is employed; video carrier frequency is not reduced to 50% as at resent, but increased to uniform level.



up to the cutoff limits will result in uniform transmission time only for frequencies near the center of the band. For example, five double tuned circuits in cascade and critically coupled may be employed to give amplitude and phase characteristics quite close to the ideal. However, the degree of rejection presented to the accompanying sound channel and to the adjacent sound channel is completely inadequate. When suitable traps or other rejection circuits have been incorporated, the phase characteristic will show considerable changes in slope near either side of the pass band. Staggered arrangements consisting of combinations of double- and single-peaked circuits in cascade, used in order to increase gain, will in general also give rise to non-linear phase characteristics near the edges of the transmission band.

Non-Linearity Results

The result of such non-linearity is seen in Figure 12. Here the upper diagram shows the normal horizontal sync and blanking with a black and white line in succession. In the lower diagram, the effects of phase shift of the carrier with respect to most of the sideband is shown. It can be seen that a white line tends to produce more overshoot than a black line; hence the white line may overshoot up into the clipping level and trigger the horizontal oscillator too soon. Then all white lines crossing the right hand side of the image will be shifted to the left by the amount of the front porch. This results in a jagged break across the image.

Old Alignment Method Recommended

This difficulty may be eliminated and the alignment procedure simplified, Mr. Minter said, by reverting to the type of receiver alignment used prior to 1941. In this method the response at video carrier frequency is not reduced 50% as standardized at present, but is increased to the uniform level. The receiver response will then be as shown in Figure 13, together with the resultant video output

(*Continued on page* 80)

FALL MEETING REPORT

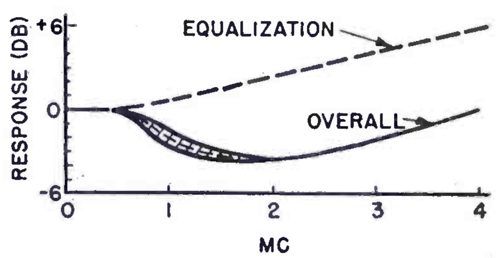
(*Continued from page* 79)

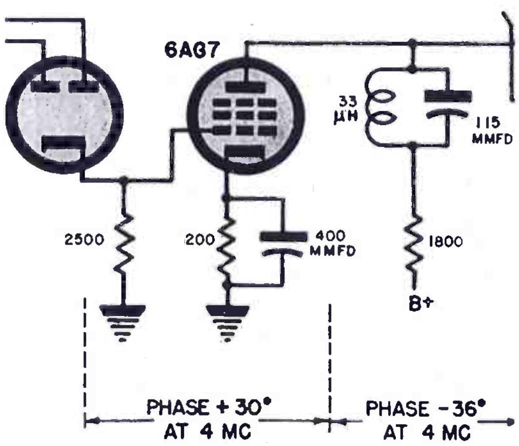
curve. To equalize the loss of video response at higher modulation frequencies, the equalizing circuit of Figure 14 has been found convenient. In addition, the equalizing circuit fortuitously reduces the phase shift at 4 mc to only 6° lagging. A type of band pass filter employing triple-tuned circuits has been used in the above system. It has the advangtae of permitting individual stage alignment. This feature, in conjunction with the reduced phase non-linearity of the system, simplifies the tuning problem.

An interesting result of this method of receiver tuning, suggests Mr. Minter, is the possibility of combining the audio and video channels by frequency modulating the video channel ± 25 kc with the audio signal. If feasible, the receiver and transmitter could conceivably be much simplified.

•

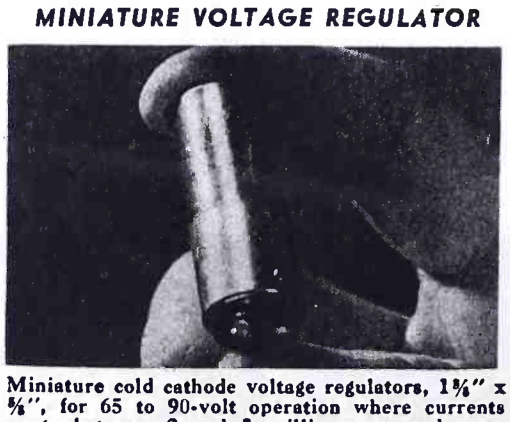
Figure 14
Video equalization circuit to equalize loss of video response at higher modulation frequencies. Plate output of 6AG7 is fed to grid of television tube.





•

MINIATURE VOLTAGE REGULATOR



Miniature cold cathode voltage regulators, 1⅜" x ⅝", for 65 to 90-volt operation where currents range between 2 and 3 milliamperes and maximum voltage variation may not exceed 3 volts, developed by Sylvania.

FROM 1/4 TO 5 KW

(*Continued from page 37*)

and 5 kv outputs. The other uses six (plus a spare) 315As in a similar circuit with 12-kv output.

The control console was custom built locally. It contains the frequency monitor with the deviation meter panel, only, on the left end of the control panel (the balance mounted underneath), modulation monitor with its large modulation per cent meter centered directly in front of the operator, control panel of a W. E. peak limiter, four-channel fader-mixer and its four controlling keys next to the monitors, and a jack panel, speech monitor and equalizing controls.

The three towers, spaced 198′ in a line 188° true, had to have field ratios of 1:00 for the ends and 1:695 for the center, and phasing of north — 135.6°. center + 4.18° and south + 135.6° for directional operation, and the center tower only with the ends detuned for non-directional operation. The directional throws a large cardiod north with small minor lobes south, southeast and southwest, giving protection to KIDO, Boise, Idaho; KWK, St Louis, Missouri; Brownwood and El Paso, Texas; and Brantford, Ontario

The phasing equipment is now housed in what used to be an office storage cabinet, with half length doors centered vertically with a blank panel below and one above containing a common r-f input ammeter, three remote antenna meters, six coaxial pressure gauges, the master intercommunications system and a Washington Institute phasemeter. The input matching net and change-over relay are mounted back of the phasemeter while the phasing nets are in the two compartments behind the doors. This unit is located at the output end of the transmitter and all of the coaxial cables terminate there.

The original circuit had an *L* net in the end branches with nothing in the center branch because of the stronger field required at the center tower. Each leg of the *L* nets contained an inductance (with clips on flexible leads) shunted by a variable capacitor with provision for mounting a fixed mica in parallel with each variable if necessary, and with additional leads so that the various components could be connected either series or parallel as needed. This made a very universal phasing unit capable of meeting any requirement in adjustment. All coils in the phasing end coupling units are identical. They are wound on ceramic spacing bars mounted on bakelite

(*Continued on page 82*)

FROM 1/4 TO 5 KW

(*Continued from page* 81)

rings, wound with No. 6 copper wire. They are 8″ in diameter, have a measured inductance of 56 μ h and a Q of 425.

The antenna coupling units use single L nets. The north center units have the inductance in series with the line and the capacity between antenna and ground, while the south unit has the capacitor in series with the line and the inductance between the antenna and ground, to aid in the phasing. These units also contain the changeover relays which ground the end towers through part of the inductance and connect another capacitor to another tap on the inductance in the center when operating non-directional. Static drain chokes and chokes of a few turns in the antenna leads were omitted, for it was believed that they were not required because of grounds on the center of the towers. They cannot be added now because of the effect on the phases. A few turns in the antenna leads would be especially helpful in causing some of the lightning surges to spill across the protective gaps, that are set quite wide because of the high r-f voltage at the bases of the half-wave towers. The capacitors are of the air stack variety, adjustable but not variable. They are ideal for coupling units because the voltages encountered there are a reciprocal of the capacity needed. That is, they are readily adjustable for high voltage with small capacity or high capacity with lower voltage or, value in between, by varying the spacing as well as the number of plates. Steel plates were buffed, the corners and edges rounded and then heavily copper plated (priorities prohibited the use of stiff copper plates).

Each capacitor originally had 25 plates. The plates are 8″ square with 7/16″ holes in each corner and are supported by 4⅜″ continuously threaded rods. The stacks are vertical with the four rods supporting the *hot* plates mounted on beehive insulators and the other four are mounted directly on the unit base. The capacitor in the south unit, however, has all eight rods insulated as both sets of plates are *hot*. The plates on each were originally spaced ½″. Considerable time can be saved in adjusting units using capacitors of this type if a variable capacitor is first used to determine the values needed and then the air stack is adjusted to that value.

As our phasemeters were calibrated only to 90° and the required phase differences to be measured were roughly 130° and 140°, the sampling loop on the center tower was inverted 180° out of phase with the end loops. True phase relationship was then determined by subtraction, the phase meter reading from 180°.

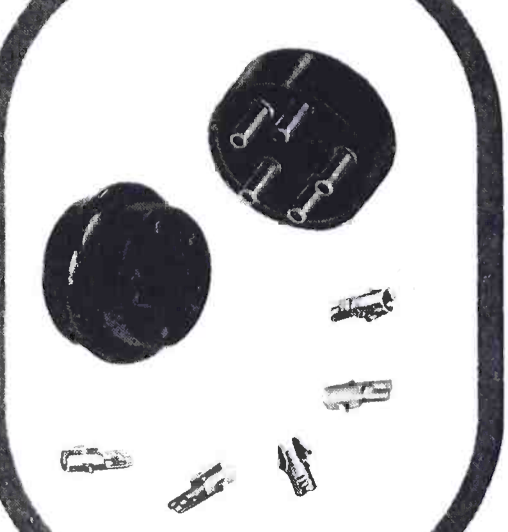
The method of isolating the phase sampling lines from the towers presented one of the most interesting installation problems. Because the towers were to be near self resonance with high voltages from base to ground, high-voltage variable capacitors were necessary for the circuit. Priorities made it impossible to secure these capacitors. A unique alternate method was used. It is customary to use a capacitor to tune a coil wound of the sampling line coax to isolate the line. Instead it was decided to use a shorted quarter-wave transmission line, with the outer conductor of the coax forming one side of the quarter-wave line and part of the tower as the other. From the sampling loop the sampling line was mounted up the side of the tower, a short distance above the theoretical ¼-wave from the tower base, then curved over a pulley and brought down through the center of the tower, centered with insulators at regular intervals down the tower and insulated at the tower base where it was brought out and connected directly to the ground. Before grounding the cable it was cut at the base and a steeplejack, sent up the tower with a shorting strip. He lowered this shorting strip, a foot or so at a time (and went above the loop each time while measurements were taken) until the point was found where grounding and ungrounding the stub at the base had no effect on the tower impedance. A permanent bond was then made up on the tower and the cable spliced and grounded permanently. At first it had been planned to use a Q meter to adjust the shorting bar, but trial showed that the Q of this arrangement was above the range of a laboratory standard Q meter, much before the point of resonance was reached.

