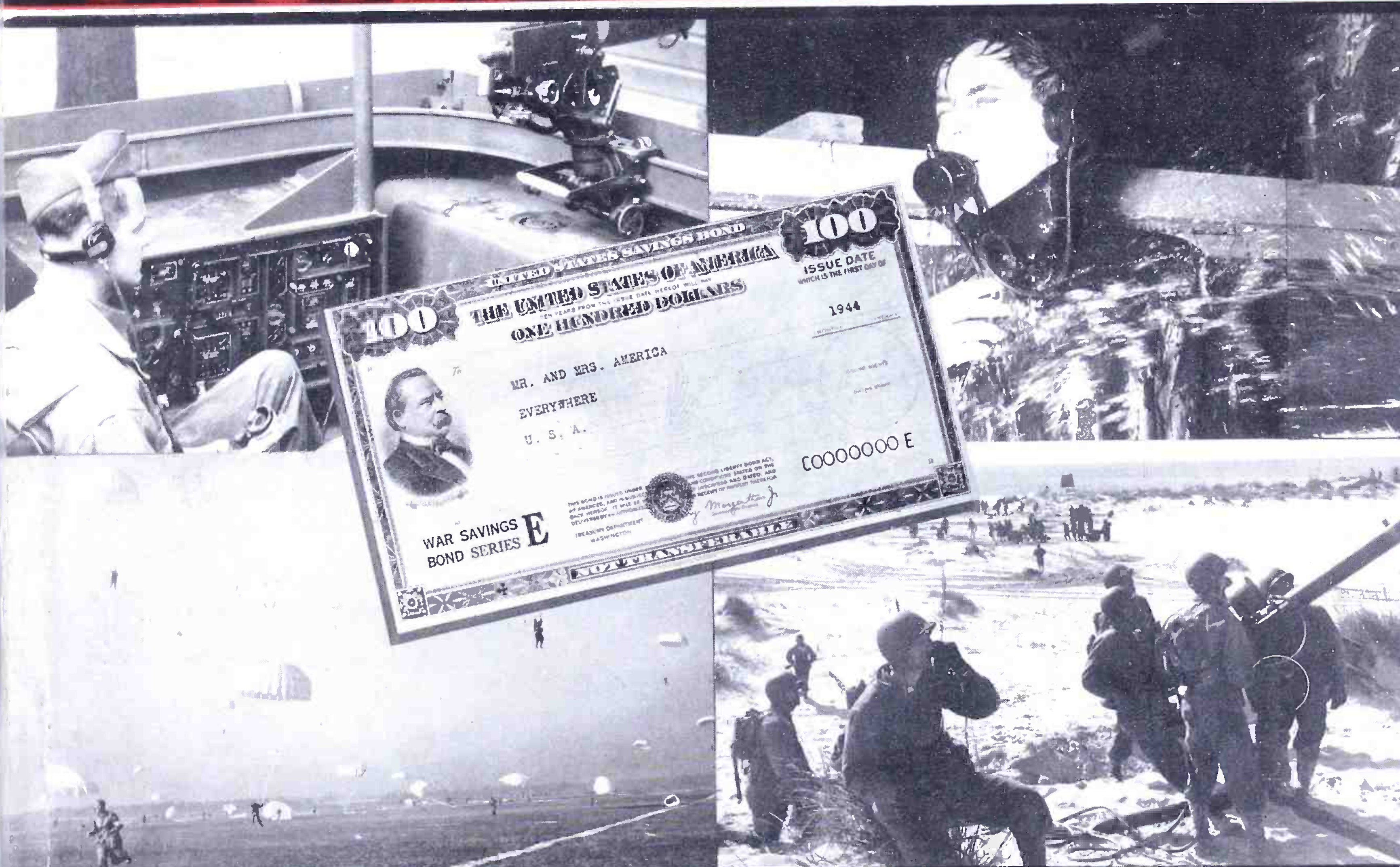
COMMUNICATIONS

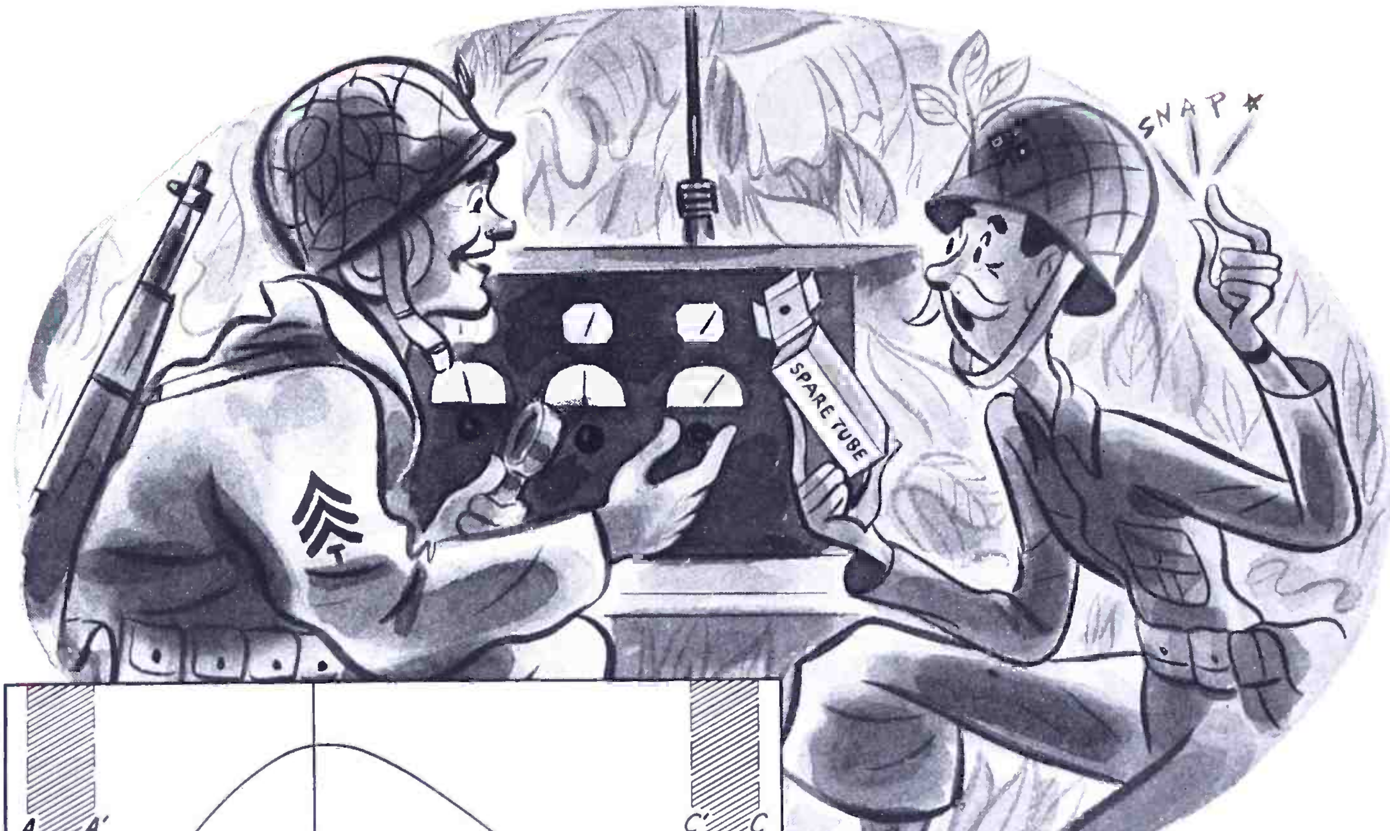


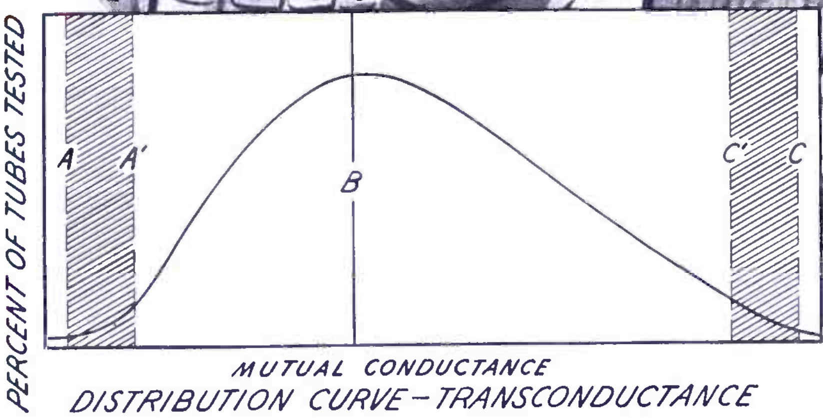
BUY ONE OF THESE BONDS TODAY!

JUNE 1944

- ★ RADIO ENGINEERING
- ★ 2-WAY SPEAKER COMMUNICATIONS
- ★ P-A PI-NETWORK TANK DESIGN
- ★ RESONANT COILED TRANSMISSION LINES
- ★ TRANSITRON CHARACTERISTICS
- ★ TELEVISION ENGINEERING

"Right On The Button"





DISTRIBUTION CURVE—TRANSCONDUCTANCE

Conscientious electronic equipment manufacturers avoid special selection of tubes. When a battlefront tube replacement is made, they want "on the button" performance. They allow for possible additive effects of tolerances for other components — and for the many minor differences of equipment assembly, wiring, and adjustment. Also they realize it is impracticable to manufacture all electronic tubes of a given type exactly alike. Yet they demand and deserve close observance of their tolerances for each tube characteristic. (See A and C on the distribution curve.) Hytron insists on still tighter factory specifications. (Compare A′ and C′.)

Hytron goes still further. Based on past experience — its own and others' — whenever practicable a "bogie", or desired goal, for each characteristic is set. (Compare B.) Controlled design and production aim at producing the majority of tubes with this preferred value, which is not necessarily and arbitrarily midway between tolerances. It is rather the ideal for peak performance—dictated by experience and attainable if exact duplication were possible.

Specify Hytron for tighter specifications — for "bogie"-controlled production — for uniform performance.

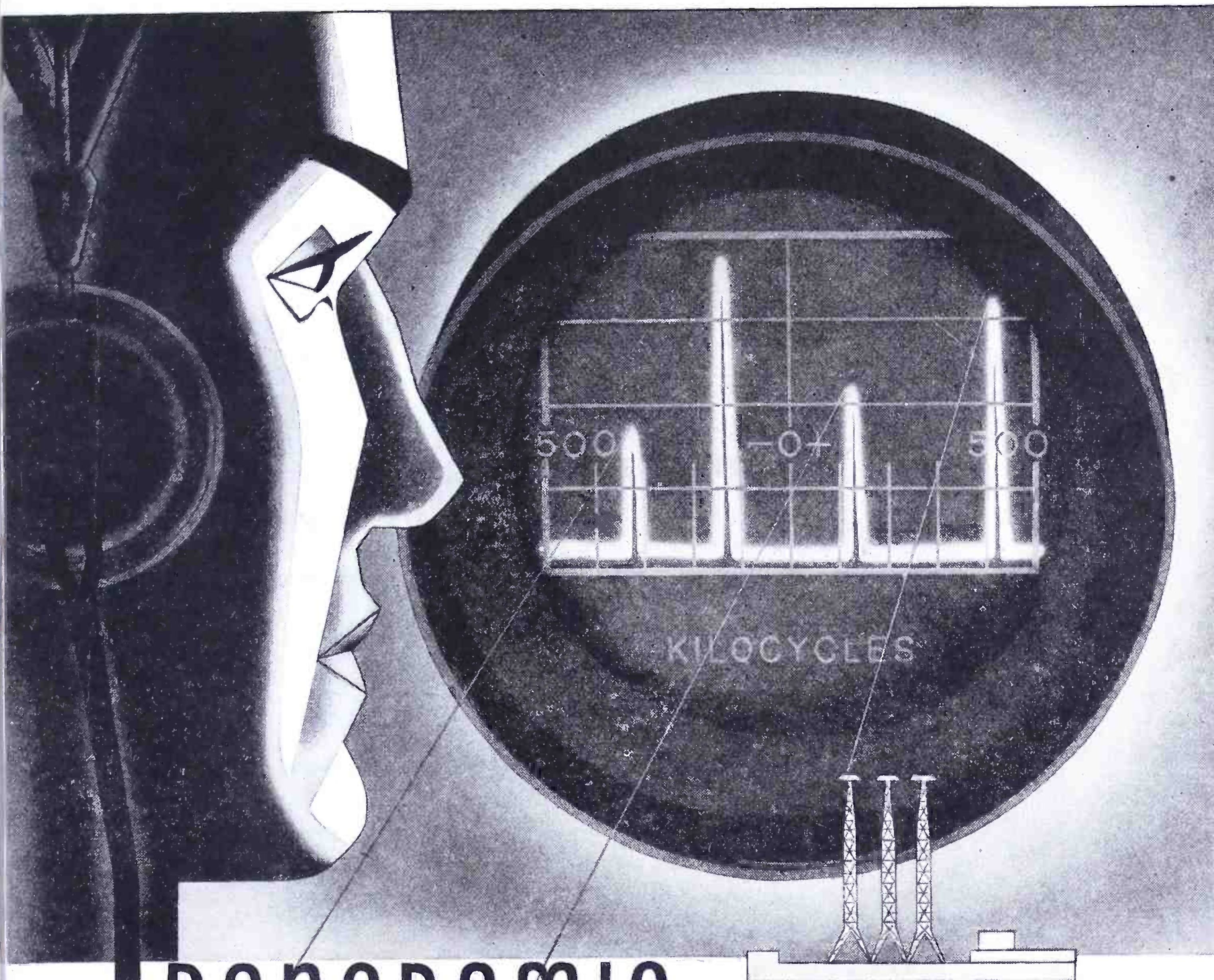
OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON CORPORATION ELECTRONIC AND RADIO TUBES

SALEM AND NEWBURYPORT, MASS.

HYTRON RADIO TUBES

BUY ANOTHER WAR BOND



PANORAMIC RECEPTION

SIMULTANEOUS VISUAL OBSERVATION OF SIGNALS OVER A BROAD BAND OF FREQUENCIES

Panoramic Reception is the technique of viewing simultaneously a multiplicity of signals received over any given portion of the radio frequency spectrum. Its uses include the measurement and comparison of frequency, inductance, capacitance, and resistance. The Panoramic Radio Corporation has conceived and pioneered the major developments in this field, yet we feel that we have but scratched the surface of the tremendous sphere encompassed by Panoramic Reception. Its successful use in communications, direction finding, navigation, production, and the laboratory presents only an incomplete picture of its possibilities. Why not let our engineers demonstrate how much of your work can be expedited by Panoramic equipment?

PANORAMIC RADIO CORPORATION

THE MARK OF THE ORIGINAL PANORAMIC

242-250 WEST 55TH ST., New York 19, N. Y.

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

We See...

THE SWEEPING MIGHT OF RADIO COMMUNICATIONS rose to new heights on that day all the world will remember . . . D-Day . . . June 6. At home and on the blazing front, this striking medium of contact met its vigorous responsibilities like a champion.

"In its vigilance and preparedness for the recounting of this momentous event," said Harold Ryan, NAB president, "American radio has distinguished itself as a great heart which never stops beating."

ENGINEERING PLANNING OF THE FUTURE will probably follow standardized organization formats, according to plans discussed at the recent RMA War Conference. Such a program will provide for groups concerned with *components, electronic tubes, transmitters, receivers, electronic applications, and engineering counsel.* In the transmitting section the problems of standard broadcasting, v-h-f broadcasting, television, aviation systems, marine systems, emergency services, fixed communications, and special electronic applications will be the major points of consideration.

This intelligent approach should eliminate many a development and production problem, and provide for better communications.

INTEREST IN TRAIN RADIO appears to be gaining daily. Several railroads have already held successful demonstrations of their communications' systems. The most recent demonstration in Chicago, by the Chicago, Rock Island, and Pacific Railway Company, using f-m, was praised by everyone.

Authorizations for experimental systems have been granted to nine railroads. And they'll be able to use a-m or f-m within the 30 to 40 and 100 to 400 mc bands, with a maximum power of 10 watts.

Train radio appears to have hit its stride.

CONGRATULATIONS TO R. C. COSGROVE on his appointment as president of the RMA.—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.

