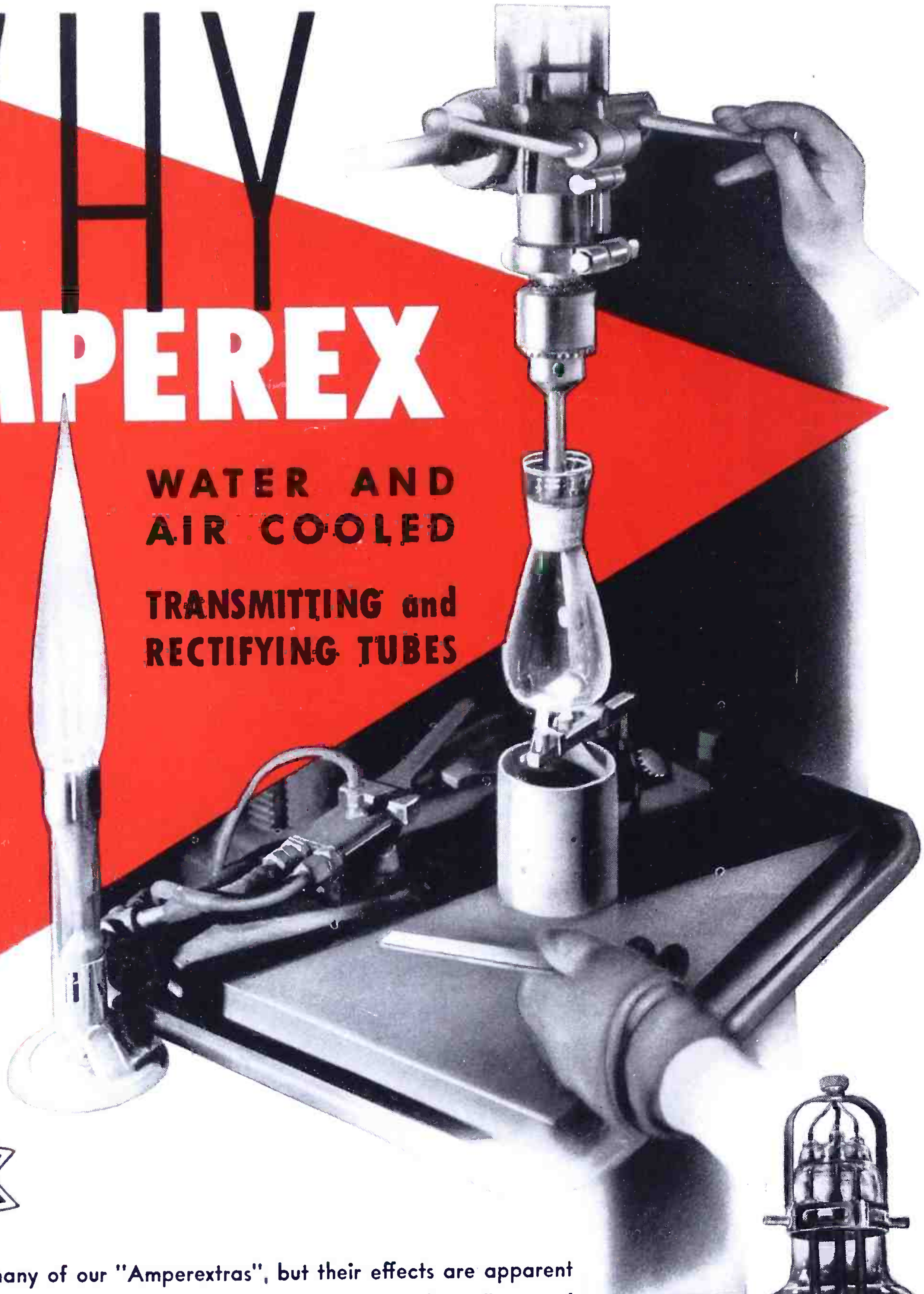
COMMUNICATIONS

MAY

★ RADIO ENGINEERING
★ CAPACITOR VIBRATOR POWER SUPPLY
★ TELEVISION ENGINEERING
★ FIELD TEST IMPROVISATIONS
★ V-H-F COIL Q FACTORS
★ PI-NETWORK HARMONIC ATTENUATION

1944

WHY AMPEREX



WATER AND AIR COOLED

TRANSMITTING and RECTIFYING TUBES

ARMY E NAVY

You can't see many of our "Amperextras", but their effects are apparent in the quality, efficiency and longer life of ***Amperex*** tubes. Illustrated is a highly specialized method of glass fabrication. Among our other novel techniques are sealing operation on rotating fires, precise welding, unique way of sealing glass to copper, extremely careful chemical cleaning. These operations are characteristic of the standards of ***Amperex***—the scientific laboratory on an enlarged scale.

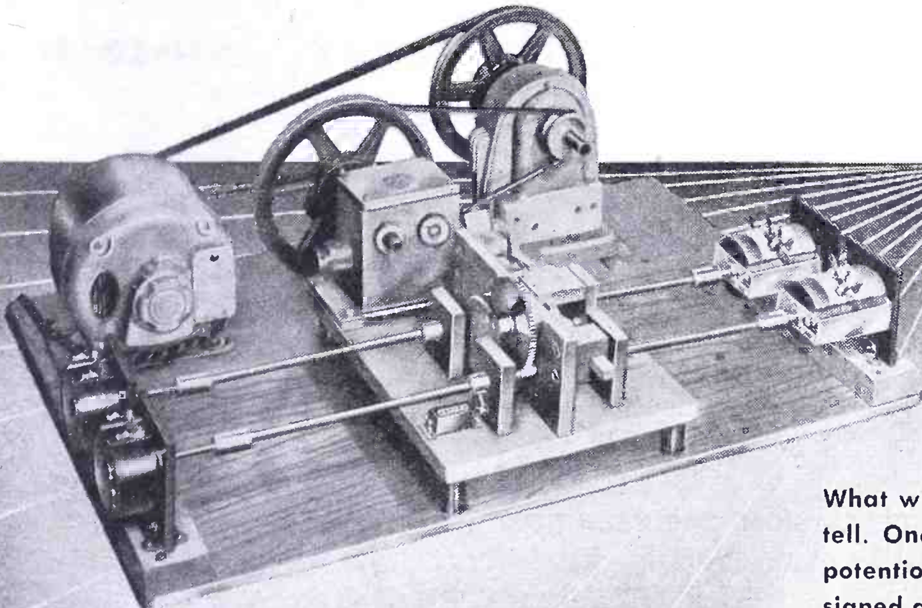
Still Your Best Investment . . United States War Bonds

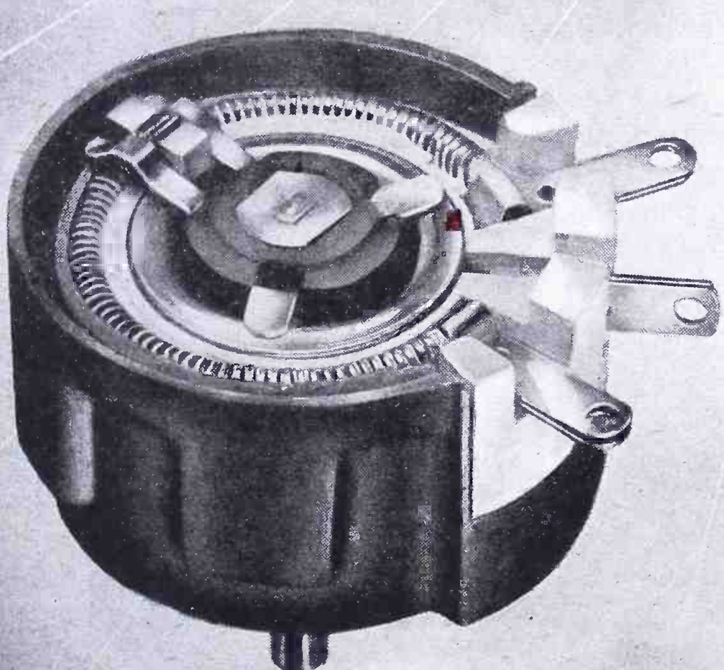
AMPEREX ELECTRONIC PRODUCTS

79 WASHINGTON STREET BROOKLYN 1, N. Y.

24-HOUR TESTS FORECAST

15 YEARS OF SUSTAINED OPERATION





What will happen in 1959 nobody can foretell. One fact is clear, however, The DeJur potentiometer that you buy today is so designed and constructed as to provide at least 15 years of efficient operation. This figure . . . and it is a conservative one . . . is based on simulated production-line tests in our laboratory as well as reports from the field.

Operating at half-cycle, at as many as 2,500,000 revolutions over a 24-hour period, a specially-developed rotation tester checks the endurance of DeJur potentiometers. The wiper travels from minimum to maximum resistance at rates stipulated in American Standards Association specifications. Mechanical and electrical characteristics are checked under abnormal as well as normal conditions. Effects of day-in and day-out performance are analyzed. Out of these tests come DeJur potentiometers whose dependability can be counted on for extended period of time. Data sheets upon request.

Support the Fifth War Loan Drive

DeJUR U.S.A.

DeJur-Amsco Corporation

MANUFACTURERS OF DeJUR METERS, RHEOSTATS, POTENTIOMETERS AND OTHER PRECISION ELECTRONIC COMPONENTS

SHELTON, CONNECTICUT

NEW YORK PLANT: 99 HUDSON STREET, NEW YORK 13, N.Y.

CANADIAN SALES OFFICE: 560 King Street West, Toronto

AWARDED FOR EXCELLENCE IN PRODUCTION AND QUALITY OF MATERIEL — ARMY E NAVY

LEWIS WINNER, Editor
F. WALEN, Assistant Editor
A. D'ATTILIO, Assistant Editor

We See...

THE PROVOKING SYMBOL PROBLEM, which has stalked the *communications* and power industries, has at long last entered the solution stage. A report from ASA cites that symbols for six components . . . fixed and variable capacitors, fixed and variable resistors, fixed and variable inductors, transformers, operating coils, and contacts . . . have already been standardized.

ASA says that these standards, which appear in Form Z32.11-1944, should eliminate symbol conflicts. They also report that revision of other symbols for the power and *communications* industries is also under way, and should be completed soon.

Everyone is most grateful for this coordinated result.

NINE TYPES OF EQUIPMENT that cannot be classified as maintenance, repair, or operating supplies, have been listed in a new clarifying interpretation of reference rating, P-133. The items are: recording or reproducing turn tables, amplifiers, microphones, speech-input consoles, transmitters, relay racks or cabinets, jack panels, frequency monitors, and antenna towers.

The interpretation states that necessary parts to maintain or repair this equipment may be purchased with P-133 ratings. But any P-133 ratings, which may have been applied to purchase orders for these nine items or similar equipment, should be canceled at once.

THE FAMOUS STEVENS HOTEL in Chicago will play host again to the annual RMA meeting. The date . . . June 6 and 7. It's to be the second war production conference, and as at the first war conference, there will be no exhibits or meetings for jobbers or dealers, and no banquet or other social features. It will be all business.

WE WERE SHOCKED TO LEARN of the death of Stuart Ballantine, one of the world's foremost communications engineers. He died on May 7, after a two-day illness.

The industry shall never forget Stuart Ballantine and his brilliant achievements.—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.

MAY, 1944

VOLUME 24 NUMBER 5

COVER ILLUSTRATION

Soldering connector plug to a flexible shielded cable containing shielded wires, coaxial cable and unshielded wires, for aeronautical communications application.
(Courtesy RCA)

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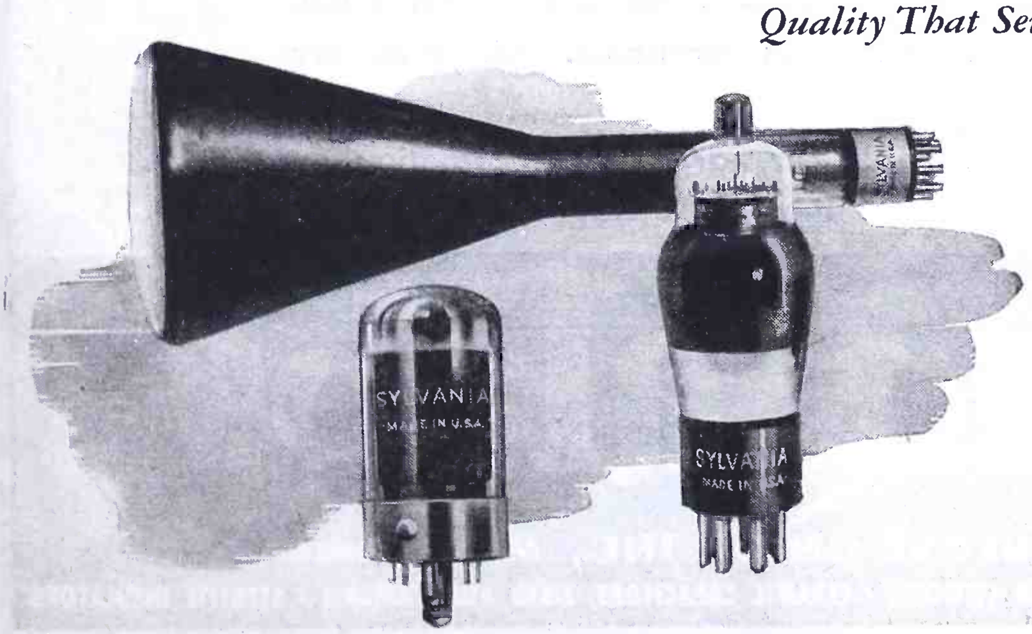

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Silver Mica CAPACITORS

Capacities from 6 to 2000 MMF

Less than one half inch in diameter . . . capacities from 6 MMF to 2000 MMF . . . ideal for numerous UHF and VHF applications.

Mica discs of the highest grade, individually silvered for maximum stability and stacked to eliminate any book effect. The assembly is vacuum impregnated. Available in a variety of terminals. All units are color coded.

Form 586 is available for additional information on these CENTRALAB Silver Mica Capacitors.

ARMY E NAVY

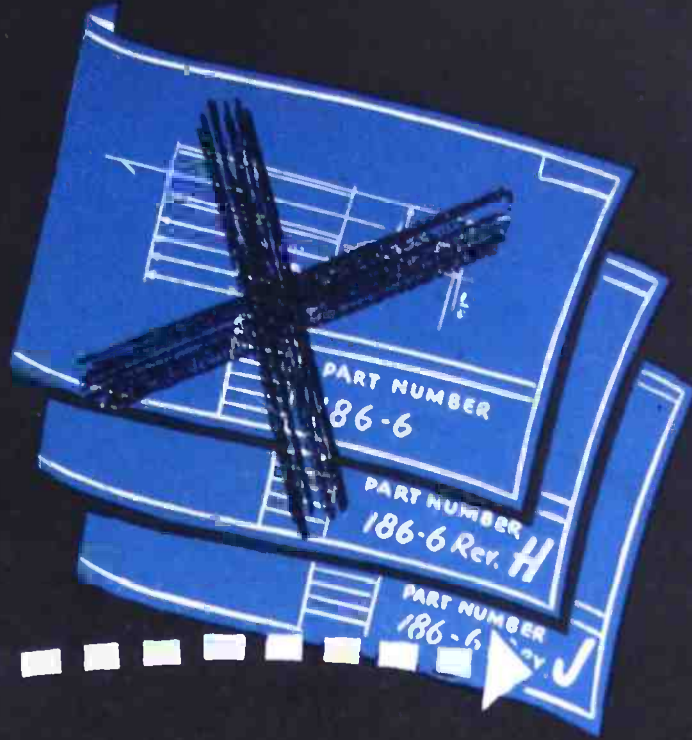
Centralab

CRL

Division of GLOBE-UNION INC., Milwaukee

PRODUCERS OF VARIABLE RESISTORS · SELECTOR SWITCHES · CERAMIC CAPACITORS, FIXED AND VARIABLE · STEATITE INSULATORS

SPEC'S CHANGED *Today?*



How quickly can you whip your revised plastic parts into your new design?

"Three years ago we produced the bulk of our plastic parts. But because we are primarily an electrical assembly and metal working plant we were unable to adapt ourselves to quick changes in plastic specifications in such parts as our fuse posts, spacers and terminal strips.

"To cope with these sudden problems we called in 'CREATIVE PLASTICS' . . . and the result has been so outstanding that we feel more secure about our plastic parts being produced in your plant than in our own."

—The above is an excerpt from one of many similar letters in our files.

In these times of sudden specification changes, whip your plastic problems by calling on "CREATIVE". Frequently we can solve your problem right from stock with such parts as insulating grommet bushings, shown at the left . . . or we can fabricate to your specifications in suitable materials.

Take the first step NOW—send us blue prints for quotations and delivery promises.

"CREATIVE" INSULATING GROMMETS

Five important characteristics save time and labor in wiring operations:—1. All holes are concentric . . . 2. All threads are clean and lubricated . . . 3. All parts have geared collars and are matte finished for quick handling . . . 4. All corners are chamfered to protect against fraying . . . 5. Four standard sizes, all immediately available from stock. *Send for free sample card.*

Creative

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AAC Quartz CRYSTALS
help keep the communications
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BRANIFF AIRWAYS
GREAT LAKES TO THE GULF
CANADIAN PACIFIC
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COLONIAL
COLONIAL AIRLINES
CONTINENTAL AIR LINES
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INLAND AIR LINES
MID-CONTINENT AIRLINES
NATIONAL AIRLINES
NORTHEAST AIRLINES
NORTHWEST AIRLINES
U.S.
PAA
Panagra
TCA
TWA
GOES ALL THE WAY
WESTERN AIR LINES
Today..and Tomorrow
Illustrated at right is a typical crystal manufactured by Aircraft Accessories Corporation and used in both ground and plane radio installations by America's commercial airlines. Many other types of AAC crystal units are being supplied various branches of the armed service and other government agencies.
Today, practically all AAC facilities are devoted to war production. Tomorrow, advanced AAC electronic developments will be available for the post-war world.
AAC
Products
AIRCRAFT
Manufacturers of PRECISION
Burbank, Calif.
Kansas

Systems of the World's Greatest Airlines Working Efficiently!

REALIZING the extreme importance placed by the airlines upon the proper maintenance of their communications facilities, Aircraft Accessories Corporation has set aside a special division of its crystal laboratories to provide rapid delivery to airlines and associated communications services of a variety of standard crystals. *Deliveries in limited quantities can be made within a few days* after receipt of purchase order with adequate priority.

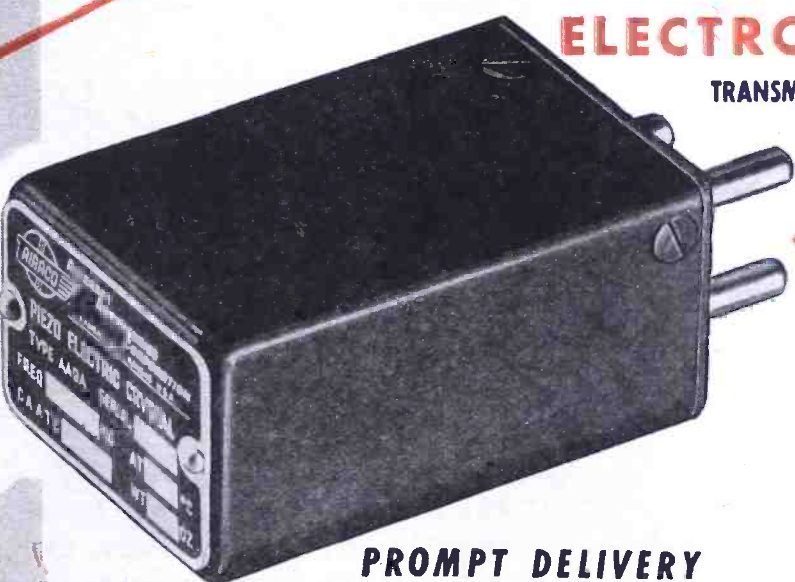
In the manufacture of quartz crystals, AAC development and production engineers employ the experience gained as one of America's largest producers of transmitters and other precision radio equipment. AAC crystal units will meet the most exacting requirements under severe operating conditions. Address all crystal orders and inquiries to Electronics Division, Kansas City, Kansas.

The services of our Engineering Department in designing special equipment are available to you without obligation.

Products of

ELECTRONICS DIVISION

TRANSMITTERS • AIRCRAFT AND TANK ANTENNAS
QUARTZ CRYSTALS • RADIO
TEST EQUIPMENT



Type AA9 Crystal, 2.5 parts/million temperature coefficient, accuracy of carrier frequency .01%. Made in three models—A, G and E, covering total fundamental frequency range of 200 to 10,000 kc. Internal adjustment screw permits small amount of frequency control in the single crystal units, AA9A and AA9G.

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Accessories Corporation

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CONTENTS OF MANUAL

The Cathode-Ray Oscillograph: introduction, general description, high-voltage power supply, amplifiers, linear time-base generator, intensity modulation, low-voltage power supply, mechanical considerations, conclusion.

• • •

Oscillograph Design Considerations: power supplies, amplifier design, time-bases or sweep generators.

• • •

DuMont Cathode-Ray Equipment: description, specifications, accessories, oscillograph type comparison list, specialty products.

• • •

DuMont Cathode-Ray Tube: general information, installation notes, type specification sheets, tube type comparison list.

• • •

Sales and Service Information: how to order, patent notice, price list, etc.

• • •

Instrument and Tube Application Notes: frequency and phase determination, photographic measurements, observation of relay rebounce, etc.

Cathode-Ray Tubes

. . . and how they are applied

For a dozen years past the Allen B. DuMont Laboratories have specialized in the development, production and application of cathode-ray tubes.

DuMont was the first to introduce the *commercialized* cathode-ray tube as a practical tool for research worker, production engineer and technician. Not only have DuMont tubes and oscillographs resulted in savings in time required to investigate the many problems to which they are applicable, but they have also revealed truths in man's laws of the working forces of nature.

And now, as a further service, DuMont engineers have compiled a manual of pertinent data, together with detailed descriptions of DuMont tubes and associated equipment. This data is in loose-leaf form. The binder permits constant revision to keep pace with the fast-moving cathode-ray technique. Each manual bears a serial number so that the name and address of its recipient may be duly registered. Additional pages are mailed from time to time.

• •

Write on your business stationery for your copy. Our Engineering Department is interested in aiding you with your cathode-ray application problems.

DUMONT *Precision Electronics & Television*

ALLEN B. DUMONT LABORATORIES, INC., PASSAIC, NEW JERSEY • CABLE ADDRESS: WESPEXLIN, NEW YORK

TKL

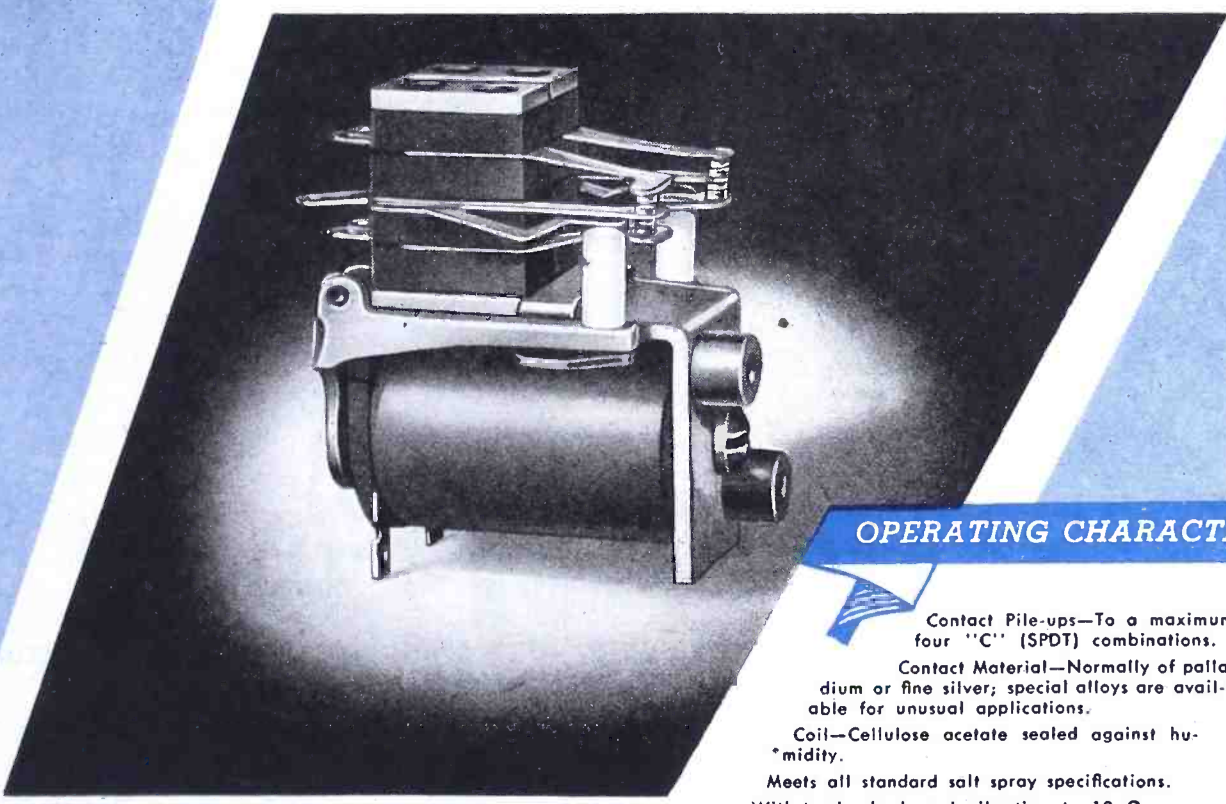
THE *newest* MEMBER OF ALLIED'S **TELEPHONE TYPE RELAY** LINE

MAXIMUM MAGNETIC EFFICIENCY . . . MINIMUM SIZE

TKL, latest of the Allied telephone type group, is an unusually compact relay with double contact pile-ups especially developed to meet the insistent demand for a small feather-weight relay of high magnetic efficiency.

TKL has a maximum rated power consumption of 1.5 watts for continuous duty. . . . Maximum sensitivity with a single A or B contact arrangement is 0.3 watts.

The unit illustrated features the use of Mycalex insulation for high frequency, low loss operation. It is also available with varnish impregnated bakelite insulation for standard switching service.



OPERATING CHARACTERISTICS

Contact Pile-ups—To a maximum of four "C" (SPDT) combinations.

Contact Material—Normally of palladium or fine silver; special alloys are available for unusual applications.

Coil—Cellulose acetate sealed against humidity.

Meets all standard salt spray specifications.

Withstands shock and vibration to 10 Gs.

Designed to conform with Army, Navy and CAA specifications.

Dimensions—1-7/16 by 15/16 by 1-1/16 inches (minus contact pile-ups).

Weight—1½ ounces (minus contact pile-ups).

ALLIED CONTROL COMPANY
INCORPORATED
2 EAST END AVENUE • (AT 79th STREET) • NEW YORK 21, N. Y.
FACTORIES: NEW YORK CITY • PLANTSVILLE, CONN. • CHICAGO, ILL.

. . . in Headphones

It is logical that engineers, long trained in designing microphones for transmitting the human voice, should be especially familiar with the techniques of voice reception. Headphone design, therefore, is a natural province of Shure engineers. The Shure headphone employs a unique moving armature design which combines light weight with sensitivity, simplicity and reliability. In headphones, as well as microphones, you may continue to look to Shure for leadership.

SHURE BROTHERS, 225 West Huron Street, Chicago

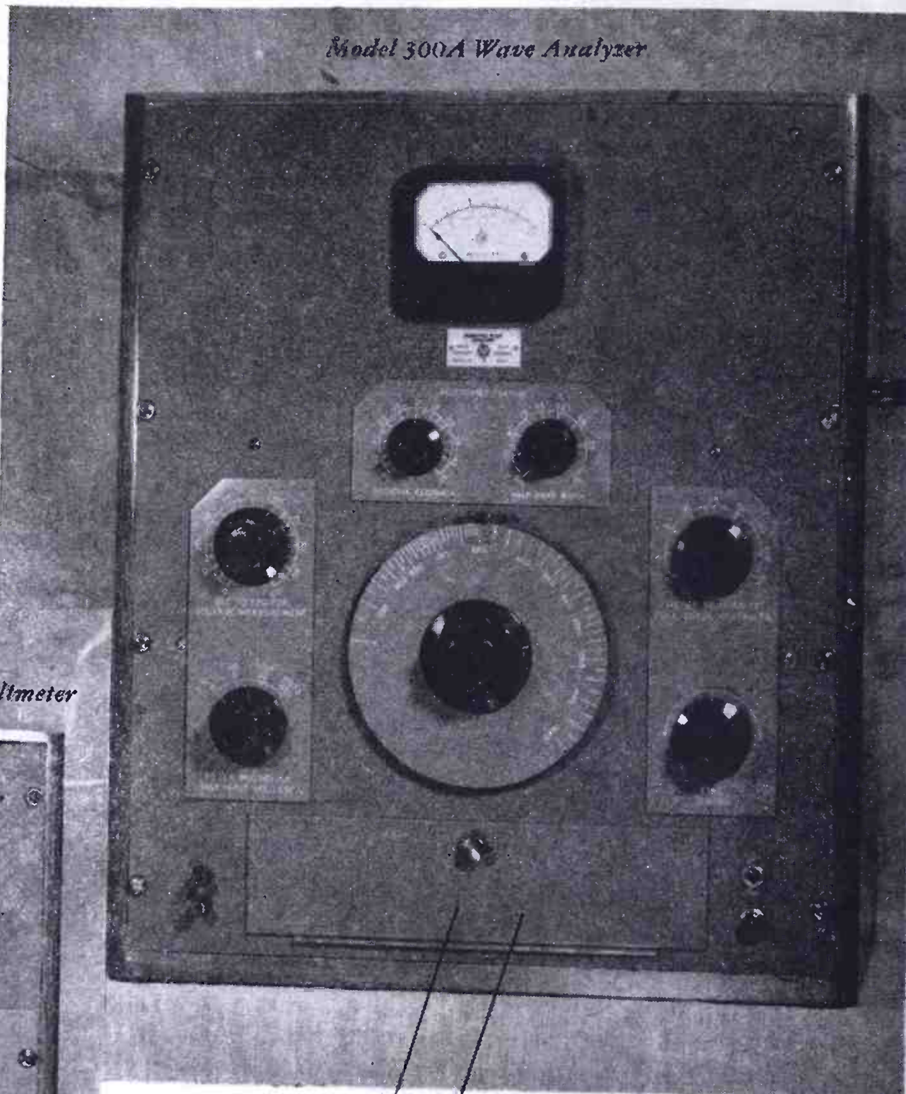
Designers and Manufacturers of Microphones and Acoustic Devices

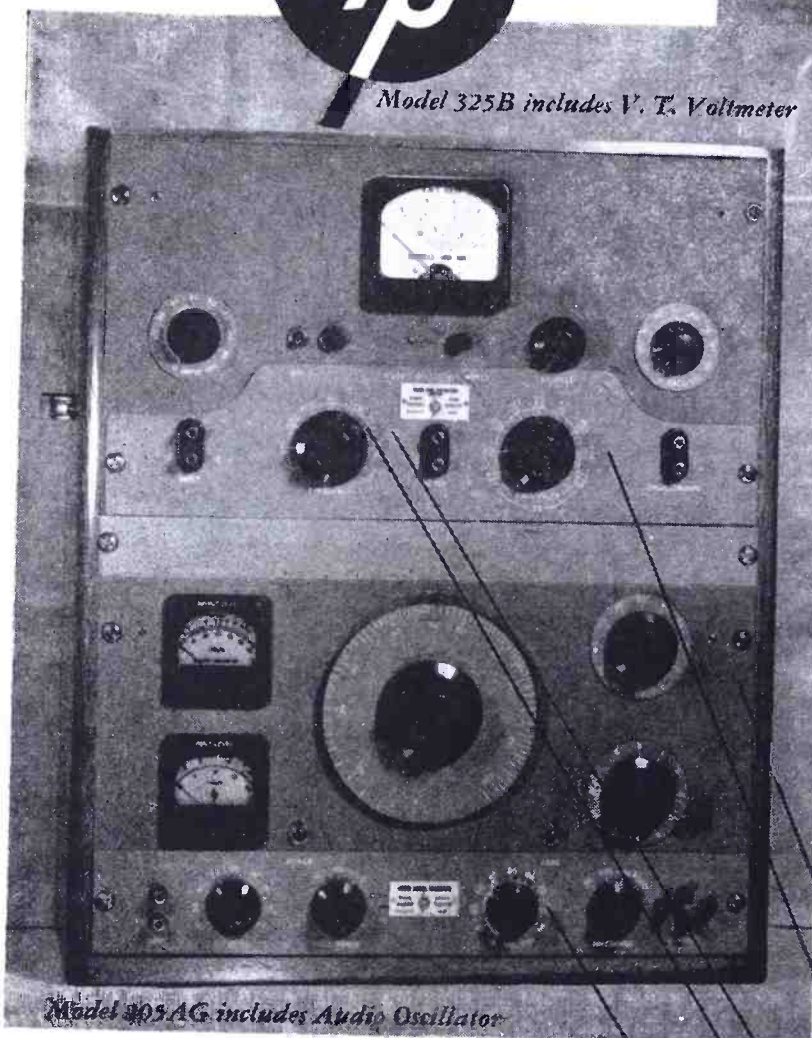
ARMY E NAVY

SHURE
MICROPHONES


MULTIPLE - TESTED
X-Ray O.K.
JUST ONE OF FEDERAL'S
MULTIPLE TUBE TESTS
X-Ray O.K.-your final assurance of a perfect tube from Federal.
Every Federal water cooled tube must pass this pre-shipment test.
It is only one of the "Multiple Tests" Federal makes to bring you the ultimate in vacuum tubes. Every known test of mechanical and electronic perfection is a Federal "must" . . . tubes are tested for high-voltage overload . . . shelf life is given to prevent shipment of tubes with glass strains or slow leaks . . . and a final, all-inclusive, operation test leaves nothing to conjecture.
Federal's "Multiple Testing" adds up to longer tube life . . . uniform electrical characteristics . . . and lower cost of operation. Radio men acknowledge that "Federal always has made BETTER Tubes."
Radio Ranges and Instrument Landing Systems manufactured by Federal mark the principal air routes of the nation and control the landing at many leading airports. Pioneers in the development of Aerial Navigation Equipment, Federal has made spectacular contributions to aviation progress.
Federal Telephone and Radio Corporation
AN IT&T ASSOCIATE
Newark 1, N. J.

In these two compact units there are really seven instruments


Model 300A Wave Analyzer


Model 325B includes V. T. Voltmeter

Model 205AG includes Audio Oscillator

There are only three standard *-hp-* instruments included in this laboratory set-up yet the two units include the following seven: an *-hp-* Resistance-Tuned Audio Oscillator, an attenuator, a vacuum tube voltmeter, a set of fundamental elimination filters, an input meter, an output meter, and a wave analyzer. The uses for this combination of instruments are too extensive to list here but some idea of its scope is shown by the following:

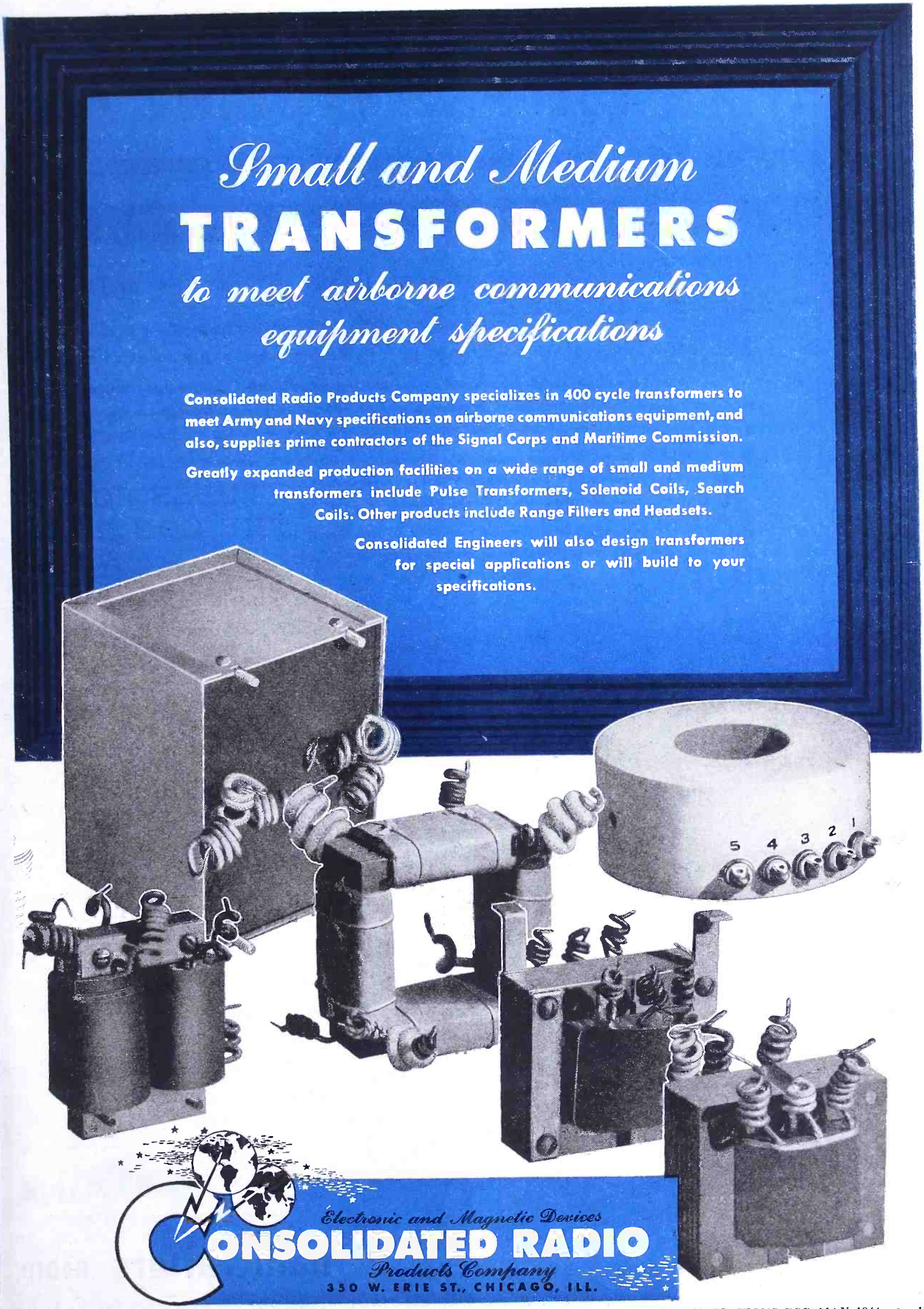
- **Measure voltage level, power output and amplifier gain.**
- **Measure noise and hum level in audio frequency equipment.**
- **Measure individual components of a complex wave.**
- **Measure voltages from 3mv to 300v—from 10cps to 100kc.**
- **Measure total distortion of frequencies from 30cps to 15kc.**
- **Integrate noise spectrum for acoustic measurements.**
- **Generate a known voltage as well as a known frequency at common impedance levels and make many another test or measurement on audio frequency equipment.**

Remember! The *-hp-* audio oscillator (in 205AG) requires no zero setting, the Model 300A wave analyzer provides variable selectivity, *-hp-* vacuum tube voltmeter indication is proportional to the average value of the full wave and the *-hp-* Audio Signal Generator makes standardized frequencies and voltage instantly available. Get full information about these and other outstanding *-hp-* electronic instruments today. Ask for the new 24-page catalog which gives much valuable information in addition to complete data on *-hp-* instruments.

HEWLETT-PACKARD COMPANY

805

Box 805E, Station A • Palo Alto, Calif.


Small and Medium
TRANSFORMERS
to meet airborne communications equipment specifications
Consolidated Radio Products Company specializes in 400 cycle transformers to meet Army and Navy specifications on airborne communications equipment, and also, supplies prime contractors of the Signal Corps and Maritime Commission.
Greatly expanded production facilities on a wide range of small and medium transformers include Pulse Transformers, Solenoid Coils, Search Coils. Other products include Range Filters and Headsets.
Consolidated Engineers will also design transformers for special applications or will build to your specifications.
5 4 3 2 1
Electronic and Magnetic Devices
CONSOLIDATED RADIO
Products Company
350 W. ERIE ST., CHICAGO, ILL.