This arrangement has proved to be an ideal harmonic filter. Our consultant's field-strength meter did not have the frequency range to measure our harmonics, but they were not found audible in good communications receivers three miles from the transmitter. We believed that placing a d-c ground to the near center of each tower (near dead short at all but our operating frequency) would be ideal protection from lightning surges and that no other protection would be needed. Thus no other was installed. We found this to be very wrong!

Recent papers discussing the isolation of f-m coaxial cables to feed f-m arrays atop present a-m towers, when using both a-m and f-m, have featured one or more coil and capacitor combinations, some very complicated. Our tests have shown that the shorted ¼-wave line method is much superior. As the a-m tower impedance has to be re-measured after the addition of an array atop, the shorted ¼-wave transmission line is much simpler and easier to install and adjust, whenever the a-m towers are ¼-wave or more high.

Walter F. Kean, broadcast consultant of Andrew Company, used a unique method of adjusting the sampling lines for length, for our system. Although definite instructions had been given that the three ¼″ coax lines should be placed side by side on the ground and cut to exactly the same length before installing, this was not possible because of the slushy ground due to melting snow. And the workmen felt that they could keep an accurate check on it without placing on the ground. However, the workmen soon found that their checks were not so accurate, being off 15′ to 20′ in some instances, enough to make considerable difference in the phase measurements. Since 100% accuracy was essential and there was doubt of the ability of the nets built into the phase-meter to compensate for the difference in line

(*Continued on page* 84)



FROM 1/4 TO 5 KW

(*Continued from page 83*)

lengths, Mr. Kean decided to short the lines at the loop terminals on the towers. Their resonant frequency were then measured with a bridge and their physical length adjusted until they were the same electrically. This provided one check for any variances in not only physical length, but also any in capacity, inductance or velocity due to bends or slight variances in manufacture.

The lines were then connected to the phase monitor. Further checking revealed some difference in the three load resistors within the monitor that were used to terminate the three lines. While this would make no difference in measuring phase relationship, the r-f voltages across the input terminals would not be a true measurement of the line current and subsequent field ratios. To accurately check these ratios, the lines were disconnected from the monitor, a single resistor connected across the input of a vacuum-tube voltmeter that was then connected across each line and the ratios of the readings noted. The phasing and coupling units were then adjusted until the right phase and ratios were indicated.

A quick check with the field-strength meter showed approximately the right pattern, but reversed 180° in direction. It was then necessary to go through a reversal re-adjustment until the meter readings were again the same. Quick checks showed this to be near, and careful cross-radial and one-mile ratio measurements proved it to be right.

To obtain accurate directional measurements without interference from other stations on the same frequency permission was received to operate directional during the daytime with no modulation except identification. Our 250-watt station was operating simultaneously on 1,400 kc with the program. Thus measurements were made of both stations at each of the measuring points. This proved to be very helpful in determining ground conductivity and in verifying changes in reception conditions in unusual localities.

The protection to the specified stations was greater than required even though in a few of the nulls higher values were measured with the field meters loop turned away from the station than toward it, due to reflection from near mountains. The highest readings obtainable were used in all protective calculations.

Many pleasant facts were uncovered. We had felt that the ground conductivity in this area was higher than the two shown on the FCC map. No measurements had been taken in this area, so that value had to be used in all calculations. It was found to be approximately 30° from north through east to south, 20° from north to northwest and south to southwest, and dropped to 2° only in a narrow strip straight west and back in the mountains some distance from the transmitter. The rms value was computed at 435, but was measured at 516. This was probably due to the addition of the 3′ beacons atop the towers (we understand that they should, but seldom are included in all calculations) and the leads from the coupling units. Data showed the 300′ towers to be .415 wavelength at 1,380 kc, but in our completed installation they were self resonant at 1,365 kc (1,370 kc non-directional) or slightly over ½ wavelength at 1,380 kc.

There was noticeable difference between the computed and the measured directional patterns because of the variance in ground conductance, it being greater to the east. The same distortion was noticeable in the daytime coverage pattern. Both directional and non-directional coverages were computed by Mr. Kean using the actual measured values, only where he had measured them, and reverting back to the FCC map values beyond there even

though all evidence indicated otherwise.

One of the oddities of this installation is the low antenna currents and the differences in them when directional and non-directional. Our input current to the center tower in only 2.4 amperes for full 5 kw using that tower only. The south tower base current is 1.15 amperes detuned (non-directional) but drops to .55 when receiving power from the transmitter on directional. This is because they are so near ¼ wave directional (near theoretical zero point), and adjusted for zero current in the sampling loops at the center when detuned, causing high current lobes at base and top of each end tower, 180° out of phase, that their effect on the center tower is cancelled.

•

RADAR COUNTERMEASURES

(*Continued from page* 52)

in relative safety, since a transmitted radar signal can be heard to greater distances than the effective range of the radar itself. Jamming was accomplished either electronically or mechanically. The latter means was very economical and simple, consisting only of dropping large quantities of thin strips of aluminum foil, called *window* or *chaff*, from aircraft. Against specific radars the strips were cut to dipole length at the enemy radar frequency, or for general use were cut to random length or used in long continuous lengths called *rope*. For example, a two-ounce package of *window*, consisting of several thousand aluminum foil strips, was capable of reflecting an echo simulating a bomber. Successive packages appeared on the enemy radars as a squadron or whole fleet of bombers, so that only a few planes were needed to stage large decoy raids. As the *window* settled and dispersed, the enemy radar display showed a continuous series of spurious responses over the affected area, through which planes could fly without being detected and followed by gun-laying radars.

Electronic jamming utilized tunable self-excited oscillators with suitable modulation. It was found that straight c-w does not jam radar effectively, the response pips still being clear against the more or less regular pattern caused by c-w. The most effective signal consisted of c-w amplitude modulated with random noise obtained by amplifying tube or other component noise. The effect of such jamming signals on *A* and *J* displays was to raise the *grass* level above the amplitude of the echoes, completely obliterating the latter; on *PPI* displays, a wide area surrounding the general vicinity of the jamming transmitter was highly illuminated, again obliterating the echo spots.

Equipment Used

A table of RRL-developed countermeasure equipment, together with principal data appears in Figures 5 and 6. It will be noted that tunable receiving systems covering a 25 to 6000 mc range and transimtters for 25 to 4030 mc were designed. These transmitters were all designed for airborne use and so were

(*Continued on page* 93)

NEWS BRIEFS

W.U. TO BUILD 22 MICROWAVE STATIONS

The Western Union Telegraph Company has received permission to build a chain of 22 experimental class II microwave relay stations extending from New York City to Pittsburgh, Pa., Pittsburgh to Washington, D. C., Washington to Philadelphia, Pa., and Philadelphia back to New York City.

The present authorization is the second link in the continuation of the W.U. development program, the ultimate object of which is to obtain a commercial radio relay system connecting all the principal traffic centers within the United States. Previous grant was made for a chain of similar stations at New York City, New Brunswick, Bordentown and Camden, N. J.

Various frequency bands, extending from 1853 to 11858 mc, will be used, with 15 watts power at each station and with types A0, A1, A2, A3, A4 and special emissions.

The Washington station will be at 41st Street near Wisconsin Avenue, N. W.

* * *

KOONTZ, JESTER AND OGILVIE IN NEW MAGUIRE INDUSTRIES POSTS

Raymond Koontz has been named general manager of all of the Maguire Industries operating divisions.

In his new capacity, Mr. Koontz will supervise all manufacturing operations.

Oden F. Jester has been appointed general sales manager of the radio and phonograph division of Maguire.

Mr. Jester will direct sales of radiophonographs and other products to be made by the Meissner Manufacturing division at Mt. Carmel, Ill., record changers and similar products in Bridgeport, Conn., products of the Thordarson Electric Manufacturing division in Chicago and of the Radiart Corp., subsidiary in Cleveland, Ohio.

Allan R. Ogilvie is now a Maguire Industries vice president, in charge of the Bridgeport, Conn., plant.

Mr. Ogilvie was formerly chief engineer of the electronics division, a post to which Carlton Wasmansdorff succeeds.

* * *

KAUFMAN OF AIREON ON RMA TUBE COMMITTEE

Jack Kaufman, vice president of Aireon Manufacturing Corp., in charge of the San Francisco division, has been appointed to the RMA transmitter tube committee.

C. N. Kimball, vice president in charge of sales engineering, will serve on the RMA emergency services committee, and W. T. Bishop, engineer in Aireon's railroad division, has been named to the RMA radio communication and marine aids, and aeronautical radio committees.

* * *

FRED O'LEARY JOINS HARVEY-WELLS

Fred O'Leary has been appointed general sales manager of Harvey-Wells Electronics, Inc., Southbridge, Massachusetts. Mr. O'Leary was formerly with the Boston division of the WPB as chief of the radio and radar division.