JUNE, 1944

VOLUME 24 NUMBER 6

COVER ILLUSTRATION

Make the world's greatest investment. . . . Buy a Bond. You're helping Uncle Sam build what he needs today, and subscribing to an investment for your future, too!
(Photos courtesy U. S. Marine Corps, U. S. Army Signal Corps, RCA Victor, Westinghouse)

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

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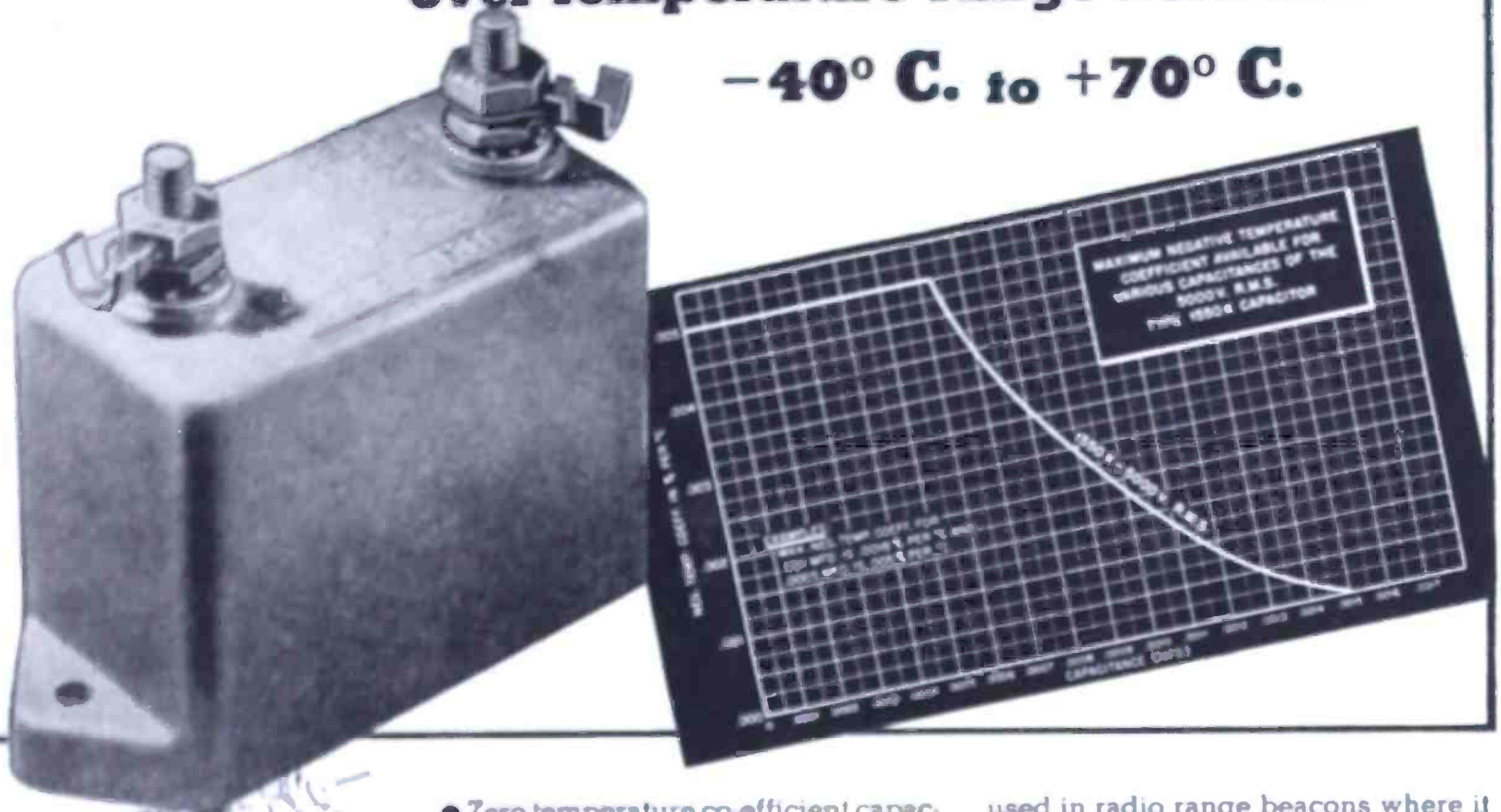
Advertising and Editorial offices, 19 East 47th St., New York 17, N. Y. Telephone PLaza 3-0483. Cleveland 6, Ohio; James C. Munn, 10515 Wilbur Avenue Pacific Coast Representative: Brand & Brand, 816 W. Fifth St., Los Angeles 13, Calif.; Telephone, Michigan 1732. Wellington, New Zealand: Te Aro Book Depot. Melbourne, Australia: McGill's Agency. Entered as second-class matter October 1, 1937, at the Post Office at New York, N. Y., under the act of March 3, 1879 Yearly subscription rate: $2.00 in the United States and Canada; $3.00 in foreign countries. Single copies, twenty-five cents in United States and Canada; thirty-five cents in foreign countries.

Accurately MAINTAINED CAPACITANCE

over temperature range between

−40° C. to +70° C.



Type K compensating capacitors are supplied only in low-loss (yellow) XM bakelite cases. Sealed for immersion.

Available in limited range of capacitances and voltage ratings as listed in latest catalog.

Obtainable in any temperature co-efficient from −.005% to +.005% per degree C. over temperature range from −40° C. to +70° C.

Standard tolerance is plus/minus 5%. Closer tolerances obtainable at extra cost. Minimum tolerance available is plus/minus 2% or 1 mmf., whichever is greater.

Can be used to correct normally positive temperature co-efficient of inductances for maintenance of constant L-C products (resonant frequency) of tuned circuits independent of temperature.

● Zero temperature co-efficient capacitors can be used wherever a *capacitance independent of temperature* is required. Furthermore, since Aerovox Type K compensating capacitors are also available in any temperature co-efficient from −.005% to +.005% per degree C., various circuits can be developed or refined to utilize the negative, zero or positive temperature co-efficients of such compensating capacitance. Examples:

One suggested application is as a shunt for the measurement of r.f. currents with a vacuum-tube voltmeter as the indicating instrument.

Compensating capacitors may be used in radio range beacons where it is essential to maintain uniform currents both in magnitude and phase relationship simultaneously in several circuits, regardless of wide temperature changes.

By the use of compensating capacitors it is feasible to obtain oscillator frequency stability comparable with that obtained from quartz crystals, and with marked economies in weight, space, cost.

Therefore, when you face the problem of maintaining constant operational characteristics despite temperature variations, just specify Aerovox Type K compensating capacitors.

● ***WRITE FOR LITERATURE...***

Aerovox Type K compensating capacitor curves, technical details and listings, are included in the new Aerovox Capacitor Manual. Write on your business stationery, for your copy.

AEROVOX *Capacitors*

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MAKE ACCURATE TESTS AND MEASUREMENTS *faster* WITH hp INSTRUMENTS

There is an *-hp-* Electronic instrument for making most every important test or measurement in the field of radio and electronics. Their accuracy is unexcelled and their performance unequalled. Simplicity of operation makes for greater speed . . . saves you valuable time whether on the production line or in the laboratory. Get the facts about *-hp-* Instruments today. Ask for catalog number 17A. Also have your name put on the list for regular mailing of *-hp-* technical bulletins which give valuable current information about electronic instruments. No obligation, of course.

823

HERE'S A PARTIAL LIST OF TESTS AND MEASUREMENTS THAT CAN BE MADE WITH STANDARD hp INSTRUMENTS

- *Distortion Measurement*
- *Generate Standardized Voltages*
- *Measure Audio Frequencies*
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- *Measure Wave Harmonics*
- *Acoustic Measurement*
- *Noise Analysis*
- *Measure Frequency Response*
- *Square Wave Measurement*
- *Establish Standard Frequencies*
- *Establish Standard Ratios by Attenuation*
- *Provide Voltage for Bridge Measurement*

Special instruments and combinations of instruments can be supplied to fill your needs. Let our engineers help solve your problem.

HEWLETT-PACKARD COMPANY

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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.

Electronic and Magnetic Devices

CONSOLIDATED RADIO

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RADIO PRODUCTS

Serve PAA

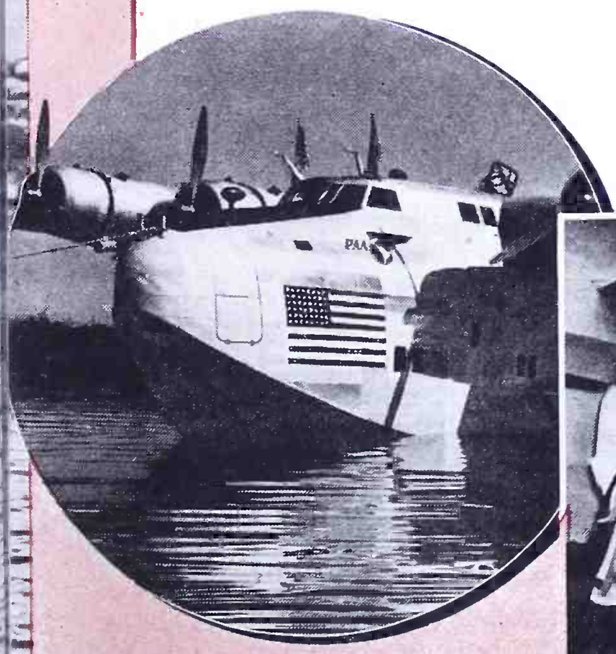
PAN AMERICAN WORLD AIRWAYS continues to perform a vital wartime service by speeding men and materials to every U.S. front and outpost . . . and AAC Precision Radio Products play an important part in this service.

As the giant *Clippers* spread their wings across the world, AAC Products help to maintain communications along the lifelines of this vast system which flies to every continent on the globe. These products are in use at operations bases, both here and overseas.

This is just one example of how the engineering and production skill of Aircraft Accessories Corporation serves the world's great airlines—as well as various branches of the armed forces. As one of America's largest producers of transmitters and other precision radio equipment, AAC offers the services of its Engineering Department in designing special equipment for you, without obligation.

ELECTRONICS DIVISION

KANSAS CITY, KANSAS



In war as in peace the PAA Clippers serve humanity. Here 1810 pounds of medical supplies go aboard at LaGuardia Field.

(E-54)

ACCESSORIES CORPORATION

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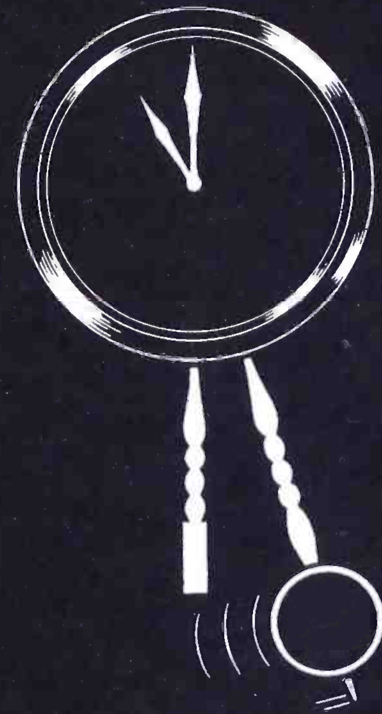
New York, N. Y. Burbank, Calif. Cable Address: AACPRO

the 11th hour... 11th day... 11th month...



1918 *Armistice* WAS SIGNED!

November 10th, 1918 . . . 1,081 men were killed, captured, and wounded! That *extra* day may mean ***your*** boy's life! . . . Those *extra* bonds, scrap, pints of blood . . . will mean *Victory* sooner! . . .

Are ***you*** making the most of your weapons?

Here, at Kenyon, we're mighty proud to be playing a small part in winning a big war. That is why every Kenyon transformer used by our armed forces reflects the same high craftsmanship and precision that went into our peacetime production. To bring victory closer, Kenyon workers are determined to do their share by turning out good transformers as fast as they know how.

THE MARK OF EXCELLENCE

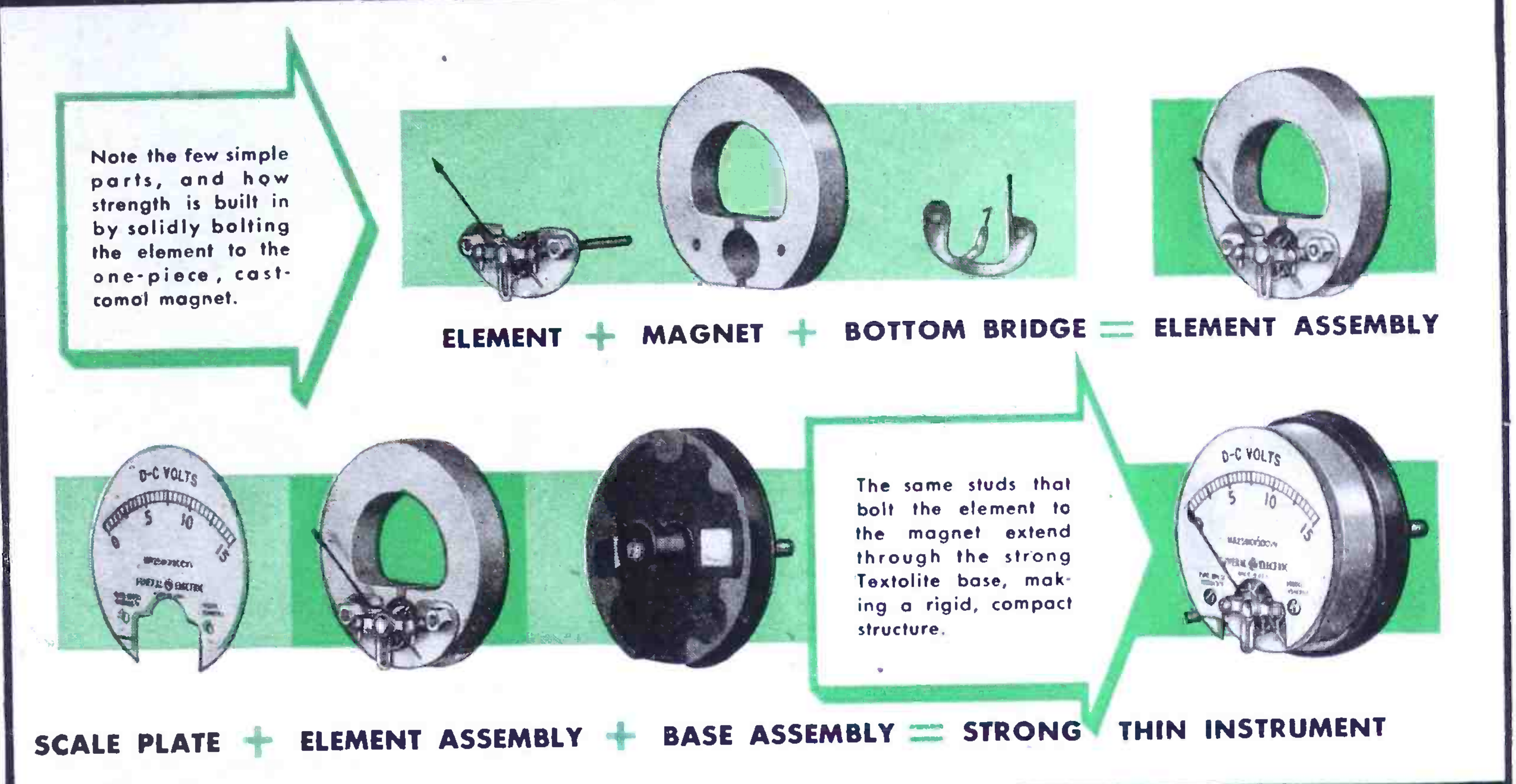
KENYON TRANSFORMER CO., Inc.

840 BARRY STREET
NEW YORK, U. S. A.

New INTERNAL-PIVOT 2 1/2-inch PANEL INSTRUMENTS ...1 inch deep

Type DW-53 d-c voltmeters, ammeters, and volt-ammeters. Designed to measure voltage and current in battery and battery-charging circuits on naval aircraft. They meet all applicable Navy specifications.

SEE THE SIMPLICITY AND STRENGTH OF THEIR DESIGN



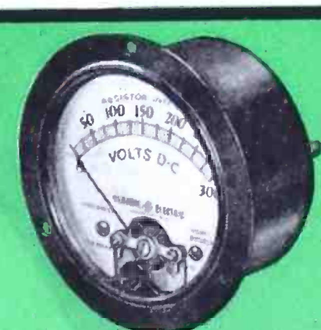
...built for tough jobs and long life

COMBAT service on aircraft and in military radio is the crucial test for any electric instrument. To meet the requirements of such severe service, G-E engineers went to extremes to gain simplicity and strength in the design of these new panel instruments.

What isn't shown clearly in the pictures above is the internal-pivot construction and how the pivots are mounted to the inside of the armature shell instead of being secured to the outside of the armature winding. The pivot shank actually extends through the armature shell, and is anchored firmly on both sides of the shell by pressing two brass washers over the pivot shank. This construction makes the entire element assembly 20 per cent thinner.

There are many other features: large-radius pivots, hard-glass jewels, good damping, and ample clearances between stationary and moving parts. Added up, these features give you an instrument well able to withstand vibration and hold its rated accuracy.

If you want the complete story of how these instruments pack all-round fine performance in a small space, ask our nearest office for Bulletin GEA-4064, which covers instruments used for radio and other communications equipment; or Bulletin GEA-4117 which describes those suitable for naval aircraft. *General Electric Co., Schenectady 5, N. Y.*



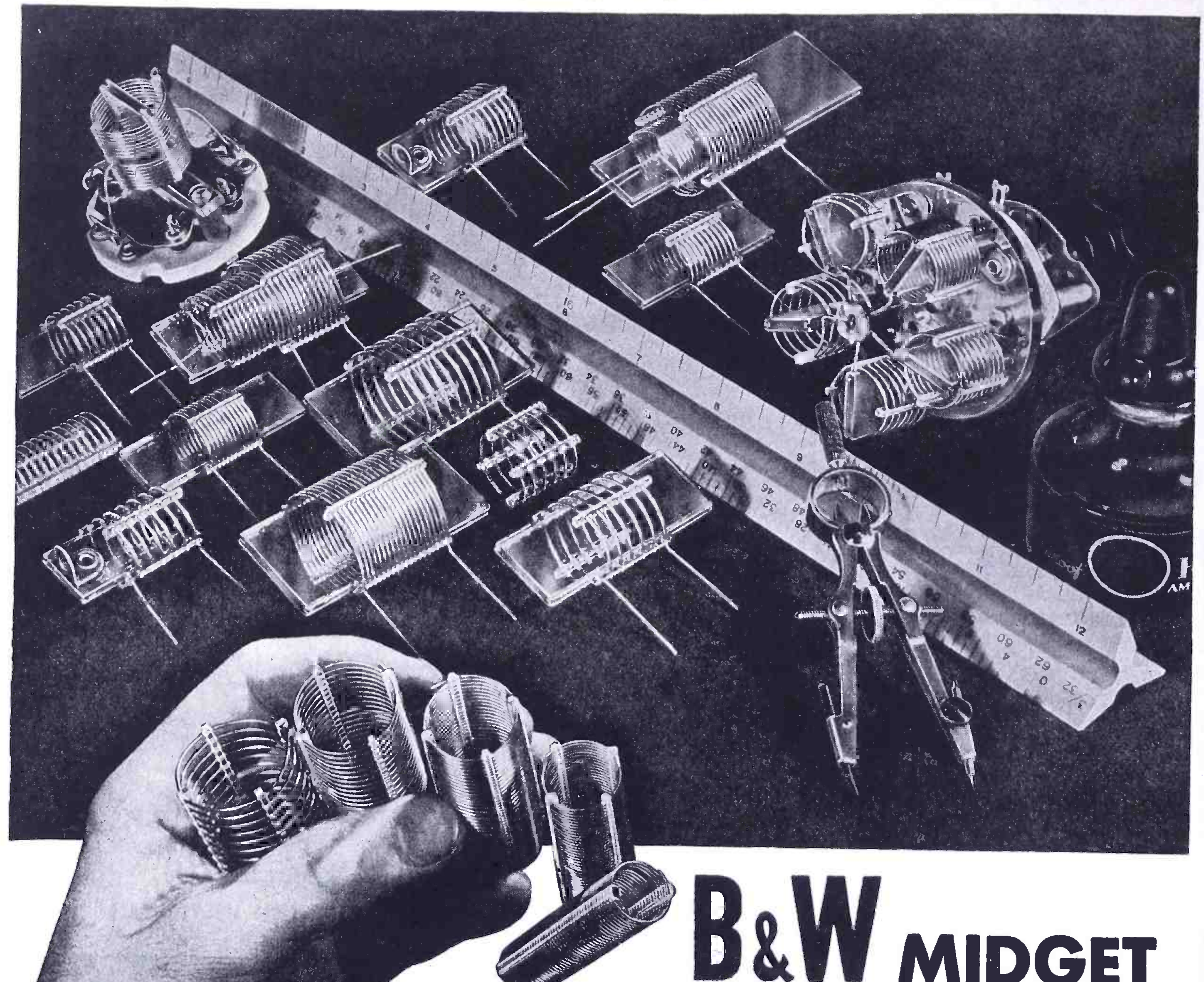
For radio and other communications service: Type DW-51 d-c voltmeters, ammeters, milliammeters, microammeters; Type DW-52 radio-frequency ammeters (a-c thermocouple-type). Cases are brass or molded Textolite.