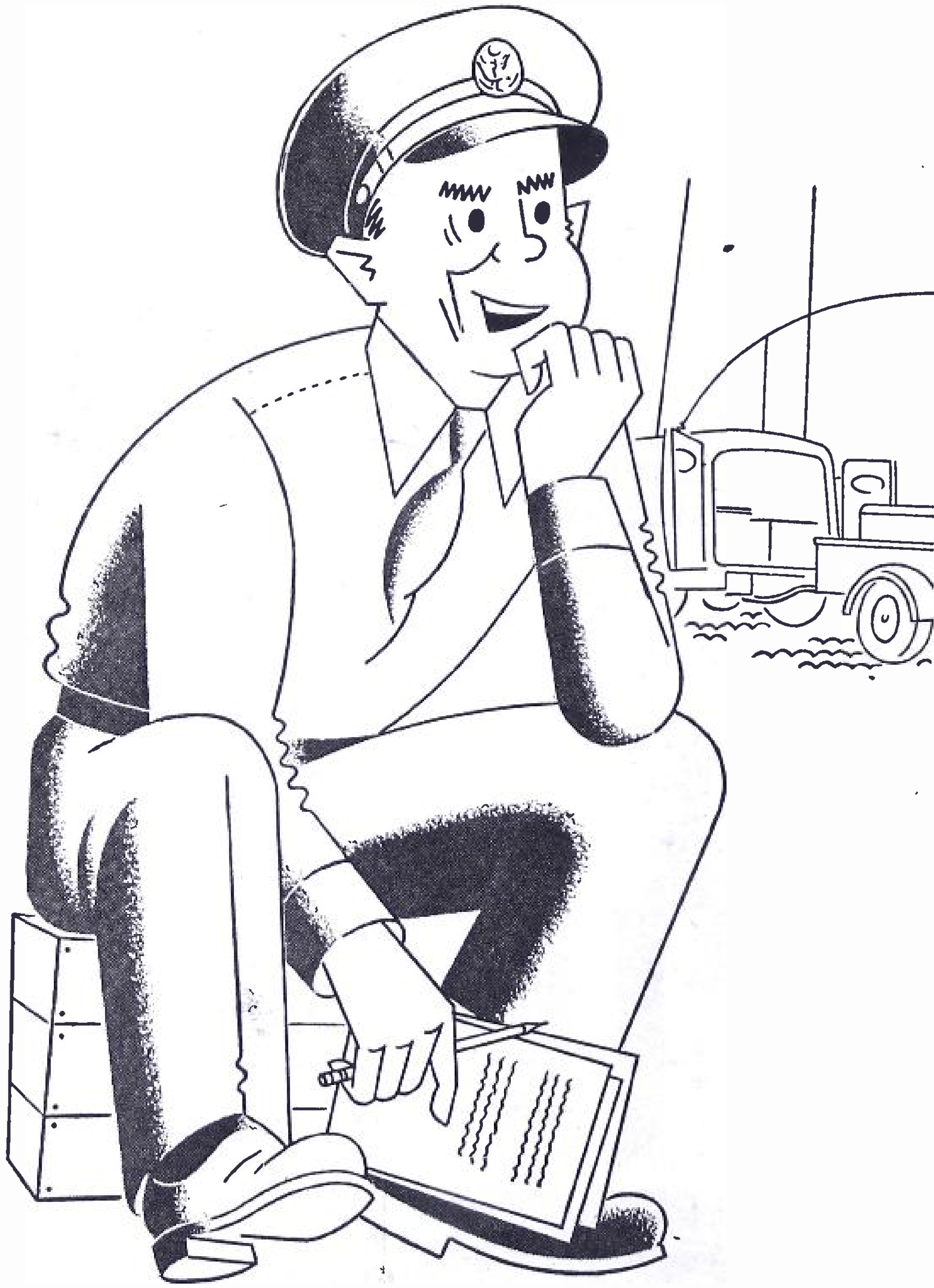
NEW LETTER CONTEST for SERVICEMEN!

ELEVEN 1st PRIZE WINNERS IN 5 MONTHS IN CONTEST No. 1!

Yes sir, guys, the hundreds of letters received were so swell that *double* first prize winners had to be awarded each of the first four months and there were *triple* first prize winners the fifth and last month . . .

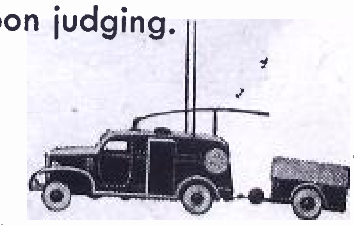
SO—HERE WE GO AGAIN!

Get in on this NEW letter contest—write and tell us your *first hand* experiences with *all* types of Radio Communications equipment built by Hallicrafters including the famous SCR-299!



RULES FOR THE CONTEST

Hallicrafters will give $100.00 for the best letter received during each of the five months of April, May, June, July and August. (Deadline: Received by midnight, the last day of each month.) . . . For every serious letter received Hallicrafters will send $1.00 so even if you do not win a big prize your time will not be in vain. . . . Your letter will become the property of Hallicrafters and they will have the right to reproduce it in a Hallicrafters advertisement. Write as many letters as you wish. V-mail letters will do. . . . Military regulations prohibit the publication of winners' names and photos at present . . . monthly winners will be notified immediately upon judging.



BUY A WAR BOND TODAY!

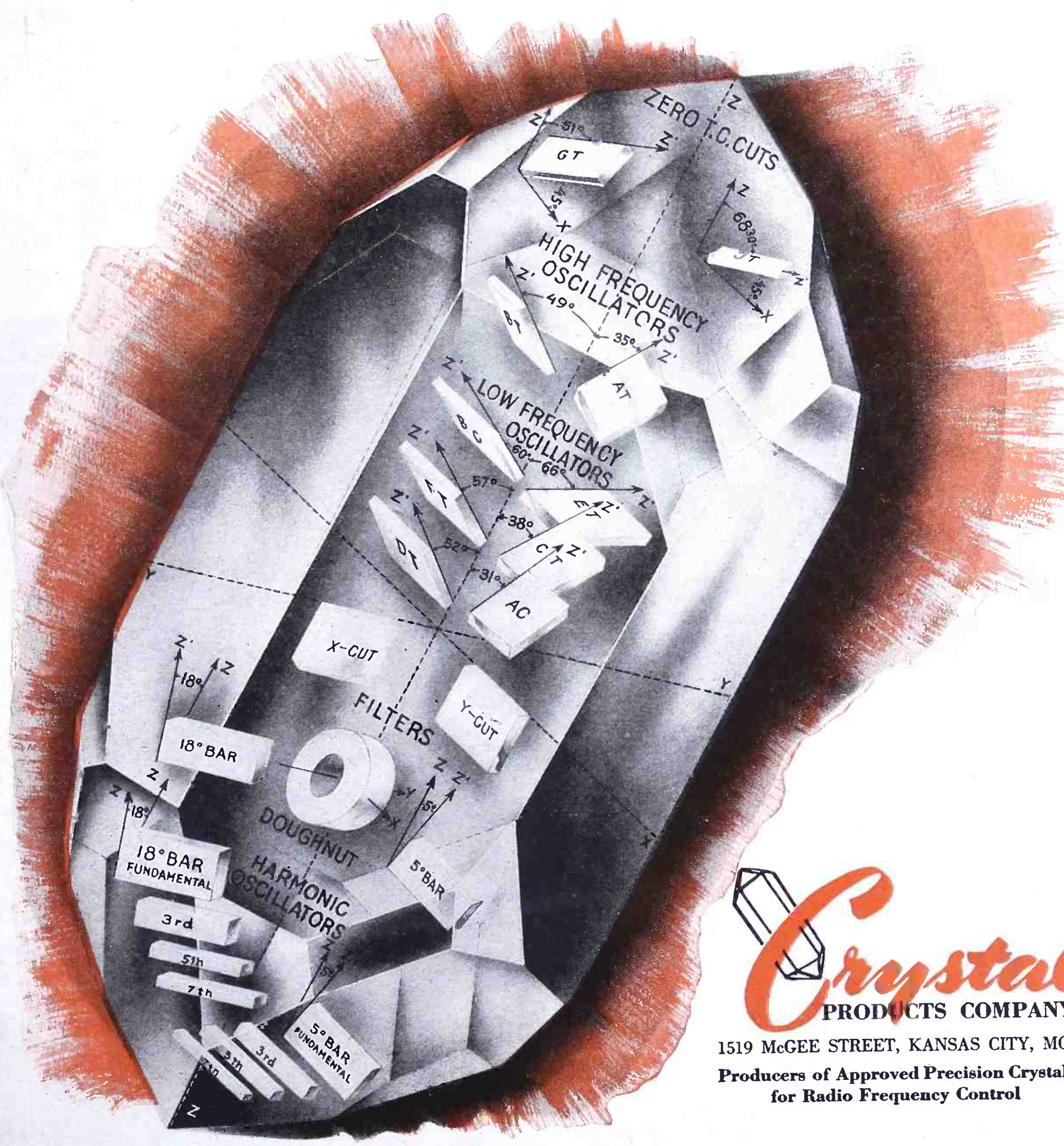
hallicrafters RADIO

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

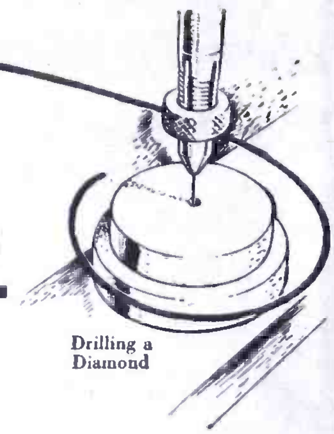
Here's How We Find The Angles To Precise Radio Frequency Control

By strictly preserving certain angular relationships with respect to the various axes of the quartz mother, this company gives oscillator plates the precision properties most suitable for specific jobs.

The experience we have gained in war production will be used to aid you in contributing new efficiency to post-war communications equipment. You can be sure with crystals made by Crystal Products Company.



Crystal
PRODUCTS COMPANY
1519 McGEE STREET, KANSAS CITY, MO.
Producers of Approved Precision Crystals for Radio Frequency Control



Drilling a Diamond

GUTHMAN I·F *Coils* in F·M

for MAXIMUM FREQUENCY STABILITY

Guthman Engineers recognize that the important need in Frequency Modulation receivers is to have excellent wide band I F coils. Guthman high gain I F coils operate on frequencies from 4.3 mc to 30 mc, and provide maximum frequency stability.

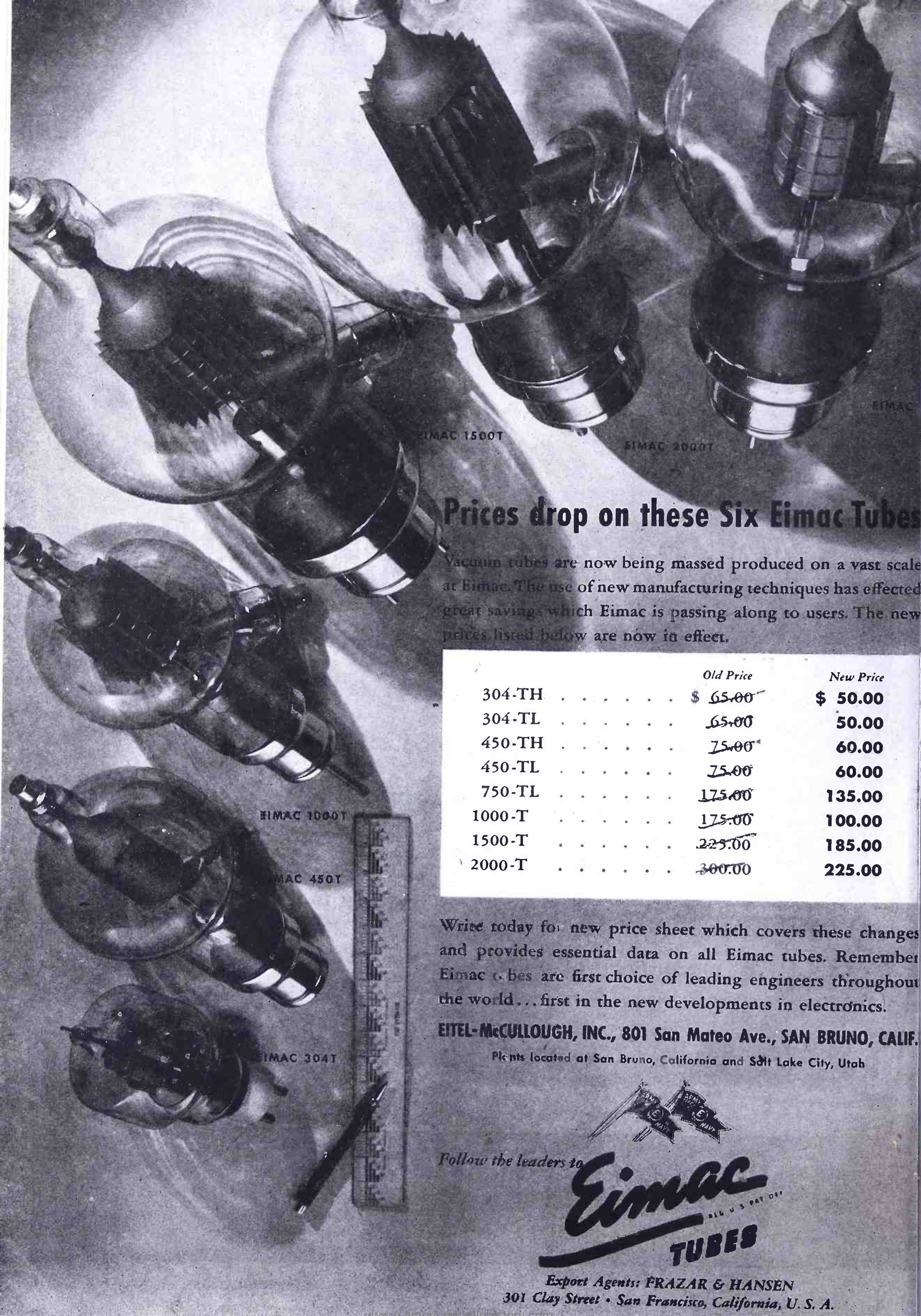
GUTHMAN *Leader in Inductronics*

Do Your Best . . . Invest in Bonds!

EDWIN I. GUTHMAN & CO. INC.

15 SOUTH THROOP STREET · CHICAGO

PRECISION MANUFACTURERS AND ENGINEERS OF RADIO AND ELECTRICAL EQUIPMENT



Prices drop on these Six Eimac Tubes

Vacuum tubes are now being massed produced on a vast scale at Eimac. The use of new manufacturing techniques has effected great savings which Eimac is passing along to users. The new prices listed below are now in effect.

	Old Price	New Price
304-TH	$ ~~65.00~~	$ 50.00
304-TL	~~65.00~~	50.00
450-TH	~~75.00~~	60.00
450-TL	~~75.00~~	60.00
750-TL	~~175.00~~	135.00
1000-T	~~175.00~~	100.00
1500-T	~~225.00~~	185.00
2000-T	~~300.00~~	225.00

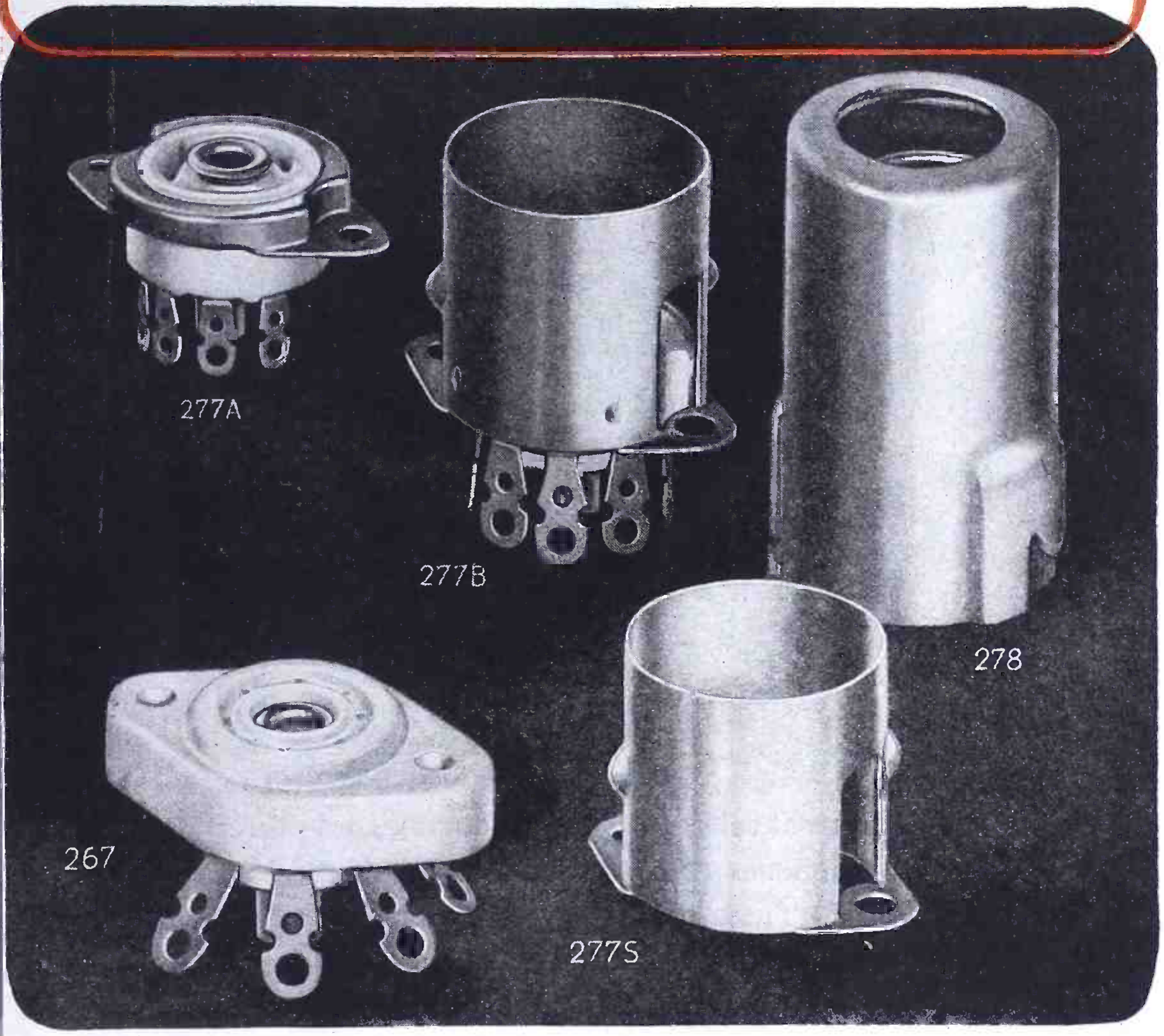
Write today for new price sheet which covers these changes and provides essential data on all Eimac tubes. Remember Eimac tubes are first choice of leading engineers throughout the world... first in the new developments in electronics.

EITEL-McCULLOUGH, INC., 801 San Mateo Ave., SAN BRUNO, CALIF.

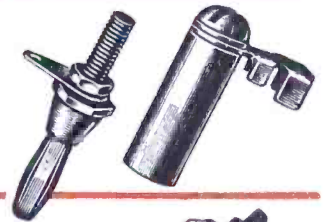
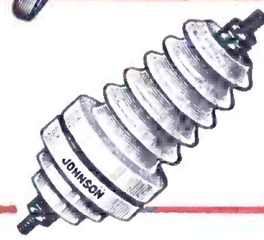
Plants located at San Bruno, California and Salt Lake City, Utah

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

Export Agents: FRAZAR & HANSEN
301 Clay Street • San Francisco, California, U. S. A.



277A
277B
278
267
277S

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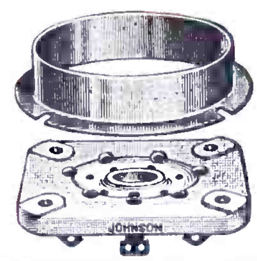
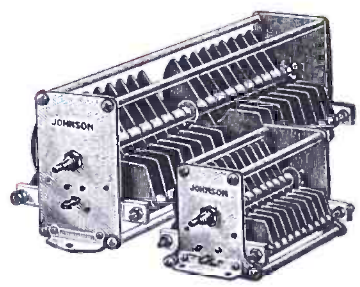
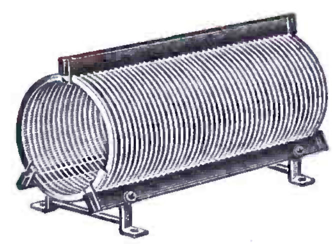
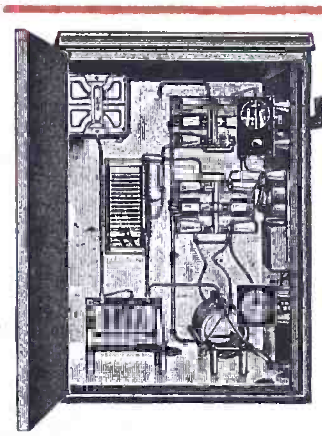


JOHNSON



JOHNSON
JOHNSON

Induction Ceremony

This is an X-ray photograph of the final step in the stiff pre-induction examination which National Union engineers are giving many of the N. U. Tubes now headed for combat duty.

Why X-ray? Because with great objectives and priceless lives at stake, it is a military necessity to know that critical-type N. U. Tubes are sound through and through—equal in every way to the ordeals they'll face in battle. Even tubes which have passed scores of operational tests with flying colors, are scrutinized by the searching eyes of the X-ray engineer. X-ray examination of the finished tubes—after all processing has been completed—helps our scientists to know that there is *no* hidden weakness *anywhere.*

This insistence upon leaving nothing to chance typifies the uncompromising scientific standards which prevail at National Union. It is assurance that every tube which carries the N. U. trademark can be counted on to do its duty, always. And for post-war industrial needs, it is a safe and sure guide to electronic tubes of known performance characteristics and dependability. *Count on* National Union.

NATIONAL UNION RADIO CORPORATION, NEWARK, N. J.
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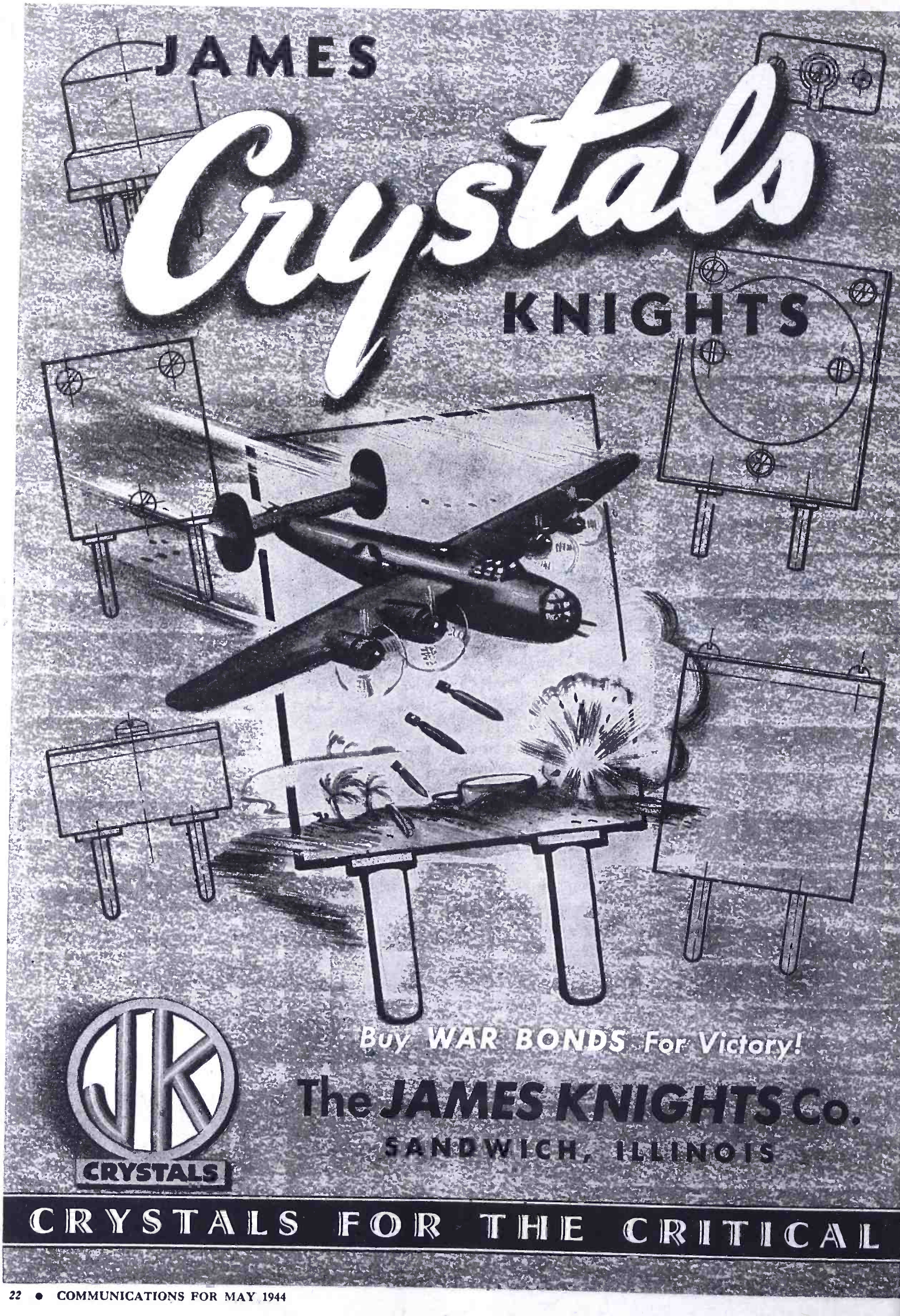
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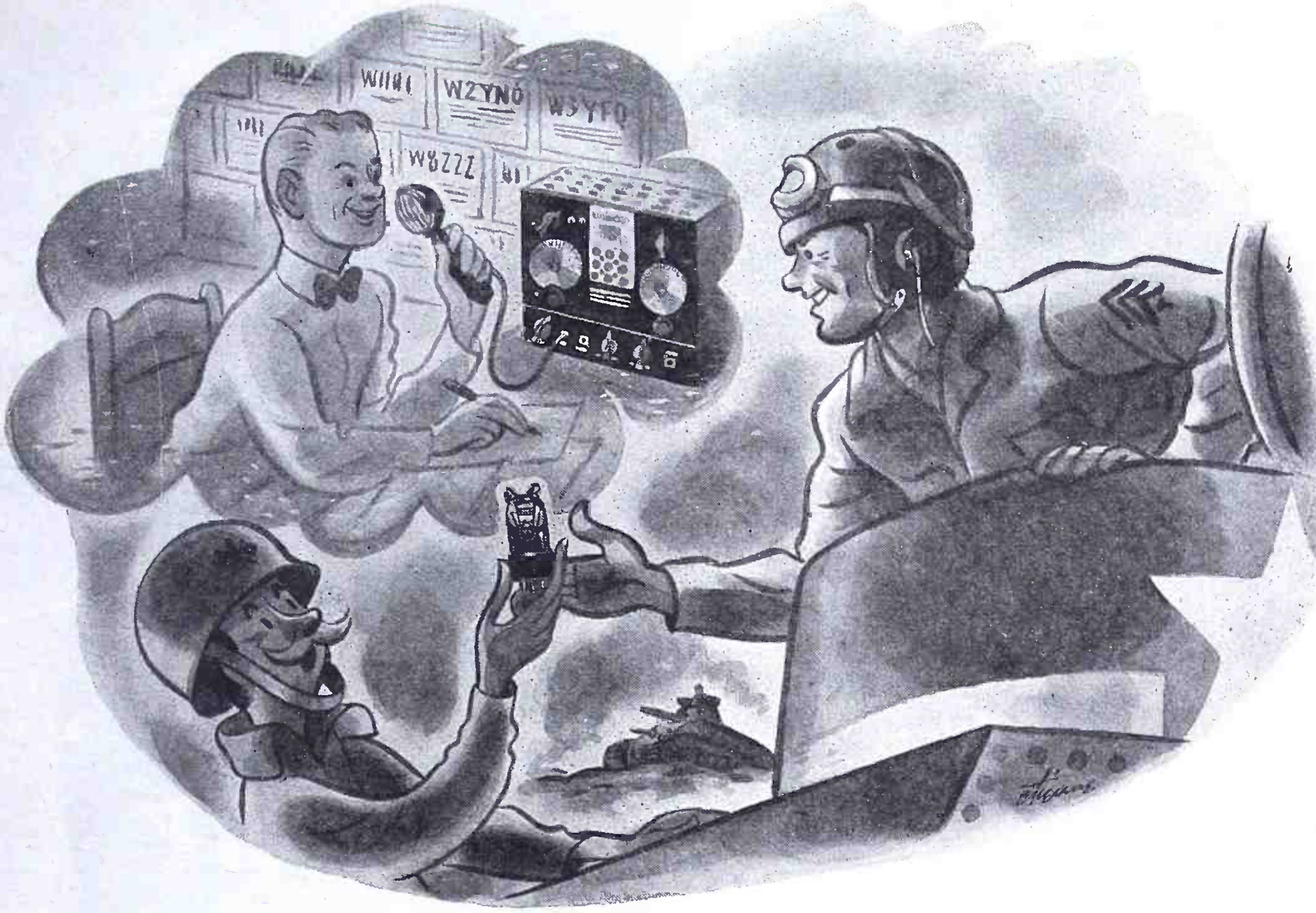

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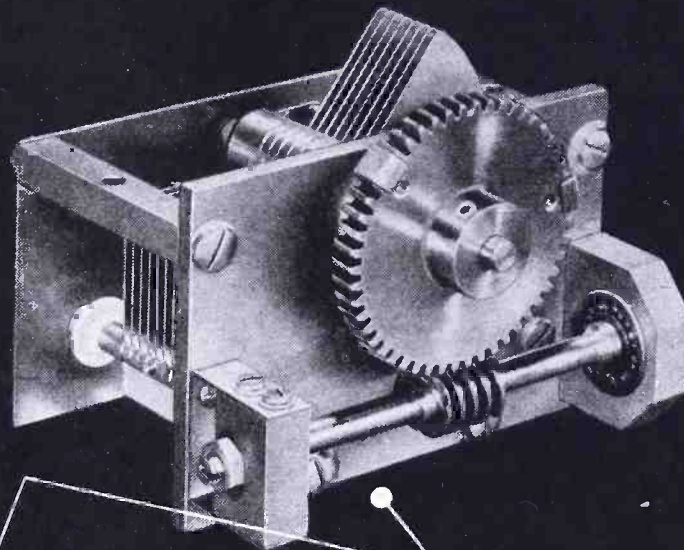

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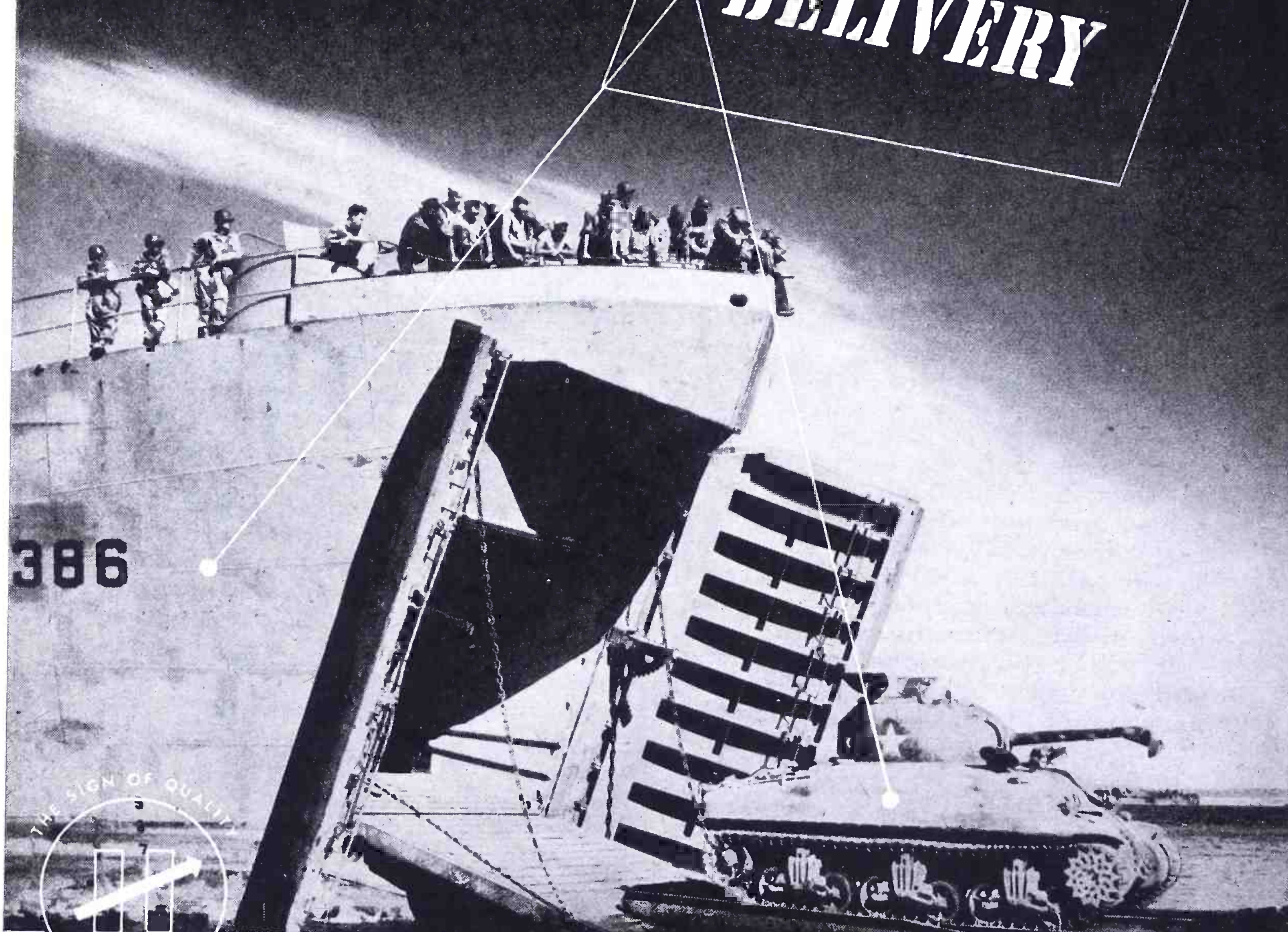

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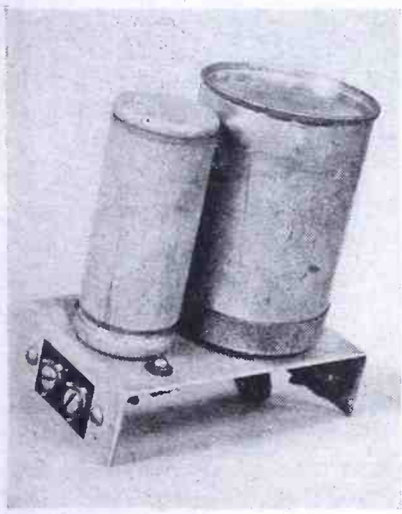
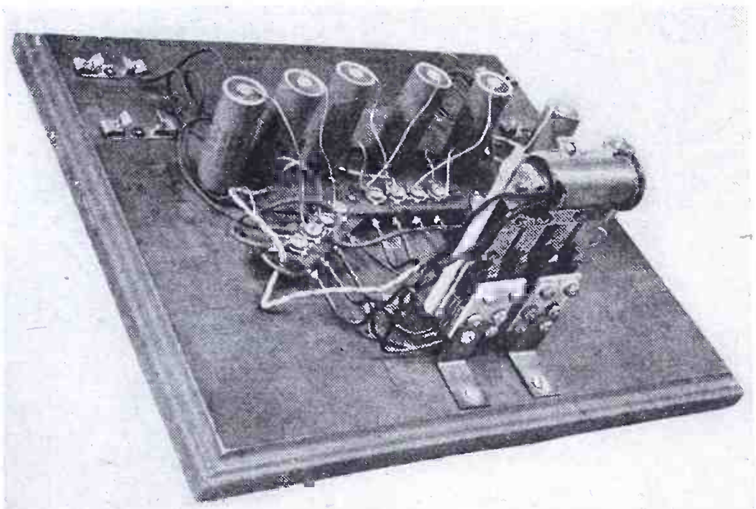
COMMUNICATIONS

LEWIS WINNER, Editor

* * MAY, 1944 * *

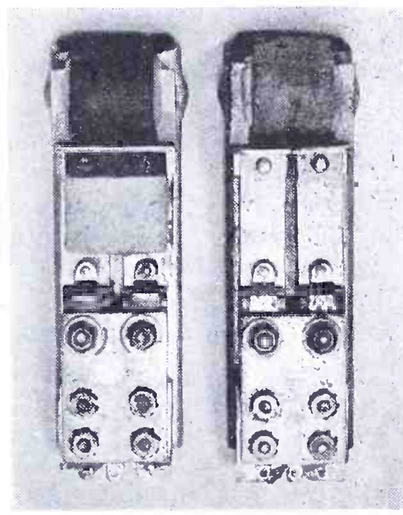
Below, a voltage doubler wherein a charged condenser, connected in series with the input line, charges another condenser to twice the input line voltage.





Above, an experimental model of the condenser-type voltage quadrupler. In this unit two split-reed synchronous vibrators are mechanically coupled to form a four-pole double-throw switch. This voltage quadrupler is quite convenient, for it permits the use of the common-cathode type of electrolytic condensers.

Below, the split-reed type vibrators used in the voltage doublers of the condenser type described in this paper.



VIBRATOR-CONDENSER TYPE

Power Supplies

by M. A. HONNELL

Associate Professor of Electrical Engineering
Georgia School of Technology

TWO types of d-c voltage transformation devices have been normally used as plate-power supplies for communications equipment: the vibrator-transformer power supply, and the motor generator, or dynamotor. Recently, interest has been shown in the use of a high-frequency oscillator and rectifier combination as a plate supply for 28-volt aviation radio equipment.[1]

There is another practical method of d-c voltage transformation. It has been employed for many years in the high-voltage field and appears to have been completely neglected by the communications engineer. This method is the commutator-condenser transformer employing a combination of condensers and a motor-driven commutator.[2] During the past few years the writer has used several low-voltage source power supplies, utilizing a group of condensers and a vibrating commutating switch, and found them to be most effective.

The basic circuit diagram of a voltage doubler is shown in Figure 1a. This circuit is the direct-current counterpart of the familiar full-wave a-c voltage-doubler circuit in which a mechanical switch takes the place of the rectifier tube.[3] The operation of this voltage doubler can be readily understood by referring to Figure 1a. A d-c potential E is connected to the blades of a double-pole double-throw switch, and the condensers C_1 and C_2 are each connected to a pair of stationary contacts. When the blades of the switch are in the lower position, C_1 is charged to the potential E; and when the blades are in the position indicated in the diagram, C_2 is also charged to the potential E. It is evident that if the condensers are separately charged to the potential E, the potential across the two condensers in series will be twice E.

The circuit of a practical voltage doubler is illustrated in Figure 1b. For the double-pole double-throw switch, a conventional full-wave split-reed synchronous vibrator is employed. The in-

[1] Sylvania News Letters 73, 77. *Rochester Fall Meeting Report*, COMMUNICATIONS, p. 27; November, 1943.

[2] W. C. Anderson, *A Direct-Current Voltage Multiplier*, Review of Scientific Instruments, p. 243; June, 1936.

[3] M. A. Honnell, *Applications of the Voltage-Doubler Rectifier*, COMMUNICATIONS, p. 14; January 1940.

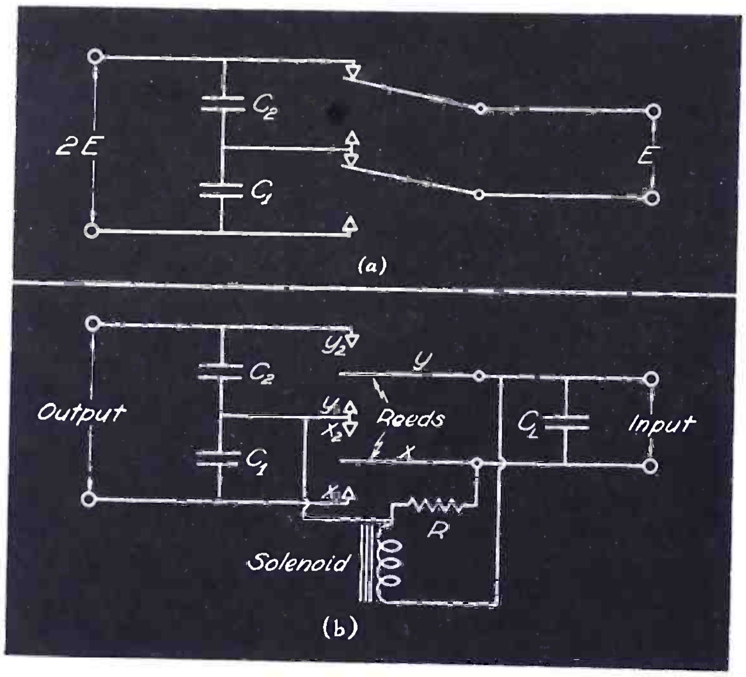


Figure 1

In *a* appears the basic voltage doubler circuit. This circuit is the d-c counterpart of the full-wave a-c voltage doubler circuit in which a mechanical switch takes the place of the rectifier tube. In *b* appears a practical voltage doubler.

dividual reeds are mechanically joined together by a soft-iron armature insulated from the reeds. The solenoid is wound for the particular input voltage to be used. For the *shunt-out* type of solenoid excitation illustrated in Figure 1, the reed contacts are left in their original adjustment midway between the two sets of stationary contacts. A resistance, *R*, of approximately the some ohmic value as the solenoid, is then necessary to complete the coil circuit. Condensers C_1 and C_2 are electrolytic condensers of from 10 to 100 mfd each. The condenser C_L may be omitted, but it improves the voltage regulation in some cases, and it acts as a filter to reduce variations in the input line voltage. The value of C_L may be the same as that of C_1 and C_2.