Clifford A. Harvey, vice president, has been named director of engineering. M. T. Hodges is now chief engineer, and J. Wakefield, assistant engineer.

* * *

HANDIE-TALKIE AIDS RACE

Handie-talkies served to keep officials advised of progress of Thanksgiving Day parade of cars held in Chicago to commemorate the fiftieth anniversary of America's first automobile race. (*Courtesy Galvin Mfg. Corp.*)

G.E. TO BUILD F-M TRANSMITTERS WITH PHASITRON CIRCUIT

A modulator tube, the Phasitron, is scheduled to be included in G.E. postwar f-m broadcast transmitters.

The Phasitron is said to permit direct crystal control using a single crystal and modulation is independent of frequency control.

The tube was proposed originally by Dr. Robert Adler of Zenith who built the first laboratory tubes and circuit. In the further development of the tube and circuit for postwar f-m transmitters, basic improvements were contributed by the tube and transmitter divisions of G.E.

* * *

WESTINGHOUSE BUILDING COLOR TELEVISION EQUIPMENT

High-definition pickup units for processing both black-and-white and color pictures and f-m sound for simultaneous pulse transmission on the same radio carrier are being built by Westinghouse in their Baltimore plant.

Basic development was completed by CBS.

The new units will produce black-and-white pictures of 1029 lines-per-frame at 30 frames per second. Color pictures will be presented at a rate of 20 per second, and scanned at 525 lines per frame for each of the three primary colors—red, green and blue—for a total scanning of 1575 lines. This scanning will be through filters admitting only one color at a time. One complete cycle of the three colors will be required to provide one full-color picture.

* * *

LT. PRINCE RECEIVES BRONZE STAR

Lt. Kenneth C. Prince, U.S.N.R., recently received the Bronze Star Medal from Vice Admiral Charles Lockwood, Commander Submarine Force Pacific Fleet.

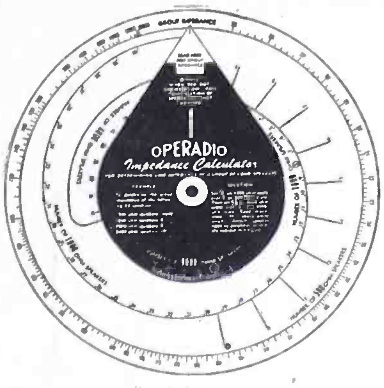
Prior to entering the Navy, Lt. Prince was legal counsel for the Sales Managers Club, Western group.

* * *

OPERADIO IMPEDANCE CALCULATOR

An impedance calculator, 5" in diameter, to aid matching of loudspeaker lines to an amplifier for sound systems covering 500, 1000, 4000, 8000 or 16,000-ohm loudspeakers, has been developed by Operadio Manufacturing Co., St. Charles, Illinois.

Scales for 500, 1000, 4000 and 8000-ohm loudspeakers are incorporated on three revolving discs. Total group impedance of all loudspeakers is obtained by matching specific ohm scales to the number of loudspeakers involved in a sound installation. Available to sound men for 25c direct or from Operadio distributors.



* * *

LOEBENSTEIN WINS RADIO RECEPTOR PROMOTION

Julian Loebenstein has been named sales manager of the selenium rectifier division of the Radio Receptor Co., Inc., 251 West 19th Street, New York City.

Mr. Loebenstein was formerly production manager.

* * *

HALLIGAN HEADS RMA HAM SECTION

William J. Halligan, president of the Hallicrafters Company, will head the new Amateur Radio Activities Section of the RMA Parts Division.

* * *

WISE RESIGNS FROM SYLVANIA; CARTER NAMED ENG. HEAD

Roger M. Wise has resigned from Sylvania Electric Products, Inc. E. Finley Carter succeeds him as vice president in charge of engineering.

Mr. Carter was assistant chief engineer of the radio division, and recently in charge of industrial relations.

Howard L. Richardson, formerly manager of personnel administration, becomes director of industrial relations.

* * *

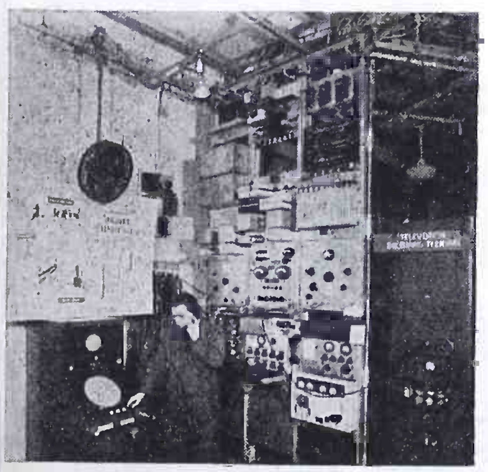
FCC ENG. DEPT. REORGANIZED

The FCC engineering department is now being reorganized and expanded to cope with industry expansion activities and increased licensing problems. There are now on file 463 applications for new standard stations, 211 applications

(*Continued on page* 88)

•

TELEVISION RECEIVING TERMINAL



Equipment at the N. Y. A. T & T. long-distance headquarters where the television signals for the Army-Navy football game, played in Philadelphia, were received via coaxial cable.

NEWS BRIEFS

(*Continued from page 87*)

for changes in existing standard stations, 707 f-m applications and 142 television applications.

The broadcast division has been renamed the broadcast branch and will be headed by John A. Willoughby, who has been assistant chief engineer in charge of the broadcast division.

The broadcast branch will consist of three divisions: Standard broadcast division, James A. Barr, acting chief; f-m division, Cyril M. Braum, acting chief; and television division, Curtis B. Plummer, acting chief.

There are to be three other branches in the engineering department: Safety and special services branch consisting of the marine and general mobile division, aviation division, emergency and miscellaneous division; field and research branch consisting of the field and monitoring division, technical information division, frequency allocation division and laboratory division; common carrier branch consisting of the domestic division, international division, rate division and the field division.

Charles A. Ellert has been appointed chief of the laboratory division and Paul D. Miles, chief of the allocation division of the field and research branch.

* * *

PRESS WIRELESS MANUFACTURING CORP. FORMED

Organization of the Press Wireless Manufacturing Corporation, a subsidiary of Press Wireless, Inc., was announced recently.

A. Warren Norton has been elected president. Ray H. de Pasquale, who has been director of manufacturing for Press Wireless, Inc., has become vice president and general manager of the new corporation.

Executive and sales offices will be at 1475 Broadway, Times Square, New York City. A newly manufacturing-engineering building is being built in Long Island City.

* * *

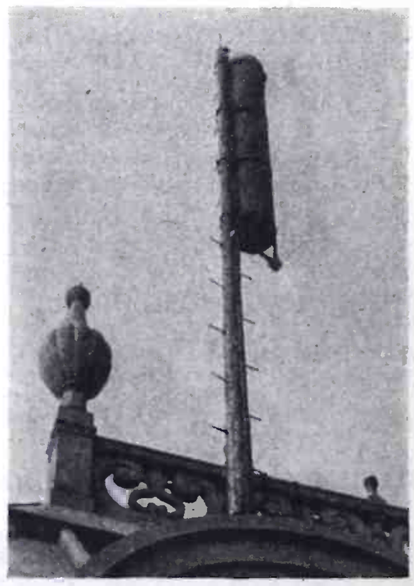
RFC SAYS RADIO SURPLUS IS SMALL

Radio and electronic war surplus so far declared is small, according to William L. Foss, chief of the RFC electronic division. About $100,000,000 of goods, on the basis of original price, has been made available to RFC.

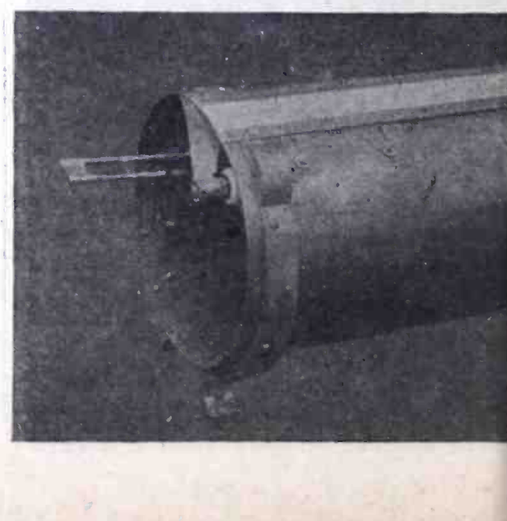
While RFC expects a large assortment of

•

SKYROCKET ANTENNA



Skyrocket antenna recently installed for WGHF the f-m facsimile station in N. Y. See opposite page for further data.



surplus handie-talkies and walkie-talkies, Mr. Foss said that no practical disposition of them has been developed. Contrary to general public belief, he said, these famed war products cannot be used in the proposed FCC citizens community services since they were made to transmit and receive on frequencies assigned to and held by the military services.

Some handie-talkies were put on the market several months ago, but Mr. Foss said he stopped the sales when he discovered that they were of little use to civilians.

Practically all radar equipment declared surplus to date, Mr. Foss said, is of an early and now obsolete character. The equipment itself has practically no civilian use although some of the parts may be salvaged.

* * *

COLE RESIGNS FROM RMA

Veteran RMA director, Sam I. Cole, formerly of the Aerovox Corporation, New Bedford, Mass., has resigned from the board of the directors. He is taking a vacation in Florida.

Mr. Cole served several terms as a director of the RMA governing board as a representative of the parts division.

* * *

CPA REPORTS RADIO RECONVERSION PEAK NEXT JUNE

By next June employment in the radio manufacting industry is expected to reach a peacetime peak almost 2½ times the 1939 level of about 110,000 and only 20% lower than the first quarter of 1945, when it reached 550,000, according to estimates of the Civilian Production Administration.