GENERAL ELECTRIC

602-45-6200

HEADQUARTERS FOR ELECTRICAL MEASUREMENT

Real "He Man" Coils IN MINIATURE!



B&W MIDGET AIR-WOUND INDUCTORS

Now, for the first time, you can get B & W Air-Wound Coils in very small sizes from ½" to 1¼" diameter, in ⅛" steps, and in winding pitches from 44 to 4 turns or less per inch. Almost any type of mounting can be supplied.

Applications for these tiny coils include: coil switching turret assemblies; intermediate frequency transformers; high-frequency r-f stages (low-powered transmitter or receiver); all types of test equipment involving tuned r-f circuits; high-frequency r-f chokes, and numerous others.

The coils have a high Q, due to the almost total absence of insulating material in the electrical field. They are exceptionally light in weight and extremely rigid. Normally wound with tinned copper wire in sizes from #28 to #14, they can also be supplied with coin silver, coin silver jacketed, bare copper, or phosphor bronze wire. All types may be equipped with either fixed or variable internal or external coupling links, or other non-standard features. Samples on request to quantity users. Send us your specifications!

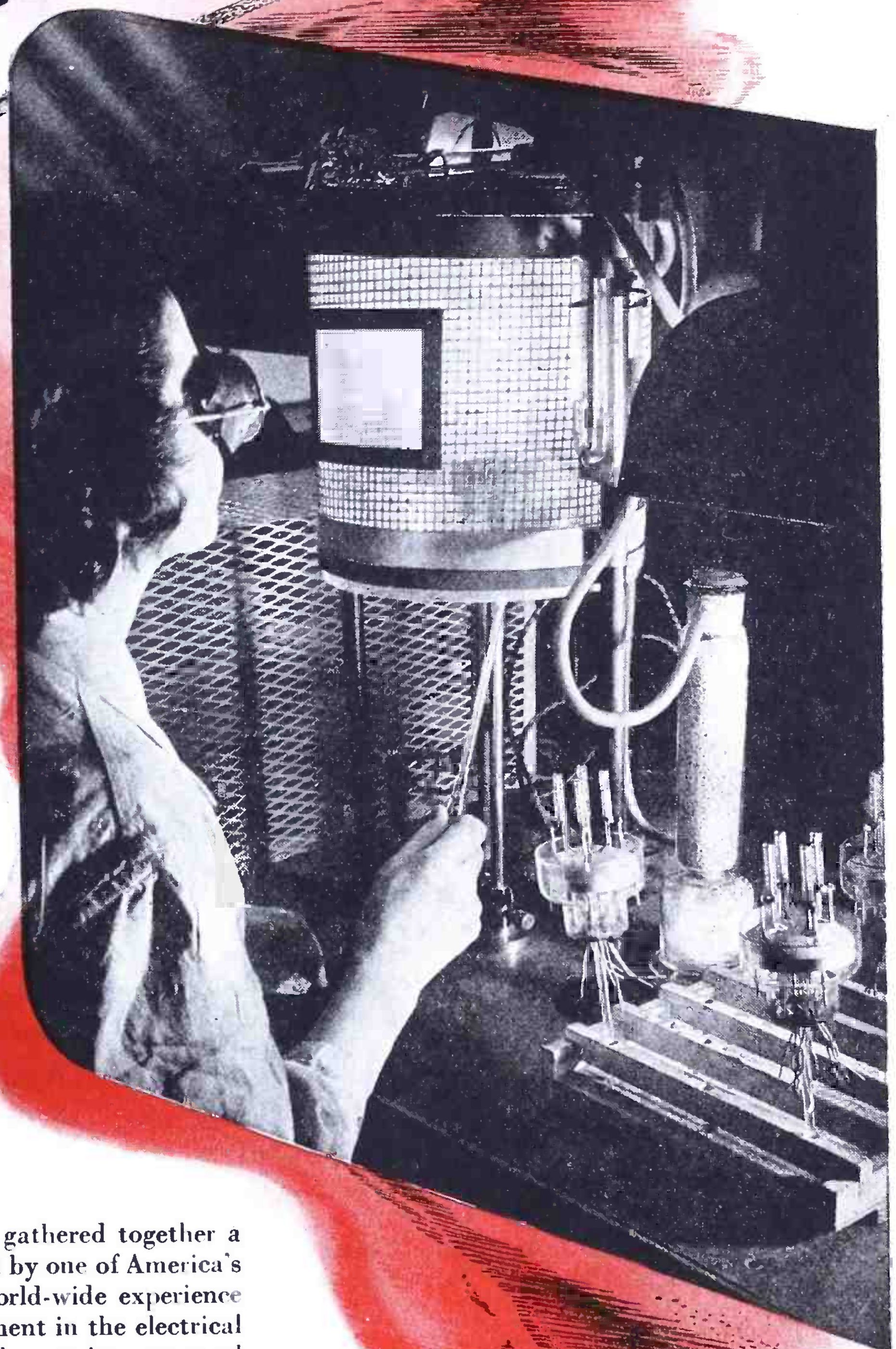
B&W

BARKER & WILLIAMSON
235 FAIRFIELD AVENUE — UPPER DARBY, PA.

AIR INDUCTORS • VARIABLE CONDENSERS • ELECTRONIC EQUIPMENT ASSEMBLIES

Exclusive Export Representatives: Lindeteves, Inc., 10 Rockefeller Plaza, New York, N. Y., U. S. A.

FLASHING LONG LIFE INTO POWER TUBES



IN transmitting tubes operating in military communications at ultra high frequencies, long life and uniform electron emission are imperative requirements. The photograph illustrates one interesting tube manufacturing operation with the tungsten filaments being "flashed" in a hydrogen atmosphere as a protection against oxidation.

North American Philips engineers build long life expectancy, optimum electron emission and all-round satisfactory performance into every NORELCO tube they manufacture.

Although all the tubes we produce now go to the armed forces, we invite inquiries from prospective users. A list of tube types we are especially equipped to produce will be sent on request.

In the North American Philips Company, there is gathered together a team of outstanding electronic engineers, captained by one of America's leading physicists, and coached by a group with world-wide experience resulting from fifty years of research and development in the electrical field. This new combination of technical talent has at its command many exclusive processes that insure electronic devices of the highest precision and quality. Today, North American Philips works for a United Nations' Victory; tomorrow, its aim will be to serve industry.

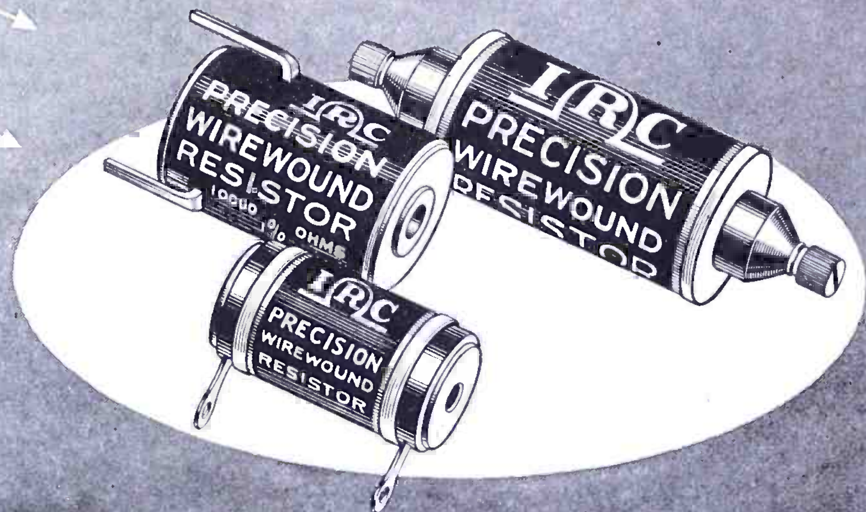
NORELCO PRODUCTS: Quartz Oscillator Plates; Amplifier, Transmitting, Rectifier and Cathode Ray Tubes; Searchray (X-ray) Apparatus, X-ray Diffraction Apparatus; Medical X-ray Equipment, Tubes and Accessories; Electranic Measuring Instruments; Direct Reading Frequency Meters; High Frequency Heating Equipment; Tungsten and Molybdenum products; Fine Wire; Diamond Dies. When in New York, be sure to visit our Industrial Electronics Showroom.

Norelco ELECTRONIC PRODUCTS by
NORTH AMERICAN PHILIPS COMPANY, INC.

Executive Offices: 100 East 42nd Street, New York 17, N. Y.
Factories in Dobbs Ferry, N. Y.; Mount Vernon, N. Y.
(Metalix Division); Lewiston, Maine (Elmet Division)

IRC WILL BE READY

with PRECISION WIRE WOUND RESISTORS



WHEN IT'S OVER "OVER THERE"

IRC will be in a specially favorable position to supply *all types* of Resistance units—of high Quality—in large Quantity—at low costs made possible by mass production.

FIRST IN WAR . . . FIRST IN PEACE

Produced by the most modern and efficient manufacturing methods, tested and perfected to meet the exacting demands of war, IRC Resistors will maintain their leadership as first choice of electronic engineers, manufacturers and service industries of tomorrow. . . . You are invited to consult our engineering-research staff now, in confidence, on any resistance problems connected with your peacetime products.

CHECK THESE FEATURES OF IRC PRECISION WIRE WOUND RESISTORS

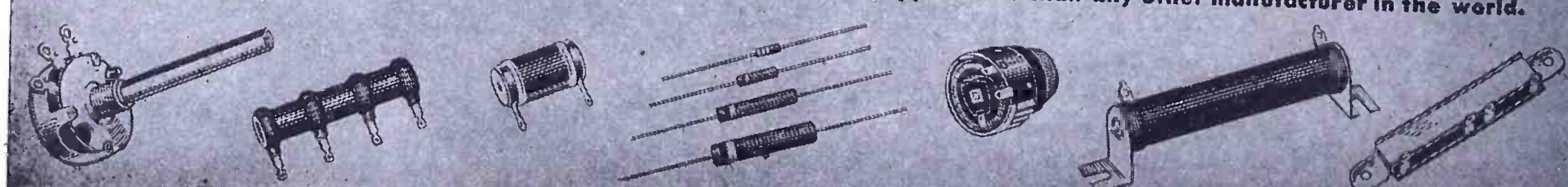
1. *Most rigid specifications on enameled wire.*
2. *Largest size wire used for each resistance value and size.*
3. *Steatite ceramic (with baked impregnation to prevent moisture absorption and to protect enameled wire from surface abrasions).*
4. *Specially designed winding machines eliminate stress and strain, avert damage to insulation and minimize fatigue of wire.*
5. *Baked impregnation of winding insures that wires remain rigidly in place and that resistors are independent of temperature variations.*

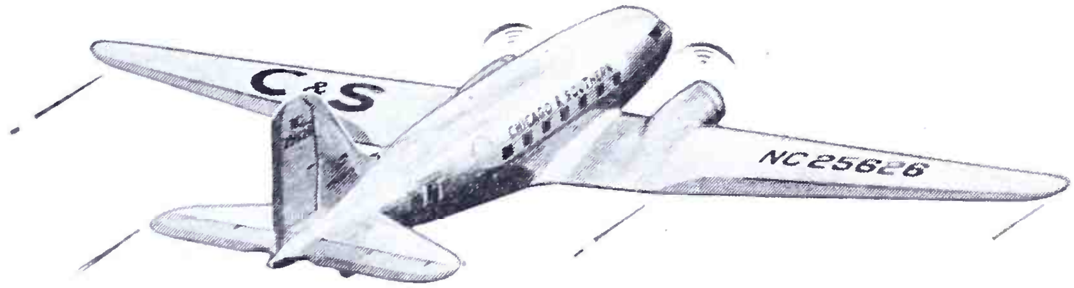
PREFERRED FOR PERFORMANCE • IRC • FIXED & VARIABLE RESISTORS

INTERNATIONAL RESISTANCE CO.

401 N. Broad St. Philadelphia 8, Pa.

IRC makes more types of resistance units, in more shapes, for more applications than any other manufacturer in the world.



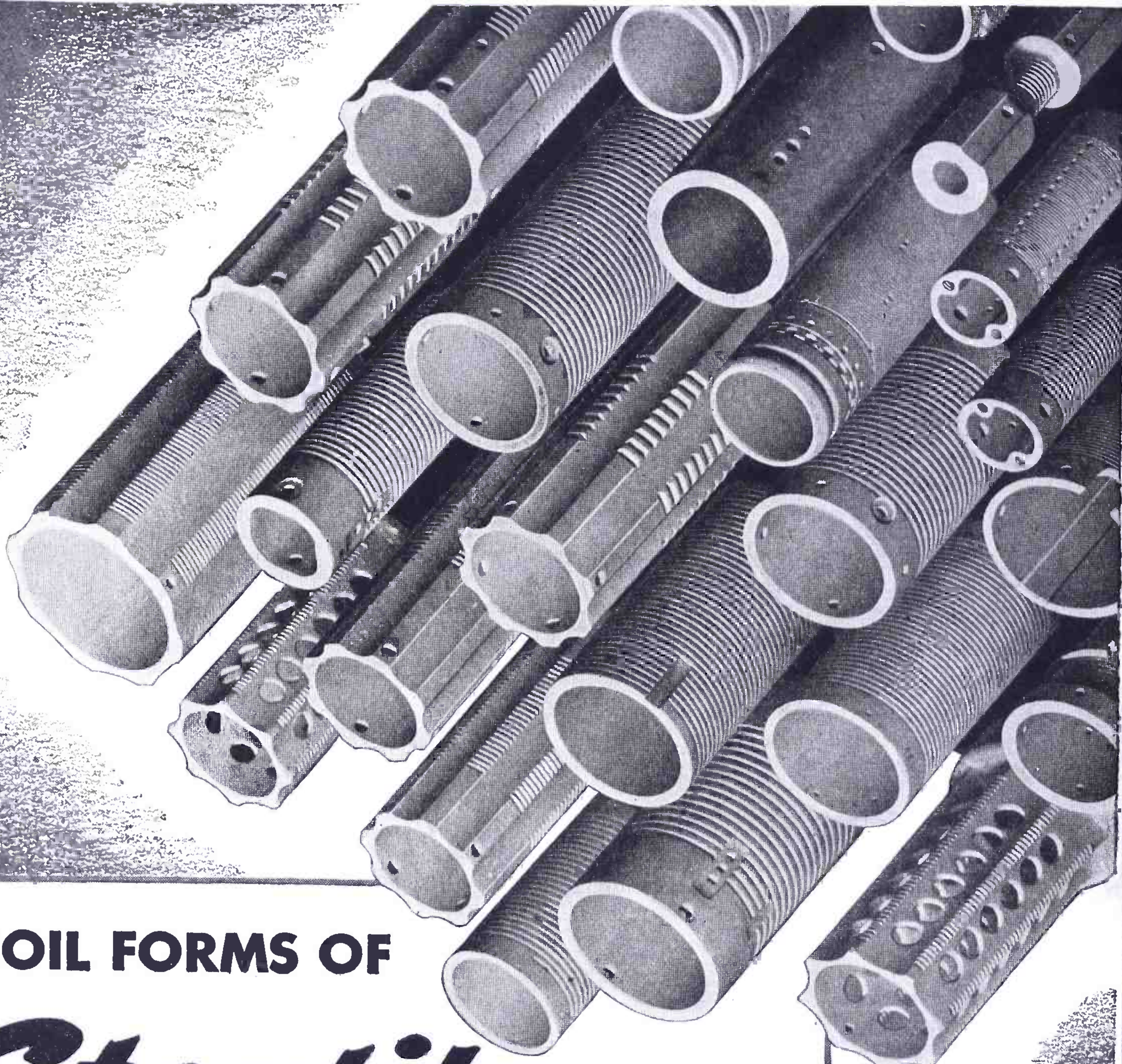


Chicago and Southern Air Lines
depend on
WILCOX RADIO EQUIPMENT

The "know how" that comes only with years of experience in research, experiment and proved production, is behind every piece of Wilcox equipment. Its reputation for reliable performance makes Wilcox preferred by major airlines. Military operations in all parts of the world today also utilize Wilcox installations for dependable communications.

WILCOX ELECTRIC COMPANY
Manufacturers of Radio Equipment
Fourteenth & Chestnut
Kansas City, Mo.

Photographs, courtesy Chicago & Southern Air Lines



GOOD NEWS FOR TELEVISION!

Since National Union established new production records on cathode-ray tubes—the dream of low-cost television for the average post-war home has taken a long step toward fulfillment.