The operation of the vibrator is conventional. Referring to Figure 1b, when a d-c potential is applied to the input, current flows through the solenoid and the resistor *R*, in series with the solenoid. The reeds are attracted downward until the reed *Y* touches the contact Y_1, thereby shorting the solenoid. The reeds are then released, and they swing upward until the reed *X* touches the contact X_2, whereupon the resistance *R* is short-circuited, and an increased current flows through the solenoid to again draw the reeds downward. This action is continuous, so that the split reed vibrates at its normal frequency, and alternately touches the upper and the lower contacts, thus charging the condensers in rapid succession. The voltage doubler of Figure 1b has a definite limitation in that it can be used only with heater-type tubes, since there is no common negative line lead from input to output. The circuits of Figure 2 remove this objection. In Figure 2a we have the familiar series coil, or *buzzer* type of excitation. This is achieved by adjusting the contacts so that when the reeds are at rest, the reeds *X* and *Y* touch the contacts X_1 and Y_1 respectively. Excitation is obtained through the reed *X* and the contact X_1. The series-coil excitation could also be obtained through a set of auxiliary contacts, but this would complicate the construction of the vibrator.

The circuit of Figure 2a is the d-c counterpart of the half-wave, or series-line, a-c voltage doubler.[3] The operation of this voltage doubler is as follows: when the reeds are in lower position, condenser C_1 is charged to the input line potential; and when the reeds move to the upper position, the condenser C_1 is connected in series with the input line to charge the condenser C_2 to twice the input line potential.

Figure 2b is the basic circuit of a voltage quadrupler using the same principle of voltage step-up as the circuit of Figure 2a. Two split-reed synchronous vibrators are mechanically coupled to form a four-pole double-throw switch for the quadrupler. Either series-coil, or shunt-out excitation of the solenoid may be employed with this circuit. The initial charge in the condensers follows the sequence C_1, C_2, C_3, C_4, C_5, C_6. This voltage quadrupler is particularly convenient, as it permits the use of the common-cathode type of electrolytic condensers.

The curves of Figure 3 are typical characteristics for a 32-volt doubler using the circuit of Figure 1b and a vibrator with a reed frequency of 60 cycles per second. A voltage doubler using this circuit is shown on page 25.

The average no-load input current to the vibrator is 17 milliamperes. It is to be noted that the efficiency of the doubler is 50% at an output current of approximately 8.5 milliamperes. This is as it should be, for the equivalent line current which supplies the 8.5 ma is 17 ma. The curves show that for a given load current the terminal voltage increases with an increase in condenser capacitance. A similar gain in terminal voltage is obtained if the vibrator reed frequency is increased.

The efficiency of the vibrator-condenser power supply is high, since the major losses are the copper loss in the driving solenoid plus leakage and dielectric losses in the condensers. The decrease in efficiency at heavy loads is due to minute arcing at the contacts and to an increase in condenser dielec-

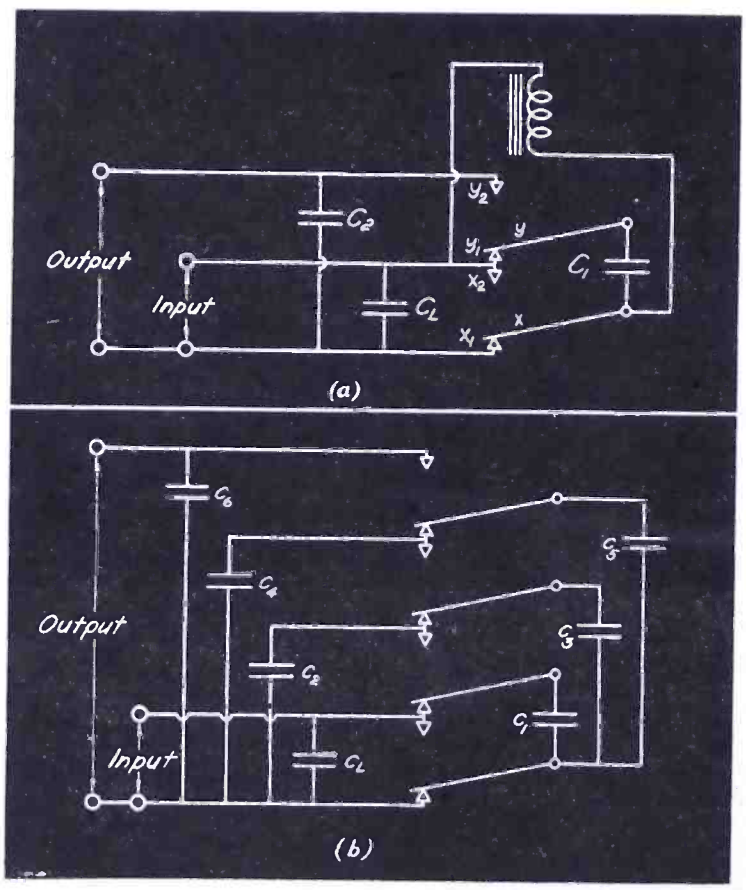


Figure 2

A common-line doubler is shown in *a*. This is the d-c counterpart of the half-wave or series-line a-c voltage doubler. The basic circuit of a voltage quadrupler is shown in *b*. This uses the same principle of voltage step-up as in *a*. The initial charge in the condenser follows a sequence of C_1 to C_6.

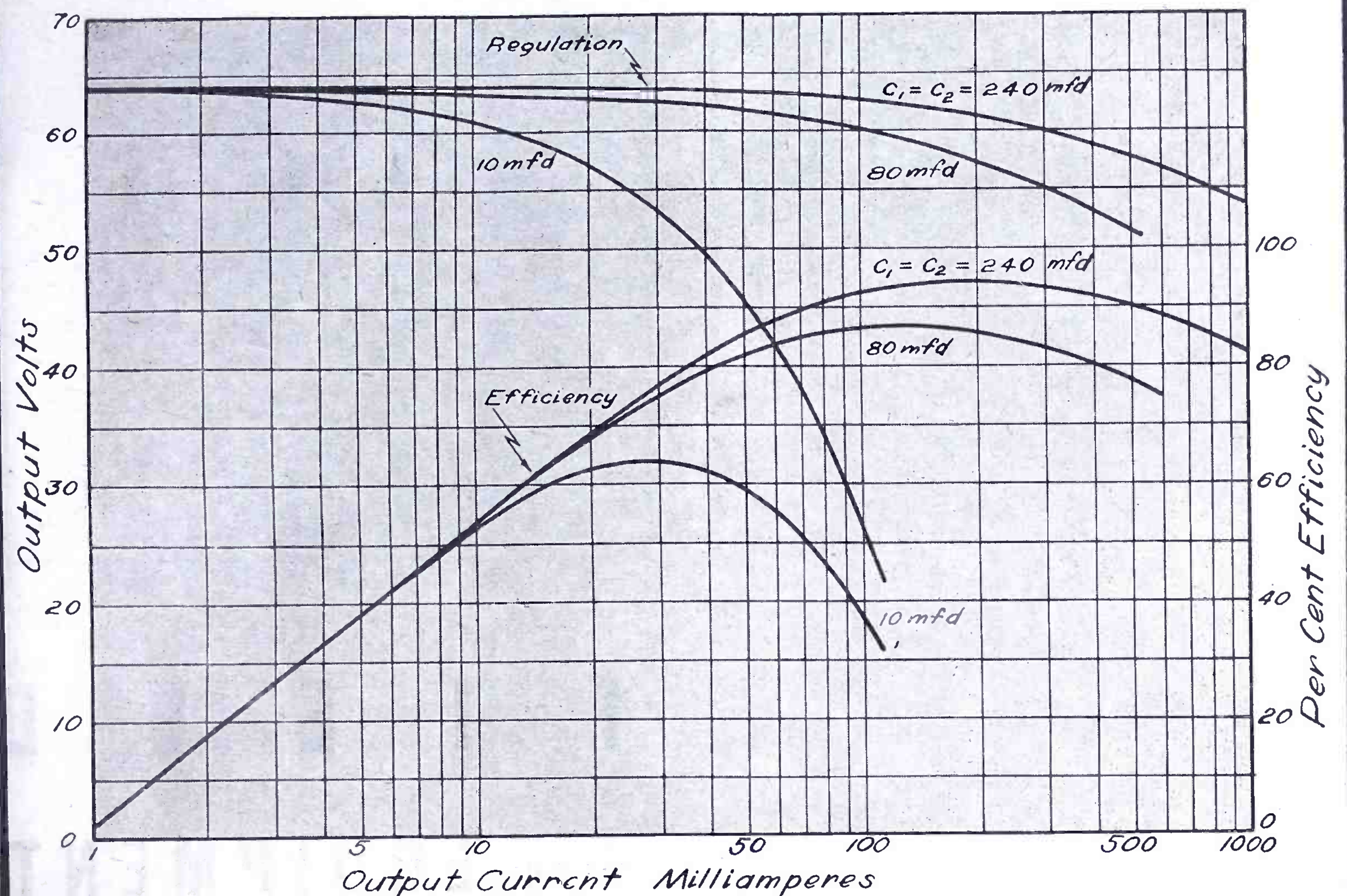


Figure 3
Typical characteristics of a 32-volt doubler using the circuit of Figure 1b, and a vibrator with a reed frequency of 60 cycles per second.

tric losses, as the results of the appearance of a saw-toothed ripple voltage at heavy loads. A maximum efficiency of 95% is readily obtained by using a vibrator with an efficient magnetic driving circuit and paper-dielectric condensers. It is cheaper, however, to use a vibrator with a non-critical magnetic circuit and electrolytic condensers, since the efficiency of the voltage doubler will be decreased only a few per cent.

The following advantages of the vibrator-condenser d-c power supply over the conventional vibrator power supply are apparent:

(*1*) A transformer is eliminated. No thorough electromagnetic shielding is, therefore, necessary. The weight of the power supply is reduced.

(*2*) The efficiency is higher than that of the conventional vibrator power supply.

(*3*) The voltage regulation, or drop in terminal voltage under load, is less than that of the conventional vibrator power supply.

(4) The adjustment of the vibrator contacts is not at all critical. The only effect of a misadjustment of the contacts is to reduce the output voltage. No severe arcing occurs under these conditions. For optimum performance, however, it is desirable that the *time efficiency* of the vibrator be high; that is, the vibrating reed should spend a minimum time in transit from one group of contacts to the other.

(*5*) There are no critical circuit components such as the *buffer* condenser in the conventional vibrator supply.

(*6*) Since an inherent part of the power supply is a high capacitance, the output voltage is relatively free from ripple.

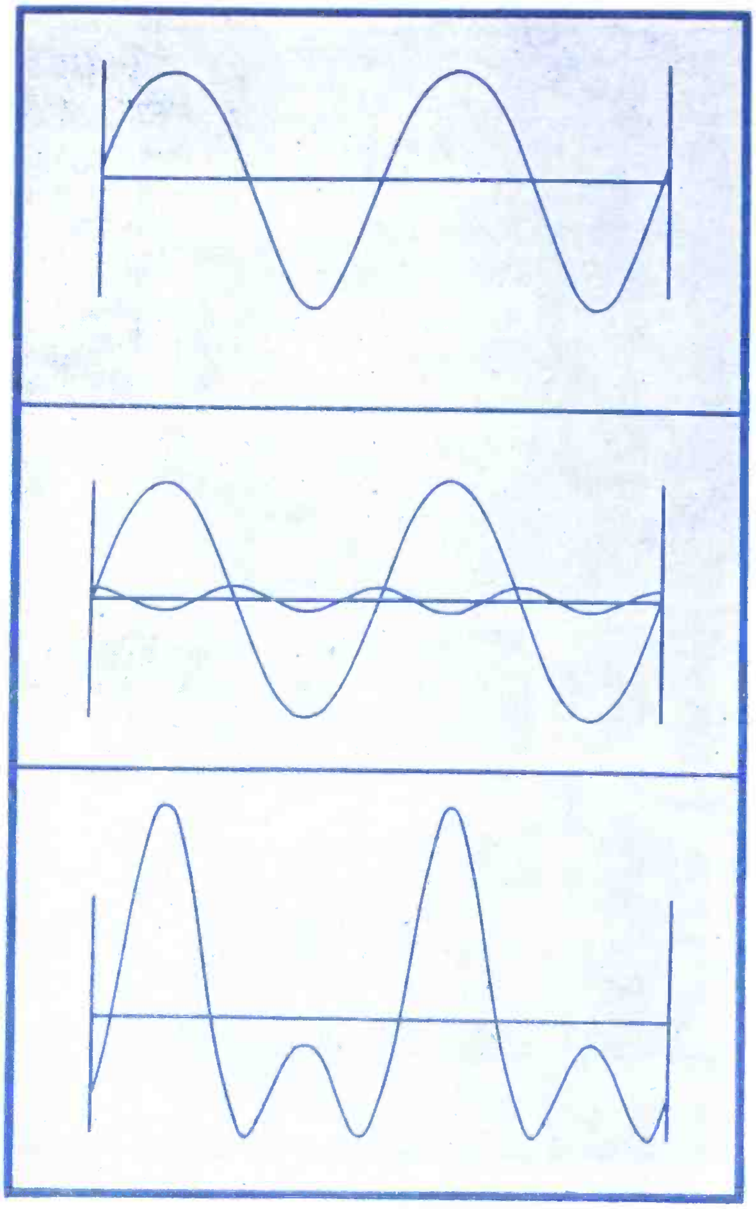
Electrostatic shielding and radio-frequency filtering requirements are the same as those of the conventional vibrator power supplies. If the 110-volt, or 32-volt d-c supply voltage has a high ripple content, the power supply must necessarily provide adequate filtering for this ripple. A small filter at the output of the power supply is all that is necessary.

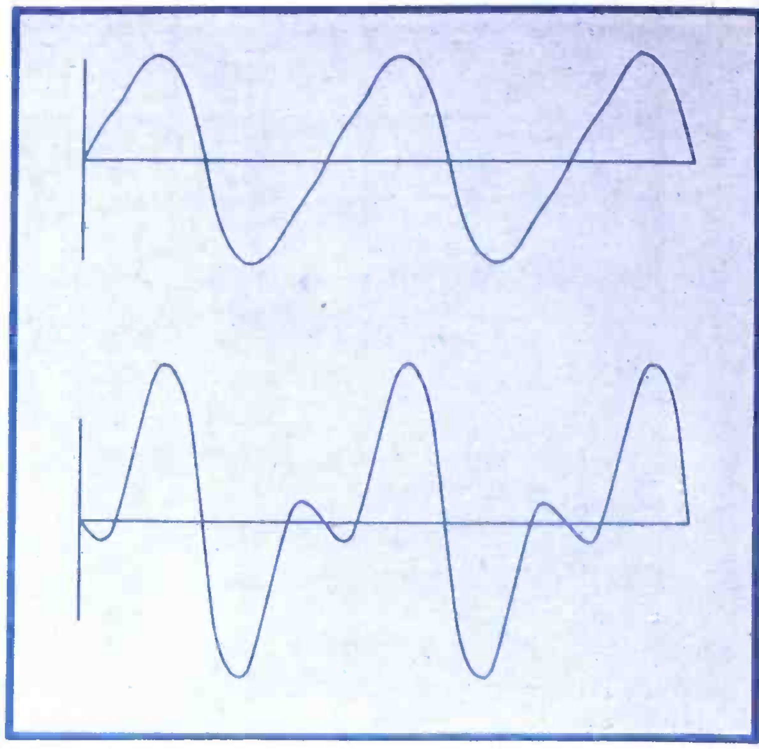
The following limitations are not to be overlooked. Vibrators with more than four reeds are expensive to build. The power supply is thus limited to voltage doubling, tripling, or quadrupling, where simplicity and low cost are to be retained. As a source of plate voltage for radio equipment, it can, therefore, be economically employed only on 24-volt, 32-volt, and 110-volt, or similar d-c systems.

The vibrator-condenser power supply can in no way replace the conventional vibrator power supply. It can, however, supplement the existing power supplies for special applications. For example, on shipboard with the usual 110-volt d-c light mains, it is often desirable to have a reliable, yet simple power pack, which will have an output of from 200 to 400 volts for public address systems and radio sets. Since both the vibrator and the condensers can be of the plug-in type, it is an easy matter to service the power pack should trouble develop.

This power supply can also be used to advantage in 32-volt d-c radio sets designed to operate from 32-volt d-c installations where the current drain must be kept to a minimum. In most rural districts a three- to five-tube radio set gives good program reception, since an effective antenna is easily installed. The voltage-doubler power supply makes possible the construction of a small 32-volt radio set with a

(*Continued on page* 52)





FIELD
WITH EQUIPMENT

Figures 1, 2, 3 (above), and 4 (top right) In Figure 1, extreme top, oscillator current output. Figure 2, center, harmonic components of current. Figure 3, the second harmonic resonance voltage. In Figure 4, at top, oscillator voltage; below, second harmonic resonance.

MANY times in field testing, an engineer finds himself in need of a measurement for which the most appropriate equipment is not available. For example, one may wish to measure the inductance, distributed capacity, and audio-frequency resistance of an audio transformer or choke without access to an impedance bridge. This can be done quite easily by the incremental-capacity method. All that is needed is an oscillator, vacuum-tube voltmeter or oscilloscope, and one standard capacitor or inductance. A high impedance, about one-half megohm is placed in series with the oscillator and the unknown coil. The oscilloscope (or vacuum-tube voltmeter) is placed across the coil as a detector. The oscillator frequency is then adjusted until the measured voltage is a maximum. This fundamental resonant frequency shall be called f_o. The frequencies f' and f'' on each side of resonance, at which the scope trace drops to 0.7 of its maximum value, are measured. The standard condenser is added in parallel with the coil, and the new resonant frequency, f_1, which is considerably lower, is also measured.

The distributed capacity of the coil is

$$C = C_s\left(\frac{f_1^2}{f_0^2 - f_1^2}\right)$$

The inductance is

$$L = \frac{1}{(2\pi f_0)^2 C} = \frac{1}{(2\pi)^2 C_s}\left(\frac{1}{f_1^2} - \frac{1}{f_0^2}\right)$$

The audio resistance is

$$R = 2\pi L\,(f'' - f') = \frac{f'' - f'}{2\pi C f_0^2}$$

C_s is the standard capacity.

Since these formulas may be easily forgotten, one can remember how to derive them when needed as follows: At fundamental resonance

$$L = \frac{1}{(2\pi f_0)^2 C}$$

With added capacity

$$L = \frac{1}{(2\pi f_1)^2 (C + C_s)}$$

Eliminating L,

$$f_0^2 C = (C + C_s)\, f_1^2\ ,$$

$$C = (C_s f_1^2)/(f_0^2 - f_1^2)$$

From the 0.707 points of the resonance curve,

$$\frac{1}{2Q} = \frac{\Delta f}{f_0} = \frac{f'' - f'}{2 f_0}$$

But

$$Q = \frac{2\pi f_0 L}{R}\ ,$$

$$\frac{R}{2\pi f_0 L} = \frac{f'' - f'}{f_0}$$

$$R = 2\pi L\,(f'' - f')$$

In case a known condenser is not available, a known inductance may be added in parallel with the coil, and the resonant frequency will rise. In this case the computations are:

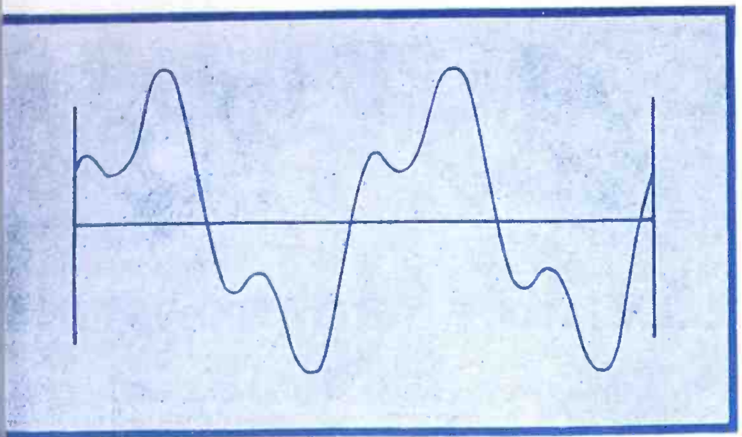
$$L = L_s\left(\frac{f_1^2 - f_0^2}{f_0^2}\right)$$

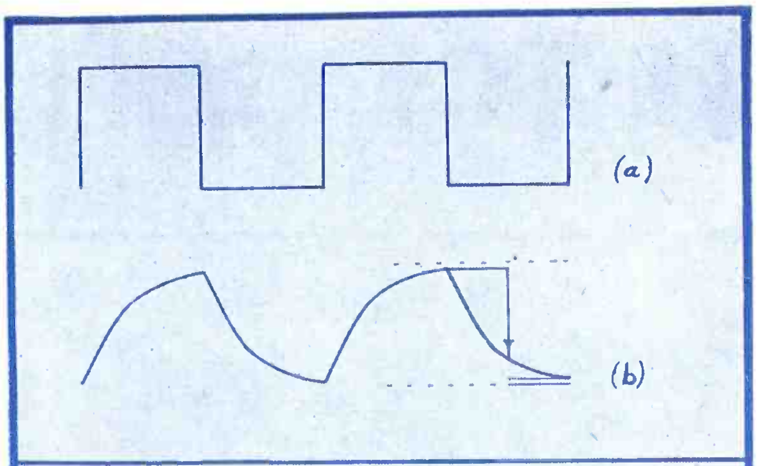
$$C = \frac{1}{(2\pi)^2 L_s\,(f_1^2 - f_0^2)}$$

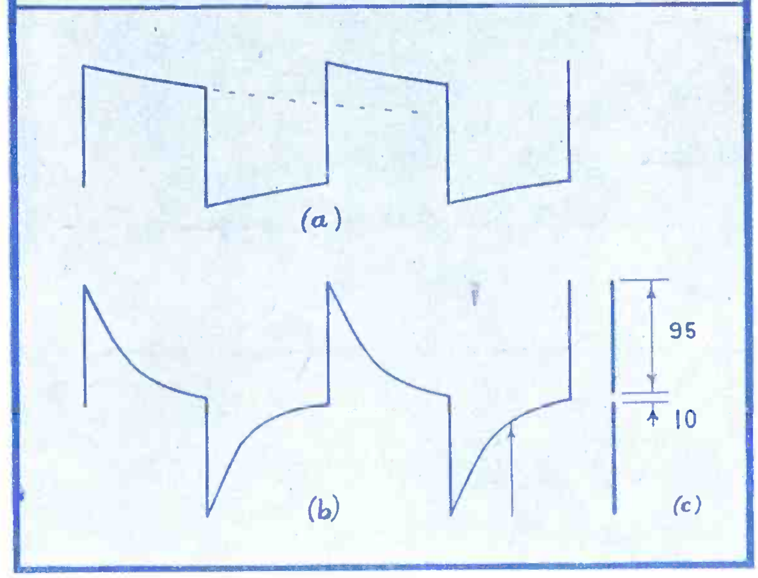
R = same as before.

This method is quite rapid, and the accuracy is very good if the change in resonant frequency is large; for example, from about 12,000 cycles per second down to a few hundred. For

MEASUREMENTS







Figures 5 (above), 6 (right, top) and 7

Third harmonic resonance is shown in Figure 5. Square-wave input appears in *6a*. In *6b*, voltage across the grid-cathode capacitance at the high frequency half-power point. In *7a* is shown the mid-frequency output. The low frequency half-power point is shown in *7b*.

TESTING LIMITATIONS

by Dr. OTTO J. SMITH
Director, Radio-Communications Eng.
University of Denver

the usual audio coils, this can be accomplished with a condenser of about 0.01 or 0.1 mfd. If the coil has a fundamental resonant frequency outside of the range of the oscillator, capacity may be added in parallel to drop the resonant frequency. The computed capacity will now be the sum of that added and the internal coil capacity.

For many purposes, d-c saturating current must be present in the coil at the time that the measurements of inductance are made. The d-c is blocked from the oscillator with a condenser of satisfactory voltage rating. A second condenser is used to isolate the scope or whatever meter is used for an indicator.

In radio-frequency measurements, the same procedure is followed as with audio. Measurements on a tank circuit are made with the tuning condenser in place. Best results are obtained with a standard condenser of over three times the capacity of the tuning condenser.

It is easy to measure resonances that occur outside of the range of the oscillator, by driving the circuit at subharmonic frequencies. In this case there is a resonant rise of voltage for one of the harmonic components of the applied voltage wave. This produces an output wave distorted by one very prominent harmonic. The actual resonant frequency is the oscillator setting times the order of the harmonic.

A common form of distorted amplifier output is shown in Figure 1. It has been exaggerated for study purposes. This has a second harmonic with a phase as shown in Figure 2. When the frequency is considerably below second harmonic resonance, both component voltages lead their respective currents by about 90°. This gives a trace similar to the negative of Figure 4a. When the oscillator is set at one-half resonant frequency, the fundamental voltage leads its current, and the second harmonic voltage is in phase with its current. The resultant trace is shown in Figure 3.

Another form of distorted oscillator output is given in Figure 4, with the corresponding appearance at second harmonic resonance.

A third harmonic resonance curve is shown in Figure 5. It is possible to recognize and measure higher harmonic resonances; however, it is much more difficult to obtain good accuracy. This method works best if the amplifier stage on the oscillator is so driven as to distort appreciably.

A square-wave generator may be used with excellent results for the low odd harmonics.

There are many good ways of checking the response of an audio amplifier. One which we have found practical, uses an oscilloscope and an oscillator-driven square-wave generator. It is possible to test with only two square-wave frequencies, 60 cycles and 10,000 cycles, but the interpretation of the results is slightly more involved than with variable frequency. To determine the mid-frequency amplification, the input signal, either sine wave or square wave, is fed to the oscilloscope vertical deflection plates, and the output to the horizontal deflection plates. The deflections are adjusted until the trace is a line making a 45° angle with the horizontal. (Vertical deflection equals horizontal). The connections are now interchanged. The amplification is the tangent of the angle of the scope trace. (Amplification equals vertical deflection divided by horizontal deflection.)

If the amplification is over 10, the original adjustment is to make the horizontal deflection equal 10 times the vertical deflection. After interchanging the connections, the amplification

(Continued on page 86)

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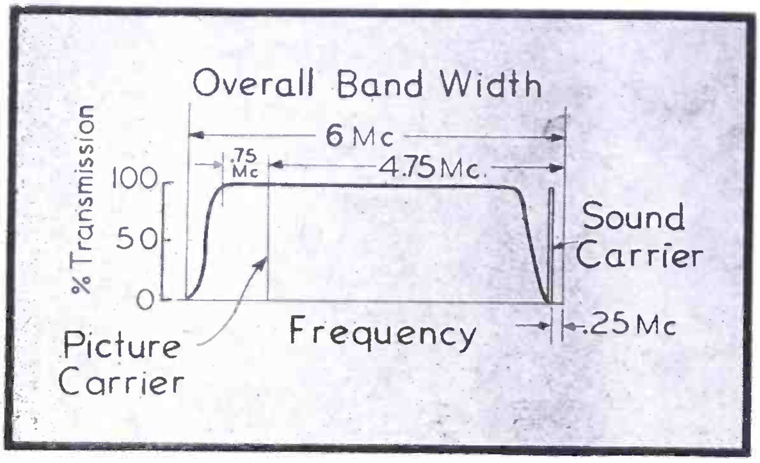
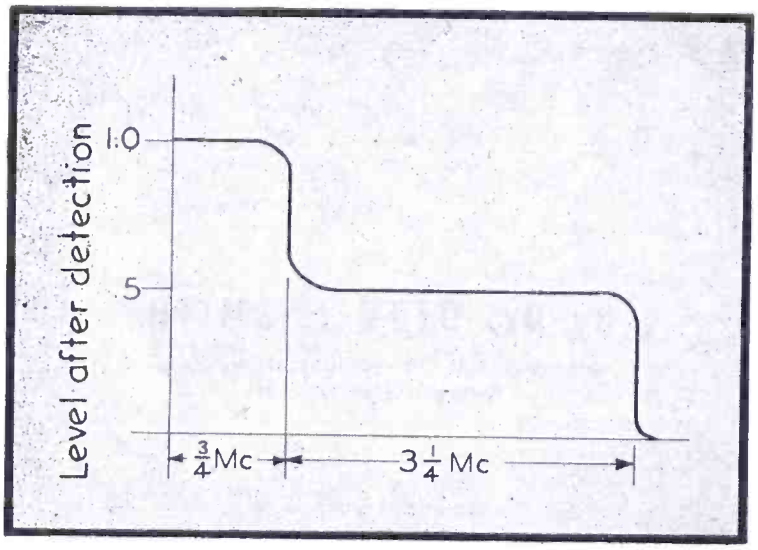
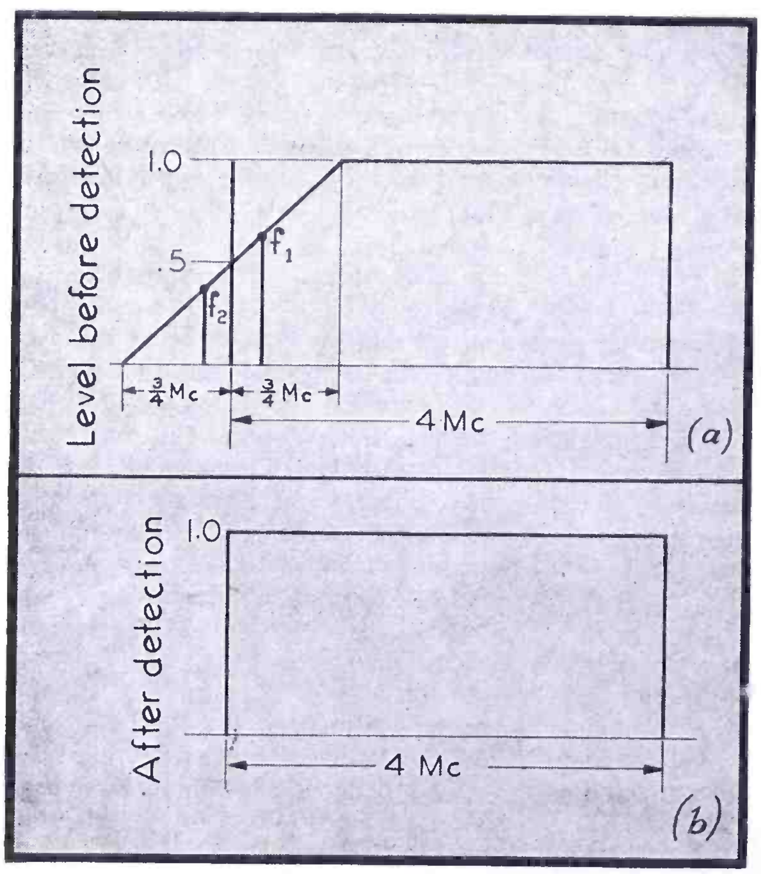


TELEVISION BROADCASTING

J. E. Keister and H. D. Fancher

General Electric





Figures 1 (top, left), 2 (center), and 3 (lower left)

A standard television channel is illustrated in Figure 1. We note here that, because of filter limitations, it has been necessary to allow a lower sideband of .75 mc and a full upper sideband of 4 mc. The sound carrier, which at present is f-m, is spaced 4.5 mc from the television carrier, the edges of the channel being .25 and 4.75 mc from the latter. In Figure 2 appear the characteristics of a receiver without equalization. If the transmission system shown in Figure 1 were demodulated by a diode detector on a linear receiver, severe amplitude distortion as shown in Figure 2 would result. In Figure 3 we have an idealized receiver characteristic. In *a*

$$\frac{f_1 + f_2}{2} = 1.0$$

In the April issue of Communications *appeared highlight reviews of the first two lectures in the television series jointly sponsored by the AIEE and the IRE. These lectures were presented by P. Mertz of the Bell Telephone Laboratories, and R. E. Shelby of NBC. Reviews of two more lectures in this series are presented below.*

THIS lecture was given in two parts. The first, covering the television transmitter and antenna, was presented by J. E. Keister; the second part concerning STL technique, television networks and rebroadcasting, was offered by H. D. Fancher. Carrier frequency was analyzed by Mr. Keister in his introduction. He pointed out that in order to pass a 4-mc band, which is four times the width of the entire broadcast band, the carrier frequency must be several times 4-mc; hence the allocation of approximately 50 to 300 mc to television, with gaps for various other services. The upper frequency limit is limited by available transmitting and receiving tubes more than any other factor, according to Mr. Keister.

In discussing modulation systems, Mr. Keister said that amplitude modulation was selected for television because f-m was subject to multiple images due to complicated reflections from buildings, hills, trees, etc. Since the eye is poor at evaluating shades of gray, he explained that a considerable amount of amplitude distortion is permissible. This greatly simplifies the method of modulation. However, phase distortion, which is not noticeable in sound reproduction, is very serious in television, said Mr. Keister, because any non-linearity between phase and frequency result in leading or trailing white or black images or to various relief effects.

To provide the best definition for a given band width of 6 mc, single sideband transmission should be used, Mr. Keister pointed out. However, because of filter limitations which preclude a sharp cutoff at the carrier frequency, it was not practical to eliminate the entire lower sideband. Thus the adopted standards allow a lower sideband of 0.75 mc and the full upper sideband of 4 mc, Figure 1. The sound carrier, which at present is f-m, is spaced 4.5 mc from the television carrier,

TELEVISION TRANSMISSION

Highlights of AIEE-IRE Television Lectures

Presented by J. E. Keister and H. D. Fancher, and Dr. P. C. Goldmark

the edges of the channel being 1.25 and 4.75 mc from the latter. This system of transmission thus places rather rigid selectivity requirements upon the receiver, said Mr. Keister.

If the transmission system shown in Figure 1 were demodulated by a diode detector on a linear receiver, severe amplitude distortion, as shown in Figure 2, would result. The first 0.75 mc, which is transmitted on both sidebands, would have double the amplitude of the remainder of the band, which is transmitted on only a single sideband. In Figure 3, showing an ideal pattern, we see how this is taken care of in the receiver characteristic. This pattern shows the carrier being cut in half and the vestigial sideband chopped down so that it complements the upper sideband, and thus the sum of the two ordinates equals 1.0. To illustrate this point, Mr. Keister showed how we could take any low frequency sideband which would fall within the vestigial band, such as 100 kc, and then draw in the sidebands, f_1 and f_2 in Figure 3. Adding them should produce the same amplitude as the remainder of the characteristic, 1.0.

Problems met in high level plate modulation, low level plate modulation and high level grid modulation were also analyzed by Mr. Keister. He pointed out that high level plate modulation is a low distortion system capable of 100% modulation which, in a sound transmitter, requires half as much audio power as the plate input to the final r-f power amplifier. But, in a video transmitter, the power required is tremendous, explained Mr. Keister. To demonstrate this, Mr. Keister presented a few rough considerations. Suppose, he said, a modulator looks into a hypothetical resistance which, for sound, is E_{dc} divided by I_{dc}. The equivalent resistance for the video band is:

$$R_v = \frac{1}{2\pi f_v C_p}$$

where R_v = modulator load
f_v = video band (4 mc)
C_p = plate capacity of modulator

or approximately 30 ohms. Thus from the expression

$$P_v = \frac{E_{dc}^2}{R_v}$$

where the plate voltage is 3860 and R_1 is 30 ohms, the modulated power would be in the neighborhood of 500 kw for a 10 kw carrier.

One other consideration makes high level plate modulation impractical, said Mr. Keister. This is the impedance of the load, given by the hypothetical resistor of 30 ohms. No present tube can work efficiently into that low a value and no transformer is yet available which will handle power at such a wide frequency range.

Discussing grid modulation of the power stage, Mr. Keister said that the capacity is of the same order but the voltage is cut to about 10%, making the power required around 5 kw which is still not so easy to obtain. However it represents the best solution so far. We cannot obtain high Q in the p-a tank circuit, explained Mr. Keister. This is due to the r-f load being equal to, for a single tuned circuit, $R = \frac{1}{2\pi \Delta f C}$ ohms, where Δf = bandwidth either side of carrier; and for a double tuned circuit, $R = \frac{.14}{\Delta f C}$ ohms.

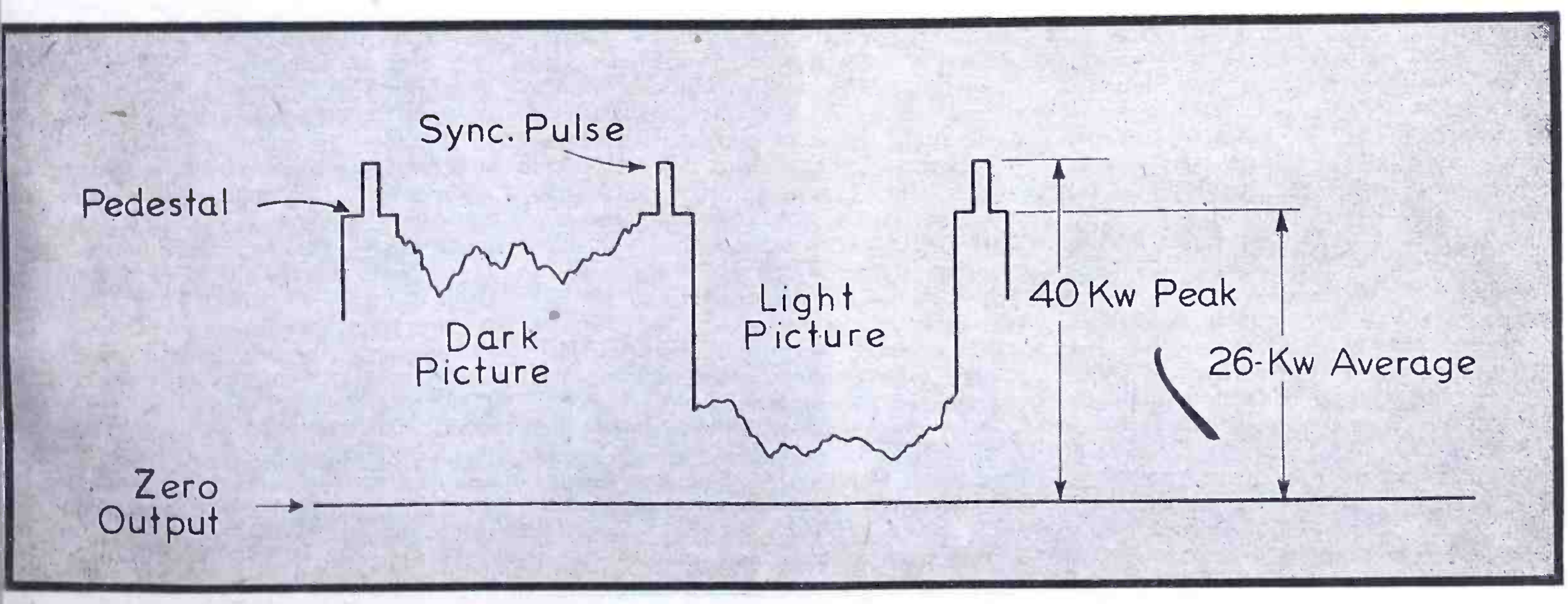
Since $P = \frac{I^2 R}{2}$, where I = fundamental component of I_p of one tube, and R, as given above, the power output is limited by the current in the p-a tubes.

Before the signal can reach the antenna, one side is filtered to produce the standard pattern with the vestigial band. The filter consists of a concentric transmission line plus a loading resistor to absorb the unwanted power.

Mr. Keister also described the difficulties encountered with low level plate modulation. Such problems concern the class B linear amplifiers required to build up r-f power. Single-tuned circuits, sharpen up too much when cascaded, he said. Thus it becomes necessary to use double or triple-tuned bandpass filters which do not cut the sidebands.

In this system modulating power is not a problem since only a low power tube is modulated. No antenna filter is required to produce the vestigial sideband, for the desired signal pattern is determined in the low level stages and amplified, ex-

Figure 4
Transmitter power level.



plained Mr. Keister. In double or triple-tuned amplifiers only the tube's output capacity appears across the coupling transformer, he said, whereas in single-tuned systems both the output capacity and the next tube's input capacity are present to lower the gain.

Since very low load impedances are required to pass the very wide band, the R_p may be neglected in calculating power gain. Thus, pointed out Mr. Keister,

$$\text{Gain} = \frac{.013\, G_m^2}{(\Delta f)^2\, C_o\, C_i}$$

where G_m is the transconductance
C_o is the output capacity
C_i is the input capacity

The average picture brightness determines the signal output power, said Mr. Keister, but the pedestal synchronizing pulse level is constant regardless of the picture content. Figure 4 illustrates first a portion of a predominantly dark picture requiring increased power, and a light picture which requires only a small amount of power. Mr. Keister also presented data covering the kw output at the pedestal or black level (26 kw average power) for a 40-kw transmitter.

The concluding portion of Mr. Keister's paper covered radiation. He described polarizing standards, stating that the horizontal is used because most man-made static is vertically polarized and, in addition, it is more convenient to erect directional receiving antennae for horizontal polarized waves.