* * *

COAKLEY JOINS EIMAC

Tim Coakley has joined Eitel-McCullough, Inc., San Bruno, Calif., as sales and engineering representative for the New England states.

* * *

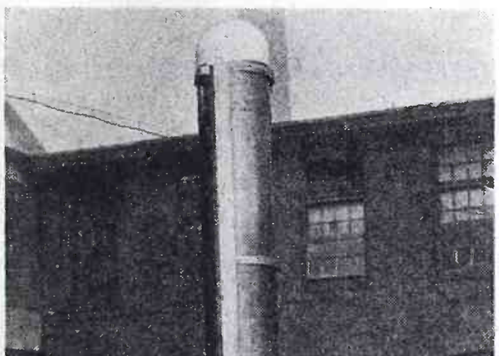
AIREON BUYS LEWIS ELECTRONICS

Aireon Manufacturing Corp., Kansas City, Kansas, has purchased Lewis Electronics, Inc.,

(*Continued on page* 90)

●

SKYROCKET ANTENNA



The 11' long, 2' diameter antenna used in the new Finch sound and facsimile station, operating on 99.7 mc. Antenna is said to radiate in all directions, with more gain than a half-wave antenna, and equal to four doughnut types or four crosses. One seal is used. Designed by Dr. Andrew Alford, the antenna is mounted 700' above sea level. Input impedance is relatively low.

NEWS BRIEFS

(*Continued from page 89*)

manufacturer of transmitting and industrial tubes, Los Gatos, Calif.

* * *

R. CLARK NOW ON SHURE SALES STAFF

R. Clark, former Shure Brothers chief purchasing agent, has joined the Shure sales staff and will handle sales to manufacturers.

He will introduce, to manufacturers, the *Glider* phonograph pickup which has a die-cast aluminum arm with no springs or counterbalances. When equipped with the Shure lever-type crystal cartridge, it has a needle force of 1⅛ ounces with outputs ranging from 1.6 to 2.5 volts.

Left to right: J. A. Berman, Shure sales manager; S. N. Shure, general manager, and R. Clark.

* * *

KORNETZ NOW WESTINGHOUSE RECEIVER DEVELOPMENT HEAD

Norman S. Kornetz has been appointed project engineer in charge of Westinghouse television receiver development.

Mr. Kornetz recently returned to this country, after serving with the U. S. Signal Corps in India as a captain with the Signal Service Battalion.

* * *

JEFFERSON-TRAVIS BUYS MUSICRAFT

Jefferson-Travis Corporation, 245 E. 23rd Street, N. Y. 10, N. Y., has acquired all of the outstanding capital stock of the Musicraft Corporation.

Musicraft will be operated as a wholly-owned subsidiary of Jefferson-Travis. Paul Puner will continue as president of Musicraft, and Oliver Sabin and Albert Marx will continue as vice presidents. Irving M. Felt, Jefferson-Travis president, has been elected chairman of the board of directors.

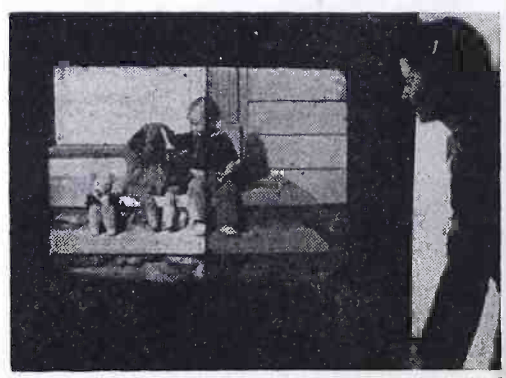
* * *

KARLSRUHER BECOMES EMERSON RADIO EASTERN SALES HEAD

Harold E. Karlsruher has been appointed eastern regional sales manager for Emerson Radio and Phonograph Corporation. Mr. Karlsruher,

●

HEAT ABSORBING GLASS



Heat-absorbing, color-transmitting glass developed for motion picture and television by American Optical Company.

who has been with Emerson for thirteen years, will cover the Metropolitan New York area, New Jersey, Eastern Maryland, Baltimore, and Washington.

* * *

OLESEN NOW G-S-M OF WESTON

Harold L. Olesen has been named general sales manager of the Weston Electrical Instrument Corp., 617 Frelinghuysen Avenue, Newark 5, New Jersey. H. L. Gerstenberger who formerly served in that capacity, continues as vice president in charge of sales.

Mr. Olesen has been associated with Weston since 1931 and has successively been in charge of radio sales, assistant general sales manager and sales promotion manager.

* * *

NEBRASKA STATE POLICE INSTALLS RADIOTELEPHONE SYSTEM

The Nebraska State Police will install a radio communications system which includes seven 250-watt and five 50-watt central stations, and 60 portable mobile units, made by Galvin.

* * *

ELLISON ELECTED ANA CHAIRMAN

Paul S. Ellison, director of advertising and sales promotion for Sylvania Electric Products Inc. has been elected chairman of the Association of National Advertisers.

* * *

READING RAILROAD TESTING V-H-F RADIO

The Reading Railroad has begun, at its Wayne Junction Yard, Philadelphia, Pa., comprehensive tests of a v-h-f radio communications system.

Frequencies being used for tests are 156.540, 156.600, 156.660, and 161.760 megacycles. Equipment was made by Maguire Industries.

Film type recorders are being used to record two-way conversations.

A 25-watt transmitter is being used in the yardmaster's office. Diesel-electric locomotives have been equipped with 15-watt battery-powered transmitters.

Nelson Wells, Maguire engineer, supervised installation of the equipment.

* * *

LEACH JOINS HAMMARLUND

E. A. Leach, formerly G.E. sales manager of emergency communications equipment, has been appointed executive engineer of the Hammarlund Manufacturing Company, Inc., 460 West 34th Street, New York 1, N. Y.

* * *

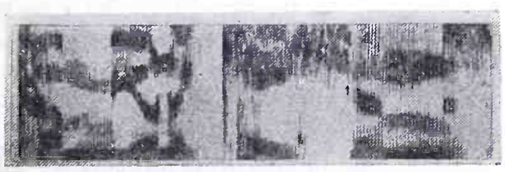
G.E. BUYS ACME ELECTRIC CLYDE, N. Y. PLANT

The Acme Electric & Manufacturing Company, Cuba, New York, has sold its Clyde, New York, plant to General Electric. This factory

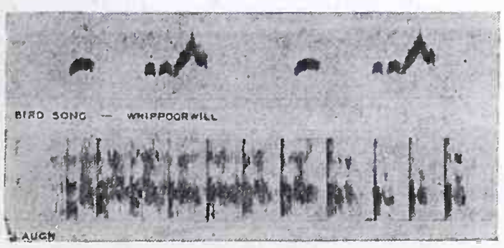
(*Continued on page 92*)

•

SOUND PATTERNS TO AID DEAF



Reproductions of speech patterns produced on a c-r tube device developed by Bell Telephone Labs to aid the deaf in not only reading, but speaking. Patterns are composed of pitch, loudness and time characteristics. Above pattern is for the word COMMUNICATIONS.



DIALCO FOR POST-WAR PILOT LIGHTS

NEWS BRIEFS

(*Continued from page* 91)

will be used by G.E. for the manufacture of fluorescent ballasts, the original product of the plant.

James A. Comstock, vice president of Acme Electric, together with the managerial and engineering personnel will move back to Cuba, New York, where a new Acme factory is being erected.

A branch factory at Allegany, New York, was recently also established by Acme.

* * *

WRONKE CORP. MERGES WITH HALLICRAFTERS

Louis J. Wronke, Inc., Oak Park, Ill., has been acquired by the Hallicrafters Company.

Louis J. Wronke, Wronke president, has joined Hallicrafters as chief mechanical engineer and director of design.

* * *

FTR PROMOTIONS

Henri Busignies has been named director of

•

45.5/91-MC FIELD TESTS

[FALL MEETING REPORT]

(*Continued from page* 46)

W3XL (99.8-mc). The Commission engineers were of the opinion that if the two antennas were of the same height, the field strength of the station operating in the new high f-m band would exceed that of the old low band station.

The FCC said that neither their tests nor the Zenith tests are conclusive on the question of power. Subsequent tests may establish that somewhat higher power might be desirable in the new band. However, there is no warrant for any such conclusion on the basis of the limited data now available. From what is known today, they said that it appears that power requirements for the new band will be substantially the same as requirements for the old band.

According to the FCC the conclusions drawn from the Zenith tests are not sound. Moreover, they said that it was misleading to discuss only one phase of the problem, namely, power, which can be greatly reduced if antenna structures are designed for high gain and placed at high locations.

Major Armstrong declared at Rochester that the FCC tests at the 20-mile distance were not as conclusive as the Zenith tests at the 76-mile distances. It is at the increased ranges that the sporadic-E interference and drop-out problem becomes serious, he pointed out. According to the Zenith tests the lower frequencies thus appeared to be better, he said.

the laboratories of the Federal Telephone and Radio Corporation.

W. P. Short has been named chief engineer and H. A. Snow senior engineer of FTR's newly created home-radio receiver department.

Mr. Short was formerly chief engineer of the Research Construction Company and staff member of the Radiation Laboratory of the Massachusetts Institute of Technology.

Mr. Snow developed the *variable mu* tube while with the Boonton Research Corporation.

Colonel Robert H. Freeman, recently of the Army Air Forces, has been appointed sales manager of pulse time modulation radio equipments and systems of Federal Telephone and Radio Corporation.

* * *

MAJ. HORWITZ JOINS INSULINE

Major Charles K. Horwitz has been named executive assistant to the president of the Insuline Corporation of America. He will also serve as director of personnel.

* * *

GEN. COLTON NOW A CONSULTING ENGINEER

Maj. Gen. Roger B. Colton and William L. Foss have opened a consulting engineering office in the Carry Bldg., 15th & K, N. W. Washington.