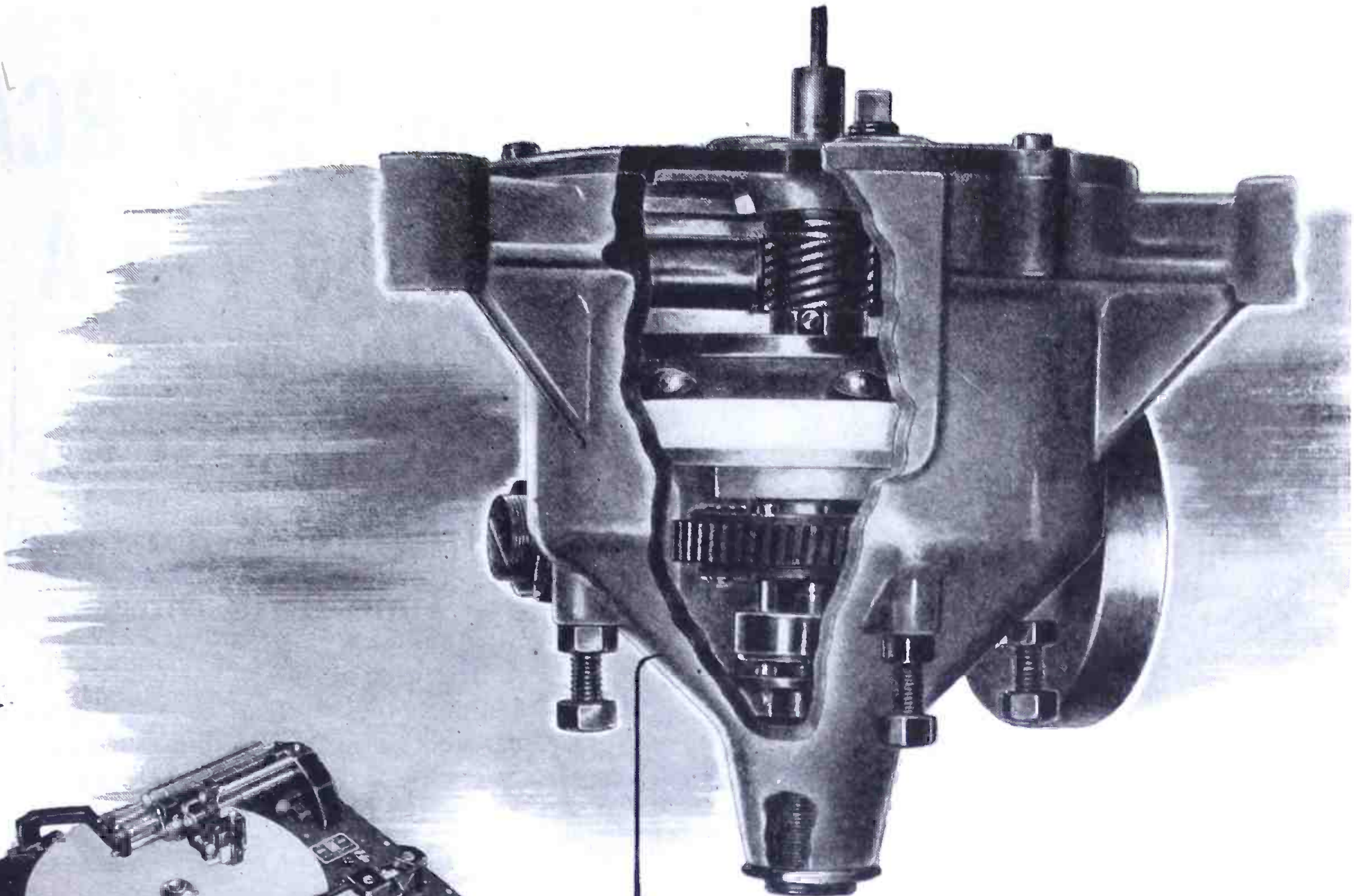
Consider the fact that National Union has succeeded in raising its cathode-ray tube production to a volume many times greater than the combined pre-war C-R tube output of the entire industry! To achieve such a production miracle required, of course, completely new techniques, new mechanical aids to operators, new quality control measures. But above all, it required imagination and technical capacity to cut loose from the long prevalent conception that the manufacture of cathode-ray tubes was strictly a laboratory project. N. U. engineers proved that these laboratory techniques *could* be adapted to high speed streamline mass production. And, it is significant that N. U. C-R tubes have acquired at the same time an international quality reputation, with special distinction for their superior fluorescent screens.

In the post-war expansion of television, as in other applications of electronic tubes for home and industry, National Union achievements in engineering and production have set new horizons. Remember to *count on* National Union.

NATIONAL UNION RADIO CORPORATION, NEWARK, N. J.
Factories: Newark and Maplewood, N. J.; Lansdale and Robesonia, Pa.

NATIONAL UNION
RADIO AND ELECTRONIC TUBES

Transmitting, Cathode Ray, Receiving, Special Purpose Tubes • Condensers • Volume Controls • Photo Electric Cells • Panel Lamps • Flashlight Bulbs



No. 539 Portable Recorder

perfect timing

Fifteen minute transcriptions play back with split-second accuracy.

Where seconds count, maintaining broadcasting schedules or dubbing sound to synchronous-driven movie films, you're offered the perfect timing of the Fairchild Portable Recorder turntable drive.

The motor is synchronous. The drive is positive. Two speeds: 33.3 rpm by worm and gear; 78 rpm by precision friction-ball-race stepup. The only necessary interlocking device to other synchronous equipment is the A.C. line.

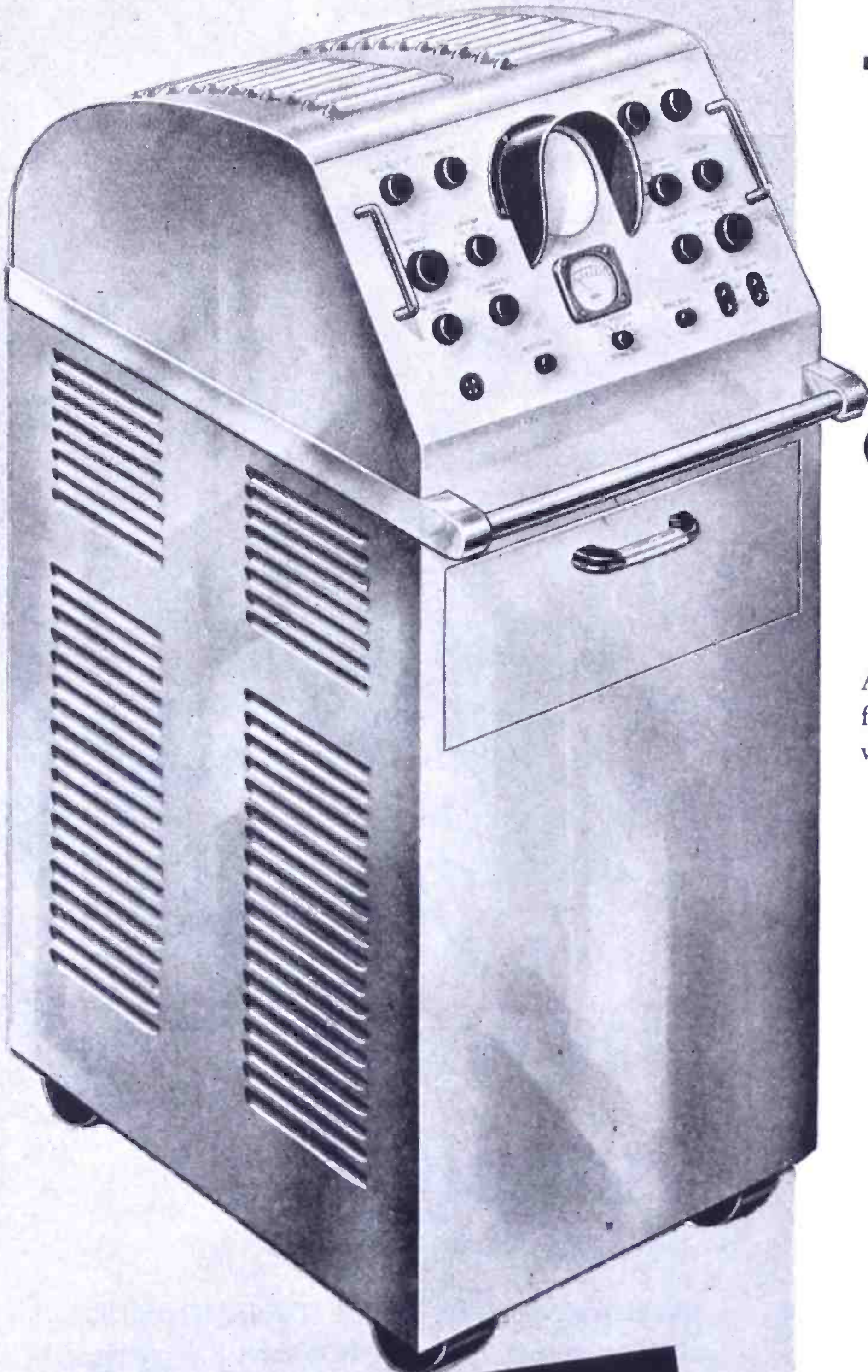
With professional use in mind, all Fairchild portable recording instruments are built to meet the exacting requirements of the radio and communications fields. To electronic skill Fairchild has added the plus of exceptional mechanical skill — skill long practiced in .0002" tolerance production of aerial cameras, aircraft sextants and aircraft computing gun sights.

The result of persistent research to provide studio-quality recording in the field is the Fairchild No. 539 Portable Recorder. Descriptive and priority data are available.

Fairchild CAMERA
AND INSTRUMENT CORPORATION

88-06 Van Wyck Boulevard, Jamaica 1, N. Y. • *New York Office:* 475 Tenth Avenue, New York 18, N. Y.

SOUND EQUIPMENT — PRECISIONIZED — *mechanically and electronically* — FOR FINER PERFORMANCE



The NEW RCA Type 715-A

Laboratory-type

OSCILLOSCOPE

Triggered Sweep and Time-Base Marker

A "custom-built" design now available for the first time for general use—especially suited for war work—ideal for post-war problems.

10 Important Features

1 Triggered sweep—individually triggered by each signal.

2 Time-base marker; one microsecond intervals.

3 Sinusoidal horizontal spot deflection at power line frequency with adjustable phase control.

4 Extended frequency range — vertical amplifier flat to 10 megacycles.

5 High vertical deflection sensitivity (.66 volts/inch).

6 Precisely compensated attenuator for vertical amplifier.

7 Calibration meter to permit direct determination of amplitude of any voltage component in signal.

8 Low input capacity and high input resistance for vertical amplifier.

9 Complete absence of cross-coupling between horizontal and vertical deflection circuits.

10 Regulated power supply to insure steady pattern on screen independent of line voltage changes.

For complete details, send for bulletin

Deliveries of this instrument will be as scheduled by WPB approved Form 3243 under Scheduling Order M-293. Please address inquiries to Test and Measuring Equipment Section, RADIO CORPORATION OF AMERICA, Camden, New Jersey.

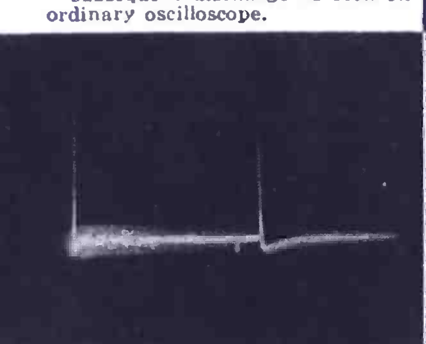
RCA

RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION • CAMDEN, N. J.

LEADS THE WAY.. *In Radio.. Television.. Tubes.. Phonographs.. Records.. Electronics*

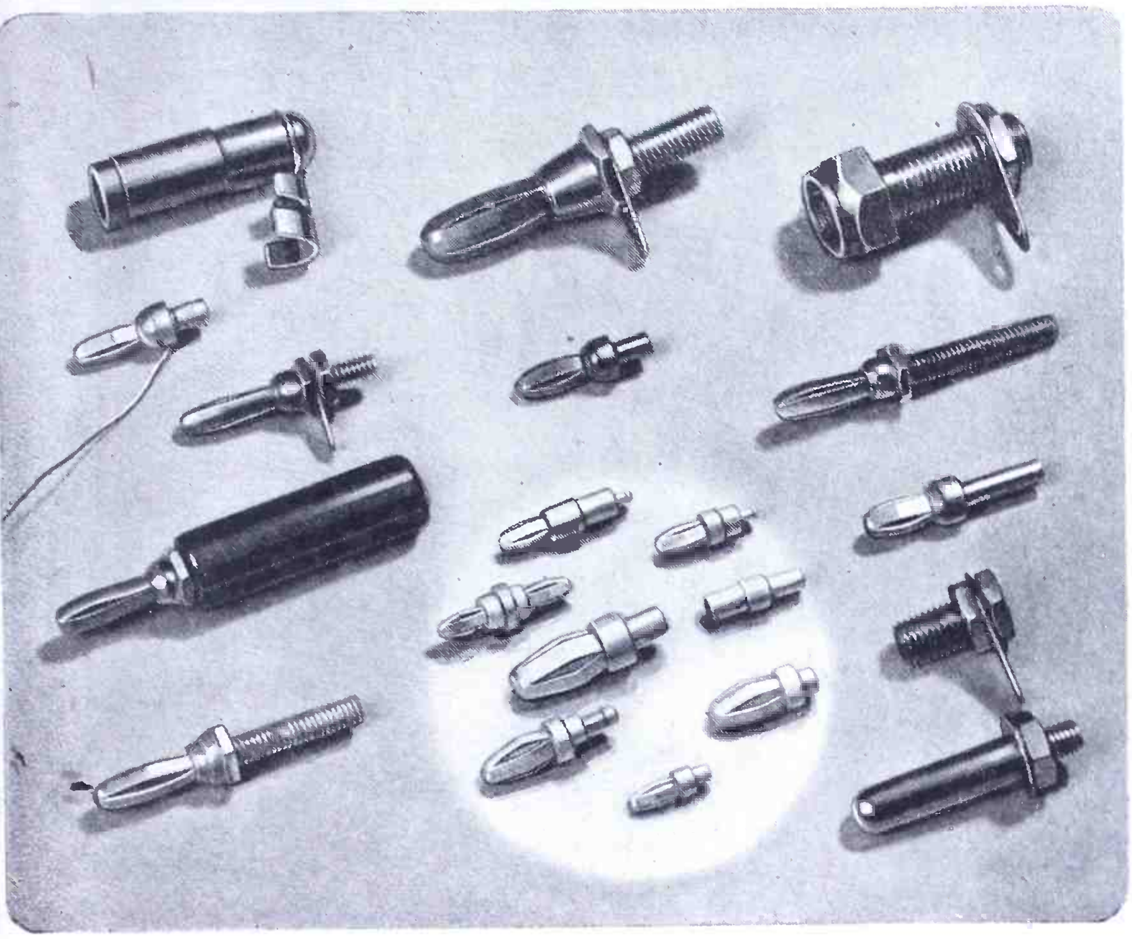
1 Sudden condenser charge and subsequent discharge as seen on ordinary oscilloscope.

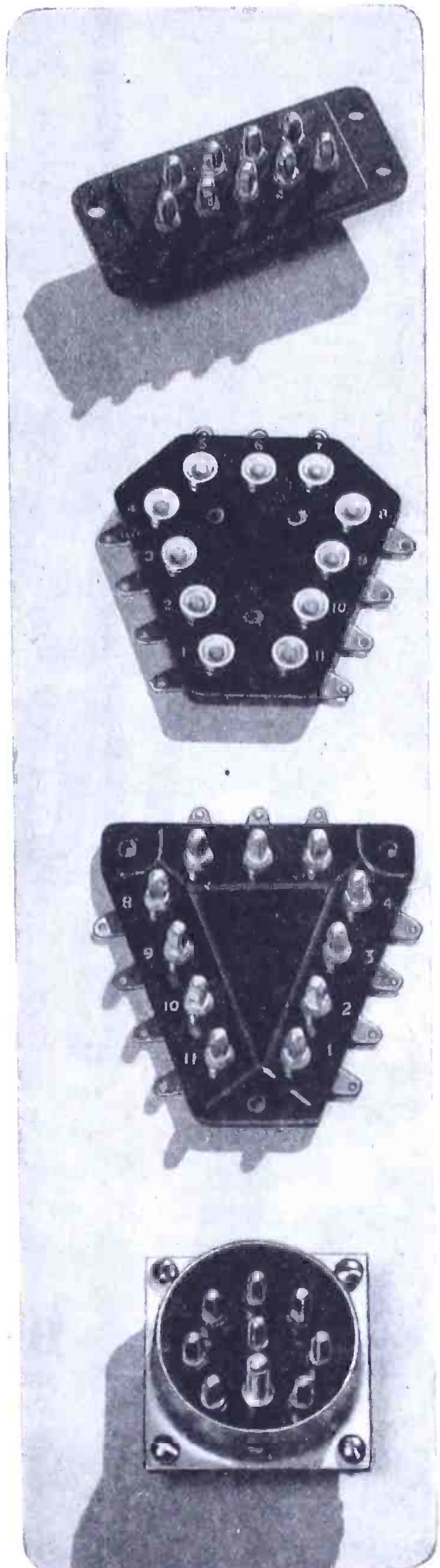


2 Externally synchronized and expanded 50 times, revealing the true form of one of the charges in Fig. 1.

3 The same charge, expanded 1000 times, permits detailed observation of the wave front.

4 Applying a one-microsecond time base marker allows determination of time intervals during the cycle.





and it's JOHNSON

That is the plus element you get at no extra cost.* Many manufacturers are producing plugs and jacks, some are very clever copies and some are not so clever. Some of these manufacturers are experienced in making electrical parts and many are not.

In Johnson you get the benefit of a quarter of a century of experience in manufacturing radio transmitter components and assemblies—a manufacturer who knows transmitter parts requirements and in fact, to assist the war effort, is actually building transmitters for the armed forces. Johnson engineers are therefore thoroughly familiar with the applications and functional requirements of all transmitter parts and these parts become more than mere mechanical assemblies. Many products are original Johnson designs and considered standard for comparison by the industry.