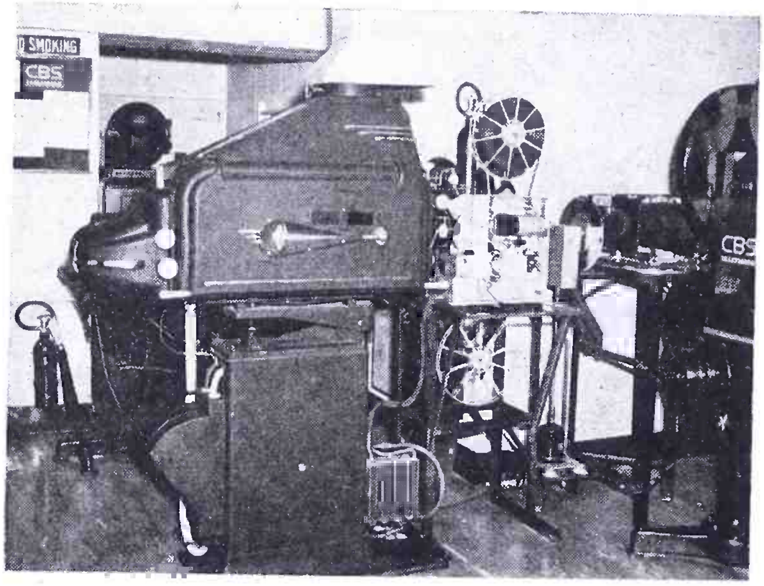
Mr. Keister pointed out that all wide-band antennas have a large $\frac{d}{l}$ ratio. The length is determined by the carrier frequency, the diameter by the passband. He said that accurate impedance matching between the transmission line and antenna is necessary, for mismatch prompts out-of-phase positive or negative ghosts. Even the spacing of the beads in the coaxial cable is an important item, he said, for, if the beads are evenly spaced, some certain frequency will be reflected back to the transmitter, producing a serious discontinuity.

Covering *STL,* studio-transmitter links, in the second portion of the lecture, Mr. Fancher pointed out that for short distances it is conventional to pipe the video and sync signals over a coaxial cable with a studio output level of 1 to 5 volts; for longer distances, such as are met in mountain-top transmitter locations, a radio link is used. For mobile pickups within a city, and a short distance from the studio, it is possible to use a standard telephone pair. This is only a stop-gap procedure, said Mr. Fancher. The full bandwidth cannot be transmitted even though the high frequency end is boosted 60 db, he explained. In addition, phase adjustments of a large order must also be made.

Several problems connected with cable transmission were related. Mr. Fancher pointed out that surge impedance is not independent of frequency, artificial loading being used to reduce this effect. When cables are laid in the street it is essential that the sheath be grounded at only one point to prevent hum pickup. At th transmission end of the cable, a high gain pentode used in a cathode-followe circuit is used to match the line impedance with very little loss, a gain o almost unity, explained Mr. Fancher. A the receiving end of the cable, a terminating resistor is used. Cathode coupling is advantageous, said Mr. Fancher, in tha it is insensitive to ordinary circuit changes and to changing of tubes.

Mr. Fancher pointed out that cable transmission without equalization wasn't possible. Both the low frequencies and the very high frequencies fall off and must be boosted with proper phase correction, he said. For the longer distances a modulated carrier signal is used instead of straight video; repeater stations are located every 4 to 6 miles. Mr. Fancher said that this eliminates the low frequency troubles.

The FCC provides for r-f studio links and relay channels in the 162-300 mc band. Powers of 10 to 50 watts are sufficient for distances up to 20 miles, said Mr. Fancher, because of the highly directive antenna systems employed at both ends of the circuit. At these wavelengths the structures are small and the gain high. This helps to prevent interference from local transmitting stations' harmonics which might otherwise be a source of annoyance. Double sideband transmission has been approved by the FCC. Thus one problem has been removed, explained Mr. Fancher. However, the receiving problem is increased, he said, because the i-f has to pass an 8-mc band instead of only 3.75 mc.



COLOR IN TELEVISION

Dr. P. C. Goldmark
Columbia Broadcasting System

A MOST comprehensive analysis of a fascinating phase of television . . . color television . . . was presented by Dr. P. C. Goldmark during his lecture.

He traced the development of the art by reviewing early systems, particularly those of Baird. The first Baird system, 1928, used a color filter spiral with blue, red and green. Because the eye retains images of all colors, it was possible in this system to rotate a multi-color disk in front of a receiving device and create a true color picture without breakup, as long as the frequency was sufficient. A similar color filter disk was used at the transmitter in front of a picture tube. The field interval of these early colored pictures was 1/120 of a second; frame interval 1/60 second; color frame interval 1/40 second; picture interval 1/20 second.

The 1938 system of Baird was also described. This used 120 lines, utilized a mirror frame 12" in diameter rotating at 6,000 rpm. Dr. Goldmark said that the Wratten series were the best series of filters and were used as standards. Another Baird system described was the one developed in 1941 which used a modified orthicon picture tube and a double-image cathode-ray tube at the receiver, both images being focused on a screen to make a composite picture. Each image corresponded to a color; one orange and one blue-green.

After the review of the British systems, Dr. Goldmark covered the color system used by CBS. It is a three-color system of red, blue and green, using filters which give faithful reproduction throughout most of the color spectrum. How a part of the blue and green region is cut-out was shown in a color triangle figure, Figure 6. Dr. Goldmark stressed the fact that the problem of light pick-up is a particularly serious one in color work since much of the light is lost in the color filters. In addition, the response of the image dissector tubes is greater in the non-visible band than in the visible.

Figure 5 (above left)
The CBS color film scanner.

Daylight fluorescent lamps are used in preference to spot lamps because they are much easier on the eyes, yet give satisfactory lighting. A typical value of light required on the subject is 200-foot candles. Arc lights are also used, said Dr. Goldmark.

At the receiver a colored picture may be less brilliant than a black and white

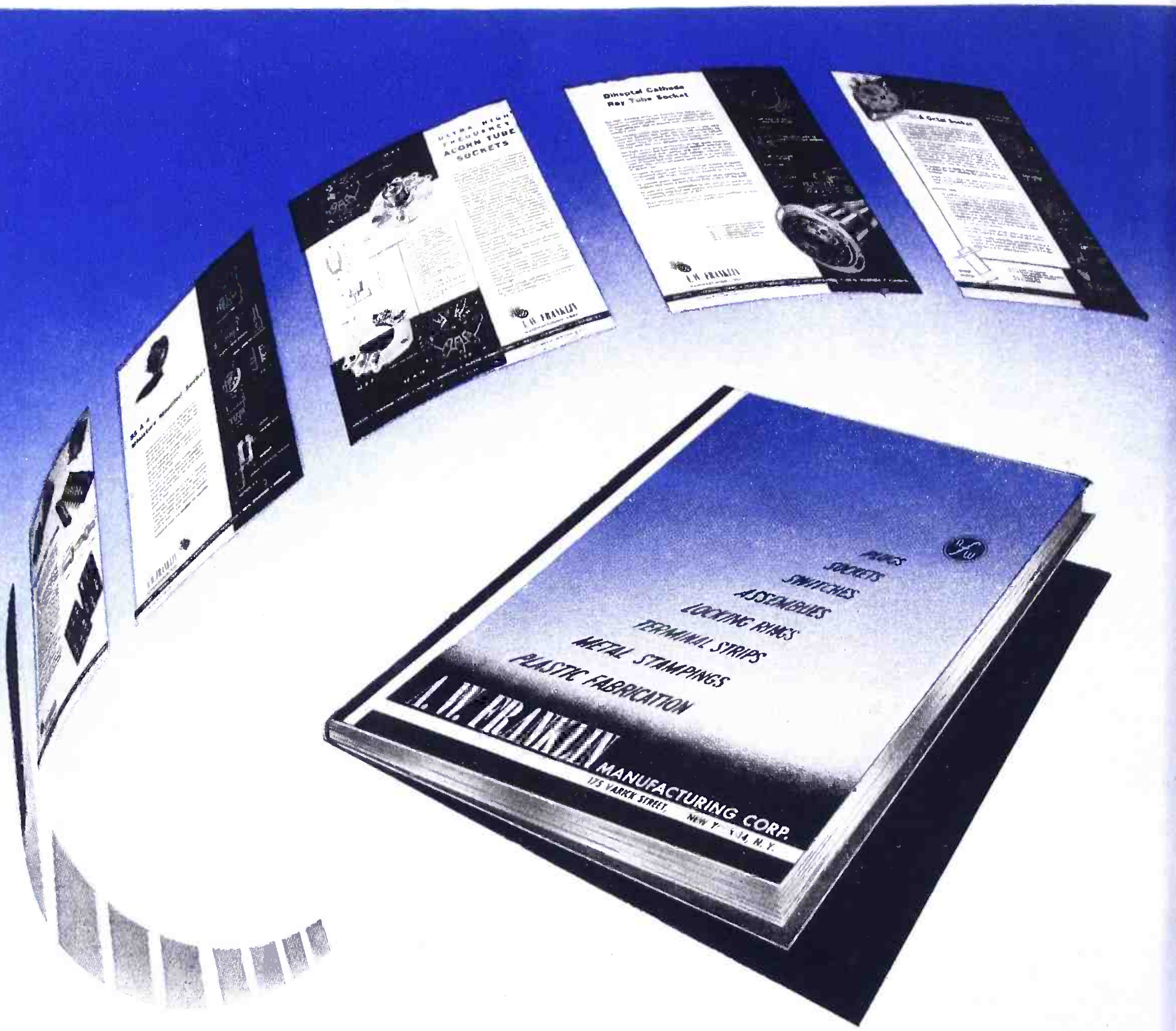


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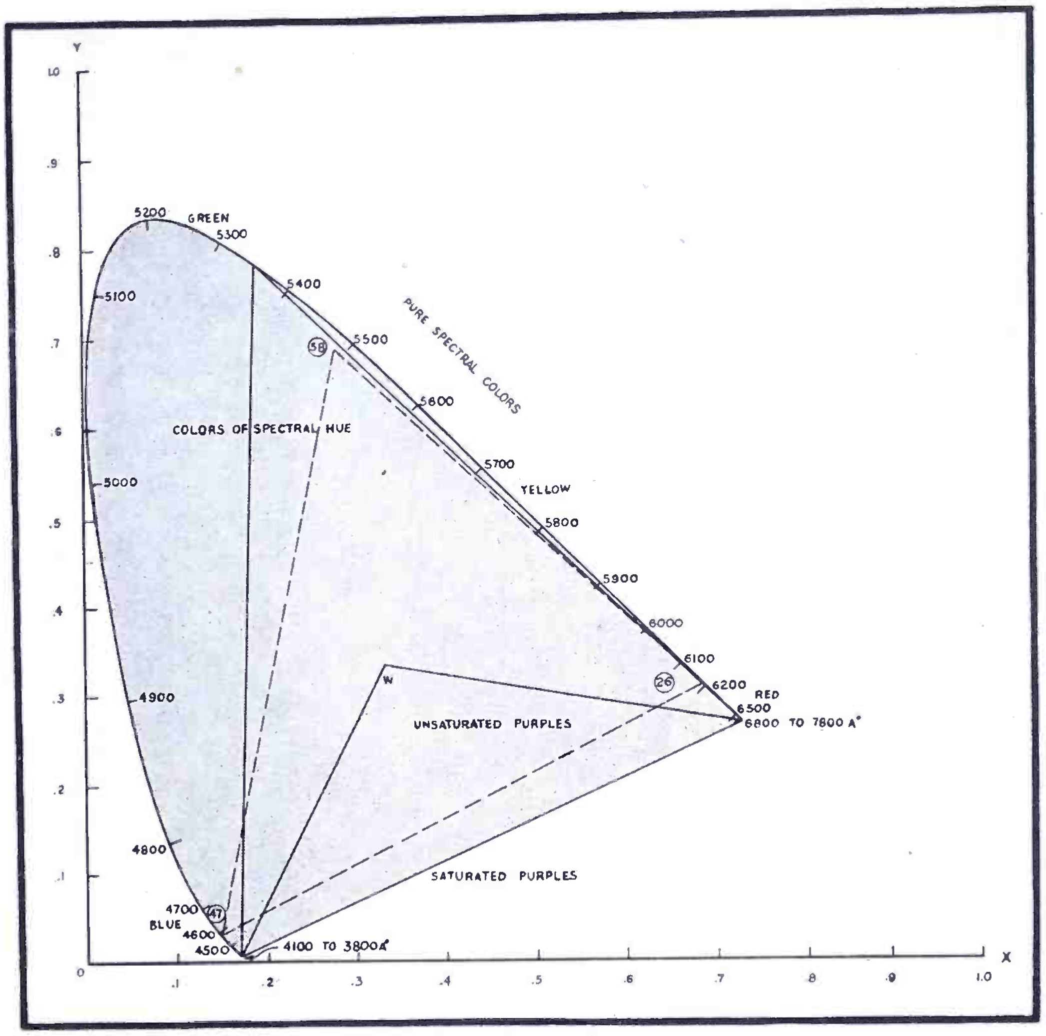
Figure 6
Color triangle figure.



icture and still give satisfactory results. his is because 2.7-foot candles in color re approximately equivalent to 10-foot andles in black and white, explained Dr. oldmark.

A block diagram of a studio pick-up sing a mirror frame, camera, video pre-mplifier and color mixer was displayed y Dr. Goldmark. In this system, the olor mixer is required to obtain a satis-ctory balance of colors, separate ampli-ers being used for each color. The am-ifiers are tied up to a common syn-hronizing generator so that each ampli-er operates for one-third of the time, the utput being the sum of all three, said r. Goldmark.

Dr. Goldmark pointed out that after n hour or so a control operator in moni-oring colored pictures loses his color ense so that it is necessary to supply a hite light for reference purposes. With-ut this reference the operator will fre-uently adjust the mixers so that the hite appears as light pink or some quivalent color. Dr. Goldmark intimated hat program directors will probably anipulate the mixers to create various ramatic effects. Such a color mixer ap-ears in Figure 7.

In discussing magnifying lenses at the eceiver, Dr. Goldmark cautioned against rying to obtain too much magnification; pproximately 1.5 to 1 would seem about ight. The rotating color disk used at BS is designed with segments shaped o allow for a maximum angle of hunting, s synchronous motors are subject to unting during line surges. The system rovides for 375 lines, 60 frames per sec-nd, 120 fields per second and 2 to 1 nterlacing. The motor turning the disk is n induction motor which normally runs lightly overspeed. The speed is con-rolled by a braking current and satisfac-ory operation is obtained from 95-124 olts. Dr. Goldmark said that the phase an shift plus or minus 25 degrees without

(*Continued on page* 82)

System No.	***1***	***2***	***3***	***4***	***5***
Color fields per second	60	120	120	180	120
Color frames per second	20	40	40	60	40
Color pictures per second	10	40	20	15	10
Interlace ratio	2	1	2	4	4
Lines per frame	525	260	375	450	525
Horizonal frequency	15750	31200	22500	20250	15750
Color break-up	U	S	S	S	S
Interline flicker	U	S	S	D	U
Picture flicker	U	S	S	S	S
Frames	30	120	60	45	30

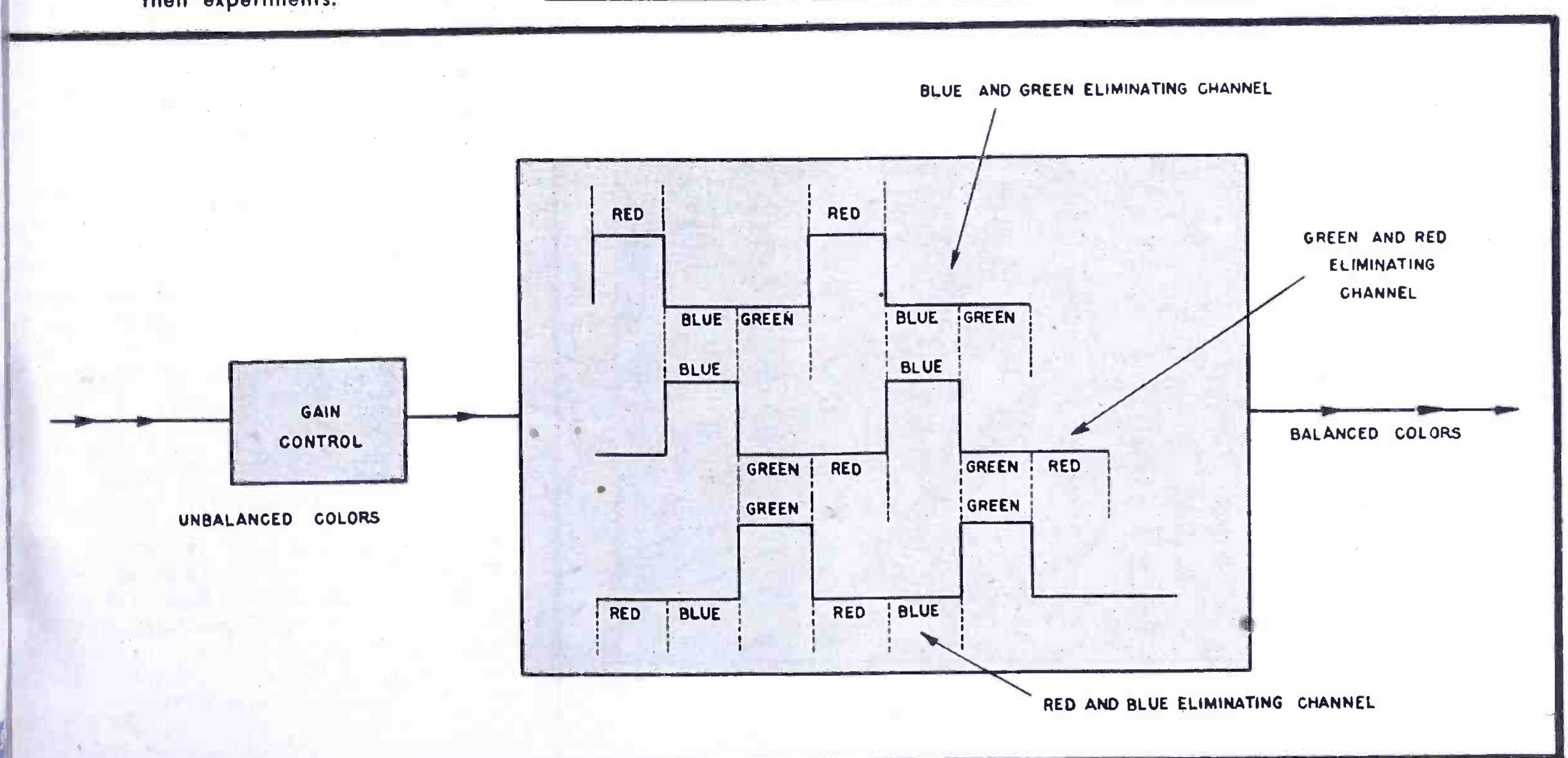
S = satisfactory; U = unsatisfactory; D = doubtful.

For no duplication of color:

$$\frac{c}{f} = 3n \pm 1$$

c = color fields/second
f = frames/second
n = interlacing — 1, 2, 3, etc.

Figures 7 (below) and 8 (right)
Figure 7 shows a color mixer amplifier. In Figure 8, five color systems tried by CBS in their experiments.



COIL Q FACTORS AT

by ART H. MEYERSON
New York Fire Department Radio Laboratory

The author checking Q.

IN the paper presented in the April issue of COMMUNICATIONS, methods used to overcome coil construction problems at v-h-f, were discussed. In addition graphs showed some of the effects of varying number of turns for a definite turn-ratio, and coil form diameters. In this paper all factors affecting v-h-f coil construction are discussed.

The determination of *Q* trends of various coil shapes is important in the design of r-f amplifier inductances. However, the proper perspective of the relative importance of *Q* to other circuit factors must be kept in mind. Coils exhibit *Q* properties over a frequency range that should properly influence their selection for the service intended. In addition, design limitations and tube parameters should receive consideration before *Q* factors are applied to coil selection. The *Q* characteristic of a coil may be predicted, but only after charting of numerous types of coil shapes. No mathematical formulae seem to apply, but relative values may be determined by the trends noted.

Before any consideration of the coil design, it is necessary to determine the *Q* characteristic needed for optimum performance. Figure 1 shows three coils of approximately the same inductance value, with their *Q* characteristic for the frequency range of 30 to 50 mc. Their curves show a wide variance in *Q* characteristic at these frequencies. For fixed frequency operation, the problem is quite simple and resolves itself into the design of a coil with the highest possibe *Q*, within the mechanical and size limitations. The problem is quite different for coils designed for band reception. At broadcast frequencies a coil with a frequency characteristic shown in Figure 1B would be permissible, since the load impedance, a function of QX_L, would increase with frequency, due to the preponderant effect of X_L or $2\pi fL$. The result would be increased load impedance and, therefore, greater sensitivity at the high frenquency end of the dial, even though the *Q* is lower. At v-h-f, however, the problem is magnified, due to the greater frequency coverage and the smaller part played by QX_L in the determination of load impedance. In addition, the loss in tube input-admittance and output-impedance, with an increase in frequency, would seriously affect the stage gain at the high end of the band, if a coil with a falling *Q* characteristic were used.

Consider an r-f amplifier circuit in its simplest form (Figure 2). The coupling network between the tubes may be resolved into that of Figure 2b. At resonance, the amplification of

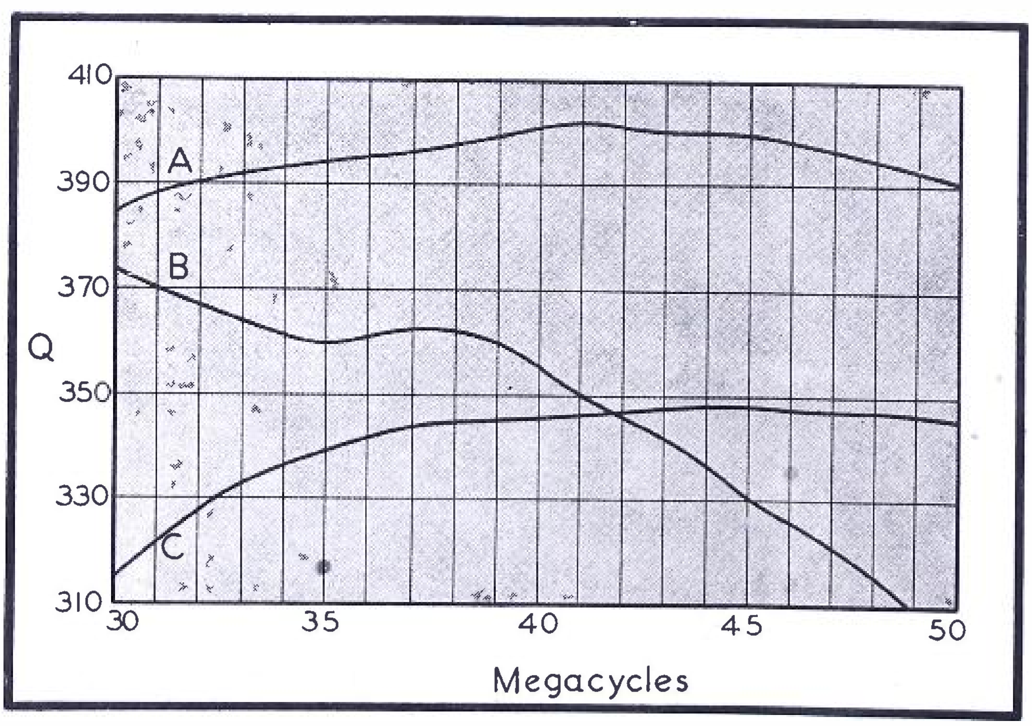


Figure 1

The wide variance in Q characteristics for three different coils of approximately the same inductance is shown here. *A* represents five turns of 10 wire, four turns/inch on a 1½" form; *B*, five turns 14 wire, six turns/inch, 1¼" form; *C*, six turns 14 wire, five turns/inch, 1" form.

V - H - F

the stage plus the preceding tube will be

$$*gm \frac{1}{\frac{1}{R_P}+\frac{1}{R_G}+\frac{1}{R_L}} \text{ or } gm \frac{R_L}{1+\frac{RL}{R_P}+\frac{RL}{R_G}}$$

where

R_P = plate resistance
R_G = grid resistance of grid load circuit
$R_L = QX_L$ or load resistance

The total impedance of the circuit, which determines the voltage gain of the amplifier, is a function of R_P, R_G, and R_L.

The input resistance of a typical pentode has been shown to vary from 36,000 ohms at 25 mc, to 8,600 ohms at 59 mc. The output resistance of the same tube, varies from 190,000 ohms at 19 mc to 22,000 ohms at 60 mc.[1] It can be seen, then, that variations in these values exert a strong influence on r-f stage gain at v-h-f, over normal bandwidths. The *Q* characteristic of the coil used then can serve as a balancing factor for uniform stage gain over the band covered.

Practical considerations include tube input and output capacitances, coil dimensions, and tuning condenser minimum and maximum values.

The minimum tuning capacitance is limited by the shunt capacitance exhibited by the tube and associated parts at the high end of the band. If this total should reach, say, 5 to 7 mmfd, the minimum tuning capacitance must be at least 25 mmfd for any degree of circuit frequency stability. The total, or 30 to 32 mmfd, represents a reactance at 60 mc of approximately 90 ohms, which is also the reactance of the complementary. This demonstrates the necessity for good circuit loading.

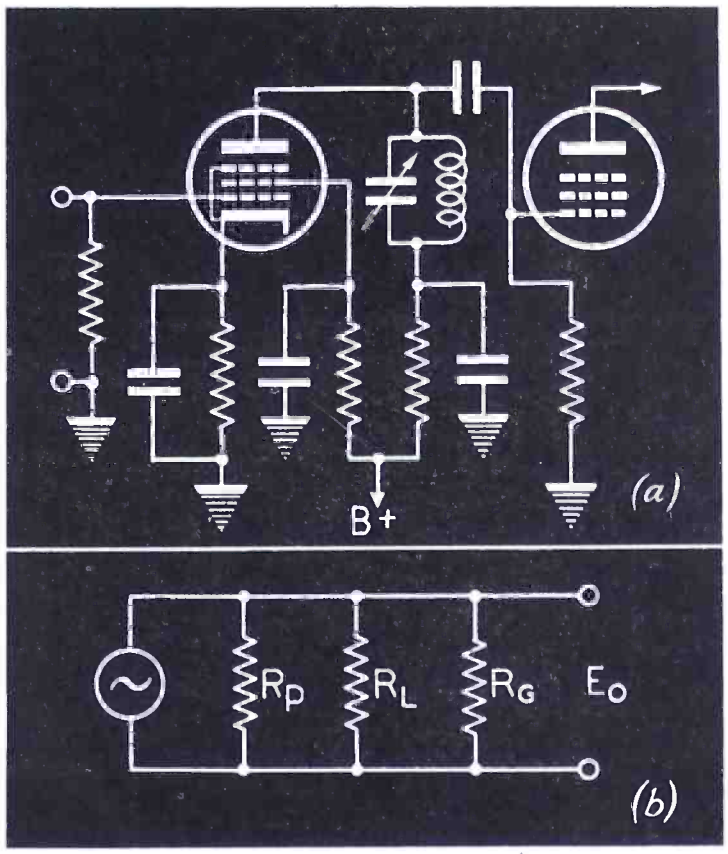


Figure 2

In *a* is shown a simple form of r-f coupling network. In *b* we see a coupling network reduced to its simplest form with three parallel resistors representing the factors in coupling.

Shielding factors limit the maximum permissible coil size. Coil diameters of 1½" are probably the largest size that can be used, since for minimum reduction of coil *Q* by shielding, a diameter of 2 x coil size is most practical.

With these limitations in mind, a series of experiments were undertaken to determine the various factors that affect coil Q at v-h-f. Wire sizes used ranged from 10 to 20, coil-form diameters from ¾" to 1½", and turns/inch, from 2 to 14.

The original intent of the experiments was to investigate the possible development of some formula that would indicate the effects of varying coil parameters on *Q*. However, a recapitulation of results showed that it was simpler and more effective to gather all the data within the usable limitations of standard practice, and simply note the trends.

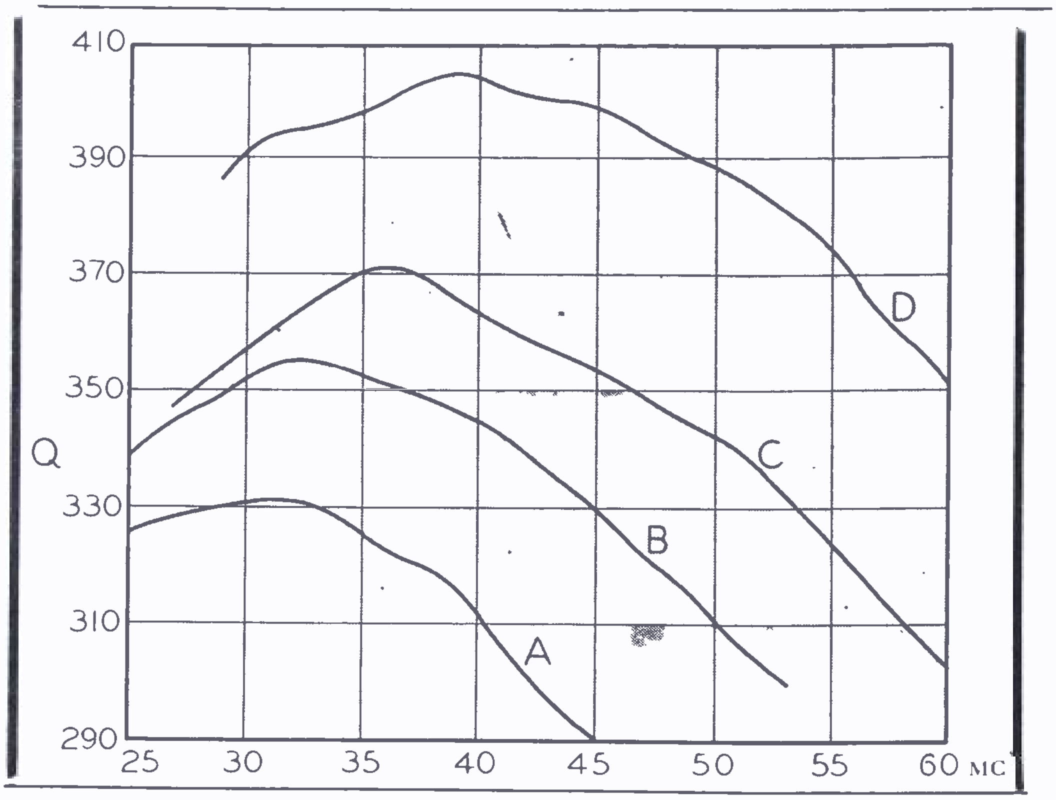
Some of the trends noted are portrayed graphically in Figures 4 to 6. In addition, a typical chart prepared for 16 wire on a 1"-coil form is presented in Figure 3. The results noted

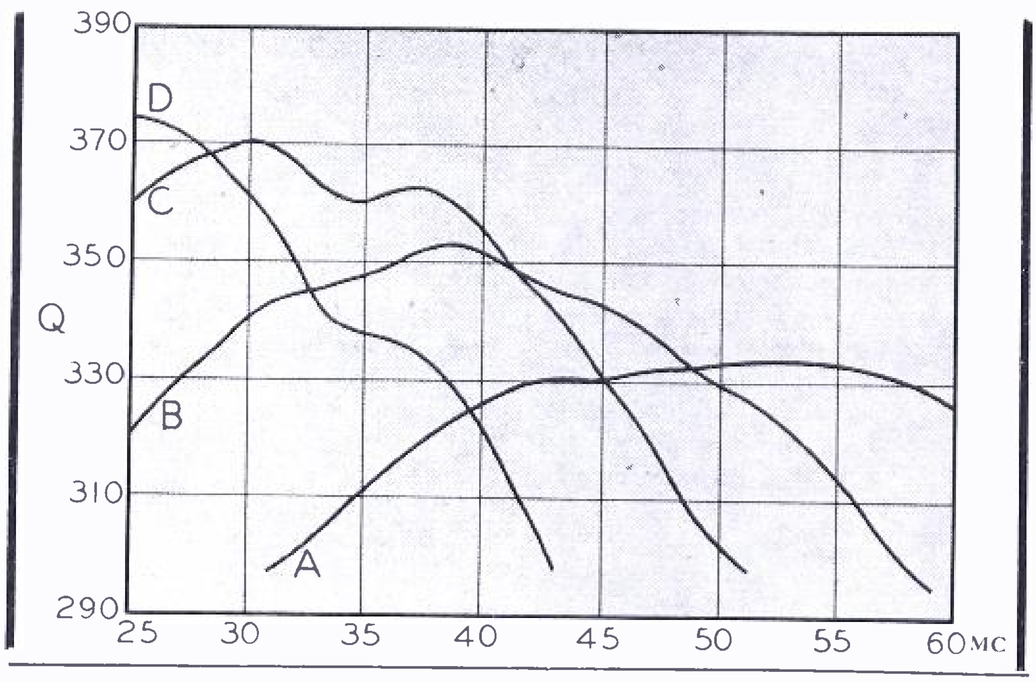
[1]Strutt and Van der Ziel, Proc. IRE, p. 1011; Aug., 1938.
*M. I. T. Staff. *Applied Electronics*. John Wiley & Sons, Inc.

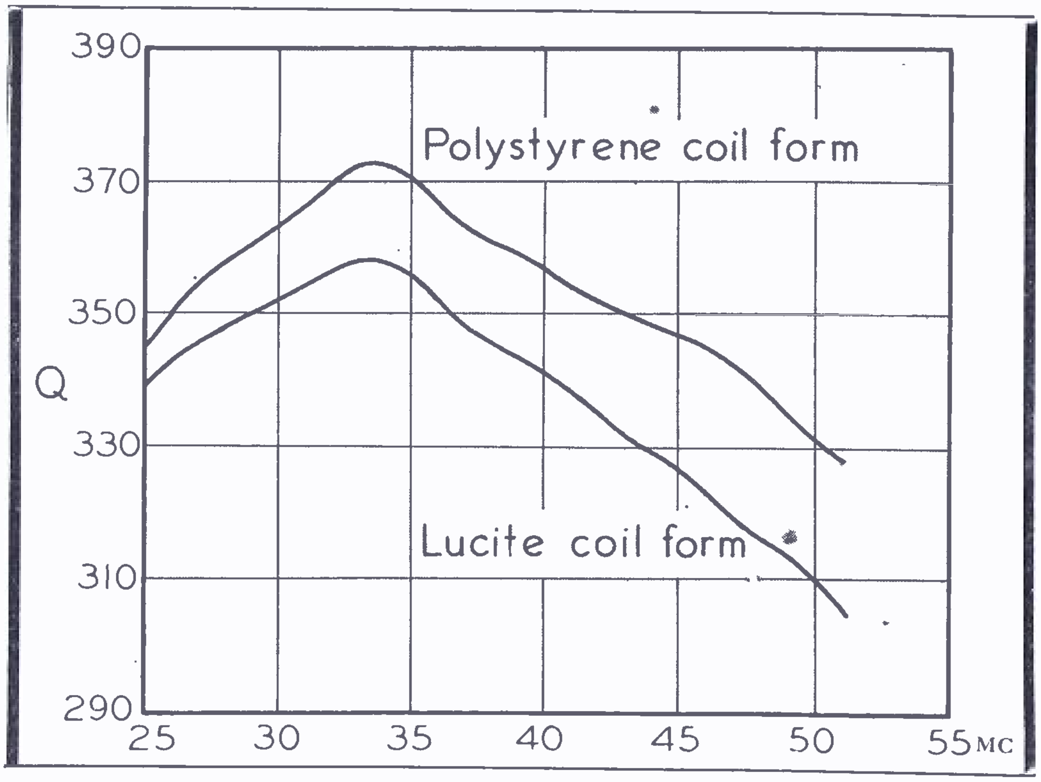
Figure 3

A chart disclosing Q values taken on a 1" form, .049" diameter, using 16 wire (winds 20.4 turns/inch). Italic figures represent peak Q. Dip at 35-37 mc is characteristic of the Q-meter used, and probably represents a resonant effect in the v-t voltmeter of the Q meter.

Frequency, Mc	7 turns per inch					8 turns per inch					9 turns per inch						10 turns per inch						
	4	5	6	7	8	5	6	7	8	9	5	6	7	8	9	10	5	6	7	8	9	10	11
25		289	314	318	*320*	290	307	326	324	*324*	291	315	324	*324*	*321*	318	293	311	318	*318*	316	302	300
27		298	319	324	*327*	298	315	329	*327*	*327*	298	321	*329*	*327*	*324*	317	300	315	*320*	*321*	316	300	298
29	283	302	324	*327*	326	307	318	*330*	*328*	324	309	*326*	*330*	324	318	314	306	316	*324*	316	312	294	288
31	290	314	*327*	*328*	326	313	*324*	*331*	327	321	314	*328*	328	318	315	307	314	*318*	319	313	307	290	282
33	298	*316*	*328*	328	321	*316*	*325*	330	321	315	*317*	*327*	326	314	311	301	*316*	*319*	316	307	301	282	272
35	306	*318*	321	317	314	*318*	318	325	312	303	*319*	322	318	305	298	289	*317*	317	311	295	288	264	
37	307	316	*327*	317	304	315	321	321	304	291	316	324	316	299	282		315	309	303	288	274		
39	*311*	318	324	314	296	316	320	317	295	284	315	319	311	290			313	306	295	279			
41	*314*	316	318	305	288	314	315	306	288		314	315	300	280			310	298	285				
43	313	314	314	297	280	311	306	297			311	307	288				306	290	276				
45	312	312	307	289		306	300	290			306	300	281				300	283					
47	311	306	300	281		303	293				301	290					292	276					
49	310	300	289			296	285				293	280					286						
51	309	297	282			292	278				285						280						
53	306	292				288					278						277						
55	303	283				279											267						
57	299	279				274																	
59	295																						







in this chart are true for all wire sizes in general, on all size coil forms, and may be summarized as follows:

(*1*) The peak frequency of *Q* increases with a decrease in the number of turns; *number of turns/inch constant.*

(*2*) The peak frequency of *Q* increases with a decrease in the number of turns/inch, *number of turns constant.*

(*3*) The peak *Q* is highest at a turns/inch winding ratio of slightly less than half the number of turns/inch, for the bare wire size. For example, 16 wire winds 20.4 turns/inch. Best winding ratio for highest *Q* is 8 to 9 turns/inch.

(*4*) The peak frequency of *Q* is highest when the ratio of number of turns to turns/inch is approximately 80% to 90%. This is only true at peak turns/inch.

(*5*) The *Q* characteristic for a given size of wire is flattest when the wire is wound at a turns/inch ratio less than optimum.

(*6*) Peak *Q* is highest for any turns/inch ratio for a given wire size: (a) when the turns/inch winding pitch is greater than optimum, the peak *Q* is at a ratio of number turns to turns/inch less than 80%; (b) when the turns/inch is less than optimum, the peak *Q* is at a ratio of number turns to turns/inch greater than 80%.

The graphs demonstrate that (*1*)—*Q* increases with an increase in wire size for a given diameter, Figure 4; (*2*)—*Q* increases with an increase in coil diameter for a given wire size, Figure 5; (*3*)—Peak frequency of *Q* moves upward with an increase in wire size for a given diameter, Figure 4; (*4*)—peak frequency of *Q* moves downward with an increase in coil diameter for a given wire size, Figure 5.

Information on the effect of cotton

(*Continued on page* 83)

* * *

Figures 4 (top left), 5 (center), and 6 (lower left)

Figure 4, the effect of increasing wire size for a given diameter, 1" form. *A* represents 7 turns 16 wire, 8 turns/inch; *B*, 6 turns 14 wire, 7 turns/inch; *C*, 5 turns 12 wire, 6 turns/inch; *D*, 5 turns 10 wire, 5 turns/inch. Figure 5 demonstrates the effect of increasing coil diameter, wire, number of turns, turns/inch constant: *A* is a ¾" form; *B* is a 1" form; *C* is a 1¼" form; and *D* is a 1½" form. All forms grooved 6 turns/inch, using 5 turns of 14 wire. Figure 6, the effect of using polystyrene coil forms instead of lucite. Both graphs represent 6 turns of 14 wire on a 1" form, grooved 7 turns/inch.

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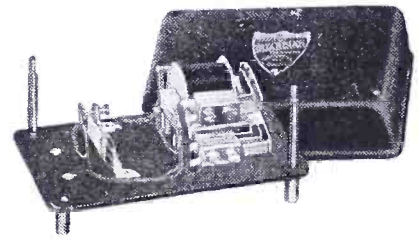

T-100 Laminated Time Delay Relay
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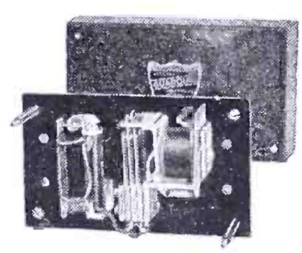

T-110 Time Delay Relay (not laminated)
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THERE'S A JOB FOR

Relays BY GUARDIAN

The filaments of oscillator type tubes require a "warm up" of 20 to 30 seconds which is usually provided by a time delay relay such as Guardian's Type T-100. In this relay the time delay is adjustable between 10 and 60 seconds and is accomplished by means of a resistance wound bi-metal in series with a resistor. The contact capacity of the T-100 is 1500 watts on 110 volt, 60 cycle, non-inductive AC. The power consumption of coil and time delay during closing of the thermostatic blade is approximately 10 VA; after closing, 5.5 VA.

A similar relay giving almost the same performance but costing somewhat less is the Series T-110. This relay may be equipped with an extra set of open or closed contacts, if desired. In industrial control, both relays may be used in applications requiring the changing of circuits after a predetermined interval.

Consult Guardian whenever a tube is used—however—Relays by Guardian are NOT limited to tube applications but are used wherever automatic control is desired for making, breaking, or changing the characteristics of electrical circuits.