Gen. Colton had been chief of research and development in the Signal Corps.

Mr. Foss was chief of the international division, Army and Navy Electronic Production Agency from 1941-3. Recently he was with the RFC electronics division.

* * *

MILO RADIO AND ELECTRONICS CORP. OPEN NEW YORK STORE

Milo Radio & Electronics Corp. have opened a store at 200 Greenwich Street, New York City.

* * *

AIREON PIEZOELECTRIC CRYSTAL CATALOG

A crystal catalog describing a variety of crystals has been published by Aireon Manufacturing Corporation, Kansas City, Kansas.

Crystal types described include: Octal type with cylindrical metal shield and standard eight-pin base; three-pin, two-channel, aircraft type; standard two-pin phenolic holders for various kinds of mobile and stationary installations (banana or pin plugs); and variable air-gap mounting with screw top electrode.

* * *

AMERTRAN TO EXPAND

The American Transformer Company, Newark, plans to build a plant on Vauxhall Road in Union Township, N. J. Occupation will begin early next year.

* * *

RADIO SPECIALTIES MOVES

Radio Specialties, Detroit, have moved to 456 Charlotte Avenue. They were formerly on East Jefferson Avenue.

* * *

FAIRCHILD PLANT AND OFFICES NOW IN JAMAICA, N. Y.

The general offices and manufacturing facilities of the Fairchild Camera and Instrument Corporation are now located at 88-06 Van Wyck Boulevard, Jamaica 1, New York.

•

RADAR COUNTERMEASURES

(*Continued from page* 85)

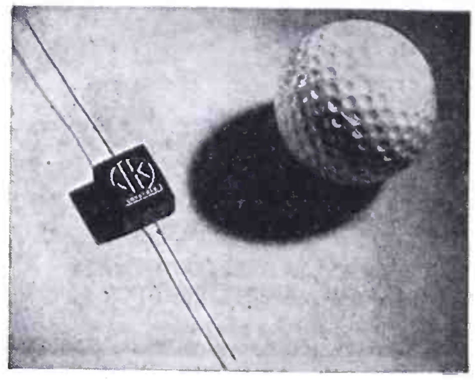
small and light. Nevertheless quite appreciable power outputs were obtained, particularly when one remembers that these power outputs are *continuous* ratings. For shipboard and special land-based applications more powerful equipments were available. In particular, an RRL-project, not listed, but especially interesting to power-conscious u-h-f broadcast engineers, was the one called *Tuba*. This was a large land-based jamming transmitter operating in the region of 500 mc and rated at 50 kw continuous. Three such installations were made in England, with highly-directive antenna systems pointed toward the continent. The three powerful beams provided paths along which RAF night-bombers could fly immune from radar-equipped German night-fighters.

THE INDUSTRY OFFERS . . . —

KNIGHTS MIDGET CRYSTALS

A midget-size *shock-proof* quartz crystal, type HI5, with tinned pig-tail connection, has been announced by the James Knights Company, Sandwich, Illinois. Crystal, complete with phenolic holder is said to weigh less than 1/5 of an ounce. Size, .600"x.725"x.350". Said to be dustproof and moisture resistant.

Available frequency range is from 3,000 kc to 15,000 kc. Frequency tolerance is said to be .01% over a temperature range of 0° C to 70° C.



* * *

MALLORY RESISTORS

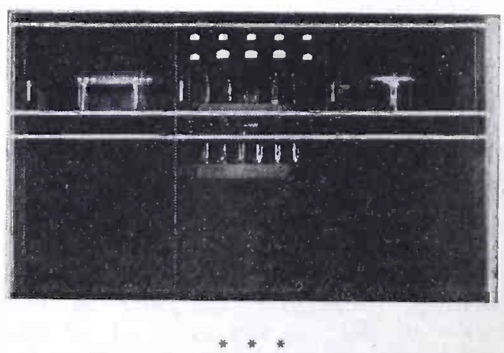
Vitreous enamel tab-type resistors, type RN, meeting joint Army and Navy Grade 1, class 1 specifications have been announced by P. R. Mallory & Co., Inc., Indianapolis, Indiana. Resistors are said to be able to withstand thermal shock from 275° C to 0 C°, and operate safely at 275° C.

COLLINS A-M BROADCAST TRANSMITTERS

A-m 5-kw broadcast transmitters, type 21A, for the 540-1600 kc range have been announced by the Collins Radio Company, Cedar Rapids, Iowa.

The audio-frequency response curve is said to be flat from 30-10,000 cps, ±1.5 db; noise level is more than 60 db below 100% modulation; distortion is less than 3% rms; carrier frequency is constant to within ±10 cps.

The 21A is said to carry full FCC approval for 5000- and 1000-watt high fidelity broadcast operation. Power output of 1 kw can be obtained instantaneously by operating a switch which controls plate voltages.



* * *

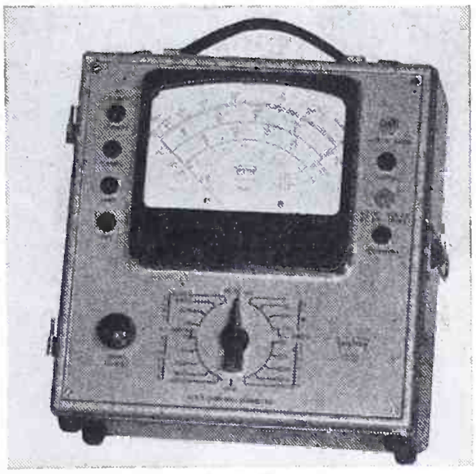
TRIPLETT VOLT-OHM-MILLIAMMETER

A volt-ohm-milliammeter, type 2405, with 25,000 ohms-per-volt (d-c), has been announced by the Triplett Electrical Instrument Co., Bluffton, Ohio.

Ranges are: D-c volts . . . 0-10-50-250-500-1000, at 25,000 ohms-per-volt; a-c volts . . . 0-10-250-500-1000, at 1,000 ohms-per-volt; d-c amperes . . . 0-10; a-c amperes . . . 0-0.5-1-5-10; d-c milliamperes . . . 0-1-10-50-250; d-c microamperes . . . 0-50; ohms-megohms . . . 0-4000-40,000 ohms, 4-40 megohms; output . . . capacitor in series with a-c volt ranges.

Has a 6", model 626, mocroammeter, adjusted to 40 microamperes.

Metal case, 10"x10"x5¾". Batteries self-contained. Weight, approximately 11 pounds.



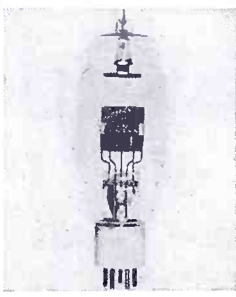
* * *

EIMAC TRANSMITTING AND RECTIFYING TUBES

Miniature external anode triodes, of the *lighthouse* variety, type 3X100A11/2C39, and grid control mercury rectifiers, type KY21A/KY21, have been developed by Eitel-McCullough, Inc., San Bruno, California.

Up to 25 watts of power at frequencies to above 500 megacycles are available with the triodes. Has a high transconductance, 100 watts of plate dissipation. Indirectly heated cathode with a 6.3-volt heater. Overall height is 2¾", diameter is 1¼".

Grid-control mercury vapor rectifier filament voltage is 2.5; filament current, 10 amperes; peak inverse voltage, 11,000; peak plate current, 3 amperes.



KY21A

3X100A11

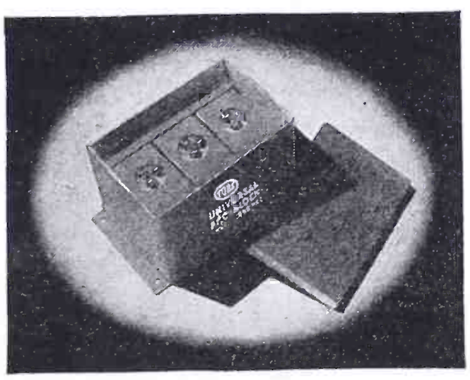
* * *

TOBE TAPPED CAPACITOR BLOCK

Capacitor blocks made up of dual 5-mfd oil-impregnated, oil-filled, and hermetically sealed metal case units, have been produced by the Tobe Deutschmann Corporation, Canton, Massachusetts.

Assemblies are available in sizes from 600 volt-amperes to 2 kva for operation at 230 volts 50-60 cycles. Capacitors are said to be capable of continuous operation at temperatures up to 75° C. Normal heat rise at full voltage is said to be less than 10° C.

The overall dimensions of the 600 volt-ampere unit are 4 13/16"x5 5/16"x7¼"; 1-kva unit is 11⅞" long; 2-kva unit is 23¾" long.



* * *

E. F. JOHNSON TO PRODUCE CABLE CONNECTORS, TIP PLUGS AND DIAL LIGHT UNITS

The E. F. Johnson Company, Waseca, Minnesota has acquired all tools, inventory and

(*Continued on page* 98)

AMPLIFIER INPUT IMPEDANCE

(*Continued from page 48*)

creased for this measurement until the amplifier voltage output is the same as in the first step. In the third step, *C* in Figure 1, we measure the input voltage, V_x, with a capacitance, C_k, in series with the amplifier input. Again the output voltage of the amplifier must be the same as before. The frequency of the generator, *G*, should be noted also.