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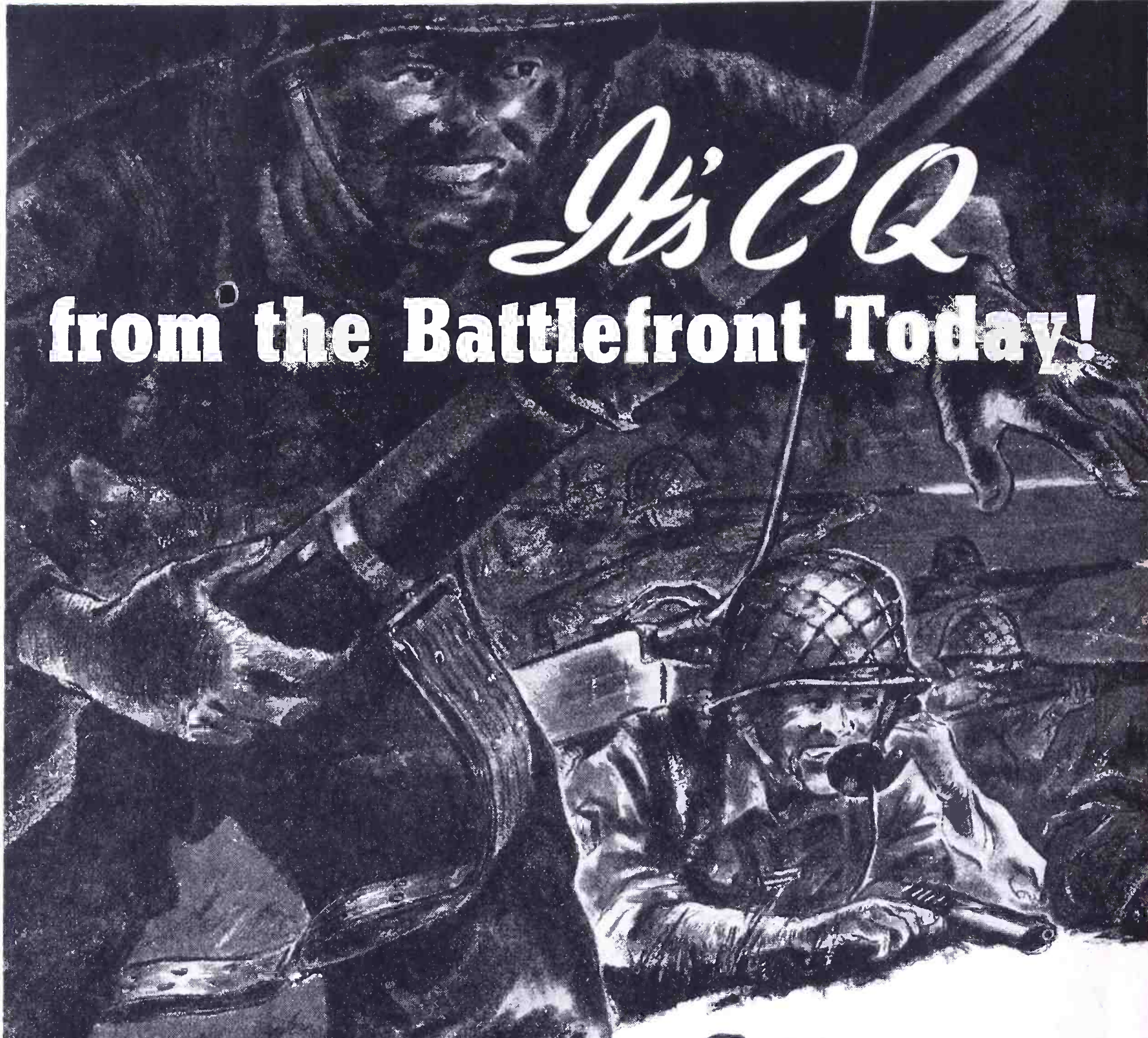

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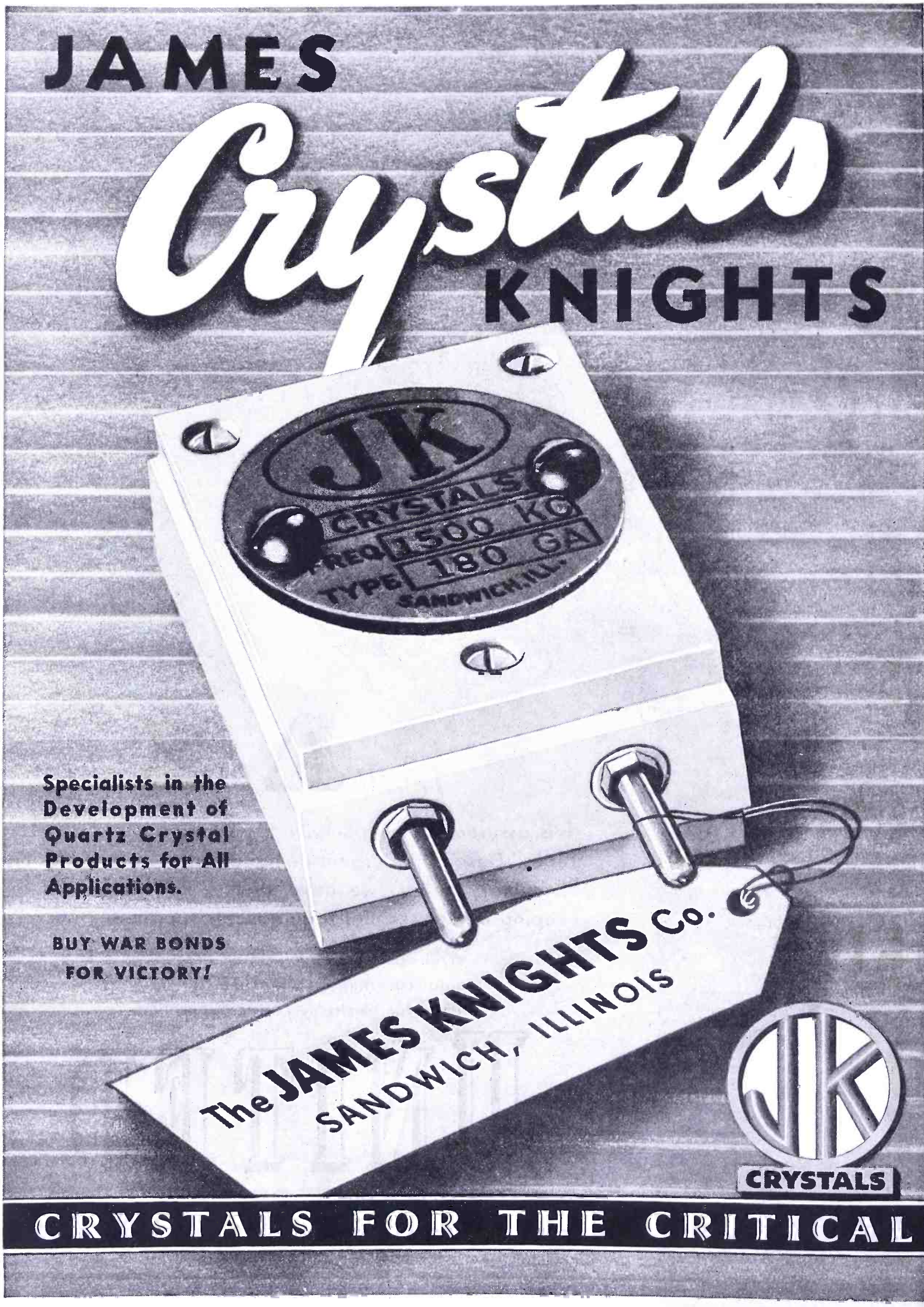
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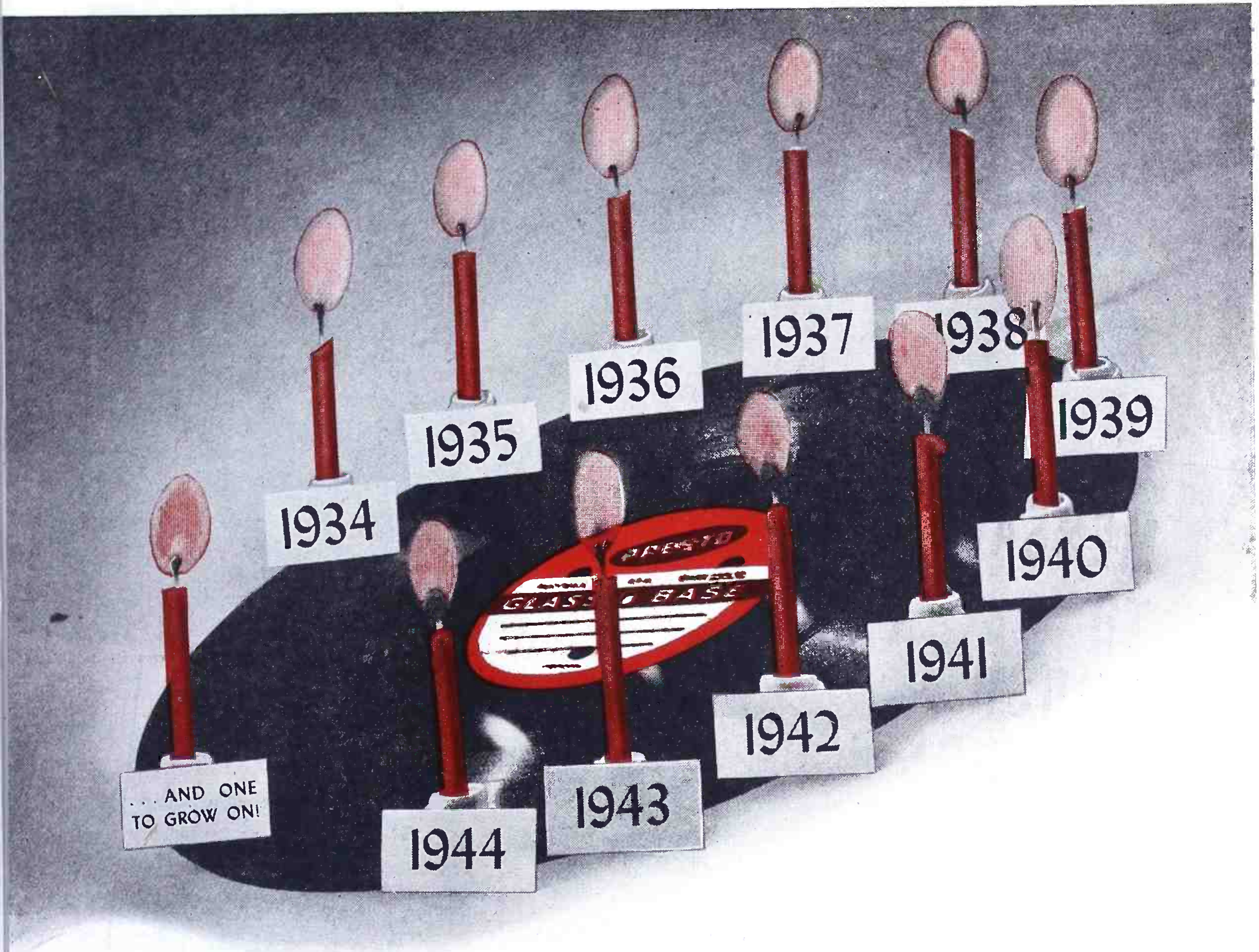

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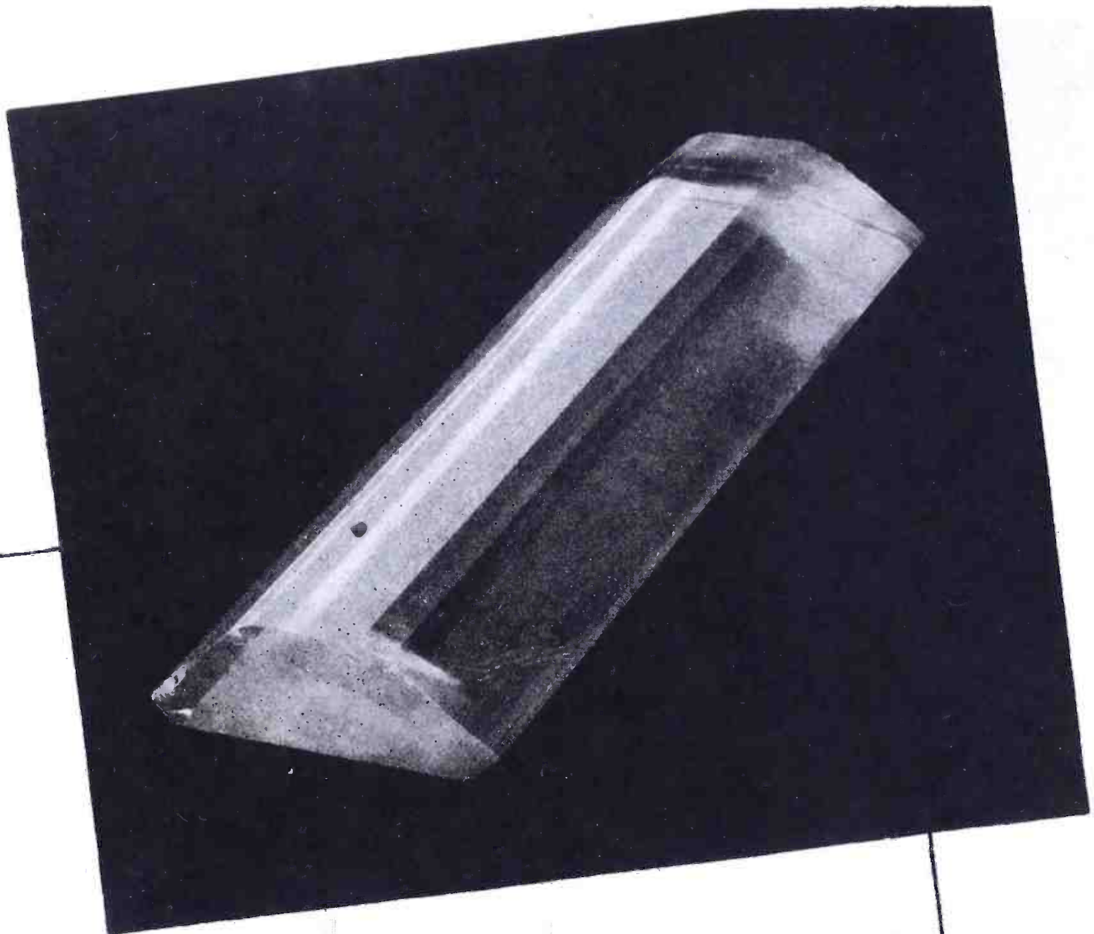

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The U. S. Treasury has set the overall goal at $16,000,000,000 — $6,000,000,000 from individuals alone. This is the biggest sum ever asked of the American people—*and it must be raised.*.

That's why the U. S. Treasury asks Management and Labor to sit down together and organize—NOW!

For organization—good organization—has been responsible for the excellent showing of the payroll market. And its most important single superiority has been personal solicitation—desk to desk, bench to bench, machine to machine personal solicitation. 71% of all persons on payroll deductions were solicited for the 4th War Loan.

Now, to personal solicitation, add the sales incentive of a definitely established plant quota. Build your campaign around a quota plan. Set up departmental goals. Stress percentage of participation figures. Stimulate group enthusiasm.

In planning your quota campaign, work in close cooperation with the Chairman of your War Finance Committee. Everything is set to make the 5th War Loan drive a huge success—with your help!

(Note: You've read this message. If it doesn't apply to you please see that it reaches the *one* person who can put it in action!)

Here's the Quota Plan:

1. Plant quotas are to be established on the basis of an *average* $100 *cash* (not maturity value) purchase per employee.
2. Regular Payroll Savings deductions made during the drive accounting period will be credited toward the plant quota.
3. 90% of the employees are expected to contribute toward raising the cash quota by buying extra 5th War Loan Bonds: 1—Outright by cash. 2—By extra installment deductions. 3—By extra installment deductions plus cash.

Example: **JOHN DOE Mfg. Co.** — 1,000 Employees

1,000 employees x $100	=	$100,000 Cash Quota
Regular Payroll deductions during the eight weekly payroll Accounting Periods of June and July		30,000
		$70,000 (to be raised by sales of extra Bonds to at least 900 employees)

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Alabama joins the growing list of States provided with the efficiency of a Motorola F-M Police Radiotelephone System. Nineteen strategically located Central Headquarter Stations equipped with three-way radio put State Police Authorities in constant touch with the 115 three-way radio patrol cars on Alabama's highways. All parts of the State are blanketed; State police forces are mobilized instantly; needless cruising is cut to a minimum; man power is conserved. Motorola designed, built, installed and services the entire system.

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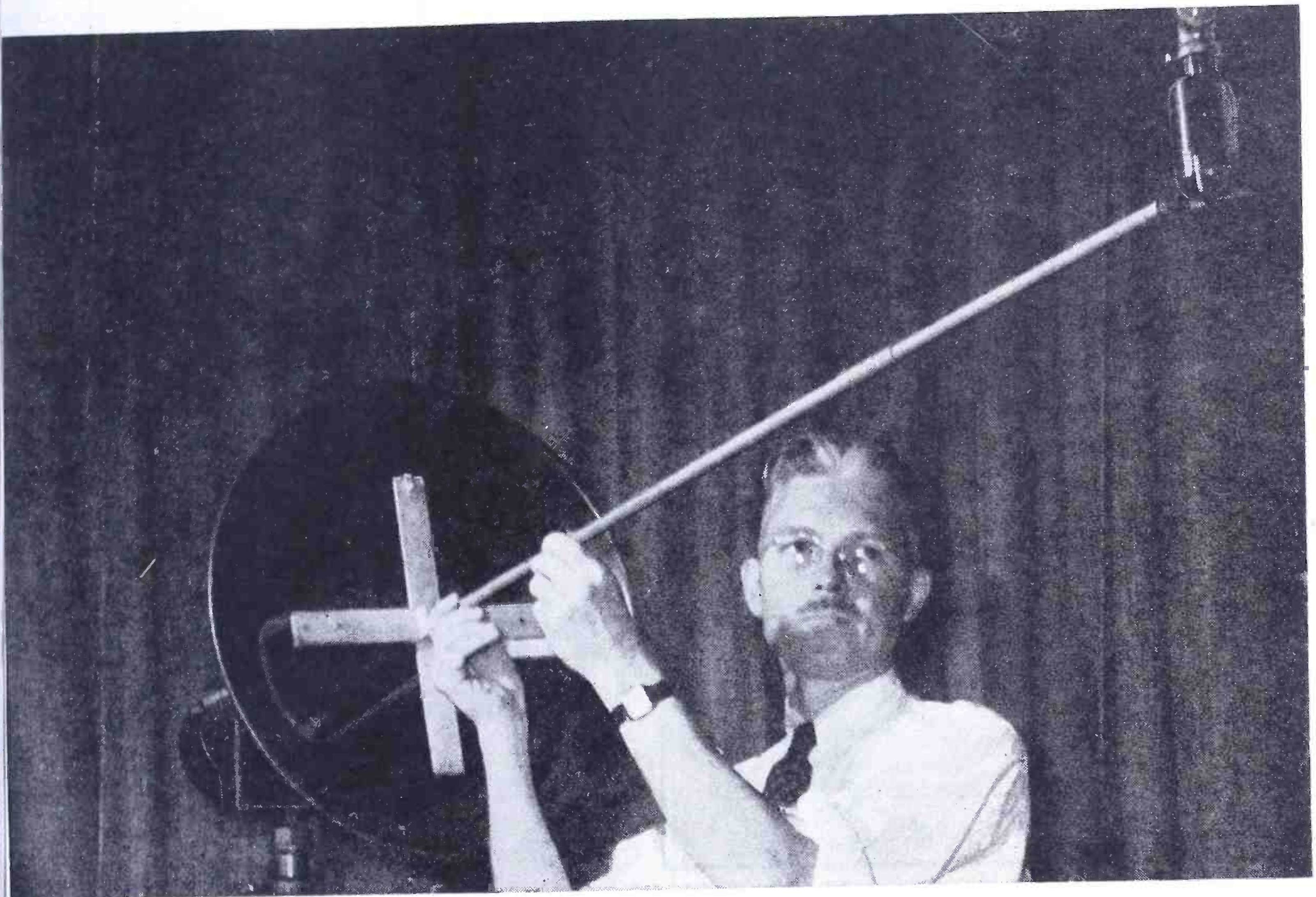

ACOUSTIC CONSIDERATIONS IN 2-WAY LOUDSPEAKER COMMUNICATIONS

by A. J. SANIAL

Chief Engineer
Powers Electronic and Communication Co., Inc.