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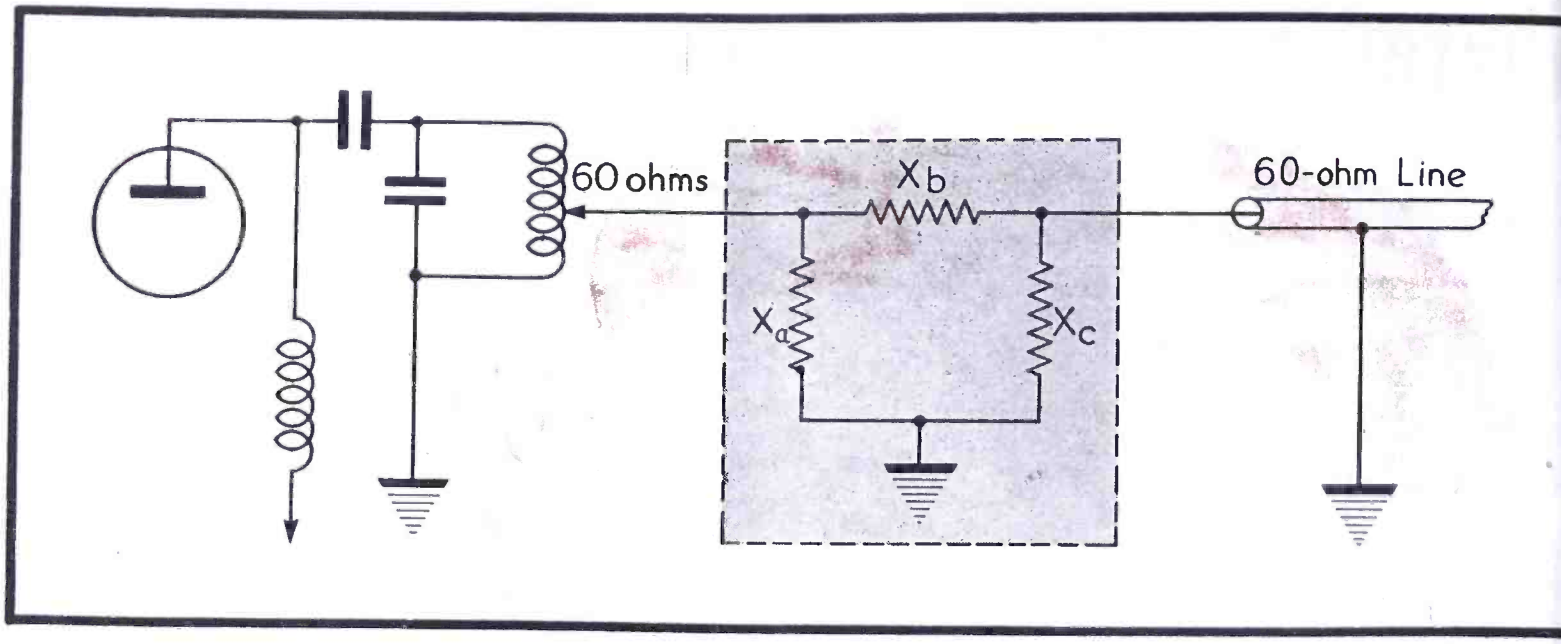


HARMONIC ATTENUATION WITH A PI NETWORK

An Analysis Of An Application In Transmitters

by OBRA W. HARRELL
Engineering Staff
WAGA, Atlanta, Georgia

THE pi network offers a most effective means of attenuating r-f harmonics in a transmitter. The electrical circuit is quite simple, easy to construct and adjust.

The pi network may be inserted between unequal or equal impedances with equal results. We will, however, consider its insertion between equal impedances (for demonstration, 60 ohms) with primary emphasis on harmonic attenuation, rather than for impedance transformation for which it is excellent and convenient.

In Figure 1 appears a circuit which demonstrates the use of the pi network. It is inserted between the final tank circuit of the transmitter and the 60-ohm transmission line feeding the antenna, although any other impedance may be used equally well.

Since at the tap on the tank coil we have 60 ohms and the transmission-line impedance is 60 ohms, the input and output impedance (X_a and X_c) of the pi network must be 60 ohms at operating or fundamental frequency; $X_b = \sqrt{X_a X_b} = 60$ ohms.

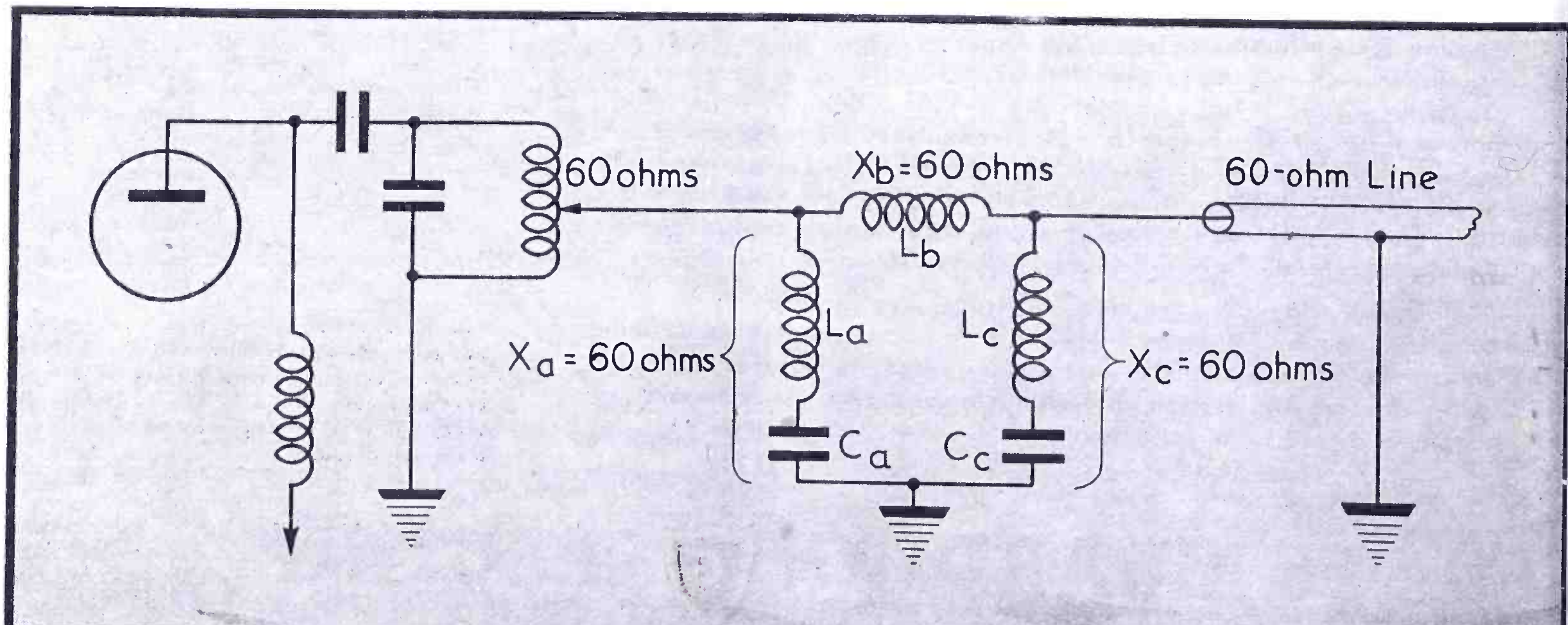
If the reactances X_a or X_c, or both X_a and X_c, can be made to look like a short circuit at the harmonic frequency, and the pi network would maintain its 60-ohm input and output impedance at the fundamental frequency, we may have a high order of attenuation of the harmonic and maximum transfer of power at the fundamental frequency.

This can be accomplished by the proper selection of inductance and capacity of the elements, so that X_a and X_c are resonant at the harmonic frequency. This provides a minimum resistance to that frequency, and still maintains a reactance of the proper value (60 ohms) for the input and out-

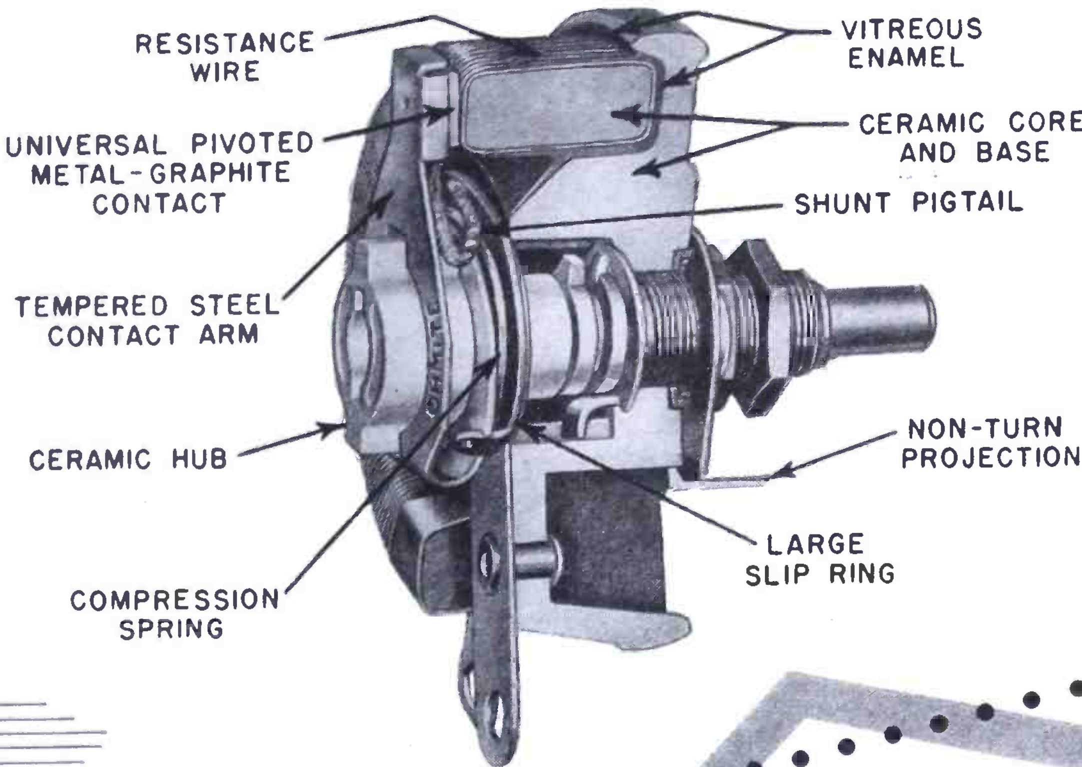
(*Continued on page 82*)

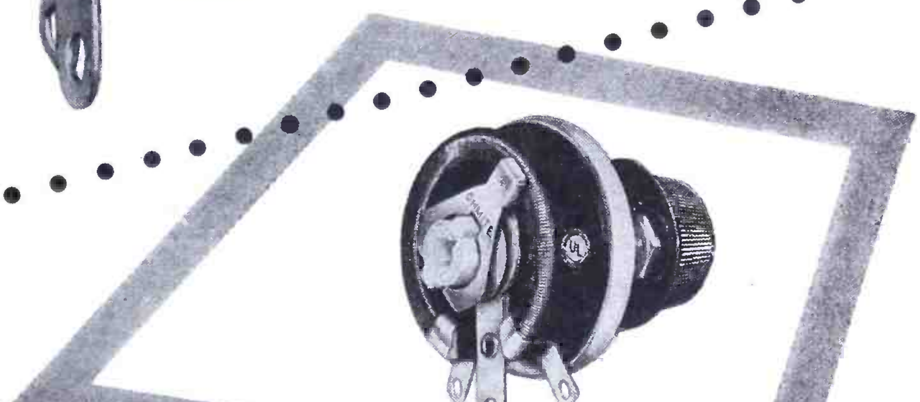
Figures 1 (above) and 2 (below)

Figure 1, circuit demonstrating the use of the pi network. In Figure 2 we note that if the pi network is inserted between equal impedances, then $X_a = X_b = X_c = 60$ ohms at the fundamental frequency.



The Inside Story of OHMITE Rheostats





OHMITE Design Makes the Difference in Smooth, Close Control

Everywhere . . . on every battle front . . . and in the tools of Industry . . . you find Ohmite Rheostats doing critical control jobs.

Permanently smooth, close control is built-in . . . to withstand shock, vibration, heat and humidity. Construction is compact . . . all ceramic and metal. There is nothing to shrink, shift or deteriorate.

Illustrated in the cutaway above are many of the features which contribute to the consistent dependability of Ohmite Rheostats.

Widest range of sizes—ten models from 25 to 1000 watts, from 1 9/16″ to 12″ diameter—in straight or tapered winding, in single or tandem assemblies—to meet every control need in the most advanced electronic devices.

Write on company letterhead for complete, helpful 96-page guide in the selection and application of Rheostats, Resistors, Tap Switches, Chokes and Attenuators.

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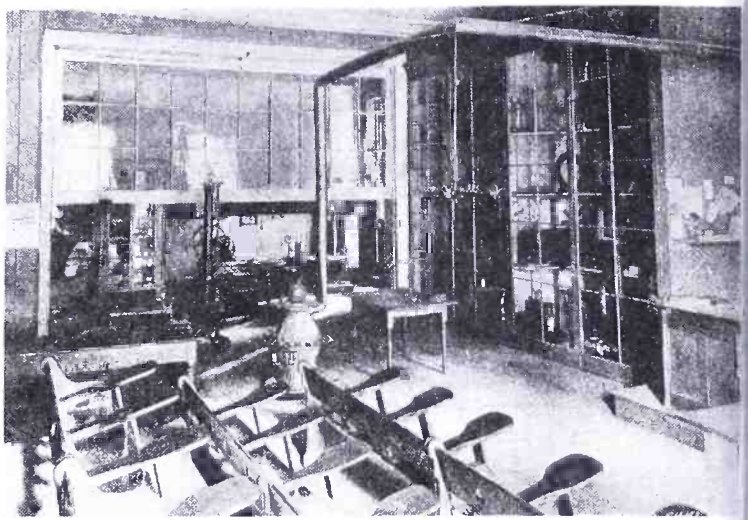
Be Right With OHMITE Rheostats • Resistors • Tap Switches

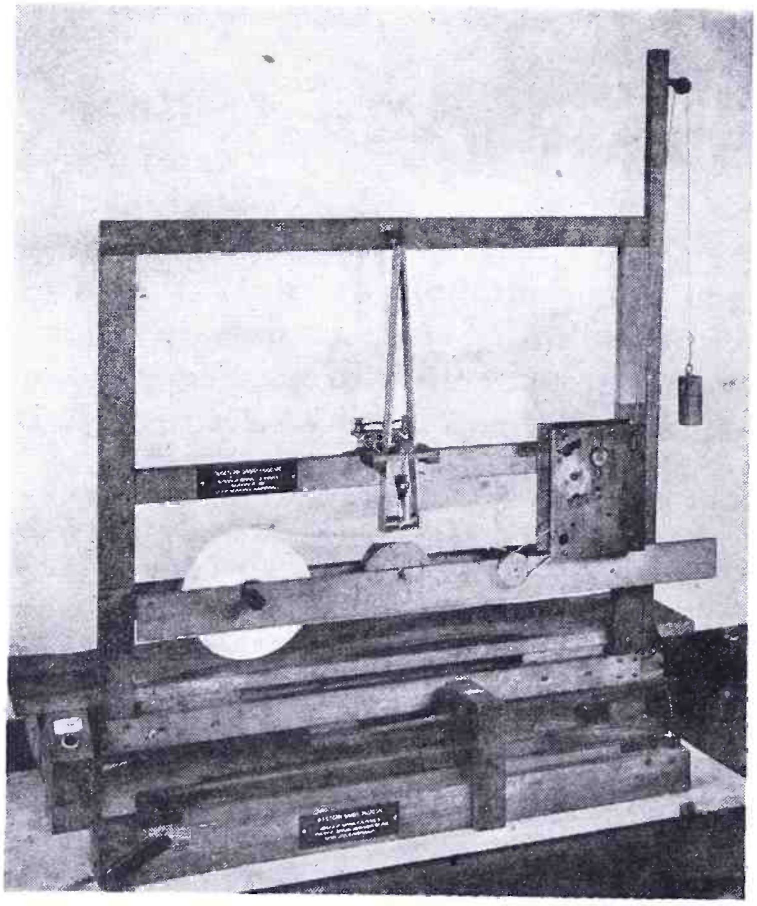
At left, a portrait of Samuel F. B. Morse, made while he was conducting his initial telegraph experiments a century ago. He was then a professor of art and design at New York University. Below, the classroom at New York University in which Morse gave his first public demonstration of the telegraph instrument on January 24, 1838. The message was relayed between two rooms.



TELEGRAPH'S CENTENNIAL

ONE of the greatest inventions of the age . . . the telegraph . . . is, this year, celebrating the one-hundredth anniversary of its first practical application. And throughout the nation members of the *communications* industry are paying tribute to inventor Samuel Finley Breese Morse who, on May 24th, 1844, sent the now historic first telegram . . . "What hath God wrought!" on his famous instrument.

Few inventions inspired so many toward the expanded development of an instrument's uses, as the telegraph. As a result of Morse's invention, Bell conceived the telephone. And later on, Marconi developed the means of using the telegraph without the aid of wires. With the introduction of radio telegraphy, the telegraph found a staunch ally. Today radio and the telegraph are boon companions in the art of communications.



A replica of Morse's first telegraph instrument, built in 1835. This used a ribbon of paper to record dots and dashes automatically. Although it was very successful in transmission, it was never used commercially. This instrument is now on display in the Western Union museum.

When Morse conceived his invention in 1832 for wire application, he was hoping to be able to transmit over a few miles. Cross-country telegraph system installations years later proved that it was possible to achieve transcontinental coverage quite effectively. The introduction of radio gave further impetus to the transmission activities of the telegraph, affording globe-circling coverage.

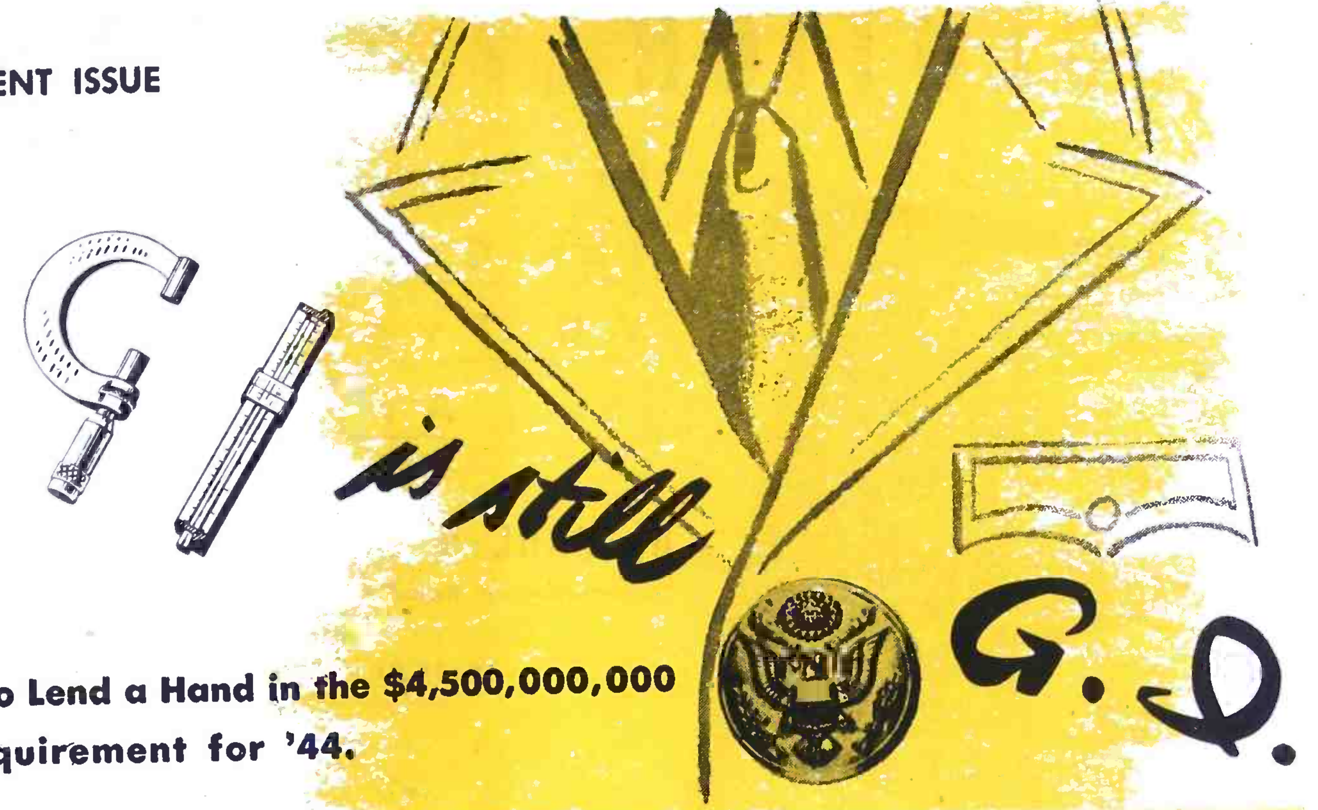
While the highly developed equipment of today bears little physical resemblance to the crude instruments first invented by Morse, it is interesting to note that many of Morse's original ideas, some of which were abandoned for various reasons, have been retained and reincorporated in systems now in use.

The first telegraph was conceived and operated as a semi-automatic device. To send a message, metal teeth were set in a row in a ruler-like object, known as a "portrule." The transmitter lever moved up and down as these notches struck it, making and breaking the circuit at short and long intervals to send dots and dashes.

In Morse's first telegraph system messages were received on paper and not by sound. In the electromagnetic receiver of 1844, a stylus was lowered for short and long intervals, controlled by the signals coming over the line and made long and short marks upon a paper tape. Modern telegraphic equipment is in the main automatic and, oddly enough, much of the re-

(*Continued on page* 84)

GOVERNMENT ISSUE



G. I. is ready to Lend a Hand in the $4,500,000,000 Electronic Requirement for '44.

Bring on those orders! We have the will and the way to help roll 'em off the assembly lines. Since Pearl Harbor—and before—mass production of electronic equipment for our armed forces has been the order of the day at G. I.

As we have geared our resources to the increased tempo of vital war work, we are now in a position to function on an expanded basis.

We are prepared to handle widescale assignments in the electronic and radar fields—assignments which will utilize our experience and special techniques for mass output of such instruments as variable condensers, automatic tuning mechanism, wired assemblies and similar devices so urgently needed for the final great push of our Allied forces.

G. I. has open capacity NOW!

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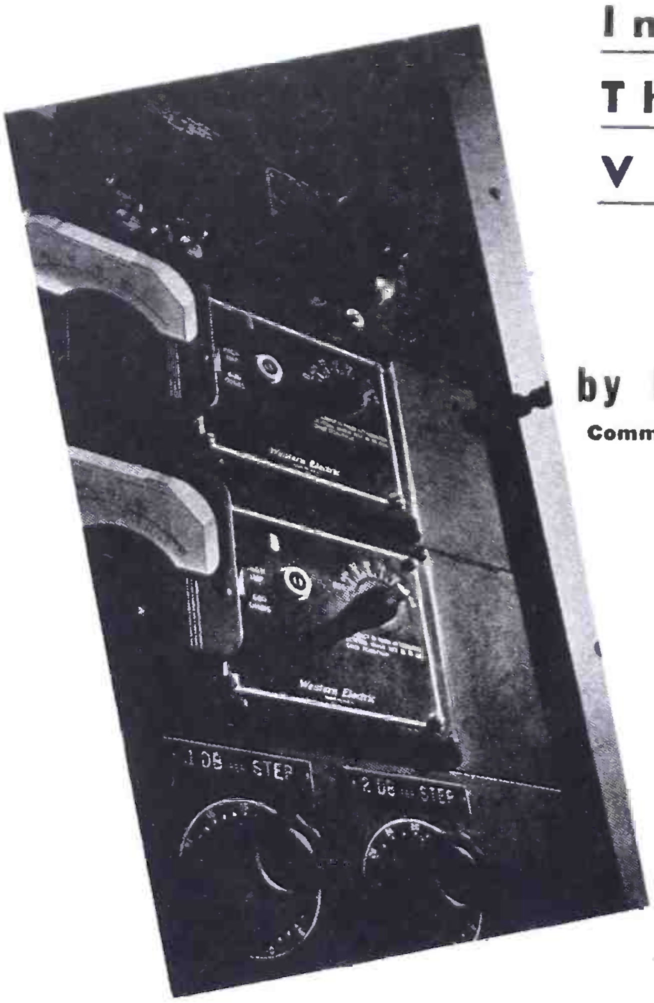
EVOLUTION OF THE DB AND VU

In This Final Installment The Characteristics Of The VU Type Of Indicator Are Reviewed



by **PAUL B. WRIGHT**

Communications Research Engineer

(PART III)

Figure 15
Speech input equipment at WBAM; 10-kw f-m affiliate of WOR.

(Courtesy Western Electric)

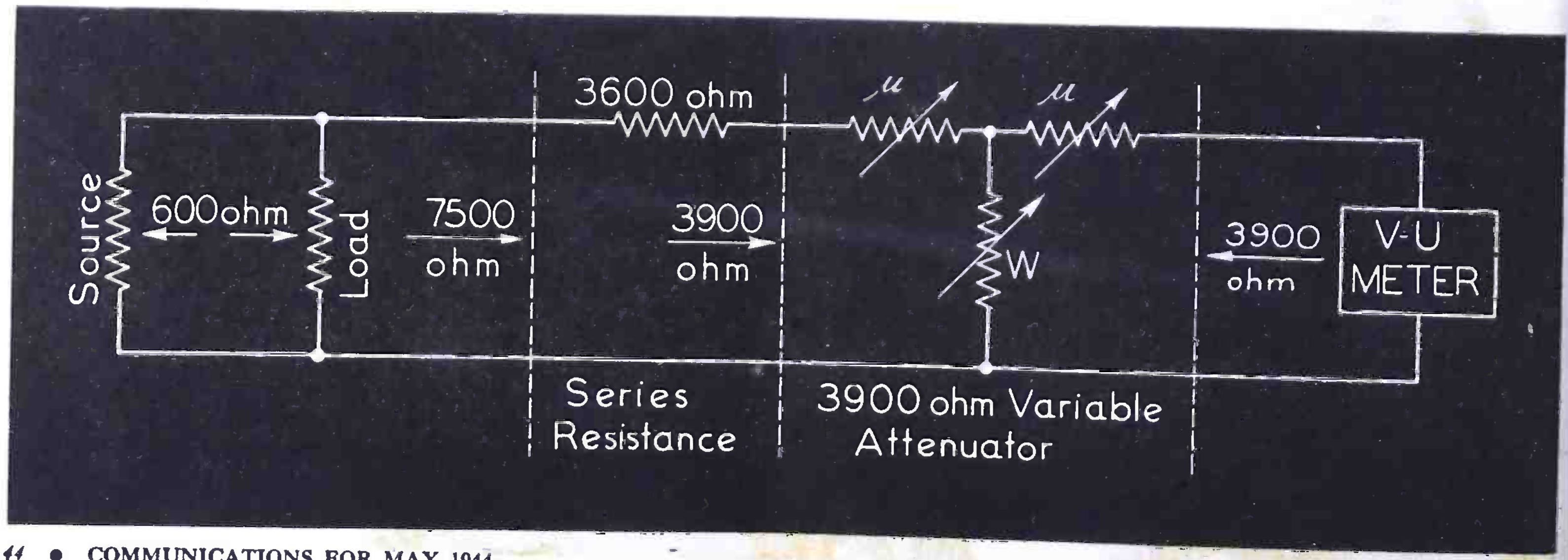
In Part 1, Mr. Wright discussed the evolution of methods of measurement and standards of performance. He analyzed the criteria used to judge the performance of cable, telegraph and telephone systems which prompted the adoption of several units during the course of development. These were: the CR law, Standard Cable Reference System, Transmission Unit (tu) and finally the Decibel unit (db). In this paper, Mr. Wright tells of the basic requirements which meters in transmission measuring systems must meet for both general and specific purposes. He discloses that the characteristics which have been adopted for the Volume Unit (vu) type of indicator have proved to be most desirable for radio network use and broadcast station maintenance and operation.

ALTHOUGH the db meter has become quite commonplace throughout the telephone, motion picture, recording, public address, broadcast network and radio control studios, its many unusual properties do not appear to be too well known.

The basic requirement of all types of output and power level meters is that they shall be capable of measuring the alternating voltage which is developed across the impedance, which provides the load for the circuit under test. This load may be the circuit which is an integral part of the meter itself, or it may be an external impedance across which the meter is connected. When the meter circuit provides the load, there is a maximum of sensitivity possible, for in this case the meter circuit may and usually does match the circuit with which it is being used on an impedance basis. Thus maximum power is transferred to the meter. When connected across the load formed by a circuit external to the meter, a considerable decrease in power sensitivity results. This is due to the inevitable losses which result from either matching two impedances on an image basis which have high ratios, or from the losses which take place in using the meter on a power division basis. In this instance, the loss is incurred by deliberately inserting a high resistance in series with the meter so that only a small amount of power is extracted from the circuit being bridged for measurement purposes.

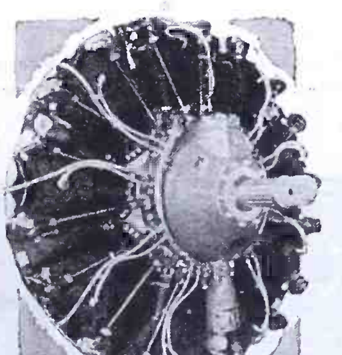
Moving iron, induction, electrostatic, dynamometer and thermal types of instruments have been tried at various times during the development of db indicators, but they suffer from either

Figure 16
Volume unit type of indicator arranged for bridged measurements, and may be bridged across a line.



Friend or Foe?

Over Africa recently a flight of American bombers on their way to a target received radio instructions to change course and attack a different objective. Because of the clarity of reception, an alert operator was able to take a bearing on the signal—only to find that it was coming from the enemy. A call back to base brought out our fighters, who proceeded to the false target and destroyed thirty out of forty-five Messerschmitts which were lying in ambush for the flight of American bombers.



Breeze Radio Ignition Shielding is engineered to designers' special requirements. Look to Breeze for the solution to your shielding problems.

Perfect and undistorted reception and transmission of signals made possible the victory related above. Breeze Radio Ignition Shielding, which effectively guards against the radiation or absorption of radio-frequency interference, maintains a dependable "quiet zone" for static-free communication.

Pioneers in developing Radio Ignition Shielding, Breeze has designed and produced shielding harnesses for hundreds of types of aircraft, marine, and automotive engines. This equipment, now being produced in ever-increasing quantities, supplements the many other items of the well-known Breeze line of accessories for America's fighting units of land, sea, and air.

Breeze BREEZE MARK

CORPORATIONS, INC. NEWARK, N. J.

PRODUCTION FOR VICTORY • PRODUCTS FOR PEACE

DB Gain	Ratios: Power	Ratios: Voltage or Current	Power (MW): 1 MW Basis	Power (MW): 6 MW Basis	Voltage 500 Ohms: 1 MW Basis	Voltage 500 Ohms: 6 MW Basis	Voltage 600 Ohms: 1 MW Basis	Voltage 600 Ohms: 6 MW Basis	Current (MA) 500 Ohms: 1 MW Basis	Current (MA) 500 Ohms: 6 MW Basis	Current (MA) 600 Ohms: 1 MW Basis	Current (MA) 600 Ohms: 6 MW Basis
0	1.0000	1.0000	1.0000	6.0000	0.70711	1.7321	0.77460	1.8974	1.4142	3.4641	1.2910	3.1623
1	1.2589	1.1220	1.2589	7.5536	.79338	1.9434	.86910	2.1289	1.5868	3.8868	1.4485	3.5481
2	1.5849	1.2589	1.5849	9.5093	.89019	2.1805	.97513	2.3886	1.7804	4.3611	1.6253	3.9811
3	1.9953	1.4125	1.9953	11.972	.99881	2.4466	1.0941	2.6801	1.9976	4.8932	1.8236	4.4668
4	2.5119	1.5849	2.5119	15.071	1.1207	2.7451	1.2276	3.0071	2.2414	5.4901	2.0461	5.0119
5	3.1623	1.7783	3.1623	18.975	1.2574	3.0801	1.3774	3.3741	2.5148	6.1601	2.2957	5.6234
6	3.9811	1.9953	3.9811	23.886	1.4108	3.4559	1.5455	3.7867	2.8217	6.9118	2.5759	6.3096
7	5.0119	2.2387	5.0119	30.071	1.5830	3.8776	1.7340	4.2477	3.1660	7.7551	2.8902	7.0795
8	6.3096	2.5119	6.3096	38.737	1.7761	4.3507	1.9456	4.7660	3.5523	8.7014	3.2428	7.9433
9	7.9433	2.8184	7.9433	47.660	1.9928	4.8816	2.1830	5.3475	3.9858	9.7631	3.6385	8.9125
10	10.000	3.1623	10.000	60.000	2.2360	5.4772	2.4493	6.0000	4.4721	10.954	4.0825	10.000
11	12.589	3.5481	12.589	75.536	2.5089	6.1455	2.7482	6.7322	5.0178	12.291	4.5806	11.220
12	15.849	3.9811	15.849	95.093	2.8152	6.8954	3.0836	7.5536	5.6304	13.791	5.1395	12.589
13	19.953	4.4668	19.953	119.97	3.1585	7.7368	3.4599	8.4753	6.3171	15.474	5.7672	14.125
14	25.119	5.0119	25.119	150.71	3.5439	8.6808	3.8820	9.5095	7.0878	17.362	6.4703	15.849
15	31.623	5.6234	31.623	189.75	3.9763	9.7400	4.3557	10.670	7.9527	19.480	7.2598	17.783
16	39.811	6.3096	39.811	238.86	4.4615	10.928	4.8872	11.972	8.9231	21.857	8.1456	19.953
17	50.119	7.0795	50.119	300.71	5.0058	12.262	5.4835	13.433	10.012	24.524	9.1304	22.387
18	63.096	7.9433	63.096	387.37	5.6167	13.758	6.1526	15.071	11.233	27.516	10.255	25.119
19	79.433	8.9125	79.433	476.60	6.3020	15.437	6.9034	16.910	12.604	30.874	11.506	28.184
20	100.00	10.000	100.00	600.00	7.0711	17.321	7.7460	18.974	14.141	34.641	12.910	31.623

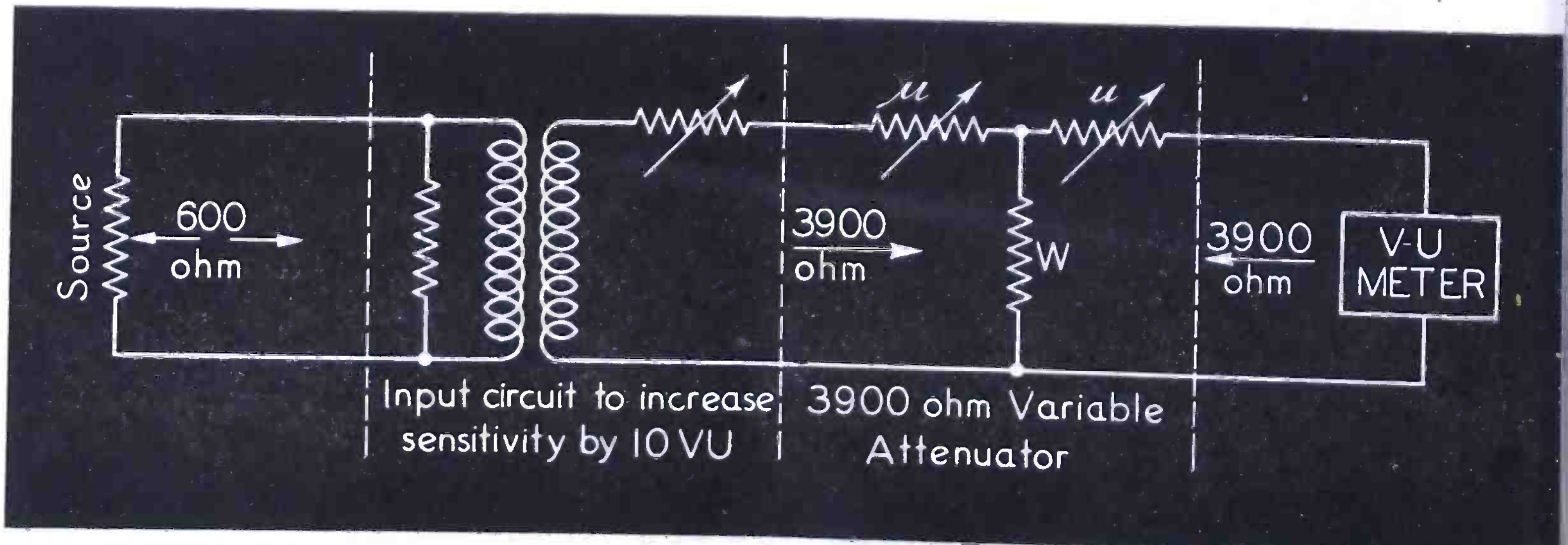
Loss DB	Power	Voltage or Current	Power 1 MW Basis	Power 6 MW Basis	Voltage 500 Ohms 1 MW	Voltage 500 Ohms 6 MW	Voltage 600 Ohms 1 MW	Voltage 600 Ohms 6 MW	Current 500 Ohms 1 MW	Current 500 Ohms 6 MW	Current 600 Ohms 1 MW	Current 600 Ohms 6 MW
0	1.00000	1.00000	1.00000	6.00000	0.70711	1.7321	0.77460	1.8974	1.4142	3.4641	1.2910	3.1623
1	0.79433	0.89125	0.79433	4.76598	.63020	1.5437	.69034	1.6910	1.2604	3.0874	1.1506	2.8184
2	.63096	.79433	.63096	3.87376	.56167	1.3758	.61526	1.5071	1.1233	2.7516	1.0255	2.5119
3	.50119	.70795	.50119	3.00714	.50058	1.2262	.54835	1.3433	1.0012	2.4524	0.91304	2.2387
4	.39811	.63096	.39811	2.38866	.44615	1.0928	.48872	1.1972	0.89231	2.1857	0.81456	1.9953
5	.31623	.56234	.31623	1.89758	.39763	0.97400	.43557	1.0670	.79527	1.9480	.72598	1.7783
6	.25119	.50119	.25119	1.50714	.35439	.86808	.38820	0.95095	.70878	1.7362	.64703	1.5849
7	.19953	.44668	.19953	1.19718	.31585	.77368	.34599	.84753	.63171	1.5474	.57672	1.4125
8	.15849	.39811	.15849	0.95094	.28152	.68954	.30836	.75536	.56304	1.3791	.51395	1.2589
9	.12589	.35481	.12589	.75534	.25089	.61455	.27482	.67322	.50178	1.2291	.45806	1.1220
10	.10000	.31623	.10000	.60000	.22360	.54772	.24493	.60000	.44721	1.0954	.40825	1.0000
11	.079433	.28184	.079433	.47660	.19928	.48816	.21830	.53475	.39858	0.97631	.36385	0.89125
12	.063096	.25119	.063096	.38737	.17761	.43507	.19456	.47660	.35523	.87014	.32428	.79433
13	.050119	.22387	.050119	.30071	.15830	.38776	.17340	.42477	.31660	.77551	.28902	.70795
14	.039811	.19953	.039811	.23886	.14108	.34559	.15455	.37867	.28217	.69118	.25759	.63096
15	.031623	.17783	.031623	.18973	.12574	.30801	.13774	.33741	.25148	.61601	.22957	.56234
16	.025119	.15849	.025119	.15071	.11207	.27451	.12276	.30071	.22414	.54901	.20461	.50119
17	.019953	.14125	.019953	.11972	.099881	.24466	.10941	.26801	.19976	.48932	.18236	.44668
18	.015849	.12589	.015849	.095109	.089019	.21805	.097513	.23886	.17804	.43611	.16252	.39811
19	.012589	.11220	.012589	.075534	.079338	.19434	.086910	.21289	.15868	.38868	.14485	.35481
20	.010000	.10000	.010000	.060000	.070711	.17321	.077460	.18974	.14142	.34641	.12910	.31623

Tabulation of the relationship between power, current and voltage on db measurements.

one or both of two serious faults. These are insufficient sensitivity or the requirement of relatively large amounts of power.