The equivalent circuits of the foregoing three steps are shown in Figure 2. The input impedance of the amplifier is taken to be $(R + j\,X)$ where *R* is the resistive component and *X* the reactive component. The reactance, *X*, is positive if the impedance is capacitive in nature and is negative if inductive. The reactance of the known capacitor, C_k, is $X_k = \frac{1}{2}\pi f C_k$, where *f* is the frequency of the generator. Since the output voltage of the amplifier is the same in each step, the input voltage and current of the amplifier must be the same. The current in each of the three equivalent circuits of Figure 2 must be equal and hence can be equated to one another, i.e.,

$$\frac{V}{\sqrt{R^2+X^2}} = \frac{V_R}{\sqrt{(R_k+R)^2+X^2}} = \frac{V_x}{\sqrt{R^2+(X_k+X)^2}} \qquad (1)$$

where: *V*, V_R and V_x are the magnitudes of the voltages measured by the voltmeter, V_1.

The solution of *1* for the two unknowns *R* and *X*, can be accomplished in two ways, an analytical and a graphical method. The analytical solution consists in changing *1* into the form

$$R^2 + X^2 - 2mR = r$$

$$R^2 + X^2 - 2nX = s$$

where:

$$a = \frac{V_R}{V}\ ;\ m = \frac{R_k}{a^2-1}\ ;\ r = \frac{R_k^2}{a^2-1} \qquad (2)$$

$$b = \frac{V_x}{V}\ ;\ n = \frac{X_k}{b^2-1}\ ;\ s = \frac{X_k^2}{b^2-1}$$

and then solving *2* for *R* and *X*.

Thus

$$R = \frac{m(2n^2-P) + n\sqrt{4m^2n^2(a^2+b^2-1) - P^2}}{2(m^2+n^2)} \qquad (3)$$

and

$$X = \frac{n(2m^2+P) + m\sqrt{4m^2n^2(a^2+b^2-1) - P^2}}{2(m^2+n^2)} \qquad (4)$$

where: $P = r - s$. There is really another value of *R* and of *X* that will satisfy *2*, but this has no physical significance.

The graphical solution consists in recognizing that the equations of *2* are really two circles and that their intersection is the solution desired. For example, the first equation of 2 can be written as

$$(R-m)^2 + X^2 = (am)^2 \qquad (5)$$

If *R* is used as the horizontal axis and *X* the vertical axis, *5* is a circle with its center on the *R*– axis at the point (*m, O*) and with a radius of (*am*). This circle is shown in Figure 3. Similarly the other equation of *2* becomes

$$R^2 + (X-n)^2 = (bn)^2 \qquad (6)$$

which is a circle with the center (*O, n*) on the *X*– axis and with a radius (*bn*) as shown in Figure 3. There are two intersection points *A* and *B*, with *A* corresponding to a positive resistance, *R*, and a positive reactance *X*, while *B* has a negative resistance, *R*, and a negative reactance *X*. From physical considerations, the point *B* was discarded, and the point *A* was used. After the two circles are drawn, the abscissa *R* and ordinate *X* of the point *A* may be measured as in Figure 3 to give the required solution.

When, for a given amplifier, the six quantities *f*, R_k, C_k, *V*, V_R, and V_x are measured, the input impedance may be calculated arithmetically by the following procedure:

1. Let us calculate

$a = V_R/V$; $b = V_x/V$; $X_k = 1/2\pi f C_k$
$m = R_k/(a^2-1)$; $n = X_k/(b^2-1)$;
$r = mR_k$; $s = X_k n$; and $p = r - s$

2. Then we obtain *R* and *X* by use of equations *3* and *4*.

As an example, the input impedance of an amplifier was to be determined for a constant output voltage of 30.5 volts. The following data were taken:

$f = 300$ cps ; $V = 150$ millivolts
$R_k = 2.15$ megohms ; $V_R = 215$ millivolts
$C_k = 223$ mmfd ; $V_x = 220$ millivolts

The solution:

$a = 1.433$; $b = 1.467$;
$X_k = 2.38$ megohms ; $m = 2.037 \times 10^6$;
$n = 2.068 \times 10^6$; $r = 4.375 \times 10^{12}$;
$s = 4.92 \times 10^6$; $p = -0.545 \times 10^{12}$.
$R = 2.96$ megohms and $X = 2.76$ megohms

The input impedance may be obtained graphically by the use of the following outline:

1. Let us calculate

$a = V_R/V$; $b = V_X/V$; $X_k = 1/2\pi fC_k$;
$m = R_k/(a^2 - 1)$; $n = X_k/(b^2 - 1)$

2. Using the horizontal R – axis and vertical X – axis, we describe a circle of radius (am) about the point (m, O). With a radius (bn) we then describe a second circle about the point (O, n).

3. The abscissa and ordinate of the intersection point of these two circles are the required values of R and X respectively.

The solution of the example used previously is:

First circle . . . center $(2.037 \times 10^6, 0)$, radius (2.91×10^6); and second circle . . . center $(0, 2.068 \times 10^6)$, radius (3.033×10^6).

These circles were described in Figure 4, and their point of intersection is $(2.94 \times 10^6, 2.76 \times 10^6)$. Hence R = 2.94 megohms, and X = 2.76 megohms.

Component Values

Both R_k and X_k should be chosen so that they have approximately the same magnitude as the input impedance of the amplifier for best results. In case the amplifier has a high gain and the input voltage is too low to be measured conveniently by a voltmeter, the meter, V, may be replaced by a microvolter or a meter and a following attenuator, providing that the input impedance of the amplifier to be tested is much higher than the output impedance of the attenuator. The waveform of the amplifier should be checked at all times during this test, because the results will be poor unless the waveform is substantially a sine wave. The residual parameters such as the inductance and capacitance of R_k and the resistance and inductance of C_k can usually be neglected by the use of sufficiently good resistors and capacitors, such as for example, mica capacitors. If very accurate measurements must be made, these residual parameters will have to be included and an extension of the present analysis used. This method can be used to measure the input impedance of an amplifier even when it has a negative resistive component. In this case, the signs of the radicals of equations *3* and *4* may have to be changed, or the second intersection point *B* of Figure 3 may have to be used.

Use in D-C

This method of measurement has been successfully used in d-c (f = 0) work. For this, X = 0 and $X_k \rightarrow \infty$. Only two measurements need be made, that of V and V_R. Then

$$R = \frac{R_k}{a - 1} \qquad (7)$$

where: $a = V_R/V$. This method was used, for example, to determine the insulation resistance of dynamos and can be used equally as well to measure the d-c input resistance of an amplifier.

THE INDUSTRY OFFERS . . . —

(*Continued from page 95*)

manufacturing rights for Mallory-Yaxley cable connectors, pilot and dial light assemblies, tip plugs and tip jacks.

Seven and twelve-wire polarized cable connectors will be made. These connectors will be available with several types of mountings for both the receptacle and pin plugs.

Pilot lights will be supplied with a variety of jewel colors.

Dial lights will be available as shell assemblies and with slip-on brackets.

Tip plugs will be of the solderless type and supplied in a long and short length. Tip jacks will be available with either metal or bakelite type heads and with round and hexagon heads.

* * *

G.E. INDUSTRIAL SOLDERING IRONS

Industrial soldering irons, ranging from 75 to 300 watts, have been announced by the industrial heating division of G.E. Available with tips from 3/8" to 1 1/4" in diameter.

Irons said to have quick recovery and high reserve-heat capacity. Calorized (surface-alloyed with aluminum) copper and 18-8 stainless steel used for parts subjected to high temperatures.

* * *

HARVEY-WELLS AIRCRAFT TRANSCEIVER

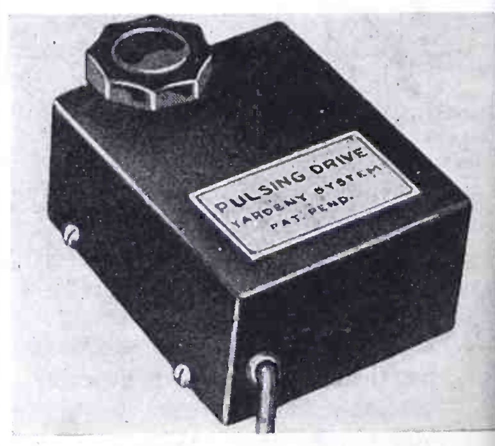
A lightweight transmitter-receiver for personal planes, type ATR-3, has been announced by Harvey-Wells Electronics, Inc., Southbridge, Mass.

Weight, 12 3/4 pounds. Size, 4 1/2" high x 5 1/2" wide x 8" deep. Operates on a 6- or 12-volt synchronous vibrator power supply.

* * *

YARDENY PULSING CONTROL DRIVE

Pulsing drives for single knob control of reversible motors have been announced by Yardeny Engineering Company, 105 Chambers Street, New York 7, New York. Motor may be continuously rotated or moved in small increments.



* * *

SIMPSON MUTUAL CONDUCTANCE TUBE TESTER

Mutual conductance tube testers have been

(*Continued on page 101*)

IULTIPLE WIRE RECORDING

by
RUSSEL J. TINKHAM
Physicist
Armour Research Foundation

RECENT improvements in the technique of magnetic wire recording, plus widespread use and 'oof of a practical low cost unit by e armed forces on the battle fronts, ive accelerated public interest in this ethod of recording.

The prospect of widespread public ceptance makes it desirable to prode means for making duplicate wire cords in quantity and at low cost.

Fundamentally wire record duplicatg differs little from making the origal records. In Figure 1*a* is illusated, in block diagram form, the ethod used in wire recording. The rrective network compensates for the equency discrimination characteristic the wire record medium, while the igh frequency component, added to e signal to be recorded, effectively raightens the non-linear reproducing aracteristic of the wire.

In the multiple duplicating process Figure 1*b*) the master record beomes the signal source replacing the icrophone, and an amplifier of suffiient power handling ability is emloyed to energize a multiplicity of imilar recording heads connected in arallel. Since 1 milliwatt at 1,000 ps is sufficient at each head, a great nany records can be made simultaneusly with a relatively low-powered mplifier.