THE use of reversible loudspeaker systems for two-way voice communication provides an important advantage over other forms of communication, because it is possible to signal or carry on a conversation with another person at a considerable distance, at which point no equipment is necessary. This is made possible by loudspeakers that amplify voice and project it in one direction and then permit pickup by a distant voice with the same units, amplifying the input to a practical volume in the other direction.

The most practical and economical audible communication systems are of the so-called *talk-back* type. A talk-back loudspeaker system is one in which the loudspeakers are used alternately as sound pickups or microphones; that is, the same electro-acoustic device is used for a dual purpose, a single amplifier system being switched so that in talking back, the loudspeaker is transferred from the normal amplifier output connection to the amplifier input. Although it would seem that such systems are inherently simple, and any special considerations of the acoustic problem involved would not be justified, this supposition finds itself discarded when we have to provide transmission and pickup of the human voice, navigational or other signals, etc., over distances up to one-half mile. It is also necessary to give special consideration to very noisy lo-

POWER AMPLIFIER PI-

by H. A. BROWN

Professor of Electrical Engineering, University of Illinois

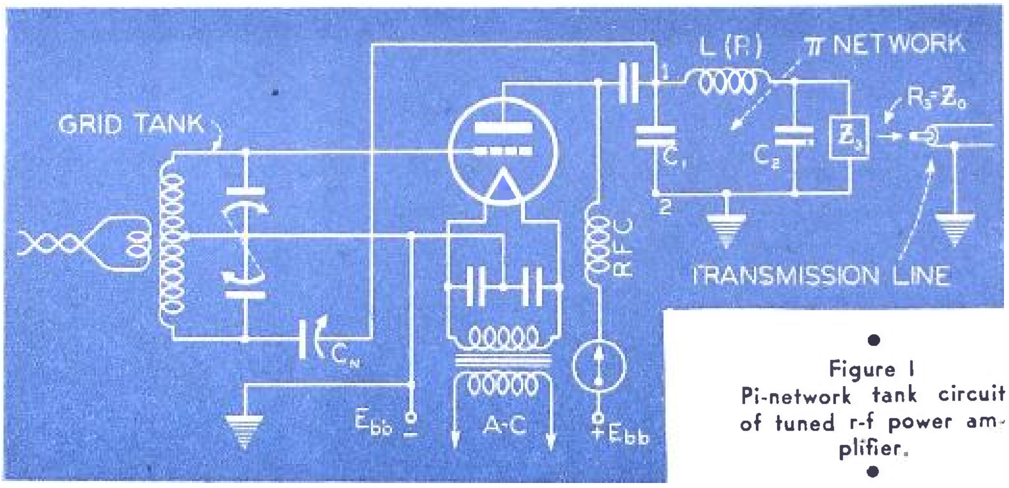

Figure 1
Pi-network tank circuit of tuned r-f power amplifier.

THE radio-frequency power amplifier incorporates the power tube and resonant external plate load impedance. The approved type which gives better suppression of harmonic components in the load incorporates a π network tank circuit. It also provides convenient connection facilities to different output circuits, especially transmission lines without the necessity of coupling coils, with their losses, space needed, etc. A typical neutralized class *B* or *C* power amplifier of this type is shown in Figure 1. The π network includes inductance *L* and capacitors C_1 and C_2. The tube and tank furnish power to an external load impedance Z_3. In many cases this latter consists of the input impedance of a radio frequency power transmission line terminated in its characteristic impedance Z_0, so that Z_3 becomes a pure resistance R_3, equal to $\sqrt{\frac{L_1}{C_1}}$ at all except the very high radio frequencies.[1] The case for which Z_3 is not non-reactive will be considered later, but let us assume for the present $Z_3 = R_3 + j0$. The fundamental frequency component plate current amplitude, I_{p-1}, is calculated from the exact method or from one of the approximate methods described in radio engineering literature. From this the required external plate load impedance r_b is found, as usual, from

$r_b = \frac{(E_{bb} - E_{min})}{I_{p-1}}$, where E_{bb} is the plate supply voltage, and E_{min} is the minimum plate voltage. The impedance looking into the π network at terminals *1, 2* is then $r_b + j0$ when the load resistance R_3 is connected. The calculation of the network constants (parameters) may be quite a complicated task, even involving cubics or higher degree equations. Methods have been given for the solution of this problem, and this paper describes a simplified, but exact method, in which the network is reduced to an equivalent simplified parallel resonant impedance having an assumed effective circuit Q_e. It would be convenient to specify a desirable value of tank circuit efficiency, but this leads to difficulties of complexity in the network solution. If, however, Q_e is specified, and is the rather low value customary for loaded power amplifiers, the tank circuit efficiency will be high if the *Q* of the tank inductance, *L*, Figure 1, is high, and the latter may be specified to be at least 300, or 400 for properly designed coils. In fact, it is very important to specify Q_e and to limit its value to *15* or even *12*, in order to reduce the possibility of distortion when the amplifier output is modulated. In this treatment, losses in the capacitors C_1 and C_2 will be neglected, which is justified with modern low-loss design types.

Equivalent Parallel Resonant Circuit

Since the impedance at *1, 2,* Figure 1, must be non-inductive and equal to r_b, as explained, the tank circuit, including the load, must be at unity power factor; its total susceptance must be zero. We then can make it equivalent to the parallel resonant circuit of Figure 2, in which L_e and R_e in series, represent the equivalent inductance and resistance of *L*, in series with the parallel combination of C_2 and R_3 in Figure 1. C_1, of Figure 2, is, of course, the same capacitance as C_1, in Figure 1. In the equivalent parallel resonant (unity power factor) circuit, the susceptance of C_1 must be equal to that of L_e and R_e. For this circuit it is readily proven that the input impedance is

$$Z_1 = \frac{L_e}{C_1 R_e} + 0j = r_b + 0j \qquad (1)$$

at unity power factor.

If the tank circuit of a power amplifier is of the form of Figure 2, it has been long recognized that the effective Q_e should be between *10* and *15* for satisfactory operation when the amplifier carries load. If Q_e is less than *10,* the *fly-wheel* effect may be insufficient to maintain essentially constant load current between the short time plate current pulses in a highly biased class *C* amplifier. Figure *2* shows how the load is placed upon such a tank circuit, and R_e is really the sum of the tank coil effective self resistance, plus that *transformed* into the tank coil by coupling coil L_m. Thus L_e is readily shown to be equal to the self induc-

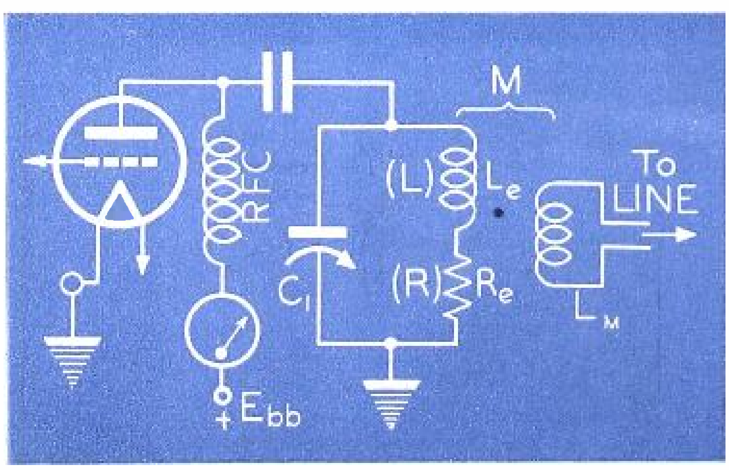

Figure 2
Simplified equivalent parallel resonant tank of power amplifier.

NETWORK TANK DESIGN

A Discussion of R-F Coupling Methods . . .

Typical Application Problems Analyzed

tance of the coil *minus* the inductance transformed from L_m.

We propose to apply the customary value of the "effective" Q or Q_e to the portion or branch L (R), $C_2 - Z_3$ of the π network tank circuit of Figure 1. Certainly this branch, illustrated in Figure 2a, will be a net positive reactance (negative susceptance) if the impedance between *1* and *2*, Figure 1, is to be a resistance, r_b. The *storage factor*[1] $\frac{1}{\omega C_1 R_e}$ must have the customary limits, *10* to *15*, and the net positive reactance ωL_e divided by R_e must be not very different from the *storage factor*, if the value does not fall below 10. We should recall that in case of Figure 2, the net effective inductance is less than that of the tank coil, by the amount of the inductance transformed into L from load coupling coil L_m, by Lenz' law. Then L_e for the π network is also less than L, due to the presence of C_2 and Z_3 (R_3 usually) as shown in Figures 1 and 2a. Even if we wish to specify limits for $\frac{\omega L}{R_e}$ instead of $\frac{\omega L_e}{R_e}$, we find from calculations shown in Table 1, that values obtained for L and L_e do not greatly differ, varying from *10* to *20* per cent. Such variation in effective circuit Q is not serious. Now in the case of Figure 2 we have, as explained,

$$Q_e = \frac{\omega L_e}{R_e} \qquad (2)$$

and from equation *1*

$$\frac{\omega L_e}{\omega C_1 R_e} = r_b = \frac{Q_e}{\omega C_1}$$

from which

$$C_1 = \frac{Q_e}{\omega r_b} \text{ for Figure 1} \qquad (3)$$

and the problem of calculating C_1 is thus simplified, when we select a desirable value for Q_e. The determination of C_2 and L of Figure 1 is not quite so simple, but is readily obtained with the aid of the easily proven parallel resonant circuit relation that

$$r_b = \frac{R_e^2 + \omega^2 L_e^2}{R_e} \qquad (4)$$

This is the reciprocal of the conductance of the coil-resistance branch of Figure 2, and is the input impedance at the parallel-resonant frequency $f_r = \frac{\omega}{2\pi}$. Equations *1*, *3*, and *4* contain the three unknowns C_1, L_e and R_e. From these

$$R_e = \frac{r_b}{1 + Q_e^2} \cong \frac{r_b}{Q_e^2} \qquad (5)$$

and

$$L_e = \frac{Q_e R_e}{\omega} \qquad (6)$$

Thus, the equivalent parameters of Figure *2* are readily solved from known quantities.

Calculation of C_2 and L

Referring to Figure 1, L, C_2 and R_3 form a series-parallel circuit whose equivalent series impedance is to be found. The admittance of C_2 and R_3 in parallel is

$$Y_{2\text{-}3} = \frac{1}{R_3} + j\omega C_2$$

and the impedance is

$$Z_{2\text{-}3} = \frac{1}{Y_{2\text{-}3}} = \frac{R_3 - j\omega R_3^2 C_2}{1 + \omega^2 R_3^2 C_2^2} \qquad (6a)$$

The resistance and reactance terms of equation (6a) are

$$R_{2\text{-}3} = \frac{R_3}{1 + \omega^2 R_3^2 C_2^2} \text{ and}$$

$$X_{2\text{-}3} = -j \frac{\omega R_3^2 C_2}{1 + \omega^2 R_3^2 C_2} \qquad (7)$$

The reactance of the combination L, C_2, R_3 is

$$\omega L - \frac{\omega R_3^2 C_2}{1 + \omega^2 R_3^2 C_2^2} = \omega L_e \qquad (8)$$

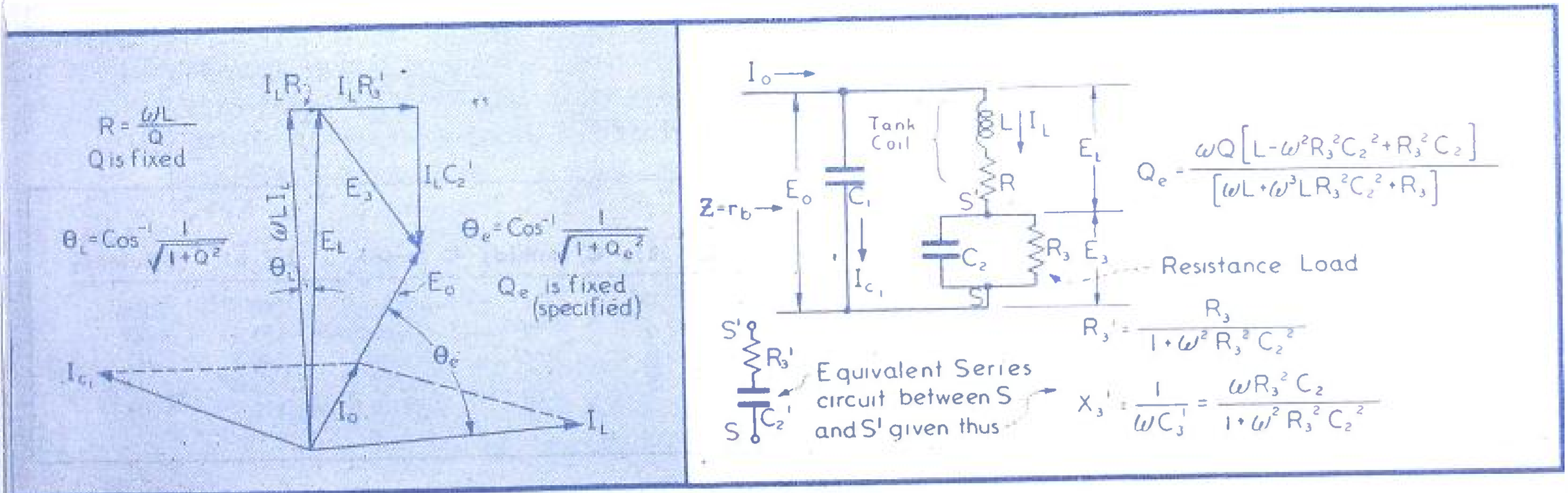

Figure 2a
Vector relations in a pi-network tank circuit with connected load resistance (not drawn to scale).

because we assume that Figures 1 and 2 are equivalent. In like manner

$$R_e = \frac{R_3}{1 + \omega^2 R_3^2 C_2^2} + R \qquad (9)$$

where R is the effective self resistance of tank coil L at resonant frequency $f_r \left(= \frac{\omega}{2\pi} \right)$. It is desirable to specify the Q of this coil, and, of course, it must be of a high Q design to give us high tank circuit efficiency. This latter will be given later. Then the value of R from

$$Q = \frac{\omega L}{R} \quad \text{or} \quad R = \frac{\omega L}{Q}$$

is substituted in equation 9, and this with equation 8 contains only two unknowns, L and C_2. Solving the resulting quadratic equation for C_2 we obtain

$$\left.\begin{aligned} C_2 &= -\frac{b}{2} \pm \sqrt{\frac{b^2}{4} - c} \\ \text{where} \\ b &= \frac{1}{\omega(\omega L_e - Q R_e)} \\ \text{and} \\ c &= \frac{(\omega L_e - Q R_e) + Q R_3}{\omega^2 R_3^2 (\omega L_e - Q R_e)} \end{aligned}\right\} \qquad (10)$$

Using *reactances* for the π network parameters, X_2 is given by the equation

$$\left.\begin{aligned} X_2 &= \frac{-m}{2} \pm \sqrt{\frac{m^2}{4} - n} \\ \text{where} \\ m &= \frac{R_3^2}{(Q R_e - X_e) - Q R_3} \\ \text{and} \\ n &= \frac{R_3^2 (Q R_e - X_e)}{(Q R_e - X_e) - Q R_3} \\ \text{and} \\ X_e &= \omega L_e \end{aligned}\right\} \qquad (11)$$

If X_2 is *positive only,* a useful solution is not obtained, because the shunt branch of the π network must be a *capacitance* in order to aid in bypassing the harmonics of the fundamental frequency f_r. It is important to note that equation *10* shows *only one* value is allowable for C_2, and C_1 is also a fixed value from equation *3*. Hence it is not permitted to design the π network section for a cut-off frequency. This is due to the specifying of the value of Q_e. Any attempt to change L, C, or C_2 changes Q_e in a complex manner. A vector diagram for the π network plus load circuit is shown in Figure 2a.

After C_2 is obtained from equations *10* or *11,* and again using equation *8,* we have

$$L = L_e + \frac{R_3^2 C_2}{1 + \omega^2 R_3^2 C_2^2} \qquad (12)$$

or

$$L = \frac{Q_e r_b}{\omega(1 + Q_e^2)} + \frac{R_3^2 C_2}{1 + \omega^2 R_3^2 C_2^2} \qquad (13)$$

with the aid of equations *5* and *6*.

Case of Reactive Load

When it is desired to drive two or more elements of an antenna array, the transmission lines feeding the elements are often connected to points on a phase-shifting network. The input impedance to this network is then Z_3, having a reactance term. Then $Z_3 = R_3 + jX_3$, and the resulting formula for C_2 is then different than equation *10*. This method of solution is similar to that for equation *1* and yields

$$C_2 = -\frac{\beta}{2} \pm \sqrt{\frac{\beta^2}{4} - \gamma}$$

where

$$\beta = \frac{[2 X_3 (R_e - \omega L_e) - \omega (R_3^2 + X_3^2)]}{[\omega^2 L_e (R_3^2 + X_3^2) + \omega R_e (X_3^2 - R_3^2)]}$$

and

$$\gamma = \frac{[\omega (L_e - X_3) + Q (R_3 - R_e)]}{[\omega^3 L_e (R_3^2 + X_3^2) + \omega^2 R_e (X_3^2 - R_3^2)]} \qquad (14)$$

R_3 and X_3 must, of course, be determined from the design of the phase-shifting and coupling device feeding the transmission lines.