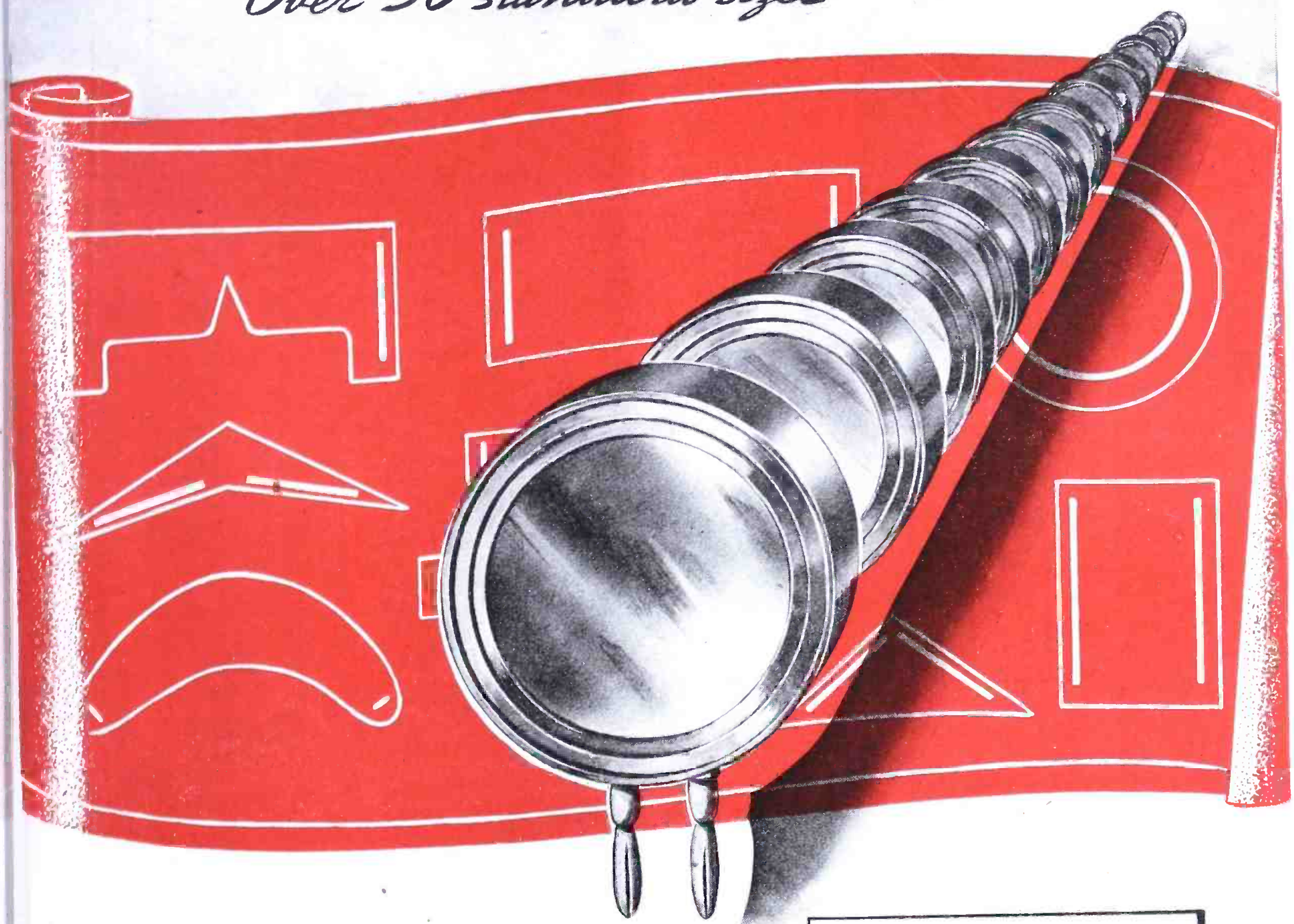
One of the types of indicators which has been used from the earliest days of radio broadcasting is the vacuum tube voltmeter. This device has the advantage of extracting very little power from the circuit being measured and

Figure 17
Volume unit type of indicator arranged for direct reading measurements, but should not be connected across a line.



SELF-GENERATING PHOTO-ELECTRIC CELLS

Over 30 standard sizes



Selenium Corporation of America photo-electric cells are of the self-generating type and are manufactured to highest sensitivity and permanence standards. All S. C. A. self-generating cells can be used in a range from −70° C. to +70° C. and are rendered permanently stable by a special forming process. The most modern methods and equipment available are used in the manufacture of S. C. A. products. All cells and types, thoroughly inspected and matched with regard to sensitivity, spectral response, etc., are available.

S. C. A. makes photo-electric cells, mounted and unmounted, in over 30 standard sizes. Many of these standard types can be shipped from stock.

Write for special technical Bulletin on photo-electric cells and Selenium Rectifiers with output from 100 micro-amperes to 1000 amperes.

SELENIUM CORPORATION OF AMERICA

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(*Continued from page* 46)

at the same time permits the use of common types of D'Arsonval meters for indication purposes. For special portable equipments and for fixed installations, this type has proven highly satisfactory. It has, however, an important disadvantage and that is the requirement of power supply equipment as well as a fairly high initial and maintenance cost, compared with a sensitive meter using passive element rectifiers, most generally of the copper-oxide type. The copper-oxide rectifier in conjunction with a sensitive microammeter may be used to measure most of the levels normally encountered in practice from —20 to +3 decibels referred to 1 milliwatt of power in 600 ohms, without an external equipment. With an amplifier and an attenuator, this range may be extended.

The character of measurement to be made will determine to a large extent

Level in Volume Units	Volts Input (RMS) Attenuation Loss = Zero
—20	0.07746
—19	0.08691
—18	0.09751
—17	0.10941
—16	.12276
—15	.13774
—14	.15455
—13	.17340
—12	.19456
—11	.21830
—10	.24493
— 9	.37482
— 8	.30836
— 7	.34599
— 6	.38820
— 5	.43557
— 4	.48872
— 3	.54835
— 2	.61526
— 1	.69034
0	.77460
+ 1	.86910
+ 2	.97513
+ 3	1.0941
+ 4	1.2276

Level in Volume Units	Volts Input (RMS) Attenuation Loss = Zero	Attenuation Loss in DB	Attenuator Series Arms μ	Attenuator Shunt Arm W
+ 4	1.2276	0	0	∞
5	1.3774	1	224.3	33800
6	1.5455	2	447.1	16790
7	1.7340	3	666.8	11070
8	1.9456	4	882.4	8177
9	2.1830	5	1093	6415
10	2.4493	6	1296	5221
11	2.7482	7	1492	4353
12	3.0836	8	1679	3690
13	3.4599	9	1857	3166
14	3.8820	10	2026	2741
15	4.3557	11	2185	2388
16	4.8872	12	2334	2091
17	5.4835	13	2473	1838
18	6.1526	14	2603	1621
19	6.9034	15	2722	1432
20	7.7460	16	2833	1268
21	8.6910	17	2935	1124
22	9.7513	18	3028	997.8
23	10.941	19	3113	886.4
24	12.276	20	3191	787.9
25	13.774	21	3262	700.5
26	15.455	22	3326	623.3
27	17.340	23	3384	555.0
28	19.456	24	3437	494.2
29	21.830	25	3485	440.0
30	24.493	26	3528	391.9
31	27.482	27	3566	349.1
32	30.836	28	3601	311.9
33	34.599	29	3633	277.2
34	38.820	30	3661	246.9
35	43.557	31	3686	220.0
36	48.872	32	3709	196.0
37	54.835	33	3729	174.7
38	61.526	34	3747	155.7
39	69.034	35	3764	138.8
40	77.460	36	3778	123.7
41	86.910	37	3791	110.2
42	97.513	38	3803	98.21
43	109.41	39	3813	87.53
44	122.76	40	3823	78.01
45	137.74	41	3831	69.52
46	154.55	42	3839	61.96
47	173.40	43	3845	55.22
48	194.56	44	3851	49.21
49	218.30	45	3856	43.85
50	244.93	46	3861	39.09
51	274.82	47	3865	34.09
52	308.36	48	3869	31.05
53	345.99	49	3872	27.68

These tables give the rms voltage required at the input of a vu meter to give the levels indicated when measured across a 600-ohm circuit. Corrections for other impedance levels may be made by adding 10 log (600/Z), when Z < 600 ohms, or by subtracting 10 log (Z/600) when Z > 600 ohms.

The element values of the attenuator for the vu meter are indicated above.

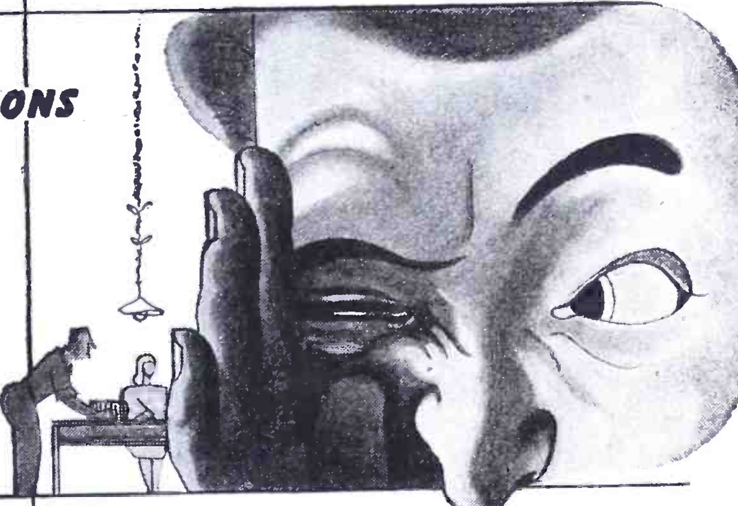
Three attitudes that hamper war production

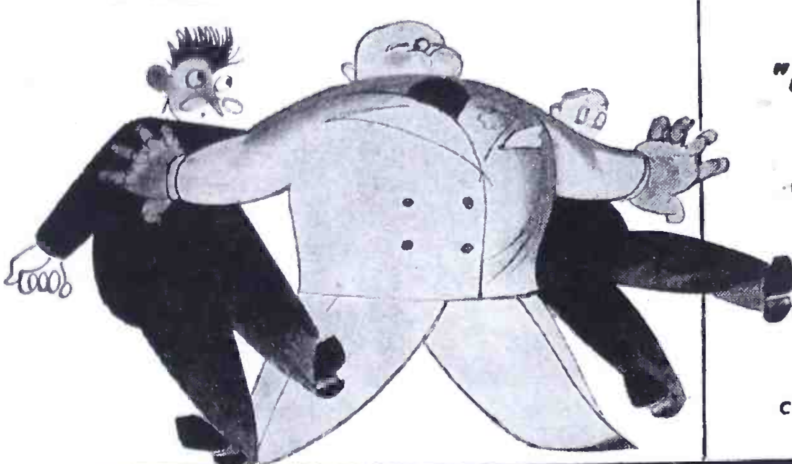
KEEPING LABOR ON LABOR'S SIDE OF THE FENCE

Ignoring successful examples of many progressive plants, some executives still choose to utilize the craftsmanship but not the wholehearted cooperation of labor. Labor appears to be non-essential around the conference table.

ONE EYE SHUT TO WORKING CONDITIONS

A healthy and contented worker is a good worker — but, unfortunately, some men close one eye to this well-established fact. Provisions for maintaining general comfort and morale on the production line are shrugged aside, and then there's wonderment if output lags.





"I'M BETTER THAN HE IS"

While boys of different colors and races and religions fight and die side-by-side, here at home there are those who practice an un-American form of discrimination. Overlooked is the actuality that harmonious relationships of all peoples can, and must, be achieved.

THERE IS NO PLACE IN THIS COUNTRY FOR SUCH ATTITUDES

At ECA, even as in your plant, we have questioned these three attitudes . . . experimented . . . eliminated them. Carrying the fundamental principles of the American dream into our organization, management and labor function as a single democratic unit. Periodic meetings have been established . . . ideas of benefit to both groups are exchanged. Here we gather suggestions for economy and efficiency. Here originate recreational facilities, group insurance and medicine plans, our extensive home front activities. Here developments are born whose value to the country have been effectively demonstrated. Here our policy of assigning jobs on the basis of merit rather than heritage is reaffirmed. *Has our plan worked?* Efficiency steadily increases and production, for example, today is six times greater than it was twelve months ago. This record gives added support to our proposition that, regardless of color or creed, to advance is the common birthright of all men . . . and that mutual cooperation between the man-in-the-front-office and the man-who-puts-things-together is not only highly desirable but highly essential.

eca

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REPRINTS OF THIS ADVERTISEMENT AVAILABLE

SHAPPE-WILKES INC.

(*Continued from page* 48)

what type of meter should be chosen. There is a wide latitude in the choice of instruments for each specific application. Meters are grouped according to two main factors; speed of response and damping. There are other factors of incidental importance, such as size, weight and cost. Speed of response is generally measured in milliseconds and refers to the rate of change in db of power with respect to change in impressed power per unit of time. In general terms, these changes are expressed as low, medium and high speed responses. The damping factor is determined by the ratio of the final steady state response to the initial angular change in response from this value. For example, if the pointer indicates 60° at 0 db, and overshoots to 70°, the damping factor $= \frac{60}{10} = 6$. Meters may be over, under, or critically damped. Those which are over damped have large circuit time constants. They allow the pointer to slowly come up to the final position without any overshoot. Under-damped meters are very light and fast with small time constants so that energy is dissipated very slowly. This type of meter gives a large overshoot and a return to a lower value than the final position. It oscillates about its final value for an appreciable period of time. The critically damped indicator allows the needle pointer to come up to the final resting point in a very short period of time without at the same time overshooting that point. Since the instrument does not have sufficient inherent damping to attain this condition, it is necessary to add a series resistance external to the unit to provide this result. Most of the meters that were used in radio broadcasting work until 1939 were approximations between the under-damped and the critically-damped types.

It may be appreciated that to obtain practical meters which will respond quickly and not overshoot, without at the same time reducing their sensitivity, is a difficult condition to achieve. It may be accomplished to a large extent by using high flux density permanent magnets and designing the shaping of the pole pieces so that the moving coil remains in the maximum possible flux; also, increasing the balancing spring torque and keeping the moment of inertia small by reducing the weight of the moving parts to a minimum.

The calibration of db meters has been a perplexing problem because of the requirements of the industry which has specified that responses should indicate peak, average, or effective (root-mean-square) values of voltage, current, or power. This manner of calibrating meters is satisfactory as long as the form of the wave is sinusoidal, but loses all meaning when attached to complex waves such as those of speech or music. Such waves are in general nonperiodic and of infinite variety in amplitude and complexity. The measurement of these waves by different observers will give as many different results as there are meters, if they have not been designed to be alike in damping and speed of response, as well as in calibration and sensitivity.

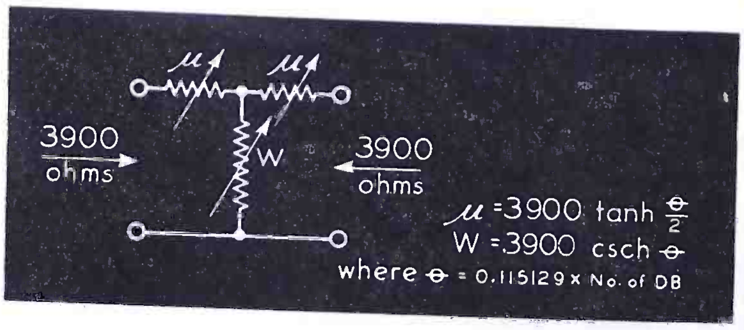
The maintenance and distribution of radio programs over large network channels have made the problem of keeping proper program levels of paramount importance to prevent overloading of amplifiers and consequent distortion that would result. With but few exceptions, all of the radio stations in the United States and its possessions are capable of being connected together at one common point. At the present time, these stations are affiliated with or are capable of being connected directly to one of the four major network systems by high quality transmission lines or radio relay links.

In 1938, through the joint activities and cooperation of representatives of the larger network companies and the Bell Telephone Laboratories, an intensive research program was evolved to develop a new type of indicator which would be suitable for everyone. It was recognized that complete agreement could not be reached upon all points of interest to each representative, but for the main part, a common ground of understanding could be reached upon which a new indicator could be developed. The attempt was not only to meet the requirements of a meter which would behave in a pre-

(*Continued on page* 76)

Figure 18

Variable attenuation but constant impedance attenuator used in connection with standard volume unit indicating meters. The range of the meter may be extended to higher levels by inserting a fixed attenuator in tandem with the variable one.



VIBRATOR-CONDENSER TYPE POWER SUPPLIES

(*Continued from page 27*)

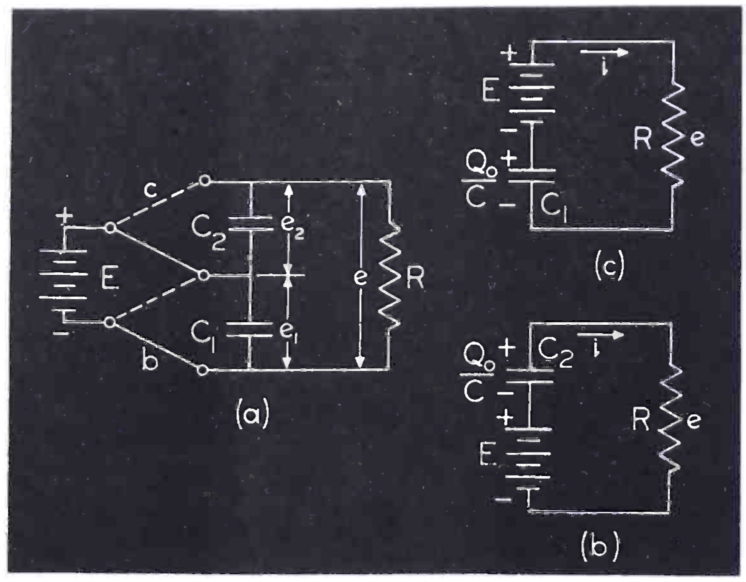


Figure 4
At *a*, the complete equivalent circuit; *b*, the equivalent circuit valid while *E* is connected to C_1; *c*, the equivalent circuit valid while *E* is connected to C_2.

total input power consumption of 5 to 10 watts.

There appears to be a field of application for this power supply in airplanes equipped with 28-volt battery systems, where it is desirable to have a high-efficiency non-critical plate supply for auxiliary radio receivers such as those used to receive Z-marker signals.

It is apparent that the vibrator-condenser direct-current power supply may also be used to efficiently step-down a d-c voltage. The circuits described in this paper are not the only possible vibrator-condenser arrangements which can be used to transform d-c voltages.

Mathematical Analysis

A mathematical analysis of the circuit of Figure 1 is readily obtained by considering the equivalent circuits shown in Figure 4. If the time of transit of the reeds from position *b* to position *c* is neglected, it is apparent that the equivalent circuit may be drawn in either of the identical forms of Figure 4b or c. It is reasonable to assume that after steady-state conditions are reached, the battery *E* charges the condensers to the potential *E* in a negligibly short interval after making contact with the condensers, since the resistance of the charging circuit is negligible as compared to the load resistance *R*.

During the entire period that the battery is connected to C_1, the potential of C_1 is *E* volts. However, C_2 was initially charged to $E = Q_0/C$ volts, and during this period C_2 will discharge exponentially through the resistance *R*. The individual instantaneous condenser voltages e_1 and e_2, and the total instantaneous voltage *e* are shown in Figure 5.

A consideration of the equivalent circuits and of Figure 5 reveals that (*1*)—the ripple frequency *F* is twice the vibrator reed frequency F_v, hence the ripple period *T* is one half the reed period T_v; (*2*)—the maximum total instantaneous voltage is obtained at the instant after the reeds make contact with a condenser, and is equal to $(E + Q_0/C) = 2E$; (*3*)—the minimum total instantaneous voltage is obtained at the instant before the reeds break contact with a particular condenser.

The following notation is used in the derivation:

- *C*, capacitance of one condenser in farads.
- *e*, instantaneous load voltage.
- *E*, input voltage.
- E_{av}, d-c load voltage.
- E_r, amplitude of the idealized ripple voltage.
- E_{r1}, amplitude of the fundamental component of the idealized ripple voltage.
- *F*, ripple frequency.

(*Continued on page 54*)

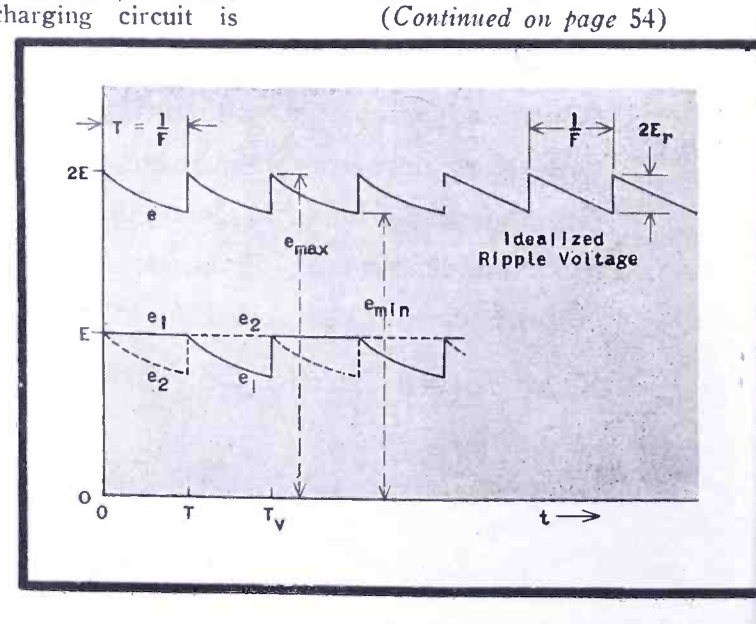
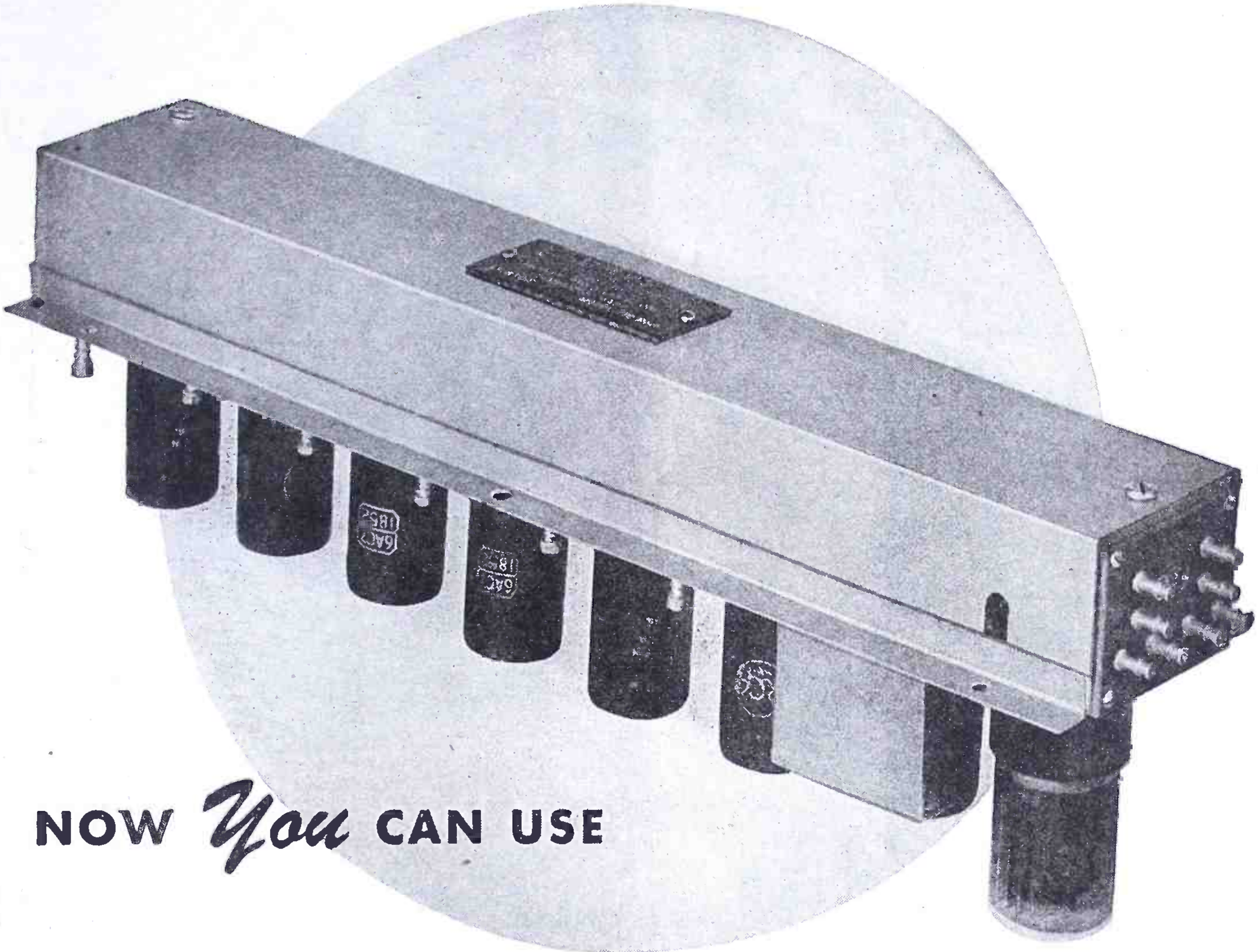


Figure 5
Instantaneous voltages in the circuit of Fig. 4*a*. Note: e_1 is the solid curve, e_2 is the dotted curve.



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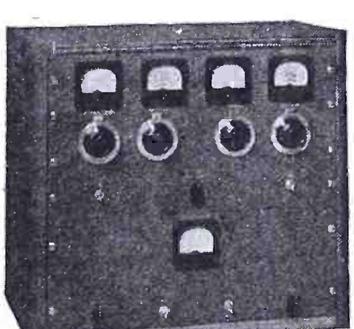

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TRANSMITTER

Compact • Dependable
Easy to Operate

A 100 WATT TRANSMITTER—TELEPHONE AND TELEGRAPH

(*Continued from page* 52)

F_v, vibrator reed frequency.
I, d-c load current.
M = FRC, a constant
Q_o = CE, initial condenser charge under steady-state conditions.
R, load resistance in ohms.

The Kirschoff law equation for the circuit of Figure 6b or 6c is

$$iR + \frac{1}{C}\int_0^t i\,dt = E + Q_o/C \qquad (1)$$

Differentiate *1* with respect to *t* and separate the variables

$$di/i = -dt/RC \qquad (2)$$

Integrate *2*

$$\ln i = -t/RC + K \qquad (3)$$

The constant of integration *K* is evaluated by noting in *1* that when t = 0, the integral of the current is zero, and

$$i_o = (E + Q_o/C)/R \qquad (4)$$

which upon substitution in *3*, gives

$$K = \ln (E + Q_o/C)/R \qquad (5)$$

Therefore,

$$\ln i = -t/RC + \ln (E + Q_o/C)/R \qquad (6)$$

which can be written as

$$i = \frac{(E + Q_o/C)}{R}\,\epsilon^{-t/RC} \qquad (7)$$

Since $Q_o/C = E$, and $e = iR$, the instantaneous load voltage from t = 0 to t = T is

$$e = 2E\,\epsilon^{-t/RC} \qquad (8)$$

When t = 0,

$$e = e_{max} = 2E \qquad (9)$$

and when t = T,

$$e = e_{min} = 2E\,\epsilon^{-T/RC} = 2E\,\epsilon^{-1/FRC} \qquad (10)$$

The d-c, or average, load voltage is

$$E_{av} = \frac{1}{T}\int_0^{T=1/F} 2E\epsilon^{-t/RC}dt$$

$$= 2EFRC\,(1 - \epsilon^{-1/FRC}) \qquad (11)$$

The ripple amplitude E_r is calculated with reasonable accuracy by assuming that the total instantaneous voltage *e* of Figure 7 is an ideal saw-tooth voltage of the form shown at the right of the figure. Then

$$E_r = (e_{max} - e_{min})/2 \qquad (12)$$

and upon substituting *9* and *10* in *12*

$$E_r = E\,(1 - \epsilon^{-1/FRC}) \qquad (13)$$

The effective value of a triangular wave is obtained by dividing the amplitude of the wave by $\sqrt{3}$; therefore from *11* and *13* the ratio of the total effective ripple voltage to the average voltage is

$$\frac{E_{r\,effective}}{E_{av}} = \frac{1}{2\sqrt{3}\ FRC} = \frac{1}{2\sqrt{3}\ M} \qquad (14)$$

where M = FRC.

A Fourier analysis of the assumed ideal saw-tooth wave gives

$$e = E_{av} + E_r\frac{2}{\pi}\left(\sin x + \frac{1}{2}\sin 2x + \frac{1}{3}\sin 3x + \ldots\ldots\right) \qquad (15)$$

where $x = 2\pi Ft$.

It is evident from *15* that the amplitude of the fundamental component of the ripple voltage is

$$E_{r1} = \frac{2}{\pi}E_r \qquad (16)$$

The ratio of the amplitude of the fundamental component of the ripple voltage to the average voltage is obtained from *11*, *13* and *16*.

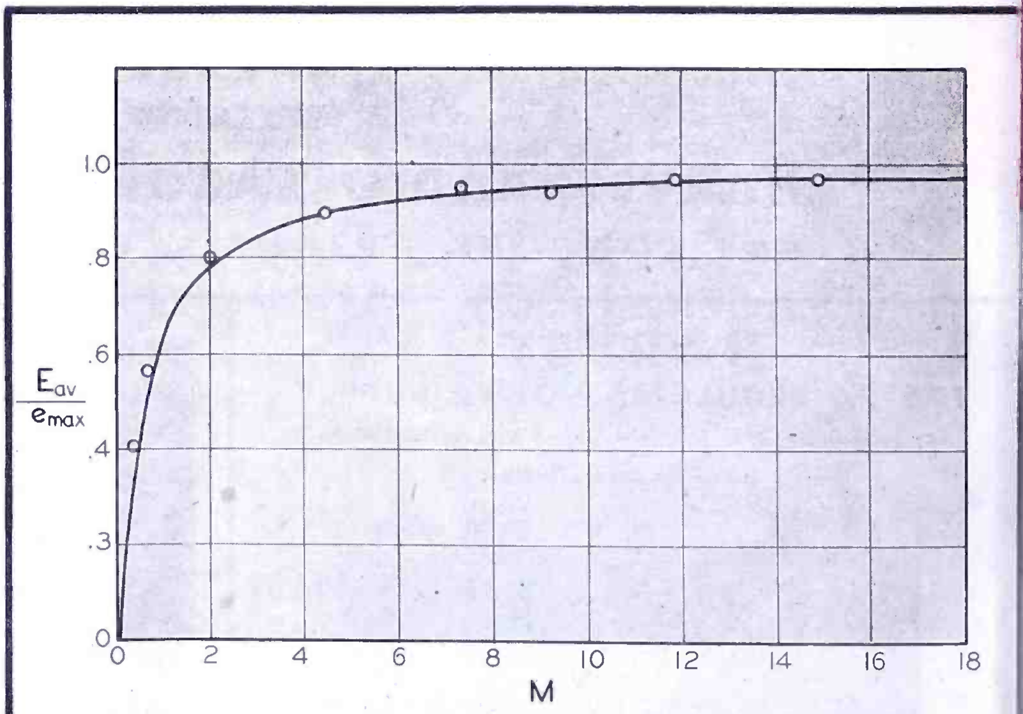
$$\frac{E_{r1}}{E_{av}} = \frac{1}{\pi FRC} = \frac{1}{\pi M} \qquad (17)$$

The performance of the voltage doubler

(*Continued on page* 64)

Figure 6

The ratio of the average output voltage to the maximum output voltage as a function of M = FRC. The circles are experimental values.



NEWS BRIEFS OF THE MONTH . . .

EPEI CONFERENCE IN CHICAGO OCTOBER 6-9

The annual meeting of the Electronic Parts and Equipment Industry will be held at the Edgewater Beach Hotel, Chicago, October 6 to 9. Among the groups that will attend are Sales Managers Club (eastern group), Association of Electronic Parts & Equipment Manufacturers (western group), the Representatives Club, and the National Electronic Distributor Association.

Herb Clough of Belden Manufacturing Company has been elected chairman of the conference. On the conference committee are: Robert P. Almy of Sylvania, Charles Golenpaul of Aerovox, Harry Kalker of Sprague, Roy S. Laird of Ohmite, A. E. Schaar of Talk-a-phone Manufacturing Company, Jack Berman of Shure Bros., A. H. Petersen of Amphenol, A. E. Akeroyd of Raytheon Products, and Jesse Fishel of the Federal Manufacturing Company.

* * *

WESTINGHOUSE APPLIES FOR 3 TELEVISION LICENSES

Application for licenses for three television stations have been filed with the FCC by Westinghouse Radio Stations Inc., Pittsburgh. The proposed television stations will entail construction of new studios, transmitters, and other facilities as additions to three of the company's standard broadcast outlets, KYW in Philadelphia, KDKA, Pittsburgh, and WBZ, Boston.

Franklin P. Nelson, director of Westinghouse's television and short-wave broadcasting activities, will supervise installation of the new television stations when the FCC grants licenses and materials are available.

* * *

R. P. GLOVER OPENS CONSULTANT OFFICE

Ralph P. Glover, formerly in charge of engineering-sales coordination and acting manager of the voltage regulator division of Webster Products Company, Chicago, has established a consulting engineering practice with offices at 1024 Superior Street, Oak Park, Illinois.

Mr. Glover will specialize in product development and product management counsel in the electronic, electroacoustic and radio fields.

CBS OUTLINES POSTWAR TELEVISION POLICY

A policy decision on postwar television, announced recently by the Columbia Broadcasting System, advocated earliest possible support of known opportunities for improvement in television, even at the cost of sacrificing prewar investments.

Continued production of prewar television sets, stated the report, will create a huge public loss when the improved standards now being tested are proved more feasible. Use of higher frequencies, wider bands, increased number of lines and color was also projected in the report.

* * *

C. B. DE MILLE AND BAMBERGER JOIN TBA

Cecil B. DeMille Productions, Inc. and the Bamberger Broadcasting Service were admitted recently to the Television Broadcasters Association, Inc., 500 Fifth Avenue, New York City.

These additions to TBA bring the membership up to twenty-two.

* * *

SYLVANIA MAY BUY COLONIAL RADIO

Sylvania Electric Products, Inc., Emporium, Pennsylvania, has begun negotiations for the purchase of the capital stock of Colonial Radio Corporation, Buffalo, New York.

* * *

RCA STATION IN ITALY COVERS WAR NEWS

The first American wholly-owned commercial radio station on the continent of Europe, an RCA station, installed with the cooperation of the U. S. War Department, began transmission of news copy to the United States recently, and today is flashing spot news accounts at a rate of 240 words a minute. Thomas D. Meola, who directed the building of the station, heads a staff of eighteen.

* * *

JOHN M. SMITH JOINS MALLORY

John M. Smith has joined P. R. Mallory & Co., Inc., Indianapolis, Indiana, as vice president in charge of manufacturing. Mr. Smith, was formerly general manager of manufacturing for RCA Victor division.

NATIONAL ELECTRONIC CONFERENCE IN FALL

The first annual National Electronics Conference will be held on October 5 to 7, 1944, at the Medinah Club of Chicago, 505 North Michigan Avenue, Chicago, Il. The conference, sponsored jointly by the Illinois Institute of Technology, Northwestern University, and the Chicago Sections of the IRE and AIEE, will provide a national forum for electronic developments and their engineering applications.

Technical papers planned will include discussions of the communication, industrial, measurement, instrumentation, control, scientific, and medical applications of electronics. Papers for presentation at the Conference may be submitted for approval to Professor A. B. Bronwell, chairman of the Program Committee, Technological Institute, Northwestern University, Evanston, Illinois; or to Beverly Dudley, secretary, National Electronics Conference, 520 North Michigan Avenue, Chicago.

* * *

ARNSON ADDRESSES IMSA MEETING

Ludwig Arnson, president of Radio Receptor Company Inc., addressed a meeting recently of the New Jersey and south New York sections of the International Municipal Signal Association at the Hotel Pennsylvania in New York. Mr. Arnson's talk stressed the immediate study of airport traffic control in all its branches. He declared that the operation of airports will be an important municipal function in the coming air age.

* * *

YOUNG AND SWOPE REELECTED BY G. E.

For the twenty-first time, Owen D. Young has been elected chairman of the G.E. board, and Gerard Swope has been elected president of G.E.

* * *

SPRAGUE SPECIALTIES CHANGES NAME

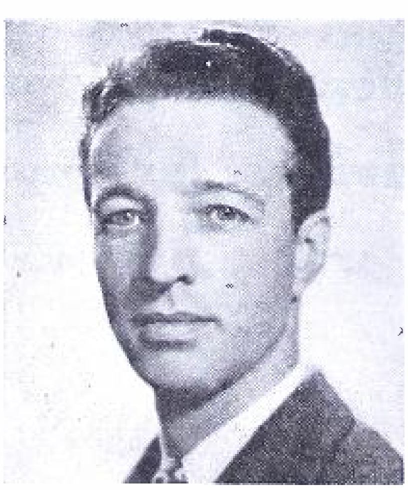
The Sprague Specialties Company of North Adams, Massachusetts, will hereafter be known as the Sprague Electric Company. There is no change in company policies, ownership, or management.

* * *

RAYMOND BIERMAN NOW WITH PERMOFLUX

Raymond C. Bierman, formerly studio field engineer for the NBC Blue network and previously with WLW, has been

(*Continued on page* 65)



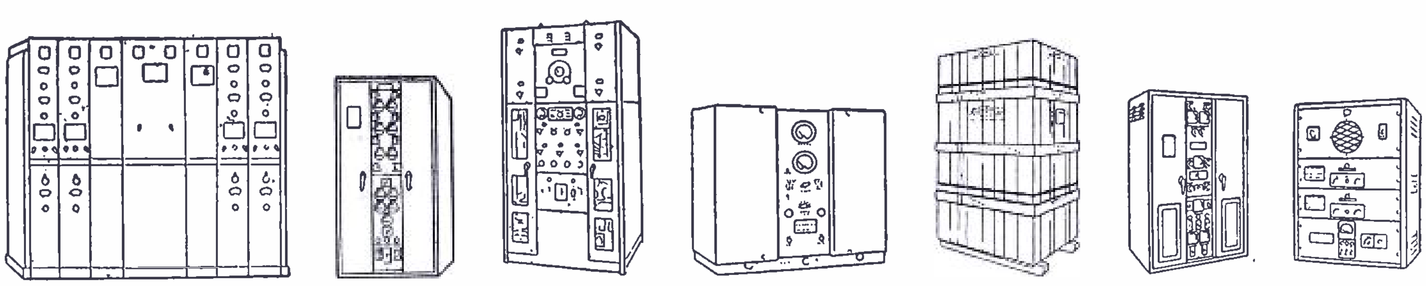
R. P. Glover

John M. Smith

Raymond Bierman

"Although as a rule GROUND FACILITIES receive little public attention, they provide the FOUNDATION upon which ALL AVIATION MUST BE BUILT. The sound growth of domestic air transport and, above all, private flying will require a considerable expansion of our system of airports and further IMPROVEMENTS of RADIO AIDS TO NAVIGATION and systems of TRAFFIC CONTROL."

WILLIAM A. M. BURDEN
Assistant Secretary of Commerce



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BOOK TALK . . . —

1944 PLASTICS CATALOG

Compiled by Dr. Gordon M. Kline, Dorothy Martin, Frederick B. Stanley, R. L. Van Boskirk, Harriet B. Josephs, Louise E. Boyden, and Shirley G. Smarr . . . 990 pp. . . . New York: Plastics Catalogue Corporation . . . $6.00.

This latest edition represents another outstanding contribution to plastics literature.

Approximately one hundred and fifty articles are contained in the twelve main sections of the book, under the headings *plastics in war, tests and specifications, materials, engineering and molding, fabricating, finishing and assembly, machinery and equipment, laminates, plywood and vulcanized fibre, coatings, synthetic fibers, synthetic rubber and rubber-like plastics.*

Eight charts provide quick reference to the key topics, including *plastics identification, plastics properties, chemical formulae of plastics resins and synthetic rubbers, solvents, plasticizers, plastics used in liquid coatings, properties of synthetic rubber,* and a flow-sheet form chart of *plastics-materials manufacture.*

A directory and cross-index sections detail plant and personnel information of plastics manufacturers, a complete glossary of commonly used terms, bibliography, and a list of educational institutions sponsoring plastics courses. —*JML*

•

FUNDAMENTAL RADIO EXPERIMENTS

By Robert C. Higgy, Assistant Professor, Department of Electrical Engineering, Ohio State University . . . 96 pp. . . . New York: John Wiley & Sons, Inc. . . . $1.50.

A description of thirty-two basic experiments in electricity, electronics and radio, including the principles involved and the laboratory procedures used, appears in this laboratory manual. The book is not intended as a complete text-book, and reference to a standard text is recommended to supplement the suggested experiments.

Among the experiments analyzed are: fundamental relations of direct-current circuit; the Wheatstone bridge; reactance of inductances and condensers; series and parallel a-c circuits; study of a-c waves with the cathode-ray oscilloscope; series and parallel resonance at low frequencies; tuned air-core transformers at r-f; characteristics of a triode; amplification factor, plate resistance and transconductance of a triode; characteristics of pentode tubes; gain and frequency response of audio amplifiers; r-f oscillators; operation of sweep circuits; public address systems — the decibel; class *A* amplifiers; class *C* amplifier characteristics; modulation; detectors; r-f transmission lines; h-f resistance measurements; u-h-f transmission lines; frequency measurements; measurement of inductance and capacitance; and vacuum-tube voltmeter.

The introduction covers the use of essential measuring instruments and equipment and construction of laboratory apparatus. Appearing too are circuit diagrams of a r-f oscillator, a-f oscillator, 100-kc oscillator and 10-kc multivibrator, and a vacuum-tube voltmeter.—*JML*

•

A PRIMER OF ELECTRONICS

By Don P. Caverly, commercial engineer, Sylvania Electric Products Inc. . . . 236 pp. . . . New York: McGraw-Hill Book Company, Inc. . . . $2.00.