The greatest problems in multiple uplicating are not in the electrical ircuits, but in developing the wire andling machinery to drive the wires t a constant and uniform speed. Figre 2 pictures an experimental machine apable of making four duplicates imultaneously from an external master, or three duplicates from the fourth wire which is the master.

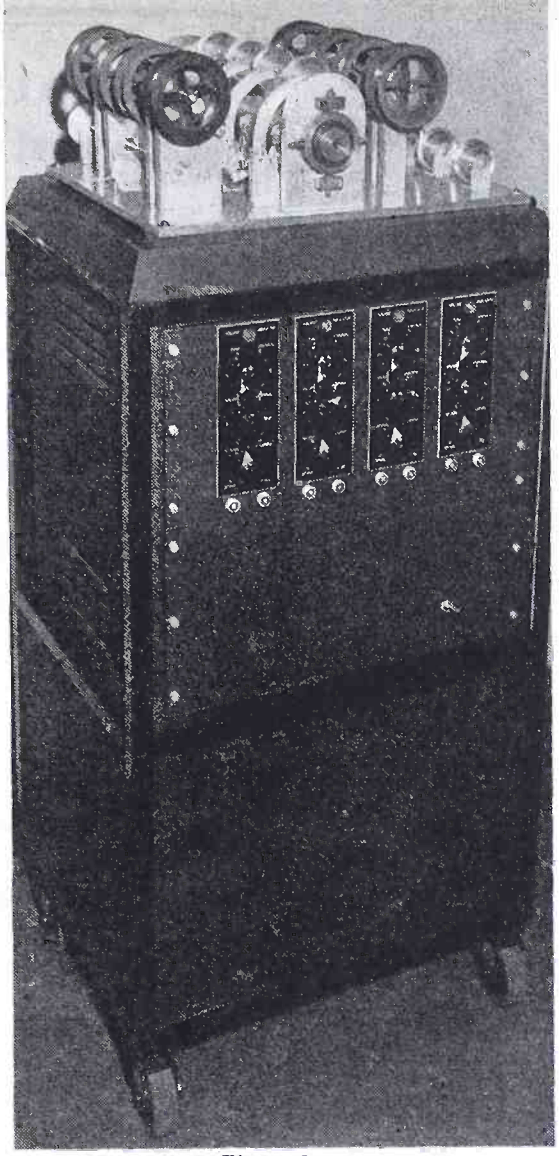


Figure 2
Multiple wire recorder duplicating unit.

Based on experiences with this and similar units other multiple duplicating machines are in the design and construction stage.

The time element in manufacturing duplicates by this method is of importance, but with high speed techniques of dubbing, using advanced designs of recording heads, this problem assumes secondary importance.

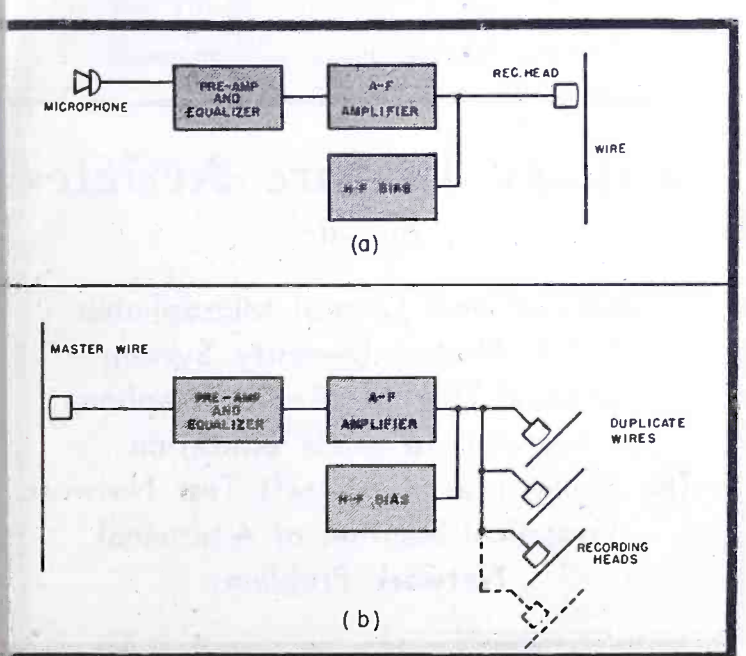


Figure 1
Method used in wire recording is shown in *a*. Multiple method is shown in *b*. In this procedure the master record becomes the signal source replacing the microphone.

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.

January Feature Articles

include

Unidirectional Crystal Microphones
CAA Alaskan Diversity System
3-Channel 25-Watt Radio Telephone
For ship to shore operation
The Glenn Martin Aircraft Test Network
Graphical Solution of 4-terminal
Network Problems

THE INDUSTRY OFFERS . . . —

(*Continued from page* 98)

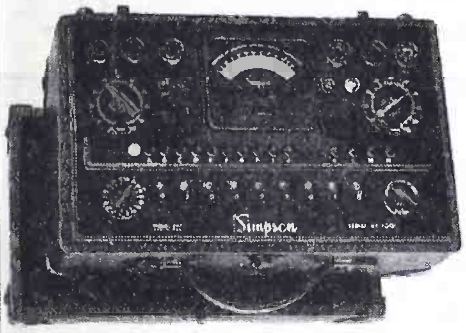
veloped by the Simpson Electric Company, hicago.

Unit tests tubes in terms of percentage of ted dynamic mutual conductance. Tube der test is compared with the standard rated icromho value for that tube. Colored zones the dial coincide with the micromho rating percent of mutual conductance, indicating at the tube is good, fair, doubtful or defitely bad.

Has ten push-button switches and nine rotatg switches of six positions; tube chart proded for quickly identifying the tube and tting the controls.

An automatic re-set button returns all itches to normal when the test is completed.

Overall size, 15½" x 9½" x 6½".



* * *

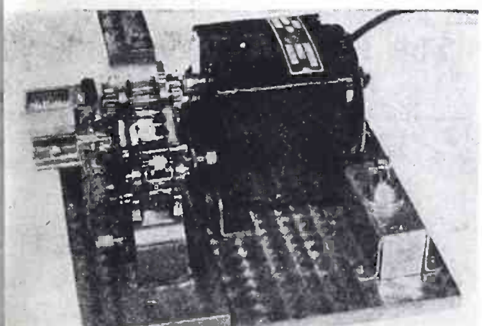
UTOFLIGHT MINIATURE TOROIDAL OIL WINDERS

mi-automatic miniature toroidal coil winders, out 6" square, have been developed by the toflight instrument division of G. M. Gianni & Co., Inc., 4522 Lankershim Boulevard, orth Hollywood, California.

Winds toroidal coils approximately ½" in ameter and accommodates form widths from 32" to ½". Wires from .005 to .001 are said have been successfully wound with this achine.

Winder consists of a link roller chain of conntional design mounted on four narrow rockets engaging only a small part of the ain rollers at their outer edges. The chain ive is by two sprockets which, in turn, e driven by a common shaft connected by two parate but equivalent gear trains. The coil rm is held by three freely mounted rollers hich position the form relative to the roller ain.

Coil form is rotated by two fingers which st on the edges on the coil form. As each rn is laid on the coil form, these fingers sh the wire over against the preceding turn d thus rotate the coil form the width of one re for each turn. A counter is provided to ow the number of turns.



* * *

.R. BROADCASTING STATION ONITOR AND TEST UNITS

vo instruments for monitoring and testing oadcast transmitters, type 1931-A a-m monitor d 1932-A distortion and noise meter, have en announced by General Radio Company, mbridge 39, Mass.

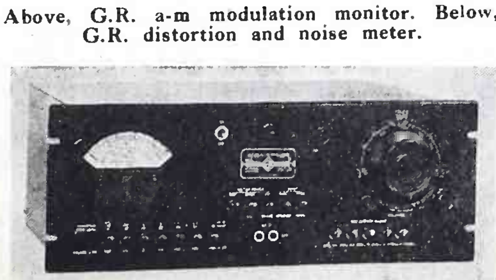
The 1931-A a-m monitor measures percentage odulation on either positive or negative peaks d is said to give a continuous indication of odulation peaks in excess of a predetermined rcentage set by means of a dial. Can also used for program-level monitoring and measing transmitter audio-frequency response.

Two audio output circuits are provided, one 600 ohms for audible program monitoring, d the other a high-impedance circuit that ves a faithful reproduction of the audio enlope for distortion and noise measurements.

Linear rectifier is designed for use at a low wer level, so that the problem of coupling to e transmitter is simplified. The required r-f wer input is 0.5 watt.

Range: 0 to 110% on positive peaks, 0 to 0% on negative peaks. Carrier frequency nge, 0.5 to 60 mc.

Above, G.R. a-m modulation monitor. Below, G.R. distortion and noise meter.



Panel, 19" x 8¾"; depth behind panel, 10".

The distortion and noise meter is a direct-reading instrument for measuring distortion, noise, and hum in audio-frequency systems. When used for measurements on broadcast transmitters, the distortion meter operates from the high-impedance output circuit of the 1931-A modulation monitor.

A continuous frequency range of 50 to 15,000 cycles, fundamental, is covered by a single dial and push-button multiplier. Distortion and noise components up to 45,000 cycles are included in the measurement. A direct-reading distortion meter provides full-scale ranges of 0.3%, 1%, 3%, 10% and 30%.

Noise range, to 80 db below 100% modulation or 80 db below zero vu.

Panel, 19" x 7"; depth behind panel, 12".

* * *

KAY MICRO-PULSER

A micro-pulser for generating short pulses, has been announced by Kay Electric Co., 8 Eaton Place, Newark, N. J.

Pulse width, ½ to 5 microseconds; pulse repetition rate, 200 to 2000 and 2000 to 20,000 cps.