Efficiency of π Network Tank

Returning to the case where the π network tank feeds a properly terminated line, whose input impedance is R_3, equation *9* gives the *total equivalent* series resistance of tank coil L in series with C_2 and R_3 in parallel. The equivalent series load resistance is that of C_2 and R_3 in parallel and is

$$R_o = \frac{R_3}{1 + \omega^2 C_2^2 R_3^2}.$$

The ratio of R_o to R_e is the tank-circuit efficiency, and this becomes

$$\xi_t = \frac{1}{\frac{R}{R_3}(1 + \omega^2 R_3^2 C_2^2) + 1} \qquad (15)$$

where $R = \frac{\omega L}{Q}$

Sample Calculations

As an example, let us assume that
$f_r = 796$ kc, $\omega = 5 \times 10^6$
$R_3 = 72 + 0j$
Q of tank coil $= 300$
Q_e of equivalent parallel resonant circuit tank (Figure 2) $= 15$
From equation *3*, $C_1 = 300$ mmfd
From equations *5* and *6*, $R_e = 44.2$, $L_e = 132.6$ μh
From equation *10*, $C_2 = .00234$ mfd, and from equation *13*, $L = 139.7$ μh
For tank circuit efficiency, we have from equation *15*

$$\xi_t = 95\% \text{ (nearly)}$$

If we change some of the assumed values, such as R_3, Q_e, etc., the calculated values will change, as shown in Table 1. We note that increasing R_3 from 72 to 300 ohms reduces C_2 somewhat, but not as much as one may expect. Finally, Q_e is decreased from 15 to 12, as is recommended by most authorities. The results are shown in the bottom row of Table 1. An interesting result is the substantial decrease in the value of C_2 when Q_e is lowered from 15 to 12.

Distortion Reduction and Harmonic Suppression

When the amplifier output is amplitude modulated, the exact determination of the degree of amplitude and frequency distortion is involved. It really requires performance calculations at the modulation peak as well as at car-

(*Continued on page* 92)

ω ($2\pi f_r$)	Q	r_b (ohms)	Q_e	R_3 (ohms)	R_e (ohms)	L_e (μh)	C_1 (mmfd)	C_2 (mfd)	L (μh)	% Tank Efficiency
5×10^6	300	10^4	15	72	44.2	132.6	300	.00235	140	95
5×10^6	300	10^4	15	300	44.3	132.6	300	.00166	153.4	93
5×10^6	300	10^4	50	300	4	40.0	1000	.006	46.8	82.7
5×10^6	300	5×10^3	15	300	22.2	66.6	600	.00242	82.0	93.8
5×10^6	300	10^4	12	72	69.4	166.5	240	.00079	170.3	95.8

Table 1

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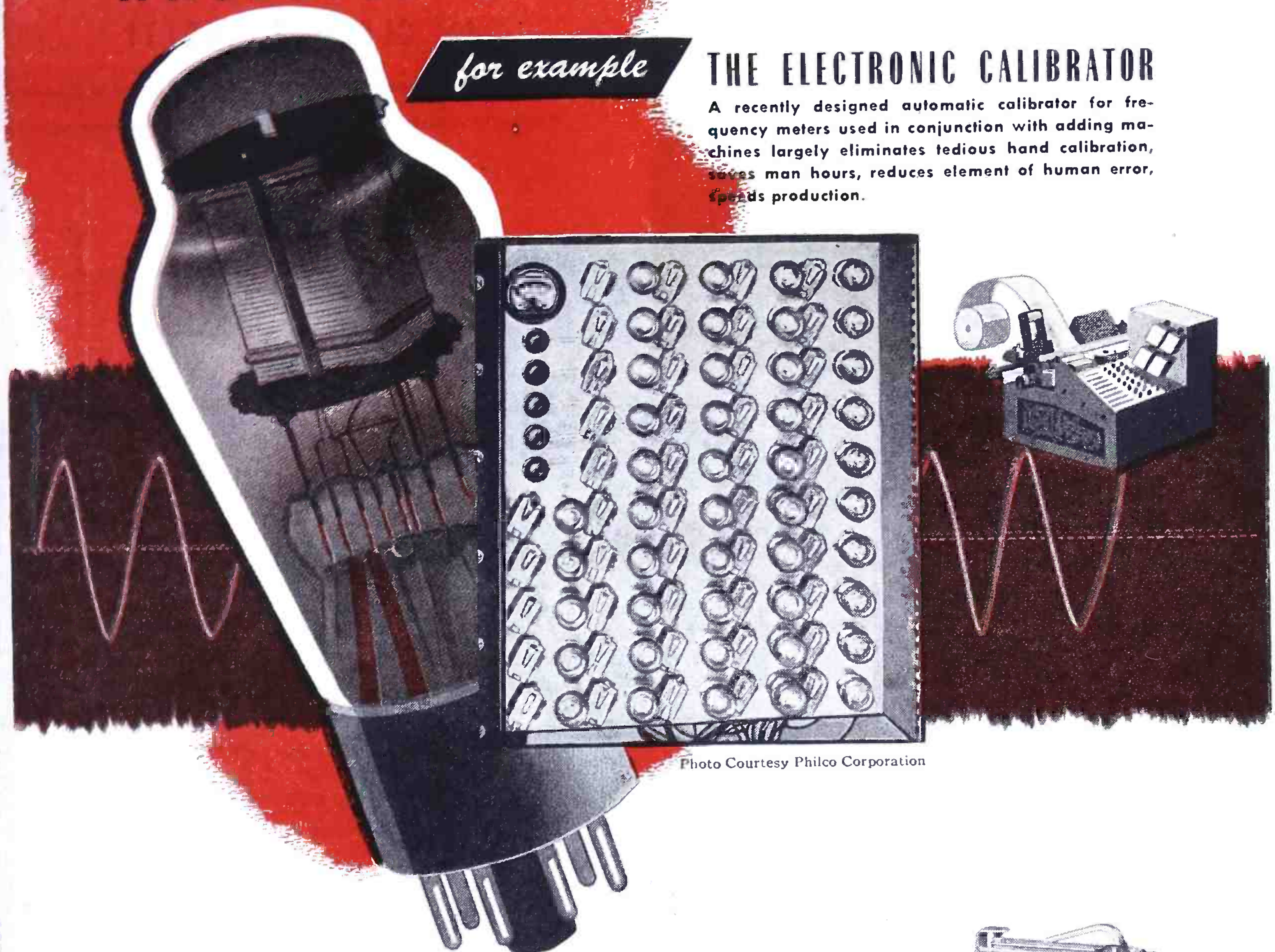

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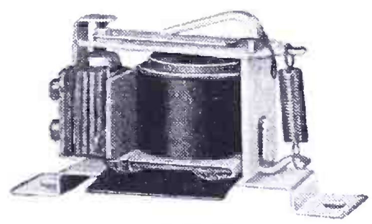

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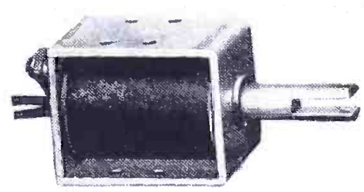

Series 4 Solenoid

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by CLEDO BRUNETTI

Chief, Production Engineering Section, National Bureau of Standards, Washington, D. C.
Formerly Assistant Professor of Electrical Engineering, Lehigh University

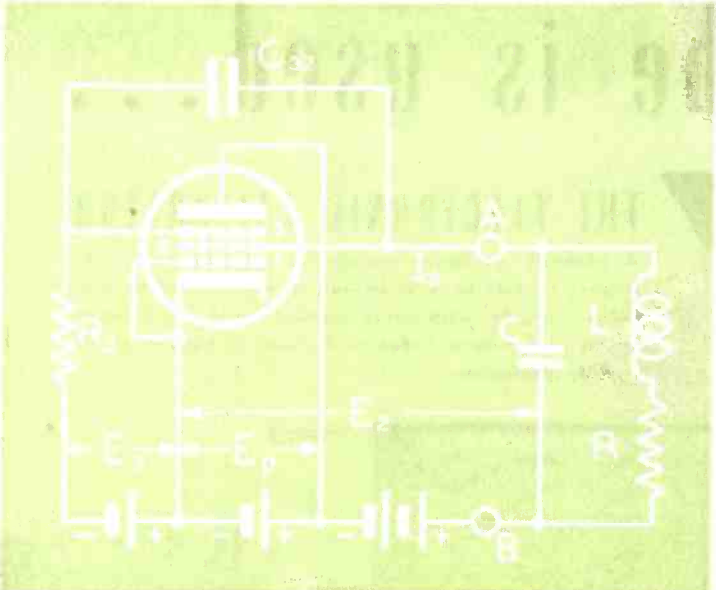


Figure 1
Transitron oscillator. Typical operating values with 58 are: L = 0.5 henry, R = 30 ohms, C = 0.02 microfarad, R_3 = 100,000 ohms, C_{32} = 0.10 microfarad, E_2 = 100 volts d-c, E_p = 12 volts d-c, E_3 = — 10 volts d-c. Frequency = 1580 cps.

This paper is based on work carried on by the author at Lehigh University.

THE retarding-field negative transconductance device or transitron is now being used in a large number of applications including the design of oscillators[1, 2, 3], special circuit components[4, 5, 6, 7], and timing and trigger circuits[8]. The simplicity of the circuit coupled with its versatility make it a practical solution to many laboratory problems. While the theory and general properties of the device have been covered in earlier papers[1, 9, 10], occasionally an experimenter is confronted with the realization of having a circuit set up directly as described in the literature and yet refusing to function. A careful review of the situation will generally show, however, that some essential feature has been overlooked. While the circuit of the transitron oscillator is, for example, much simpler than that of the feed-back type of oscillator, certain fundamental requirements must be met in any oscillator before it can be expected to function. In the transitron oscillator, Figure 1, the requirement reduces to meeting one condition, namely satisfying the relationship

$$-R_n = L/RC \qquad (1)$$

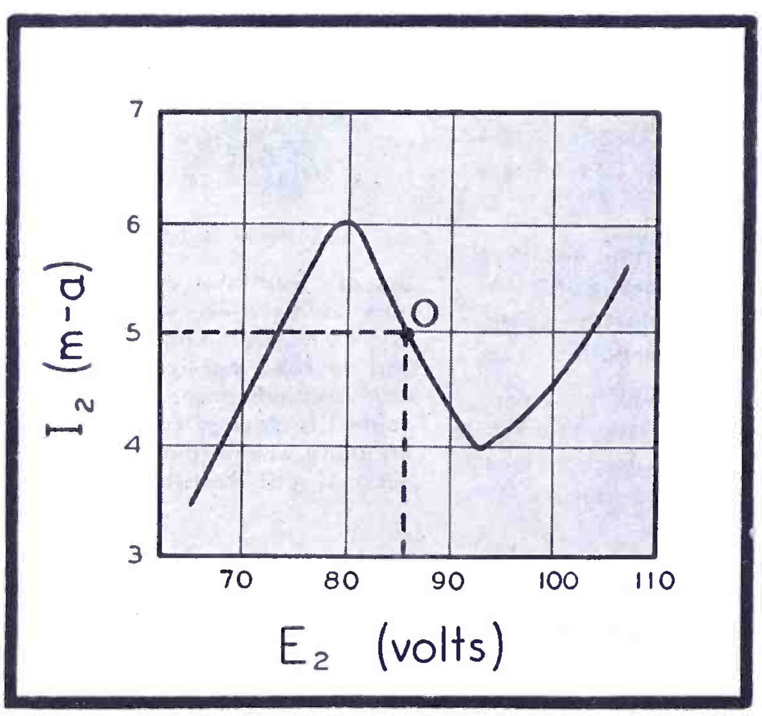
where R_n is the average negative resistance[9] of the device and *L, R* and *C* are the constants of the tuned circuit. *R,* the resistance of the coil, is assumed to be small compared with L/RC, the resonant tuned circuit impedance.

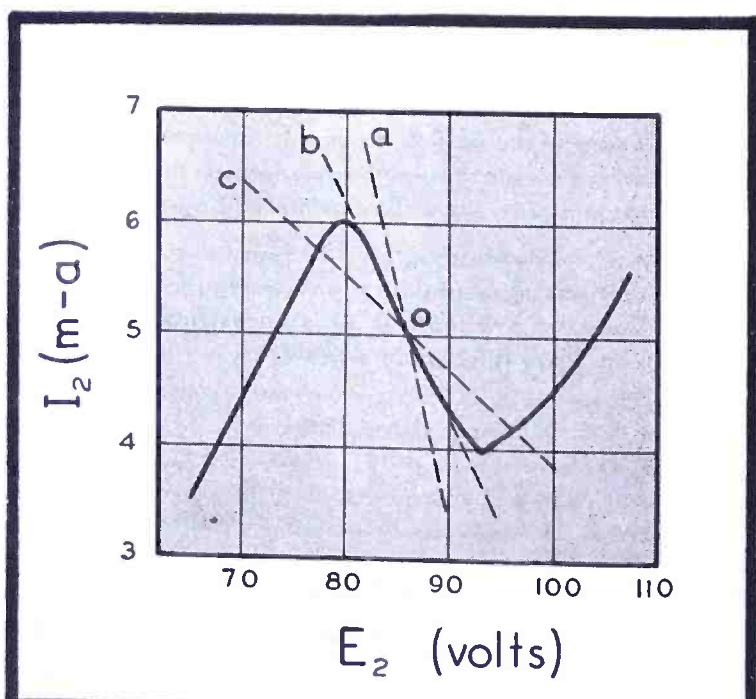
The average negative resistance of the transitron depends on the type of tube used and on the magnitude of the d-c voltages applied to its elements. It is possible that with a given set of d-c supply voltages one type of pentode will produce oscillations in a given tuned circuit whereas another will not. Figure 2 shows a transitron static characteristic for a type 58 tube with the supply voltages as specified. If E_2 is set at 86 volts the operating point will be at *0*; that is, with the circuit completed as in Figure 1, but not oscillating, the current I_2 will have the value shown at point *0* or 5 m-a. For small oscillations the average negative resistance, R_n, is equal to the reciprocal of the slope of the characteristic at the operating point. This is the smallest value of R_n obtainable under the given conditions of operation.

If the quantities *L, R* and *C* are adjusted properly, oscillations will occur in the tuned circuit. The amplitude of the oscillation will be limited by the shape of the transitron characteristic. As the quantity L/RC is increased, oscillations will start when the quantity is equal to the reciprocal of the slope of the transitron characteristic at the operating point *0*. As L/RC is increased further, the amplitude of oscillation will increase until ultimately it

Figures 2 (left, below) and 3 (right, below) Figure 2, transitron static characteristic, showing operating point *0*. Firgure 3, effect of tuned circuit impedance on amplitude of oscillation:

(*a*) $\frac{L}{RC}$ = 2,400 ohms; (*b*) $\frac{L}{RC}$ = 5,000 ohms; (*c*) $\frac{L}{RC}$ = 12,000 ohms.





OF THE TRANSITRON OSCILLATOR

vings way over the bends of the haracteristic. As the amplitude in-reases, the magnitude of R_n increases ntil equation *1* is satisfied. For this eason the amplitude is determined ot only by the shape of the char-cteristic of the tube, but also on he constants of the tuned circuit con-ected to it[9]. If the quantity L/RC is maller than the reciprocal of the slope f the characteristic at the operating oint, oscillations will not be sustained n the tuned circuit even through oscil-ations of a decaying transient nature nay momentarily be set up upon apply-ng the d-c supply voltages.

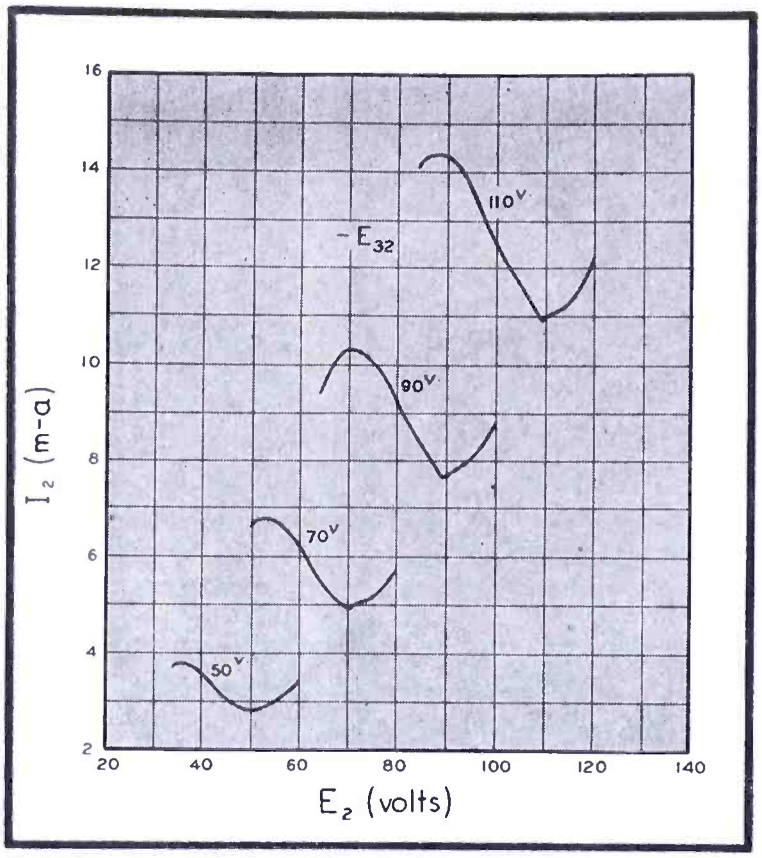
Figure 3 illustrates the point further. The dotted lines *a*, *b* and *c* have slopes equal to $\frac{1}{2400}$ mhos, $\frac{1}{5000}$ mhos and $\frac{1}{12{,}000}$ mhos, respectively. They represent tuned circuits having values of L/RC equal to 2400, 5000 and 12,000 ohms. The dotted line *a*, has a slope which exceeds that of the transitron characteristic at point *0*; consequently the circuit represented by it will not sustain oscillations when connected to the transitron. If, however, the value of L/RC is increased to 5000 ohms (dotted line *b*) as, for example, by decreasing *C*, the circuit will spring into oscillation and develop a sinusoidal waveform of voltage across the tuned circuit having a peak magnitude of approximately 4 volts. If L/RC is increased to 12,000 ohms, then, as shown by dotted line *C*, the oscillations will swing over the bend of the characteristic. Although this will introduce a small amount of harmonics in the waveform, the latter will still be indistinguishable from a sinusoid if viewed on a cathode-ray oscilloscope. It is only when the excursion is carried far over the bends of the characteristic and a low-*Q* tuned circuit is used, that the waveform begins to deviate from the sinusoidal.