A simplified analysis of electronics and electronic tubes and circuits appears in this timely volume.

The book opens with a non-technical discussion of the atom, the electron, and static and electron discharges; followed by an explanation of electric current, magnetism, and electromagnetic radiation. The author also discusses in an exceptionally lucid way the operation of radio tubes, fluorescent lamps, cathode-ray tubes, ignitron, and other tubes and their basic connections. Some two hundred illustrations appear in the book.—*JML*

•

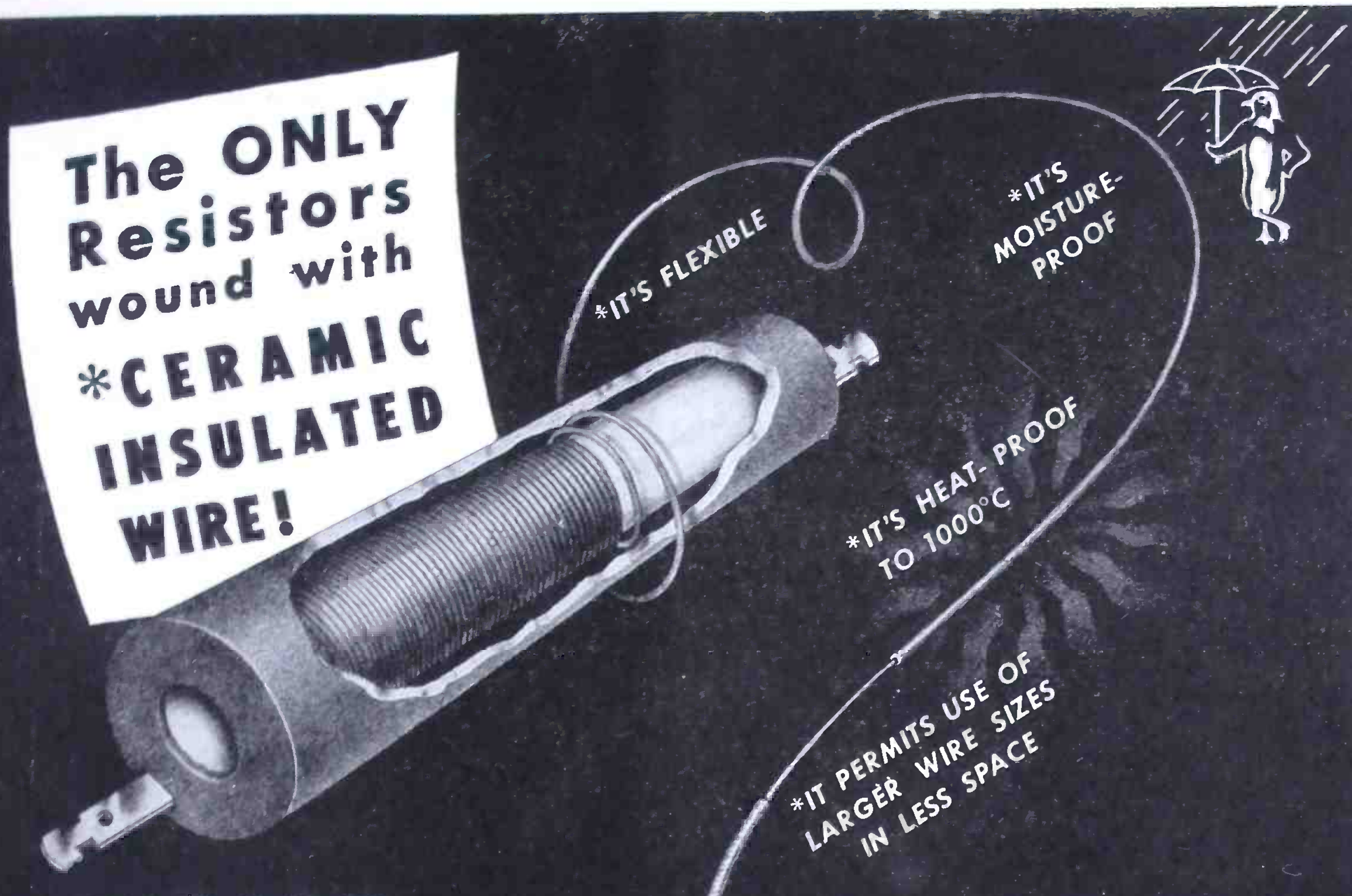
ELECTRON-OPTICS

By Dr. Paul Hatschek: translated by Arthur Palme . . . 162 pp. . . . Boston: American Photographic Publishing Company . . . $3.00.

Another text on the fundamentals of electronics, presented without mathematics, and well illustrated. Translated from Dr. Hatschek's manuscript, which was written eight years ago, the book presents a broad background of electron-optics from its inception.

Chapters cover a fundamental treatment of electricity flowing in a vacuum; elementary and applied optics; television, recording and amplifying tubes; evolution of bullseye lens to the biconvex lens; electron, light-controlled, and voltage-controlled multipliers.

Translator Palme closes the book with a chapter on modern electron-optic developments, such as the electron microscope.—*JML*



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The outstanding superiority of Sprague Koolohm Resistors in practically every important characteristic could—and did—result only from an entirely different engineering approach to basic problems—from the wire up. Research proved that the resistor was no better than the insulation on the wire. Koolohm ceramic insulation applied to resistance wire permitted such valuable engineering features that, in less than four years, these resistors have set higher standards of performance on hundreds of the most exacting applications. Standard units include 5- to 150-watt power types, bobbin types and meter multipliers. Write for Catalog—today!

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UNWIELDY SIZE
REDUCED WATTAGES
CHANGED VALUES
HIGH AMBIENTS
MOUNTINGS
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...and many more!

SPRAGUE KOOLOHM RESISTORS

THE INDUSTRY OFFERS . . .

DAVEN ATTENUATORS

Attenuators, featuring a new detent gear and new type steel cover, have been announced by the Daven Company, 191 Central Avenue, Newark 4, New Jersey.

The detent gear is said to provide more positive action. Contacts and switches of these attenuators are made of tarnish-proof silver alloy.

The steel cover is said to provide improved magnetic shielding. The body of the cover forms an integral part of the attenuator assembly, protecting the resistors. A snap-on cap affords ready access to switch blades and contacts.

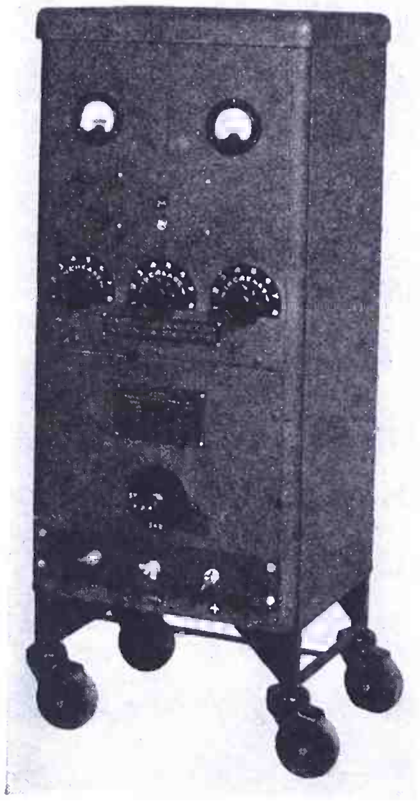
* * *

MALLORY PORTABLE D-C POWER SUPPLY

A portable d-c power supply, for use where 12 or 24-volt systems are required has been developed at P. R. Mallory and Company, Inc., Indianapolis, Indiana.

The unit is designed to operate from 3-phase a-c lines of 208 and 230 volts. Three models are offered: VA1500, with d-c output of 10 to 16 volts at 100 amperes or 20 to 32 volts at 50 amperes; VA3000, with d-c output of 10 to 16 volts at 200 amperes or 20 to 32 volts at 100 amperes; VA4500, with d-c output of 10 to 16 volts at 300 amperes or 20 to 32 volts at 150 amperes. Models with similar d-c output but for operation on 460 volts a-c, are also available.

Rectification is provided by Mallory magnesium-copper sulphide dry-disc rectifiers.



* * *

BATTERY HOLD-DOWN CLAMP

A battery hold-down clamp with cam action that replaces the two wing nuts on the battery and eliminates safety wiring has been developed by The Paul Henry Company, 2037 South La Cienega Boulevard, Los Angeles 34, California.

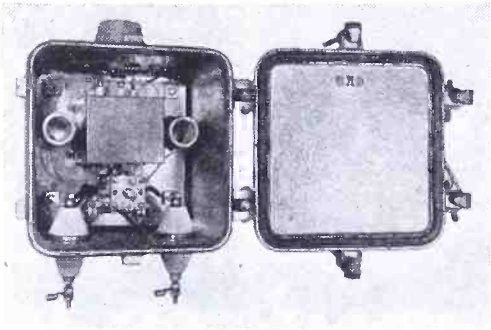
The clamp is obtainable with various nut sizes, and screws into present battery boxes. The cam lever can be released manually.

ANDREW RHOMBIC ANTENNA TRANSFORMER

An antenna transformer unit for coupling an unbalanced 70-ohm coaxial cable transmission line to the 700-ohm terminals of a rhombic receiving antenna (or to any antenna terminal stub of 700-ohm impedance), has been produced by the Andrew Company, 363 East 75 Street, Chicago, Ill. Losses are said to be held down to less than 1 db over a frequency range of from 4 to 22 megacycles.

The transformer unit is designed for out-of-doors installation as close to the antenna terminals as possible. Housed entirely within a weather-proof cabinet with a water-tight cover.

Circuit design of the transformer unit is said to afford d-c continuity checking throughout the whole length of the antenna from the coaxial cable input terminal position, facilitating antenna inspection and maintenance. Unit features close coupling and powdered iron transformer cores of high permeability.



* * *

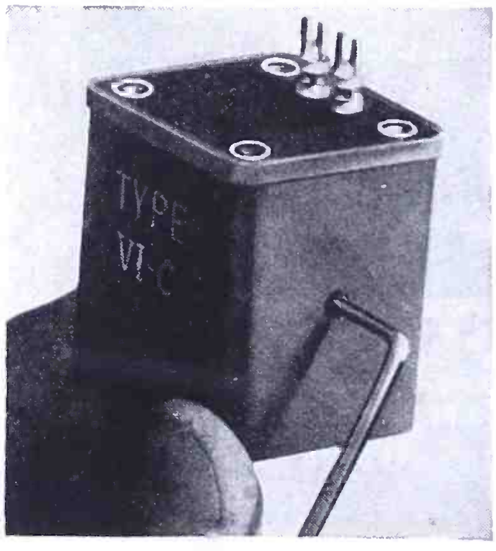
UTC VARIABLE INDUCTOR

Variable inductors with inductance values ranging from 10 microhenrys to 10 henrys, for peaked amplifiers, filters, etc., are now being made by United Transformer Company, 150 Varick Street, New York 13. Units are sealed. Measures 1¼" x 1 7/16" x 1 7/16".

Inductors are said to have a wide range in inductance variations.

Housed in a die cast case; weighs approximately 5 ounces. Inductance is varied by means of an 8/32 set screw located in one of the sides, which may be turned by an Allen set screw wrench. Where remote and frequent adjustment is desired, this screw can be replaced by a threaded rod to which a knob may be attached.

Nineteen standard types are available.



* * *

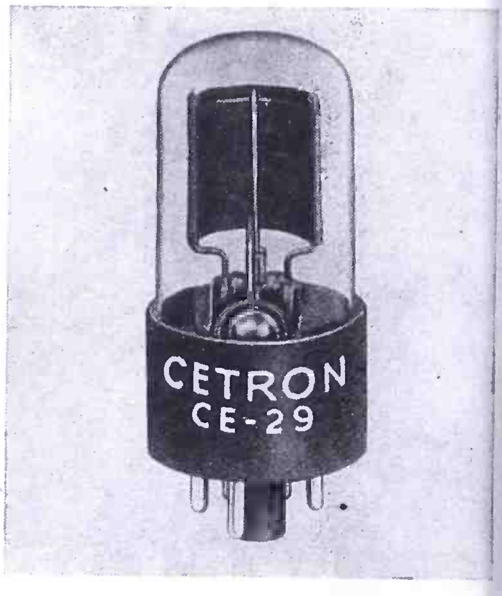
UNGAR ELECTRIC SOLDERING PENCIL

A soldering pencil 7" long and weighing 3.6 ounces is now available from Harry A. Ungar, Inc., 615 Ducommun St., Los Angeles 12, California. The pencil is said to heat in 90 seconds and draw 17 watts.

CE-29 PHOTOTUBE

A blue sensitive phototube using an octal five-pin base, interchangeable with other similar tubes has been developed by Continental Electric Company, Geneva, Illinois.

The CE-29 is particularly sensitive to blue and violet light near the short wavelength limit of visibility. It is, therefore, particularly useful with light sources rich in violet, blue, and green light. RMA spectral sensitivity designation is S-4.



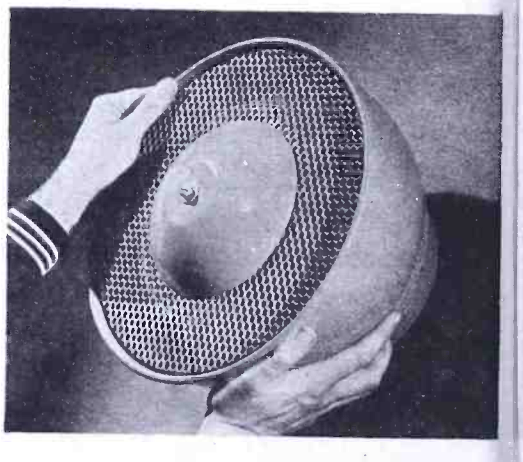
* * *

W. E. MARINE SPEAKER

A high powered speaker for heavy duty marine use, designed by Bell Telephone Laboratories, is now being produced by Western Electric Company, 195 Broadway, New York 7, N. Y.

The speaker has an outside diameter of 12½" and weighs approximately 25 pounds. The unit is composed of three principal sections: the base, which provides space for a transformer, and a terminal strip, and provisions for the lead-in cable; the horn, which is of the folded exponential type; and the magnetic unit which is fitted with a two-piece permanent magnet, and diaphragm. The loudspeaker is constructed principally from formed sheet steel and moulded plastic.

The voice coil impedance of the unit is approximately 7.5 ohms. The speaker develops a pressure of 50 dynes per square centimeter when operated at the rated electrical input and measured at 10' from the speaker on the sound axis in open air.



* * *

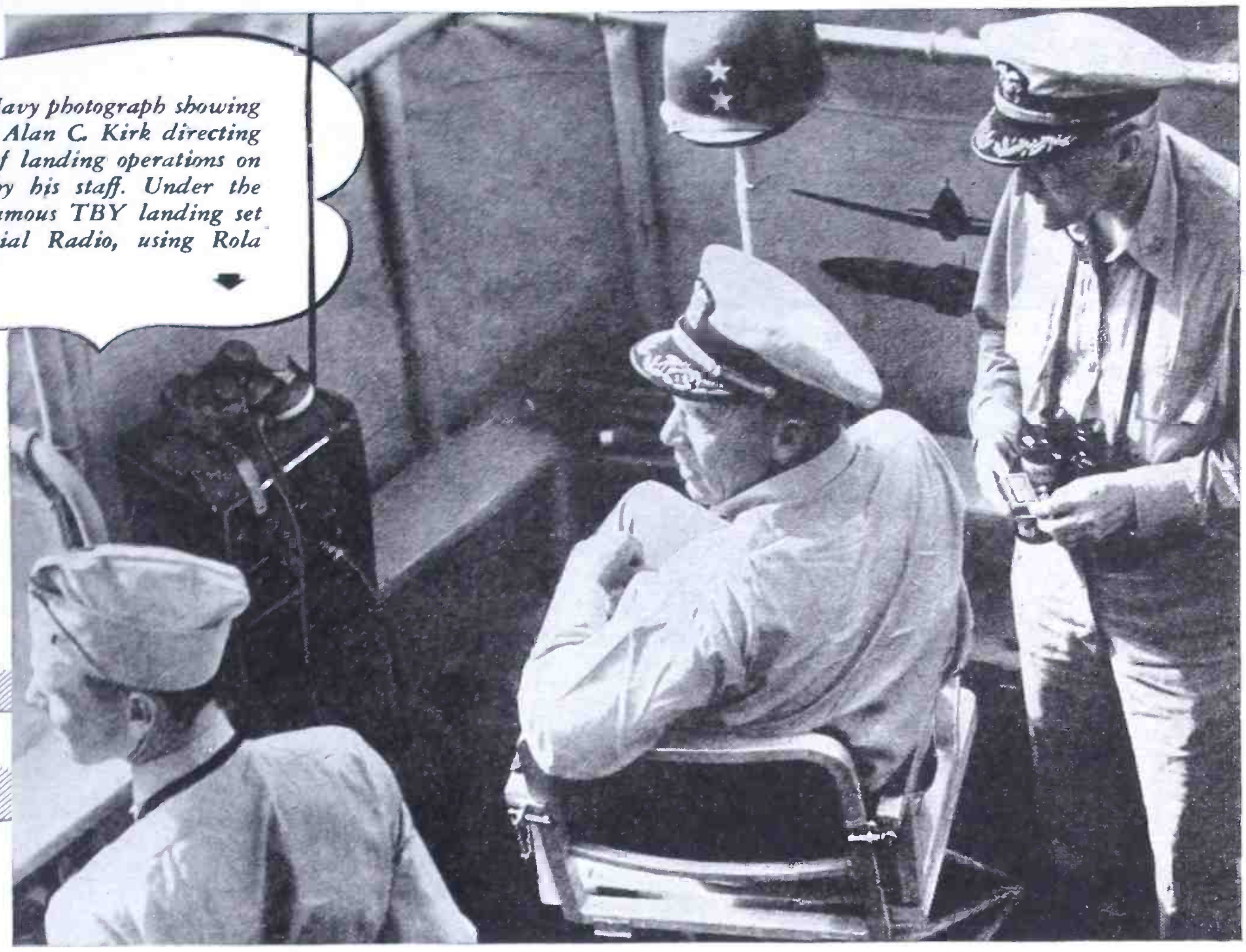
M-W LACQUER

A lacquer that is said to be moisture-resistant, have high dielectric strength, and retard the growth of fungi has been announced by Maas and Waldstein Company, 438 Riverside Avenue, Newark, New Jersey.

The new lacquer is marketed as Dulac Fungus-Resistant Lacquer No. 86, and is said

(Continued on page 72)

Official U. S. Navy photograph showing Rear Admiral Alan C. Kirk directing Naval phases of landing operations on Sicily, aided by his staff. Under the arrow is the famous TBY landing set built by Colonial Radio, using Rola Transformers.



"Design for Invasion"

MONTHS ahead of landing operations the military plans are laid, and often . . . months ahead of that . . . new equipment to serve some new and vital purpose has to be designed and built.

We're now in the invasion phase of the war and with so much staked on the *availability* and *dependability* of Communications, the makers of this equipment have been asked again to increase their output.

The Electronic Industry has done a good job. Now, it must do a *better* one and Rola will contribute to the full extent of its facilities, its knowledge and its ability.

THE ROLA COMPANY, INC., 2530 SUPERIOR AVENUE, CLEVELAND 14, OHIO

ROLA

Let's do more ARMY E NAVY *in forty-four!*

MAKERS OF THE FINEST IN SOUND REPRODUCING AND ELECTRONIC EQUIPMENT

At the 77th Division Club meeting in New York City on April 27.

A GRAND letter recently came in from Captain Carl F. Holden, formerly Director of Naval Communications and now *skipper* of one of our newest battleships in the Pacific area. He wrote in part: "Our mail has been a bit behind us, as we have been traveling with seven-league boots lately, as you have no doubt read in the papers. We hope that you all like the news we are sending back and also hope that we can continue to send back more good news. It is very nice to feel that one's friends back home are thinking of them." We will be glad to furnish Captain Holden's address to our members who desire to drop him a note. In the meantime, good luck and Godspeed to a real fighting skipper. . . . 'Bill' Simon is on an extended trip through the South inspecting Tropical Radio facilities. . . . So if your membership card is a bit late in arriving, you'll know why. . . . J. F. De Bardeleben has arrived in this country after an extended absence. He is now stationed at Kingsville, Texas. . . . Glad to hear from Mark MacAdam of the Boston chapter, one of the earliest of *Down East* pioneers. . . . Lt. Cmdr. E. W. Lovejoy, for some years stationed at the Brooklyn Navy Yard, was recently given a Pacific coast assignment. Cmdr. Lovejoy is a real veteran having been employed as wireless operator with the old Wireless Telegraph Company in 1910.

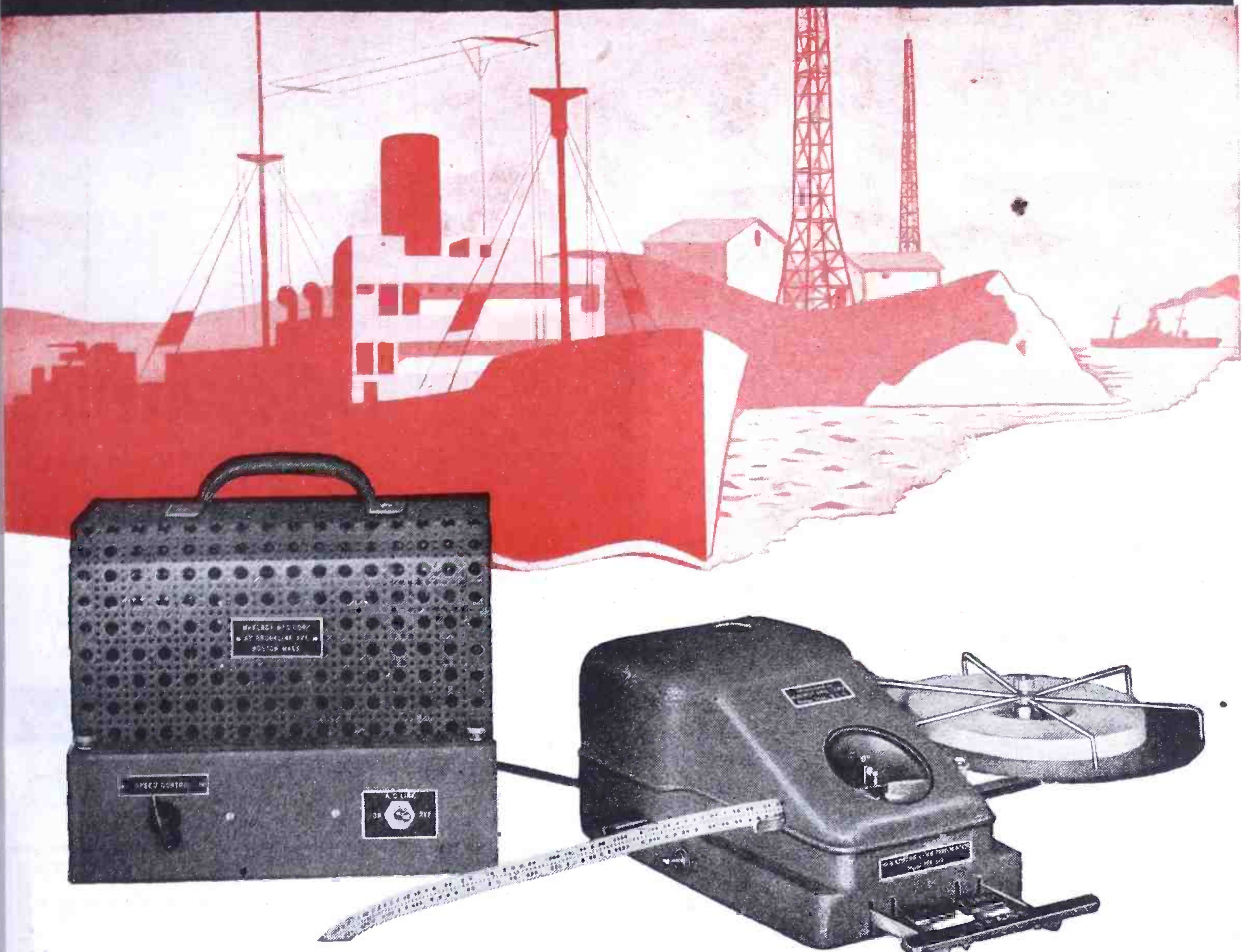
GEORGE CLARK did a splendid job at the recent 77th Division Club get-together on April 27th. His description of the code speed artists before *MC* (McElroy in this case) and the scientific explanation of the operation of the vacuum tubes which preceded the comparatively simple De Forest invention (he termed the early ones Egyptrons) was superb. Congratulations, George, and many thanks for a swell evening. . . . Present at the 77th on the 27th were five members of the Radio Committee of the Merchant Marine Institute: Schliting, Cornell, Medford, Huston and Simon, each of whom represented a large steamship organization. . . . Ludwig Arnson told some grand stories of the pioneer days. . . . Lt. Cmdr. D. McWhorter, one of the first of the radio personnel of the United States Navy, spent a good portion of the evening reminiscing with C. D. Guthrie another Navy radio pioneer. . . . J. K. Keers, who designed our Association pin, was present after a long absence. George Duvall, president of the Television Technicians Association, was also around. . . . 'Bill' Stedman always manages to come to our meetings despite the fact that he is not completely recovered from a very serious accident. . . . R. J. Iverson of the radio staff of the *New York Times*, who did such creditable work with both Byrd Expeditions, was a welcome guest. . . . Ben Beckerman, pioneer of pioneers, told some very interesting and amusing stories. . . . Others present were Roscoe Kent, now with the Gemex Company on important War work; Peter Podell, our founder, now back in the automobile business in the Bronx; Sam Schneider, one of our first treasurers; H. H. Parker, who did such a splendid job as secretary for many years; Wm. C. Simon, treasurer and executive secretary; William J. McGonigle, president; A. J. Costigan, vice president; George H. Clark, secretary; George Mathers, George Davis, and R. H. Pheysey of Tropical Radio; and Henry T. Hayden, Mr. Pearson, and Mr. Wunderlich of Ward Leonard.

In Memoriam

William S. Fitzpatrick, one of the

(*Continued on page* 81)

For every ship and marine station!



NEW, IMPROVED McELROY ELECTRONIC
CODE TAPE PERFORATOR PFR - 443 - A

For High Speed Radiotelegraph Transmission

SHIP-to-SHIP
SHIP-to-SHORE
POINT-to-POINT

Entirely mechanical the PFR - 443 - A not only improves the efficiency of transmission but confines human error to minimum. Comprising two units—the Keying device and Electronic mechanism—this Perforator can be operated by anyone with a basic knowledge of dots and dashes. Those with experience can easily maintain an accurate speed of more than 40 words per minute in all Morse combinations assigned to the Russian, Turkish, Arabic, Greek and Japanese alphabets and languages. Sending is automatic . . . tapes are clean and precise. Time, expense, and even lives, may be saved. The PFR-443-A has aroused more than usual enthusiasm. May we send complete details?

ARMY E NAVY

McElroy MANUFACTURING CORPORATION
82 BROOKLINE AVENUE
BOSTON, MASS.

WE CREATE...DESIGN...BUILD...WE ARE NEVER SATISFIED WITH MEDIOCRITY

KEEP IT UP...BUY MORE AND MORE WAR BONDS

VIBRATOR-CONDENSER P-S

(*Continued from page* 54)

is conveniently expressed in a normalized form by dividing *11* by *9* and letting M = FRC; then

$$\frac{E_{av}}{e_{max}} = M\,(1 - \epsilon^{-1/M}) \qquad (18)$$

It is apparent that the factor *M* determines the performance of the voltage doubler. (Using the vibrator reed frequency, the factor $M = 2F_vRC$.)

The d-c load current is

$$I = E_{av}/R = \frac{2EM}{R}\,(1 - \epsilon^{-1/M}) \qquad (19)$$

Equation *14* expressed as a percentage is the per cent ripple. Equation *17* plus an acquaintance with *15*, however, reveals more pertinent information about the ripple to be expected at the output of the doubler. Calculated and measured values of ripple voltage are in close agreement for values of *M* greater than 5.

Output Voltage Drop

Equation *18* is plotted in Figure 6 as a function of *M*. It is seen that the output voltage drops to 90% of the no-load value, if *M* is approximately equal to 5. Figure 5 is of assistance in the rapid choice of the approximate value of capacitance to use in a voltage doubler to deliver a particular output voltage at a specified current.

Improving Regulation

In a particular application, *F* is fixed by the vibrator design, and $R = E_{av}/I$ is determined by the required load current. Improved regulation is, therefore, obtained solely by increasing the capacitance of the condensers. Figure 6 shows that only a 5% gain in output voltage is secured by increasing *M* from 5 to 10.

Analysis of Figure 2

The mathematical analyses of the voltage multipliers of Figure 2 are similar, although somewhat more involved, than the above analysis.

It is hoped that this paper will stimulate some interest in the vibrator-multiplier, as it is a reliable and efficient device, though admittedly limited in its field of application.

NEWS BRIEFS

(*Continued from page* 56)

appointed chief engineer of the Permoflux Company, Chicago.

* * *

WPB AMENDS RADIO AND RADAR M-293

The radio and radar table of Order M-293, Table 9, has been revised to include some electronic equipment items which were listed as *undesignated products.*

Limitation Order L-203, governing electrical indicating instruments, has also been revoked because provisions for placing, accepting and filling orders for these instruments have been included in the table of Order M-293.

A fourth column has been added in the amended Table 9 to specify the period for which a manufacturer's shipping schedule is frozen.

Vacuum tube production machinery has been added to the Table 9 list as an *X* product, which requires that the manufacturer must submit an operational report and order board to WPB. A frozen period of three months on shipping schedules is listed.

Industrial and mechanical instruments are listed in the revised table in detail as undesignated products, with a four-month frozen period for shipping schedules.

Transformers, electronic vibropacks and vibrators, microphones and loudspeakers, and radio and radar switches are now listed as undesignated products, with a two-month frozen period.

* * *

EIMAC BOOKLET ON ELECTRONIC TELESIS

A 64-page illustrated booklet entitled *Electronic Telesis* covering the evolution of electronics and its prewar, present and postwar applications, has been published by Eitel-McCullough Inc., San Bruno, California.

* * *

WEST COAST EMA OFFICERS ELECTED

H. L. Hoffman, president of Hoffman Radio Corporation, Los Angeles, was elected president of the West Coast Electronic Manufacturers Association, at a meeting recently of the executive council of the southern and northern California areas. Other permanent officers appointed include Jack Kaufman, vice president, Herb Becker, secretary, and Howard Thomas, treasurer.

Some forty-five electronic manufacturers are represented in the WCEMA.

Executive Committee and Officers of West Coast Electronic Manufacturers Association. Top row, left to right: Lew Howard, Peerless Electrical Products Co.; E. Danielson, Remler Co., Ltd.; Leslie Howell, Gilfillan Bros., Inc.; James L. Fouch, Universal Microphone Company; Clayton Bane, Technical Radio Co.; and E. P. Gertsch, Air Associates, Inc.. Botton row, left to right: Herb Becker, Eitel-McCullough, Inc.; H. L. Hoffman, Hoffman Radio Corporation; Jack Kaufman, Heintz and Kaufman, Ltd.; and Howard Thomas, Packard-Bell Co.

* * *

JEFFERSON BALLASTS CATALOG

A 12-page catalog on ballasts for fluores-

(*Continued from page* 67)

WHEN YOU CHECK UP ON YOUR PLANT'S PAY-ROLL SAVINGS PLAN FIGURES!

These days, things change with astonishing speed. The Pay-Roll Savings Plan set-up that appeared to be an outstanding job a short time ago, may be less than satisfactory today.

How about checking up on the situation in *your* plant? Checking up to see if everybody is playing his, or her, part to the full measure of his, or her, ability. Checking up to see if 'multiple-salary-families' are setting correspondingly multiple-savings records.

A number of other groups may need attention. For example, workers who have come in since your plant's last concerted bond effort. Or, those who have been advanced in position and pay, but who may not have advanced their bond buying accordingly. Or even those few who have never taken part in the plan at all. A little planned selling may step contributions up materially.

But your job isn't finished, even when you've jacked participation in your Pay-Roll Savings Plan up to the very top. You've still got a job before you—and a big one! It's the task of educating your workers to the necessity of not only buying bonds, but of *holding* them. Of teaching your people that a bond sold before full maturity is a bond robbed of its chance to return its full value to its owner—or to his country!

So won't you start *checking* . . . and *teaching* . . . today?

War Bonds To Have And To Hold!

LET'S ALL BACK THE ATTACK— WITH WAR BONDS!

The Treasury Department acknowledges with appreciation the publication of this message by

COMMUNICATIONS

This is an official U. S. Treasury advertisement—prepared under auspices of Treasury Department and War Advertising Council

NEWS BRIEFS

(*Continued from page* 65)

ent lamps has been released by Jefferson Electric Company, Bellwood, Illinois. Data and dimension charts covering sin-le, two-, three-, and four-lamp ballasts, nd the enlarged group of bottom lead allasts, are included along with wiring iagrams for ballasts and lamp switches, nd comparative mounting dimensions.

* * *

I. G. NELSEN WESTINGHOUSE DISTRICT MANAGER

ndrew G. Nelsen has been named man-ger of the middle western district for Vestinghouse Lamp Division, Pitts-urgh, Pennsylvania. Mr. Nelsen has een with Westinghouse since 1923.

* * *

IAGGERSON ELECTED .C.C. PRESIDENT

red H. Haggerson, vice president and irector of Union Carbide and Carbon orporation, has been elected president the company, succeeding Benjamin 'Shea who becomes chairman of the ard. Mr. Haggerson has been with .C.C. for twenty-five years.

* * *

. L. HOFFMAN GUEST N COAST NEWS PROGRAM

. L. Hoffman, president of the Hoffman adio Corporation and of the West oast Electronics Manufacturers Asso-ation, appeared on the Los Angeles imes' program recently, broadcast over MPC, Hollywood, as a guest speaker. e discussed the electronic era in post-ar days.

* * *

ESTERN ELECTRIC ROMOTES D. C. COLLINS

. C. Collins, formerly eastern manager r Western Electric, has been appointed anager of the electrical research prod-ts division.

* * *

IDUSTRIAL CONDENSER EXPANDS

new plant which will house a million-lt research laboratory, is being built Industrial Condenser Corporation, hicago, Ill.

* * *

LINGER SALES APPOINTED Y KARP METAL

ne Ellinger Sales Company, 9 South inton Street, Chicago, Illinois, has been pointed midwestern sales representative r the Karp Metal Products Company c., 129 Thirtieth Street, Brooklyn 32, ew York.

* * *

000 ATTEND TECHNICAL LINIC IN CHICAGO

ne second conference of the Chicago

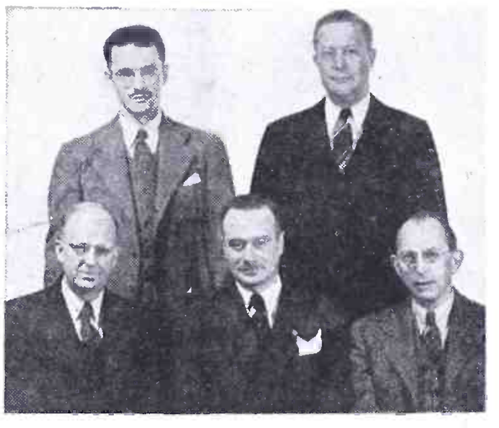
(*Continued on page* 68)

NEWS BRIEFS

(*Continued on page 67*)

Technical Societies Council, which met recently at the Stevens Hotel, had a record-breaking attendance of four-thousand engineers, scientists and manufacturers. The conference was held at the request of the WPB in cooperation with the Army and Navy.

Membership or other information on the Council is available from K. H. Hobbie, corresponding secretary, Chicago Technical Societies Council, c/o Driver-Harris Company, 1140 West Washington Boulevard, Chicago 7.



Officers of Chicago Technical Societies Council. At upper left, Paul S. Smith, recording secretary, IRE; upper right, K. H. Hobbie, corresponding secretary, American Society for Metals; lower left, G. P. Halliwell, treasurer, American Institute of Mining & Metallurgical Engineers; lower center, T. S. McEwan, president, American Society of Mechanical Engineers; lower right, B. E. Schaar, vice president, American Chemical Society.

* * *

SOLAR WINS SECOND WHITE STAR

An additional white star has been added to the "E" flag of the Solar Manufacturing Corporation plant at West New York, New Jersey.

* * *

RICARDO MUNIZ JOINS ESPEY

Espey Manufacturing Company, New York City, has appointed Ricardo Muniz as engineering director. Mr. Muniz was formerly chief engineer and plant manager of Radio Navigational Instrument Corporation, and electronic consultant for the Telector division of IBM.

* * *

G.E. PROMOTES PEARE AND ERBEN

Robert S. Peare and H. V. Erben have been elected vice president and commercial vice president, respectively, of General Electric Company, Schenectady.

Mr. Peare, manager of publicity and broadcasting, and chairman of G.E.'s general advertising committee, is also esident for the Maqua Company, henactady. Mr. Erben, manager of the ntral station divisions of G.E., has been ith the company since 1917.

* * *

HITE STAR TO SPRAGUE PLANTS

second white star has been added to e "E" flag of the three plants of Sprague lectric Company, North Adams, Massausetts.

* * *

LLISON OF SYLVANIA EADS ALUMNI FUND

ul S. Ellison, director of advertising d sales promotion for Sylvania Electric oducts, Inc., Emporium, Pennsylvania, s been appointed chairman of the St. wrence University Alumni Fund for 44. Mr. Ellison is a member of St. wrence's class of '22.

* * *

ECK AIRPLANE TO EED DELIVERIES

Monocoupe airplane has been purased and is now being used by the hn Meck Industries, Plymouth, Indiana, emergency order shipments. The plane said to be fully equipped with radio d blind-flying instruments.

* * *

AYDU BROTHERS TO PEN NEW PLANT

new plant adjoining their present one ll be opened shortly by Haydu Broths in Plainfield, New Jersey.

* * *

MC DISCONTINUES SEVERAL ITEMS

bulletin issued to sub-contractors by e Universal Microphone Company, glewood, California, cites the disconuance of plugs, jacks and switches, cause of the need of facilities for microone production.

* * *

NITED ELECTRONICS EMPLOYEE UGGESTION PROGRAM

new program to increase employee ggestions has been inaugurated by the ar Production Drive Committee of the nited Electronics Company, 42 Spring reet, Newark, N. J. A white star was cently added to the UEC "E" flag.

* * *

ELCHER NOW A. T. & T. TREASURER

onald R. Belcher has been elected easurer of A. T. & T., succeeding James Behan, who retired.

* * *

AINES RESISTOR CATALOG

1944 catalog, *Resistors By Haines,* has

(*Continued on page* 70)

GUADALCANAL RADIO CITY

ome of the *Mosquito Network* on uadalcanal, from which originate many ograms from the Pacific theatre of war. (*Official U. S. Marine Corps Photo*)

NEWS BRIEFS

(Continued from page 69)

been published by Haines Manufacturing Corporation, 274 McKibben Street, Brooklyn 6, New York. The catalog covers vitreous enamelled wire wound resistors.

* * *

AIRCRAFT ACCESSORIES WINS WHITE STAR

A white star was added recently to the Army-Navy "E" flag of the Aircraft Accessories Corporation's power controls division of Burbank, California.

* * *

E. R. PLACE JOINS RCA INFORMATION

Edward R. Place, former assistant to the director general of the War Production Drive, has joined the information staff of Radio Corporation of America.

* * *

STAR AWARDED TO ROLA

The Rola Company Inc. of 2530 Superior Avenue, Cleveland, Ohio, has been awarded a star for its Army-Navy "E" flag.

* * *

CRANE HEADS LEAR AVIA RADIO DIVISION

Elmer R. Crane has been appointed general manager of the radio division of Lear Avia Inc., Piqua, Ohio and Grand Rapids, Michigan. Mr. Crane was associated with Western Electric for eighteen years, and more recently with the radio and radar division of the WPB. His headquarters will be in Grand Rapids, Michigan.

* * *

SOLAR CAPACITORS CATALOG

A 40-page catalog, containing sixteen pages of official Signal Corps color photographs of front-line scenes, has been released by Solar Manufacturing Corporation, 285 Madison Avenue, New York 17, N. Y. The catalog describes the company's products in various phases of their war service.

* * *

GODDARD APPOINTED SYLVANIA PRODUCT MANAGER

Charles H. Goddard has been appointed

•

CONSOLE ELECTRON MICROSCOPE

The electron microscope, in console desk form, with Dr. V. K. Zworykin (seated, left), associate director of the RCA Laboratories; Dr. James Hillier, youthful pioneer in electron microscopy, and Perry C. Smith (standing), RCA Victor design engineer.

roduct manager of fluorescent fixture ales of Sylvania Electric Products Inc., pswich, Massachusetts. Mr. Goddard vas formerly vice president of the 'ittsburgh Reflector Company.

* * *

:OLE HEADS MECK'S N. Y. IELD OFFICE

hester A. Cole, eastern district manager, as been placed in charge of the recently opened New York City offices at 00 Fifth Avenue, for the John Meck Inustries, Plymouth, Indiana.

* * *

;OLAR APPOINTS ADELMAN AS N. Y. REP.

.eon L. Adelman has entered the repreentative business. He will represent mong other lines, Solar Capacitor Sales Corporation, 285 Madison Avenue, New York 17, N. Y., in the metropolitan New York area.