Output pulse both positive and negative. Low impedance, positive pulse at approximately 150 ohms, negative pulse at approximately 400 ohms.

Size, 10" x 14" x 8". Weight, 30 pounds.

AGAIN AVAILABLE— COMMUNICATIONS

(12 Big Issues—$1) **Group Subscription Plan**

Saves Fifty Per Cent of the Subscription Price if Four or More Orders, Including Your Own, Are Properly Entered on This Form

To COMMUNICATIONS:
52 VANDERBILT AVE., NEW YORK 17, N. Y.

Please enter annual subscriptions (12 issues) for each of the undersigned for which payment is enclosed at the rate of $1.00 each. (This rate applies only on 4 or more subscriptions when occupations are given.)

Name ....
Address ....
City-State ....
Occupation ....
Employed by ....
Nature of Business ....
(State if Manufacturer, Broadcast Station, etc.)
Product ....

Name ....
Address ....
City-State ....
Occupation ....
Employed by ....
Nature of Business ....
(State if Manufacturer, Broadcast Station, etc.)
Product ....

Name ....
Address ....
City-State ....
Occupation ....
Employed by ....
Nature of Business ....
(State if Manufacturer, Broadcast Station, etc.)
Product ....

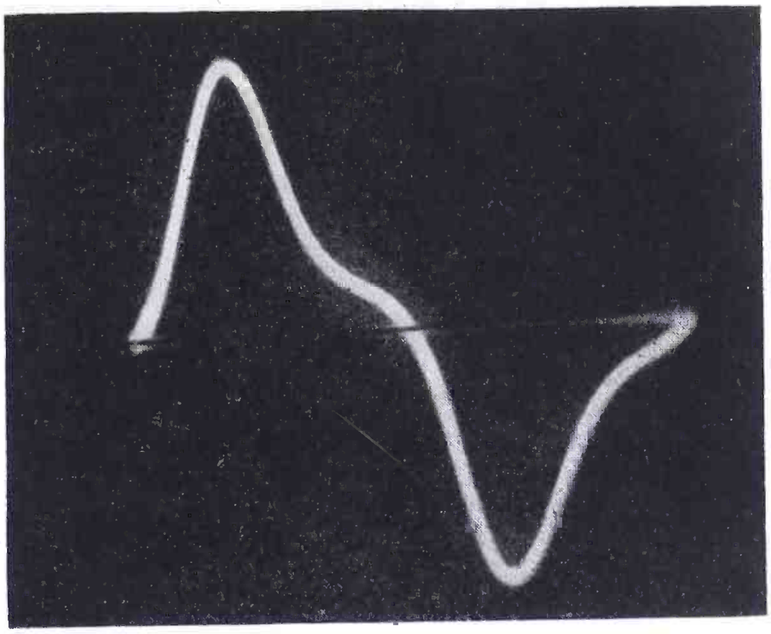
Name ....
Address ....
City-State ....
Occupation ....
Employed by ....
Nature of Business ....
(State if Manufacturer, Broadcast Station, etc.)
Product ....

WAVE ANALYSIS

(*Continued from page* 40)

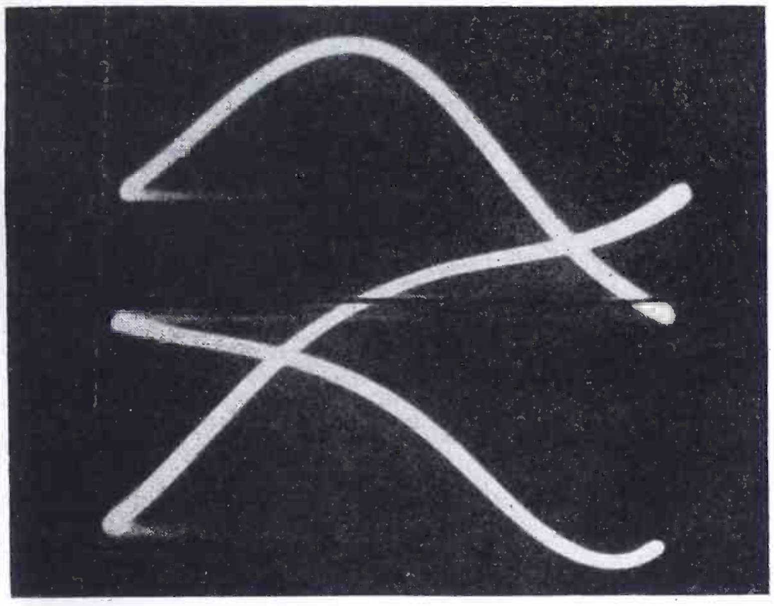
of the complex current of Figure 2, as a result of adjustment of the linear sweep frequency to 180 cps.

In Figure 4, retracing of the superposed patterns of Figure 3, addition of ordinates, and division of each resultant ordinate by 3, reveals the third harmonic as shown. It should be observed that Figures 2 and 3 have been plotted to different time scales.



Figures 2 (right) and 3 (below)

Figure 2 illustrates the exciting current of a small filament transformer. In Figure 3 we see how the adjustment of the linear sweep frequency to third harmonic of fundamental of exciting current superposes three wave divisions.



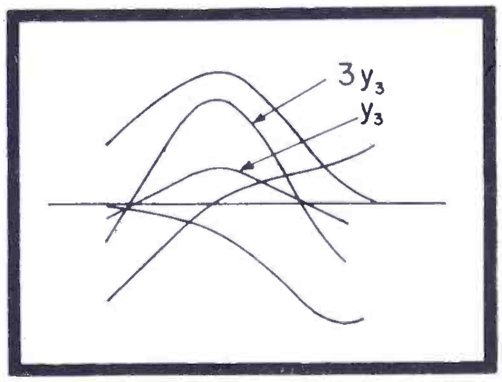


Figure 4 (right)

Approximate analysis for third harmonic of Figure 2, using superposed traces of Figure 3.

ADVERTISERS IN THIS ISSUE

COMMUNICATIONS — DECEMBER, 1945

MORE VARIACS*
NOW!

A portion of our greatly expanded VARIAC production has been released from war orders. VARIAC deliveries are improving daily. We hope that within a comparatively short time *all* models of the VARIAC can be shipped promptly upon receipt of your order.

In the meantime you'll find several weeks required for delivery of some models well worth the waiting . . . VARIACS are still the *original* continuously-adjustable autotransformer first introduced by General Radio . . . redesigned to meet all of the mechanical and electrical requirements for all types of service . . . assuring rugged construction, long life and the same manufacturing care that is given to the finest G-R laboratory instrument.

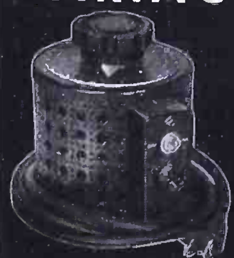
You may have to wait a little longer for VARIACS, but you'll be satisfied many times longer.

YOU CAN GET THESE FROM STOCK

At the moment we have a small stock of the popular Types 100-Q and 100-R VARIACS and can ship immediately. These models are rated at 2,000 va. The Type 100-Q supplies continuously adjustable voltages from zero to either 115 or 135 volts from a 115-volt 60-cycle line with a maximum output of 18 amperes; the Type 100-R supplies a maximum of 230 or 270 volts from either a 230- or 115-volt line with a maximum current rating of 9 amperes from a 230-volt input, or 4.5 amperes when used on 115 volts. Price of either model: $40.00.

**The trade name VARIAC is registered at the U. S. Patent Office. VARIACS are manufactured and sold only by General Radio Company under our U. S. Patent 2,009,013.*

VARIAC



MADE ONLY BY **GENERAL RADIO COMPANY**

Cambridge 39, Mass.
NEW YORK
CHICAGO
LOS ANGELES

It's Here!

The NEW TEMCO

Multi-Frequency

COMMUNICATION TRANSMITTER

in power ranges of

100 to 1000 WATTS

in a Single Cabinet

These new Temco Transmitters are the answer to a long standing need for communication equipment characterized by flexibility in its operational features and capable of covering continuously a wide band of frequencies. Temco Engineers have achieved this by means of a single dial controlled, highly stable exciter unit which is continuously variable from 2-32 megacycles and may be hand operated or motor driven depending upon requirements. This unit permits selection of any of four crystal positions affording crystal control or master oscillator over the entire frequency range. It is self contained having its own power supply and is common to all Temco Transmitters.

The intermediate amplifier and power amplifier stages are normally supplied with motor tuning units. Available on special order is an added tuning feature which permits local or remote selection of ten fixed pre-determined frequencies within the 2-32 megacycle range. In addition, vertical construction is used throughout to permit easy access to all components for minimizing servicing problems.

To fill requirements for power outputs greater than 1000 watts it is only necessary to add another cabinet containing amplifiers producing the power required. Thus original equipment is retained, for, in designing these transmitters every step has been taken to protect customers against obsolescence of equipment and make possible power output increases at will with minimum effort and the least expenditure.

FEATURES

- **Single Control-Tracked Tuning Exciter Unit** eliminating independent tuning of all low powered R.F. stages.
- **Motorized Tuning Controls** permitting placement of components in chassis positions best suited for maximum circuit efficiency.
- **Eye-Zone Meters and Hand-Level Controls** introducing a highly desirable innovation for ease of operation.
- **Temco Power-Flex Multiple Unit Design** for expanding power output without making obsolete lower power units and retaining uniform over-all appearance.
- **Multiple Cabinet Plan** for power requirements in excess of 1 KW.
- **Dust and Tamper Proof Cabinets.**
- **Forced Draft—Filtered Ventilation.**
- **Handsome, dignified styling throughout.**

TEMCO

RADIO COMMUNICATION EQUIPMENT

TRANSMITTER EQUIPMENT MFG. CO., INC.
345 Hudson Street • New York 14, N. Y.