* * *

ARMY-NAVY "E" TO RCA TUBE PLANT

The Army-Navy "E" flag was awarded ecently to RCA's Victor division tube lant at Lancaster, Pennsylvania. Brig. Gen. John H. Gardner, Assistant Chief of the Procurement and Distribution Service, presented the flag.

* * *

ASTATIC NAMES CARTWRIGHT REP.

The Astatic Corporation, Youngstown, Ohio, has appointed J. M. Cartwright, 1276 Peabody Avenue, Memphis, Tennessee, representative in the states of Louisiana, Mississippi, Arkansas, and western Tennessee.

* * *

SCHERR SURFACE FINISH FOLDER

A 4-page folder, which illustrates four Spencer binocular microscopes for finish control, is available from the George Scherr Company, Inc., 200 Lafayette Street, New York 12, N. Y.

* * *

FTR HANDBOOK OF OF TUBE OPERATIONS

A 72-page manual, discussing transmiting and rectifying tubes, has been pubished by the Federal Telephone & Radio Corporation, Newark, New Jersey.

Among the subjects analyzed are *raphical methods of harmonic analysis, alculation of class C plate modulated r-f ower amplifiers, grid-bias modulated r-f mplifiers, multiphase filaments, the Doerty high-efficiency amplifier,* and *graphcal design of frequency multiplier ampliiers.*

* * *

THIRD WHITE STAR TO HALLICRAFTERS' E" FLAG

A third white star has been added to the "E" flag of the Hallicrafters Company, 2611 Indiana Avenue, Chicago 16.

(*Continued on page* 88)

THE INDUSTRY OFFERS . . . —

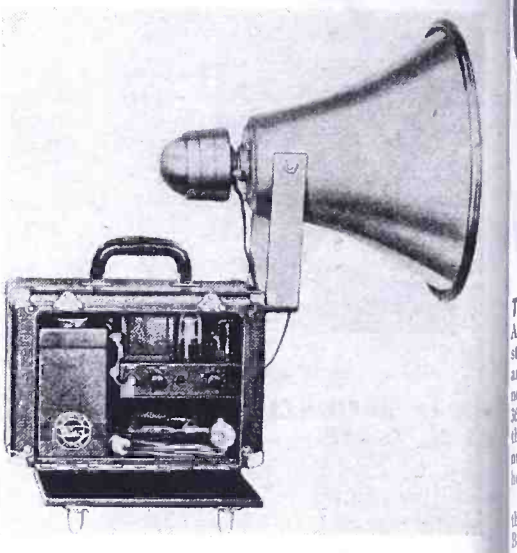
(*Continued from page 60*)

to be clear and quick-drying, and may be applied by spraying, brushing or dipping. It is said to comply with U. S. Signal Corps specifications.

* * *

NEWCOMB PORTABLE SOUND UNIT

A portable sound system with self-contained power supply is being manufactured by the Newcomb Audio Products Company, 2815 South Hill Street, Los Angeles 7, California. Output is said to be approximately 95 decibels at 100 feet. Weight, 39½ pounds.



* * *

BENDIX HYGROMETER STRIP

A plastic hygrometer strip, replacing the human hair in the radiosonde, has been developed jointly by the Bureau of Standards and the Friez Instrument Division of Bendix Aviation Corporation, Baltimore, Maryland.

The hygrometer is said to be more sensitive to atmospheric variations.

The basic difference between the new strip and human hair is that the latter varies in length with changes in humidity while the former varies in electrical characteristics.

The plastic strip is roughly, about five inches long, an inch and a half wide, and about an eighth of an inch thick. The edges are specially treated so as to provide electrical conducting surfaces and the surface is so treated that the electrical resistance between the edges varies with the amount of moisture in the air.

* * *

DALE INSTRUMENTS

A complete line of electrical voltmeters, ammeters, microammeters, and milliammeters in standard 2" and 3" AWS case construction have been announced by Dale Instruments Electronic Development Co., 2055 Harney Street, Omaha 2, Nebraska.

Bakelite bridge construction is used for body of the movements. Incorporated also are soft iron pole pieces.

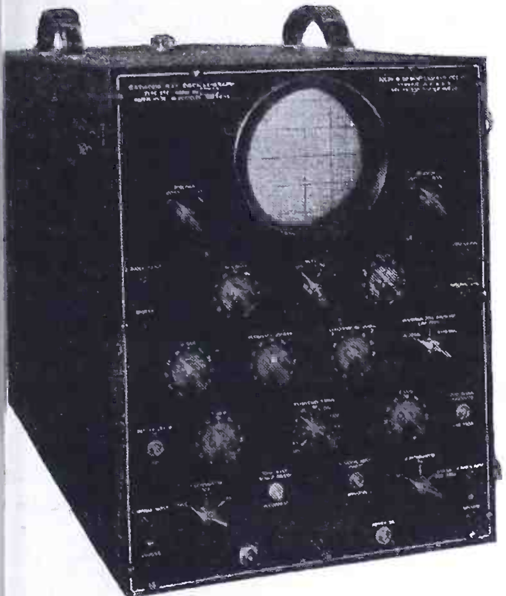
* * *

DUMONT OSCILLOGRAPH FOR TRANSIENT STUDIES

An oscillograph, type 247, using the Army-Navy preferred type 5CP1 cathode-ray tube with intensifier electrode, operated at an overall accelerating potential of 3000 v, has been announced by the Allen B. Du Mont Laboratories, Inc., Passaic, N. J. High-intensity patterns are said to be obtained on the 5" diameter screen. The medium-persistence green screen is standard. If a permanent record of transient phenomena is required the instrument may be supplied with short-persistence blue screen for high-speed photographic recording, or with the long-persistence green screen for visual observation of low-speed phenomena.

The sweep frequency range has been extended down to one-half cycle per second, for observations on low-speed machinery and for other low-frequency functions. The time base provides recurrent, single or repetitive sweep operation. A beam control circuit with single sweep operation is used. This permits darkening of the screen except during the actual sweep cycle.

providing a reduction of background illumination and resulting in photographs of greater contrast. Dimensions: 14" x 19" x 26"; weight 130 pounds.



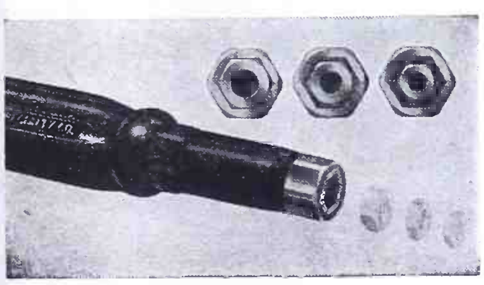
* * *

THREE-IN-ONE SOCKET WRENCHES

A multi-socket wrench that accommodates 10 standard, 12 standard, ¼" standard and light, and 5/16" light hexagon nuts has been announced by The Eastern Specialty Company, 3617-19 North 8 St., Philadelphia, Pa. Pressing the wrench over any of the three sizes of nuts automatically selects the proper nested hexagonal tube suited to that particular nut.

The wrench is designed to provide a clearance through the barrel for studs up to 5½" length. Both handle and barrel have moulded insulation capable of withstanding a dielectric test for one minute at 5,000 volts rms.

Handle is a die cast aluminum member pressure-moulded to the hexagon steel barrel.



* * *

RCA U-H-F AND V-R TUBES

Four tubes have been announced by the RCA Victor division of RCA, Harrison, N. J. They are: 6J4 u-h-f amplifier triode (grounded grid, miniature type); and OA3/VR75, OC3/VR105 and OD3/VR150 voltage regulators.

The 6J4 is a miniature triode for use primarily as a grounded-grid u-h-f amplifier at frequencies up to about 500 megacycles. Its design features an amplification factor of 55 combined with a transconductance of 12000 micromhos. Permits grounded-grid operation with a high signal-to-noise ratio. May also be used in conventional triode circuits with ungrounded grid.

The OA3/VR75, OC3/VR105, and OD3/VR150 are cold-cathode, glow-discharge tubes superseding VR75-30, VR105-30, and VR150-30. The new types feature a maximum d-c operating current of 40 milliamperes as compared with 30 milliamperes for the superseded types.

* * *

SHALLCROSS KELVIN-WHEATSTONE BRIDGE

The Kelvin and Wheatstone bridges have been incorporated in a portable bridge unit, type 638-2, by Shallcross Manufacturing Company, Jackson and Pusey Avenues, Collingdale, Pa. The bridge provides resistance measurements of from 0.0001 ohm to 11.11 megohms.

When used as a Wheatstone bridge for measurements between 1 ohm and 1 megohm, a normal accuracy of 0.3% is said to be avilable. Low-resistance measurements using the Kelvin range utilize current and potential terminals to eliminate lead and contact resistance.

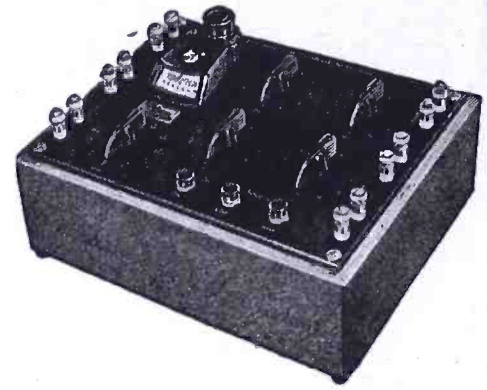
The accuracy of Kelvin measurements at ranges lower than 0.1 ohm is said to be on the

(*Continued on page* 74)

THE INDUSTRY OFFERS . . . —

(*Continued from page 73*)

order of 3%. The rheostat is variable in steps of 1 ohm for Wheatstone bridge measurements, and 1 microohm for Kelvin bridge measurements. Accuracy of component resistors is 0.1% except the 1-ohm resistors which have an accuracy of 0.25%. Built-in galvanometer has a sensitivity of 0.25 microamperes from millimeter deflection.



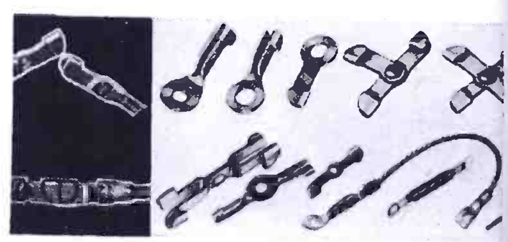
* * *

AMP SOLDERLESS KNIFE-DISCONNECT SPLICING TERMINALS

A series of solderless knife-disconnect splicing units have been developed by Aircraft-Marine Products Inc., 1591F North Fourth Street, Harrisburg, Pa.

Units have been adapted to t-link, y-link, h-link and cross-link applications, and to stud tab, jumpers and small electrical assemblies such as switches, relays, etc.

All terminals are annealed, hot electro-tinned copper. A diamond-grip insulation support type terminal is available in wire sizes 22 to 10; standard type B is available in wire sizes 22 to 8.



* * *

PORTABLE ELECTRIC MEGAPHONE

A portable electric megaphone that is said to project intelligible speech under favorable conditions up to one-half mile distance, has been announced by National Scientific Products Company, 5013-25 North Kedzie Avenue, Chicago 25, Illinois.

Under normal conditions encountered by ships at sea, the manufacturer states the new megaphone transmits voices clearly at a quarter-mile.

The amplifier chassis is shock-mounted to the top section of the cabinet. Speakers and microphones contain waterproofed, molded phenolic diaphragms. Batteries used are said to provide 40 hours of operation and still retain 70% of original voltages. Power is consumed only during actual transmission of voice.

Megaphone cabinet is 9½" x 4½" x 7⅛"; weighs 11¼ lbs. Speaker is 13¼" long with a 7¾" diameter bell opening. Complete unit, including megaphone and cabinet, weighs 15 pounds, 5 ounces.

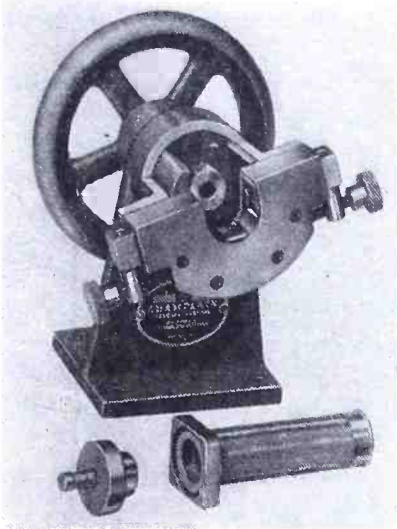
* * *

CHAMPLAIN FERRULE BEADING MACHINES

Ferrule beading machines for attaching aluminum ferrules (with either straight or flared barrels) onto flexible shielding conduit, are now being produced by Champlain, Division of the Fred Goat Company, Inc., 636 Eleventh Avenue, New York 19, N. Y.

The machines can be used to attach ferrules to either wire braided conduit or synthetic covered conduit; only the beading rolls need to be changed to permit use of the machine with either type.

Machines are available in 3 sizes each accommodating a different size range: No. 0, a nd-type tool, accommodating ferrules 3/16", ", 3/8", 1/2", 5/8", 3/4" in diameter; No. *1*, a nch-type for ferrules 3/16", 1/4", 3/8", 1/2", 5/8", ", 1", 1 1/4" in diameter; No. 2 bench-type for ", 1 1/2", 1 3/4", 2", 2 1/2" diameter ferrules.



* * *

I-ACRO SHEAR

shearing machine, Di-Acro Shear No. 3, th a maximum shearing capacity, full width, 18 gauge steel plate, has been produced by Neil-Irwin Manufacturing Company, 322 ghth Avenue South, Minneapolis 15, Minsota. It has a built-in gravity chute. Maxium shearing width is 12".

Shear blades are of heavy tool steel. Blades e reversible.

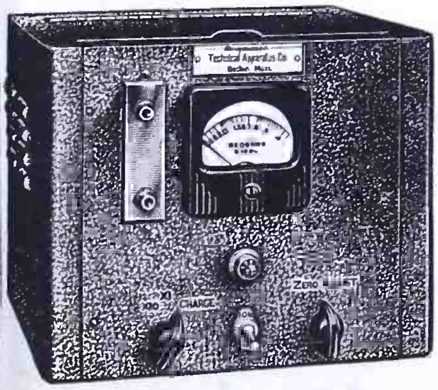
All main bearings are adjustable or replacele for wear and alignment. All upper bearings e provided with oil cups and rifle drilled provide lubrication for the second bearings mediately below with one oiling.

Automatic spring charged action. Net weight approximately 150 pounds.

* * *

IRECT-READING MEGOHMMETER

megohmmeter, TAC model 404-J, for measurent of resistances from 400 megohms to 100,000 gohms is now available from the Technical paratus Company, 1171 Tremont Street, ston, 20, Massachusetts. Resistance values measured under an applied d-c potential 90 volts and are indicated on an individually ibrated scale. The instrument is said to have accuracy of 5%. It has a built-in current iter to prevent damage to the instrument the test terminals are accidentally shorted. he measuring circuit, including its 110 volt, cycle power supply and the test battery, contained in a steel housing 8" x 10" x 8".



THE VU AND DB

(*Continued from page* 50)

scribed manner, but efforts were also made to take into account some of the physiological and psychological factors which enter into the maintenance of program material upon a daily routine basis.

These efforts resulted in the provision of a new type and kind of indicator that met the requirements of the operating personnel of the companies involved. The new meter was given the name of a *volume indicator*, and the new unit which was used for its calibration was termed the *volume unit* and abbreviated *vu*.

Since none of the meter scales, which have been calibrated in terms of the peak, average, or effective values of the sine wave, met the requirements for control and monitoring of radio programs, the idea of *volume* was evolved. This permits the magnitude of complex waves to be readily expressed providing that a definite time interval is associated with the operation of the indicator of the meter. Hence, it may be appreciated that the new unit was created to meet a practical need and is an empirical unit. However, the creation of the new unit retained the advantages of a ready means of calibration by means of a steady single sine wave frequency. This has been the method used for years in the calibration of other forms of db meters. The new meter was designed to have prescribed dynamic characteristics which are fully as much so or more important than the single frequency response to sinusoidal waves.

The exact manner of conducting the tests to determine the best type of response for the *vu* meter and the proper calibration for it have been adequately described in the literature, and references are attached to this paper that may be consulted for details. There

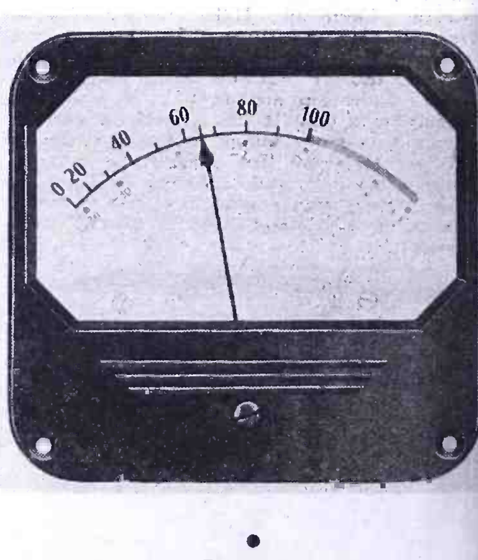


Figure 19
Volume level indicator.
(*Courtesy Weston*)

have been, however, some rather unusual initial tests that we will describe nere briefly. In one such test twelve observers judged thirteen different samples of program material. These ncluded male and female speech, lance, music, piano, violin, and brass band selections. It was assumed that he twelve observers were representative of the listening public, although because of their previous training in naking many tests of somewhat similar nature, these twelve might, if anything, be inclined to be somewhat more critical than the average listener. For example, they would pick up distortion at a lower level than average, and hence f the criterion of their judgment was used, adequate protection would be given against overloading conditions in amplifier systems. Peak and root-mean-square types of instruments were horoughly explored over a wide range f levels, by tests and observations. The rms type of instrument was chosen nainly because it fails to respond to phase and slightly non-linear types of listortion. Likewise, the ear fails to detect such distortion. The peak types of nstruments on the other hand respond quite well to rapid changes in wave orm and hence do not give an accurate picture of what is heard aurally. In recent years the development of the copper oxide rectifier has advanced to the tage where it can be used successfully o obtain sufficient sensitivity for most general purposes without resorting to vacuum tube amplifiers.

To determine just what dynamic and lectrical characteristics should be used or standardization in the new meter, echnicians and engineers who had een accustomed to the use of volume ndicators in their daily activities were urveyed. Wide ranges of damping nd speeds of response were studied, nd definite conclusions reached as to vhat values of damping and speed of esponse would be most suitable to give ccurate average reading over all anges of volume and types of program

(*Continued on page* 78)

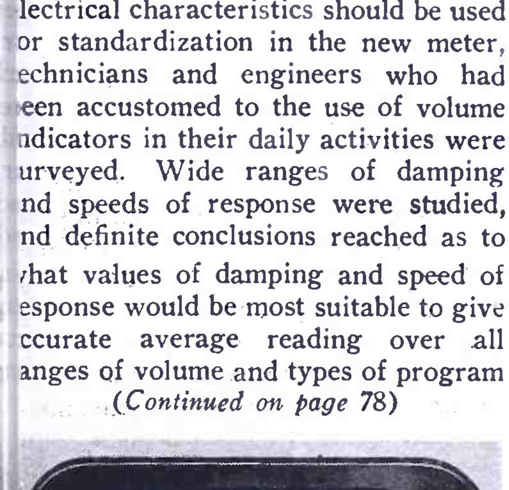


Figure 20
Illuminated type volume level indicator.
(*Courtesy Weston*)

(*Continued from page 77*)

material with a minimum of eye strain. The most satisfactory speed of response was decided to be that response which would cause the pointer to read 99% of its final deflection in 0.3 second when a 1000 cycles per second sine wave was suddenly applied. The damping was determined to be most satisfactory when slightly less than critically damped, so that the pointer would swing to not less than 1% nor more than 1.5% of its final steady value under the same 1000 cycles applied.

The dynamic range of the *vu* meter was chosen so that it would read from — 20 to + 3 *vu*. This was a compromise between wide-range dynamic compression and location of the upper part of the dynamic range close to the overloading point of equipment during its normal operation.

Considerable attention was paid to the best color design of the scale card, and the division markings. Two scales were chosen with an arc line in between the two scales. One scale is the *vu*, and the other is a percentage scale. The arc line is black except for the portion to the right of the 100% mark, which is red. All numerals are black. The object of the per cent scale is to give a direct indication of the percentage of modulation of the radio transmitting equipment. The speech input equipment in this case is adjusted so that any volumes exceeding the 100 on the meter scale would indicate over-modulation of the radio transmitter. The *vu* scale is intended to be used with an accompanying attenuator, so that the algebraic sum of the scale and the attenuator reading provides the number of *vu* above or below reference volume.

The subject of reference volume is an important one and one which in past years has aroused considerable discussion and frequently much confusion. In spite of the great amount of care taken to attempt to eliminate such confusion with the new *vu* indicator, there appear to be many radio transmission and trained technical men who seem to still have doubts as to just what a volume unit is, and if it might be thought of as exactly the same thing as a decibel. All of them have expressed the firm conviction that one volume unit equals one decibel, and that four volume units equal 4 decibels, etc. Apparently, two thoughts have caused the major portion of the confusion. For instance, many do not appear to be completely familiar with the basic difference between the new *vu* and the older *db* meters. In addition many attempt to make the zero of the *vu* scale equal zero reference volume.

Reference volume in any system would be entirely arbitrary, and applied to the *vu* indicator, it is equally so. It is a convenient concept which is needed to give specific meanings to readings obtained by instruments having specified special characteristics, and requiring certain operating technique. Applied to the *vu* meter in particular, it is only describable in terms of the electrical and dynamic characteristics of the instrument, its single frequency calibration, and operating technique in reading it. A definition of reference volume as given by those responsible for the *vu* meter is "that level of program which causes a standard volume indicator, when calibrated and used in the accepted way, to read 0 *vu*."

Specifications for the calibration of the *vu* instrument call for a reading of 0 *vu* when the instrument is connected to a 600-ohm resistance in which is flowing 1 milliwatt of sine-wave power at 1000 cycles per second, or n *vu* when the calibrating power is *n* decibels above 1 milliwatt.

Sensitivity of Meters Today

The sensitivity of the present design of meter is only great enough to allow the meter to read –4 *vu* with 1 milliwatt of power applied to it; hence a volume level of + 4 *vu* 1000 cycle power will cause the meter indicator to read zero on the scale. The attenuator setting is marked + 4 on its lowest setting, but actually has zero loss in this position. Therefore, when 1 milliwatt of power is applied, the meter reading is –4 and the attenuator setting is + 4 giving a net of 0 *vu*. When + 4 *vu* or 4 *db* of power above one milliwatt at 1000 cycles per second is applied to the *vu* indicator with the attenuator in the + 4 position, the pointer will indicate 0 *vu*. Thus the level is a net of 0 + 4 = + 4 *vu* above reference volume.

The impedance of the volume indicator arranged for direct measurement is 600 ohms, while for bridged mea-

(*Continued on page* 80)

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Figure 21
Another vu-type indicating instrument.

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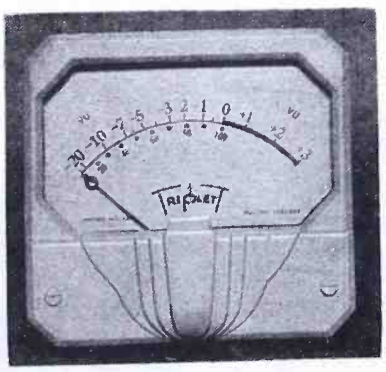


(Continued from page 79)

surements it is about 7500 ohms and causes a nearly constant loss of 0.3 db. Of this 7500 ohms, the copper-oxide full-wave rectifier and meter has about 3900 ohms, and the 3600 ohms must be supplied externally to the meter. An attenuator is used to extend the range of measurements. The highest reading in most standard instruments is + 26 *vu*, but may be extended by using an attenuator with more steps and greater range if desired. A constant impedance type attenuator is used whose impedances are equal. The characteristic impedance of the attenuator is 3900 ohms. The series arms of the T type attenuator used $= 3900 \tanh \frac{\theta}{2}$, and the shunt arm $= 3900 \operatorname{csch} \theta$, where $\theta = 0.115129 \times$ No. of db loss required.

The accuracy of the *vu*-type indicator is specified as being within 0.2 *vu* of the 1000-cycles indication from 25 to 10,000 cycles per second, with 0 *vu* voltage on the instrument, and does not exceed 0.5 *vu* at 16,000 cycles per second. The reason for the variation comes about largely because of the imperfections inherent in copper-oxide rectifiers. Adjustment of a resistance

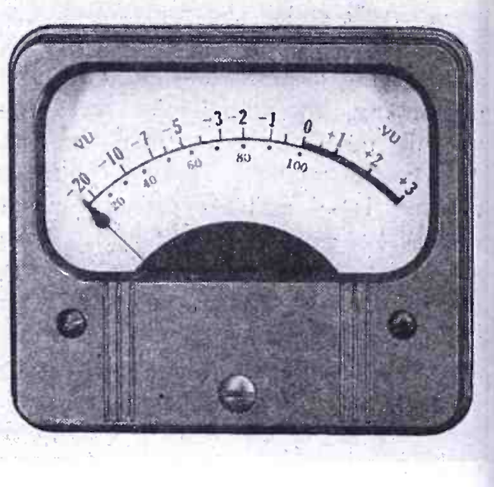
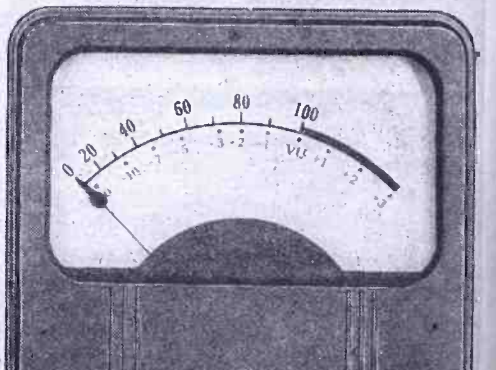


Figure 22
At top, an internally illuminated-type vu meter. Below, a non-illuminated style.
(*Courtesy General Electric*)



is provided to correct for scale and instrument errors and deviations with age from the calibration point. The attenuator of constant impedance is necessary in the circuit to preserve the dynamic characteristics of the indicator.

Since on a steady-state sine-wave basis, 0 *vu* corresponds to 0 *db*, the *vu* indicator may be used on transmission measurements to determine the transmission characteristics of lines, loops, amplifiers and associated equipment.

Used with proper weighting networks and a suitable amplifier giving sufficient gain, the indicator may be used quite satisfactorily to measure the amount of crosstalk between pairs in studio cabling and wiring, or the crosstalk and noise on loops and lines between the studio and the transmitter, for example. If reference crosstalk and noise levels are not of importance, but only comparative values are of interest, the meter would be suitable with an amplifier, to give strictly comparative measurements without those reference values.

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VWOA NEWS

(*Continued from page 62*)

most colorful figures of the old wireless art, particularly in marine circles, died recently. Interment was at St. Patrick's Cemetery, Watervliet, N. Y., his birthplace.

Fitzpatrick, who was born on February 22, 1886, became a wireless operator for the United Wireless on shipboard, in 1912. Later he became one of the Marconi men when that company absorbed UWT. He stayed with Marconi-RCA until his death, the latter part of his career being with RCA Institutes and Radiomarine.

With Peter Podell and J. V. Maresca he founded the VWOA.

His service with RCA was varied. First he was in charge of the *Static Room;* then he worked in production and service; from this he became Home Study Examiner for RCA Institutes. He assisted editor C. S. Anderson to prepare the later issues of the *Wireless Age,* and performed the same service for *RCA Review* later. His last work with the company was as manager of the Gift Service department, which enabled passengers at sea to order by radio, gifts for friends ashore.

He was an able writer, and edited a column in *RCA News* and another in *Broadcast News* for many years. He was also a frequent contributor to the *Wireless Age.*

'Bill' will be deeply missed by all.

COLOR TELEVISION

(*Continued from page* 35)

being noticed, a 90-kc pulse being provided to control the speed and phase of the motor.

Several slides were shown illustrating the difference between black and white and color pictures with the number of lines adjusted so that the transmitted bandwidth would be equal. For a 2-megacycle band this would be 343 lines for black and white, and 243 lines for color. Similarly for a 4-megacycle band, 525 lines are required for black and white, 373 lines for color.

Five systems have been tried by CBS during their color television experiments, said Dr. Goldmark. These are shown in Figure 8.

Dr. Goldmark explained that system *3* (Figure 8) was the best all-around compromise with 375 lines, 2 to 1 interlacing and 20 color pictures per second. Dr. Goldmark picked *4* as next best, the weak point being 15 color pictures per second. However, the strong point was 450 lines with 4 to 1 interlacing. Systems *1* and *5* were called very bad because of the low picture rate; thus the interline flicker starts to be noticeable. System *1* with only 20 color frames per second produces color break-up which, Dr. Goldmark explained, causes a moving object to be seen in successively different colors of which it is composed, instead of having the colors present simultaneously. The weak point in system *2* is, of course, the low number of lines, causing loss in definition.

•

ATTENUATION OF HARMONICS

(*Continued from page* 40)

put of the pi network at the fundamental frequency.

If the pi network is inserted between equal impedances, or 60 ohms, then $X_a = X_b = X_c = 60$ ohms at the fundamental frequency.

For any harmonic, where n = number of harmonics

$$L_a = L_c = \frac{X_a}{(1 - n^2)\,w}$$

$$C_a = C_c = \frac{(1 - n^2)}{n^2\,w\,X_a}$$

$$L_b = \frac{X_b}{w}$$

For second harmonic control

let $w = 2\pi f$

Then $$L_a = L_c = \frac{X_a}{(1 - 2^2)\,w}$$

$$C_a = C_c = \frac{(1 - 2^2)}{2^2\,w\,X_a}$$

$$L_b = \frac{X_b}{w}$$

X_a, C_a and L_a, may be used for one harmonic and X_e, C_e and L_e, for another if desired, although for maximum attenuation of any one harmonic, both can be applied for that particular harmonic.

The resonant circuits of X_a and X_e are surprisingly critical, and maximum attenuation of harmonic may be expected only if reasonable care is taken in the adjustment of these circuits. A communcations type receiver with a signal strength meter has been found to provide a simple and highly satisfactory method for this final adjustment. The pickup antenna should be placed a hundred yards or so from the transmitting antenna with a transmission line, with a minimum pickup, doublet type, feeding the receiver. If the station is using a directional antenna, the sampling loop on a tower not in use may be used for pickup very satisfactorily. With the receiver tuned to harmonic frequency, adjustments are made on L_a and L_e by means of clips or taps, separately, one at a time. Changes in the harmonic energy radiated are noted on the signal-strength meter on the receiver. As little as ¼-turn change on either L_a or L_e will make appreciable difference when the circuits are tuned near their optimum point for maximum harmonic attenuation. With a little care this can be adjusted right on the *nose*. Adjustment of these coils is necessary because of the variation in the manufacture of condensers and the possible error made in measuring the inductance of the coils used.

As an example, let us take a 1000-kc signal and second harmonic attenuation

$$L_a = L_e = \frac{60}{(1-2^2)\ 2\pi \times 1{,}000{,}000} = 3.18\mu\ h$$

$$C_a = C_e = \frac{(1-2^2)}{2^2 \times 2\pi \times 1{,}000{,}000 \times 60} = .0019 \text{ mmfd}$$

$$L_b = \frac{60}{2\pi \times 1{,}000{,}000} = 9.55\ \mu h$$

It is reasonable to assume that in the most stubborn cases satisfactory results will be obtained even if only one harmonic is being attenuated.

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COIL Q FACTORS

(*Continued from page* 38)

covering on wire was also gathered. In Figure 7, *A* represents cotton-covered wire; *B* shows the increase in *Q* when the cotton covering was removed; column *C* shows the effect of annealing

(*Continued on page* 84)

Figure 7

Resultant Q using wire with and without covering; 6 turns 14 wire, 1" lucite form, grooved 7 turns/inch.

	A		B		C	
Frequency, Mc	Q	C	Q	C	Q	C
25	331	53.0	334	53.8	337	53.9
27	341		344		345	
29	343		346		348	
31	346		353		354	
33	348		355		357	
35	346	26.2	352	26.9	355	27.0
37	333		345		346	
39	331		344		345	
41	327		339		340	
43	318		331		332	
45	314	14.8	328	15.1	329	15.0
47	303		318		321	
49	299		312		314	
51	288		303		305	

COIL Q FACTORS

(*Continued from page* 83)

the wire. For this chart, the same piece of wire was used for the three recordings.

Figure 8 shows the effect of grooving on coil Q. The results do not warrant the lighter grooving, since it is much easier to wind in the heavier groove.

Figure 5 shows the effect of using pure polystyrene coil forms instead of lucite. In gathering the data for the previous Figures*, lucite was used exclusively because it is much easier to machine. However, polystyrene is superior, particularly at the higher frequencies.

*V-H-F Coil Construction, COMMUNICATIONS, April, 1944.

•

Figure 8
Effect of grooving on coil. *A*, grooved .030" deep; *B*, grooved .010" deep; *C*, value of tuning capacitance in mmfd for resonance: for 6 turns 14 wire on 1" lucite form, grooved 7 turns/inch.

•

Frequency, Mc	A Q	A C	B Q	B C
25	339	52.6	333	52.8
27	346		344	
29	350		348	
31	354		353	
33	358		357	
35	356	26.1	356	26.2
37	348		348	
39	344		344	
41	339		339	
43	331		332	
45	329	14.6	330	14.8
47	318		322	
49	314		316	
51	303		305	

•

MORSE CENTENNIAL

(*Continued from page* 42)

cording is via paper tape.

Recent years have seen the development of simultaneous transmission methods. The introduction of automatic relaying, automatic repeaters, facsimile and carrier circuits has further advanced the art of communications, in which the telegraph plays its vital role.

The development of the telegraph has served progress in a full way. A salute to Samuel F. B. Morse on this centennial!

FIELD TESTING

(*Continued from page 29*)

will be calculated as 10 times the ratio of vertical to horizontal.

The cut-off values of high and low frequency for a multi-stage amplifier correspond to the half-power frequencies of an individual stage. These can be quickly obtained with a square-wave input, and observation of the wave form of the output. A square wave is a series of repeated transients, or sudden changes in voltage, and the effect of this on capacitances in the circuit is to charge and discharge them alternately. The condenser voltages will then follow a repeated logarithmic curve. The high-frequency equivalent circuit of an amplifier is a high resistance in series with a small grid-cathode or input-shunting capacitance. For intermediate frequencies, this capacitance charges up so rapidly that its voltage seems to follow perfectly the square wave. As the frequency is increased, however, less time is allowed for the condenser to charge and discharge, and instead of a square-wave output, a series of repeated logarithms will be observed, Figure 6. In this Figure, the dotted lines indicate the final values of voltage if more time were allowed. This is the standard wave for the half-power frequency, where the fundamental component of the square wave has been shifted in phase 45° in going through the amplifier. Higher harmonics have been shifted almost 90° and reduced considerably. For identification, it will be noticed that the curve rises to 85% of its peak value (80% of its asymptotic value) in one-half of the time allowed for charging. This is characteristic only of the half-power frequency. This frequency can be read off of the oscillator dial.

The low-frequency equivalent circuit is again a condenser in series with a resistance. This time the output voltage is across the grid-input resistance, so that the output is proportional to the charging current to the coupling capacitor. At a frequency at which the response is still good, the a-c voltage

(*Continued on page 89*)

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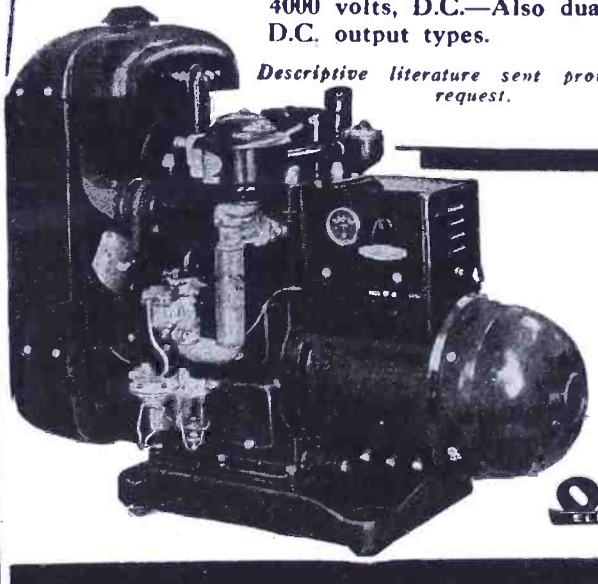

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ONAN ELECTRIC PLANTS

M. M. PETERMAN AWARDED SILVER STAR

Private Morse M. Peterman, formerly with Ralph L. Power, servicing the Universal Microphone Company account, has been awarded a Silver Star for gallantry in action near Cassino.

* * *

CLOUGH JOINS WPB COMMITTEE

H. W. Clough, vice president of Belden Manufacturing Company, Chicago, became a member recently of the Copper Wire & Cable Mill Industry Advisory Committee of the WPB.

* * *

BLAKESLEE EASTERN MANAGER FOR RCA VICTOR

M. F. Blakeslee has been appointed eastern regional manager for the sale of all

NEWS BRIEFS

(*Continued from page* 71)

RCA Victor products, covering the areas from Maine to Virginia, and New York to Cleveland. Prior to joining RCA in 1935, Mr. Blakeslee handled department store sales nationally for U. S. Rubber Company. His offices are at 411 Fifth Avenue, New York City.

* * *

STANCOR WINDOW DISPLAY RECRUITS WORKERS

A unique window display, set up by the Standard Transformer Corporation in the vicinity of their plant at 1500 North Halsted Street, Chicago, was responsible for the recruiting recently of many employees. The display, designed in cooperation with the WMC, showed typical male and female employees at work on Stancor communication equipment.

* * *

WPB L-204 ON TELEPHONES REPLACED

A new utilities order, U-8, was issued recently by the Office of War Utilities of the WPB to replace limitation order L-204, limiting the manufacture of telephone sets. The new order does not substantially change the provisions of L-204. However, it eliminates the controls over delivery of telephones to the Army and Navy which L-204 carried, and which are now covered by limitation order L-183-a.

FIELD TESTING

(*Continued from page 86*)

across the coupling condenser never rises to a value large enough to materially oppose the charging current. It is almost constant for each half-cycle, as shown in Figure 7a. If the frequency is reduced, however, the time for each half-cycle is so long that the condenser charges up and the charging current dies down to almost zero, Figure 7b. This is the standard wave for the low-frequency half-power value. It again corresponds to a fundamental which has been shifted 45°. Its logarithm component is identical to that in Figure 6b. The same criteria can be used to identify the wave. Another quick method is to turn off the oscilloscope sweep circuit and one will see two heavy lines, Figure 7c. The length of each line is 9.5 times that of the space between.

Care must be taken that only one amplifier stage is tested at a time. The scope should be in the plate circuit, not across the grid, in order to minimize the effect of its input capacitance on the high frequency response. The oscilloscope vertical amplifier may also introduce errors when testing above 100 kilocycles, and may be turned off.

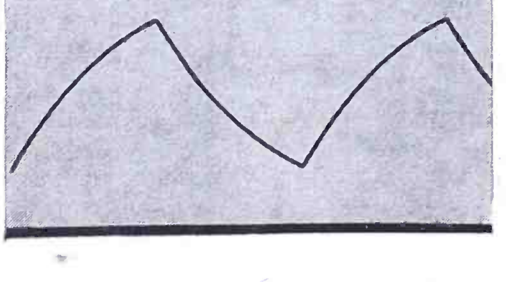
One can perform an overall test on the amplifier, but the output waves will be different than those given here. For example, a three-stage amplifier in which each stage has the same frequency response, can be tested at the half-power frequency of one stage. This will correspond to the 1/8th power frequency for the entire unit, and the output wave shape will be that given in Figure 8.

A commercial square-wave generator is the most convenient to use, but it is possible to perform these tests without one.

A square-wave generator may be built with two stages of *clipper* circuits, but in an emergency a one-tube amplifier does nicely. A grid leak of several megohms is used and the input signal is large enough to saturate the tube on positive half-cycles, and to cut-off on negative half-cycles. This is satisfactory in the audio range.

It is interesting to note that all of these tests may be performed without the use of any calibrated meters.

Figure 8
Output at h-f 1/8-power point.



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COMMUNICATIONS—MAY, 1944

* Due to paper restrictions several advertising pages had to be omitted from this issue.

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Sincerely

H. H. Dawes

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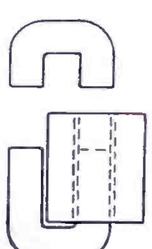
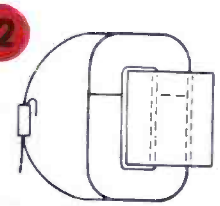
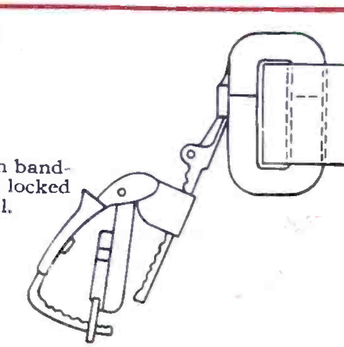
1. Core is placed around coil.



2. Core parts are butted together. Strap is threaded through seal and . . .



3. . . . tightened with banding tool. Band is locked in place with seal.



Banding Straps, Seals and Tools available from Westinghouse. See Page 9 of booklet B-3223-A.