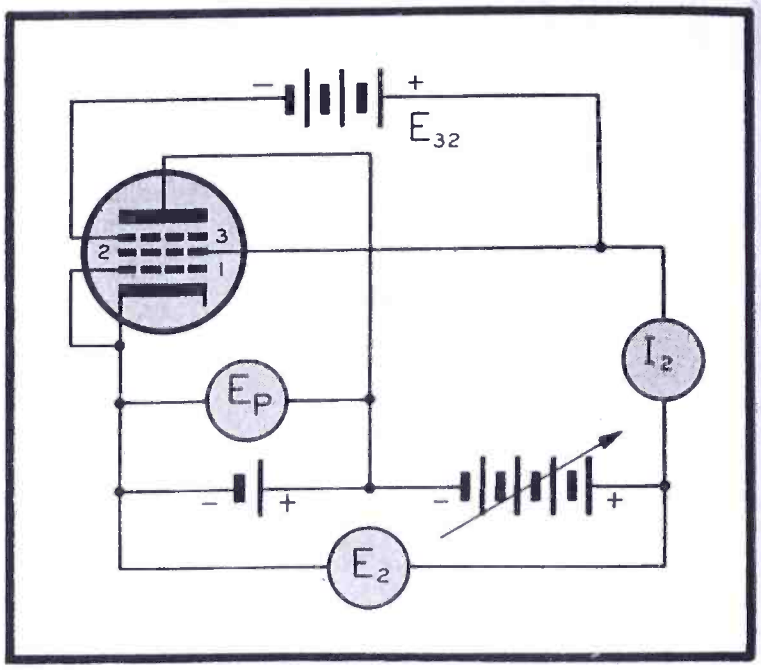
Figure 4 is a reproduction of actual oscillograms taken on a transitron oscillator having a slightly different characteristic from the one in Figure 3. The waveform for the two low impedance examples was very good. For the case where L/RC = 40,000 ohms, the harmonic content in the voltage waveform was still low (less than 5%), as care was exercised to keep the value of *R* in the tuned circuit low. Further details regarding this behavior have appeared in earlier papers by the writer[2, 9].

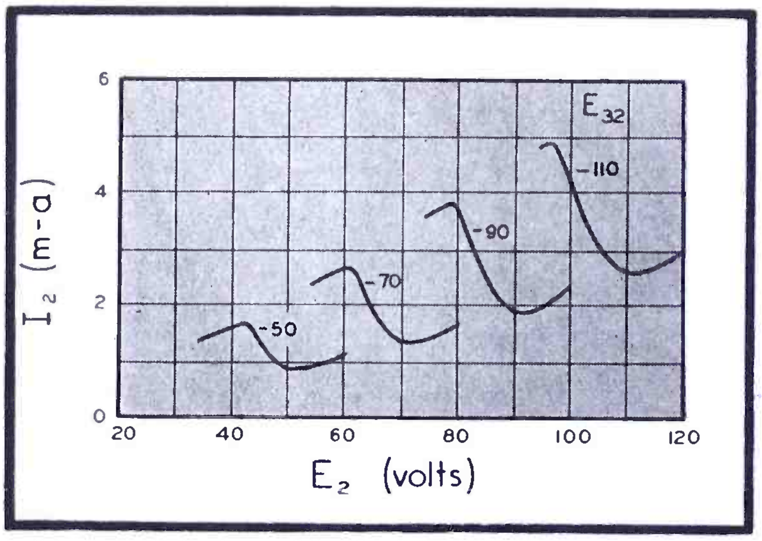
Figures 5, 6 and 7 show families of typical transitron static characteristics

Figures 4 (top), 5 (center) and 6 (right)

Figure 4, reproduction of oscillograms showing dependence of oscillation on tuned circuit impedance. Figure 5, transitron characteristics for 57 tube. Figure 6, transitron characteristics for 58 tube (tube 1). Data for 57 is obtained by setting E_{32} at stated value; E_p is held constant at 22 volts; I_f = 1 ampere; E_1 = 0 volts. E_2 is varied, and E_2 and E_1 are recorded. Data for 58 are secured by following procedure applied for 57 tube, except that I_f is held at 1 ampere.

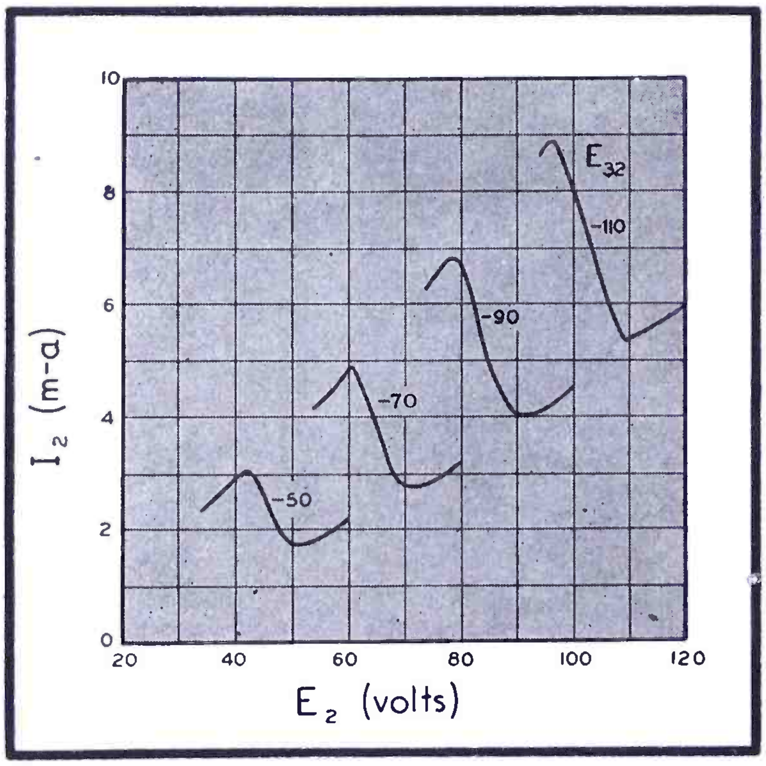






Figures 7 (upper left), 8 (upper right), 9 (center) and 10 (below, left)

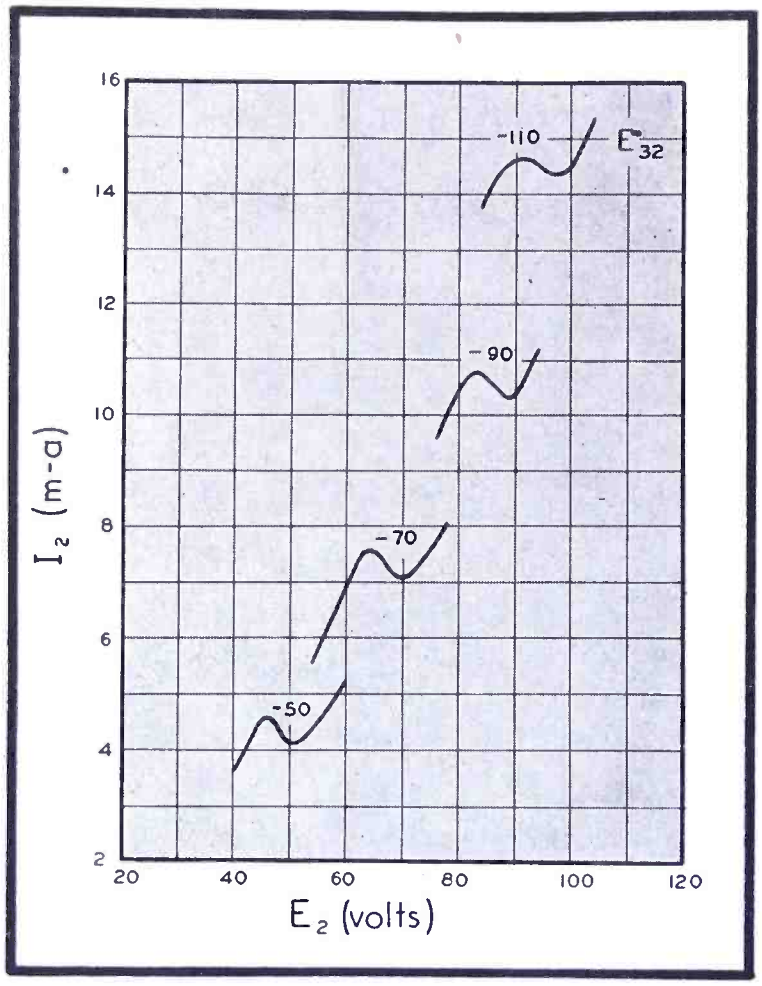
Figure 7, transitron characteristic for 59 tube. Figure 8, circuit for obtaining transitron characteristics. Figure 9, transitron characteristic for 6J7G. Figure 10, transitron characteristic for 6K7G. To obtain tube data, E_{32} is set at stated value; E_p is held at 22 v; E_1 = 0 volts; E_2 is varied. E_2, I_2 are recorded. For 6J7G and 6K7G tubes, I_f = .3 ampere; for 59, I_f = 2 amperes.



for the 57, 58 and 59 tubes respectively. These characteristics were obtained by means of the circuit shown in Figure 8 in which the coupling condenser between grids *2* and *3* was replaced by a blocking battery E_{32}. While this method allows the current drawn by grid *3* to flow through the recording meter, the magnitude of this current is small compared with the current drawn by grid *2*. In fact no current flows to grid *3* until E_2 approaches E_{32} in magnitude.

The shape of the characteristic may be determined by analyzing Figure 8. As the anode voltage E_2 is increased from some small value, the current to the anode (grid *2*) increases. The high negative potential of grid *3* repels all electrons passing through grid *2* returning them to the latter. At the top bend of the characteristic the negative potential on grid *3* with respect to the cathode has decreased sufficiently to allow some of the electrons passing through grid *2* to pass through grid *3* and to be picked up by the plate which is at a positive potential. A further increase in E_2 is followed by a greater loss of electrons to the plate through grid *3*, with the result that the net flow of current to the anode decreases. This action takes place throughout all of the negative sloped portion of the characteristic. At the lower bend of the characteristic, the potential of grid *2* has reached a sufficiently high positive value to retract some of the electrons which slip through its meshes, and with subsequent increase in E_2 the flow to grid *2* increases again.

In the circuit of Figure 1 a similar phenomenon takes place. Assuming the d-c supply voltages are adjusted so that the operating point is at *0*, Figure 2, electrons attracted by the high positive potential of, and passing through, grid *2* are repelled by the negative

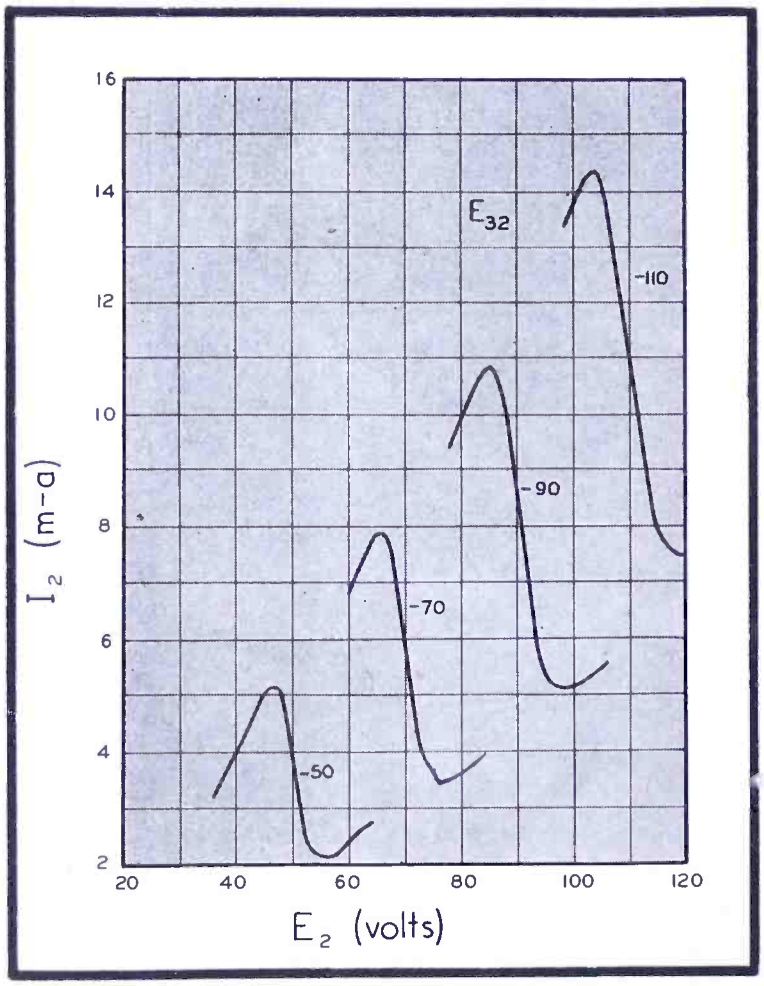


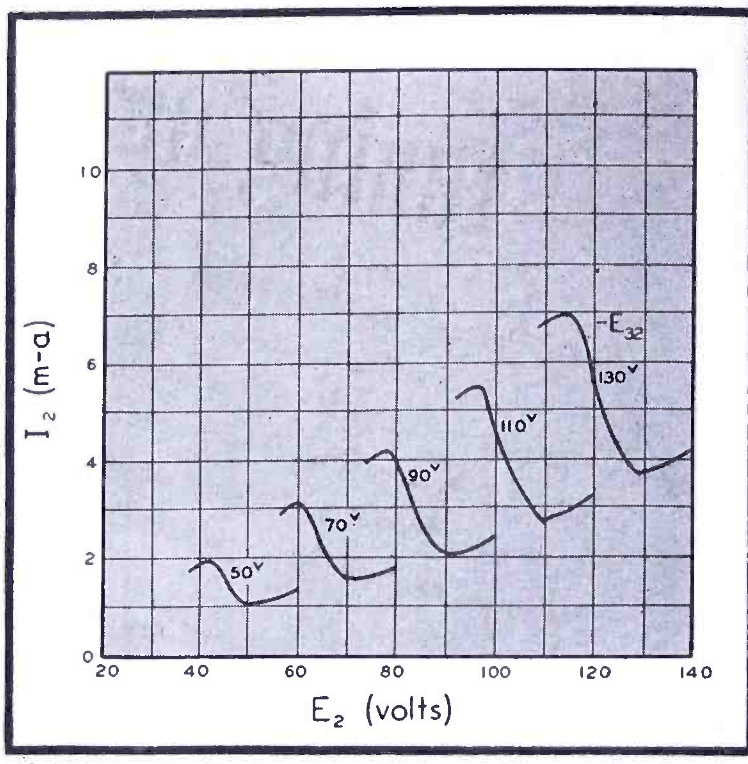
potential of grid *3*. A slight positive increment in voltage across the tuned circuit *L, R, C,* is transmitted by means of the condenser C_{32} simultaneously to both grids *2* and *3* causing the latter to attract more electrons and the net flow to grid *2* to decrease. A negative increment in voltage, by the

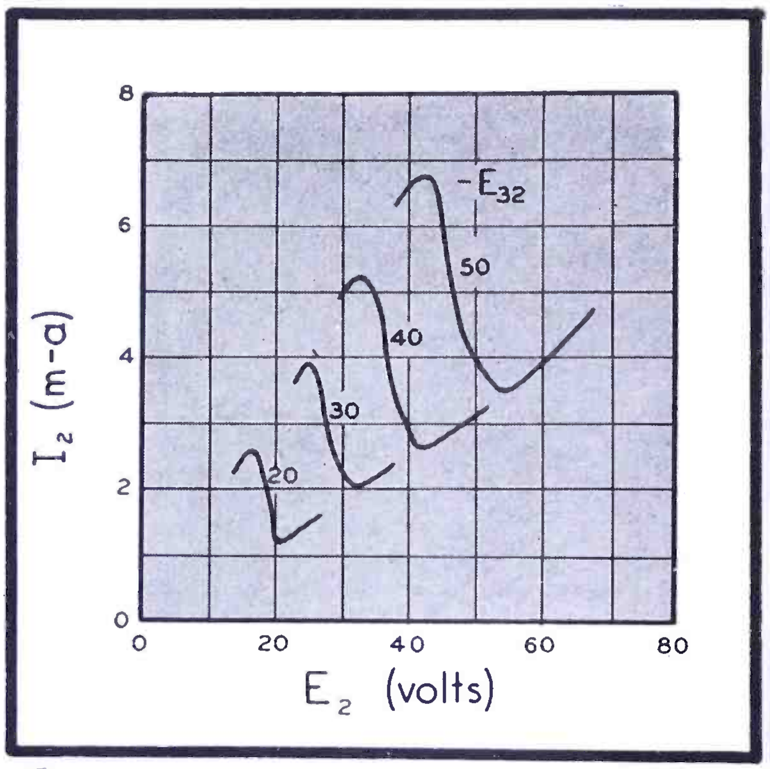
(*Continued on page* 87)

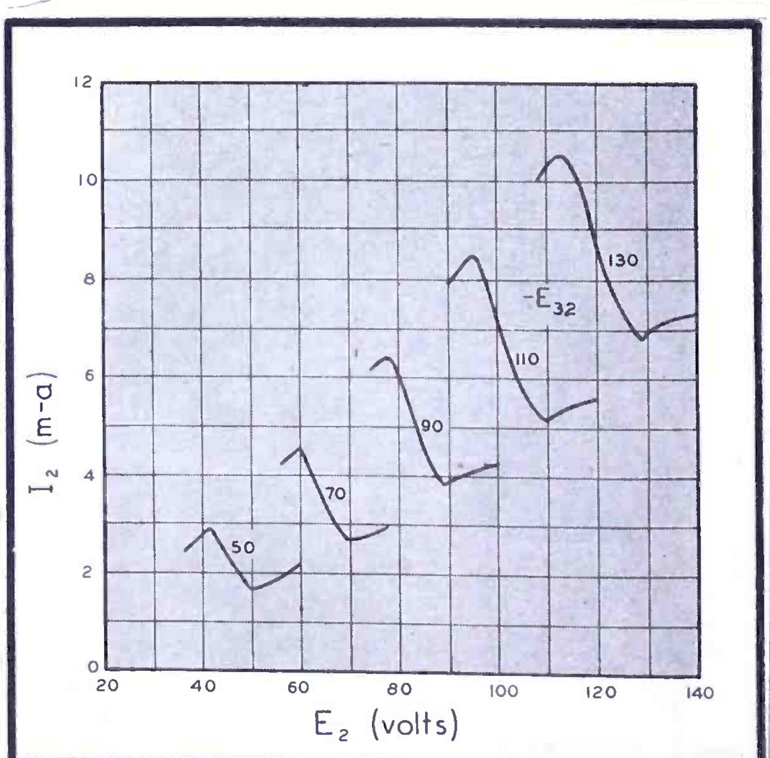
Figures 11 (top, left), 12 (below, left), 13 (top, right), 14 (center, right), 15 (below, right)

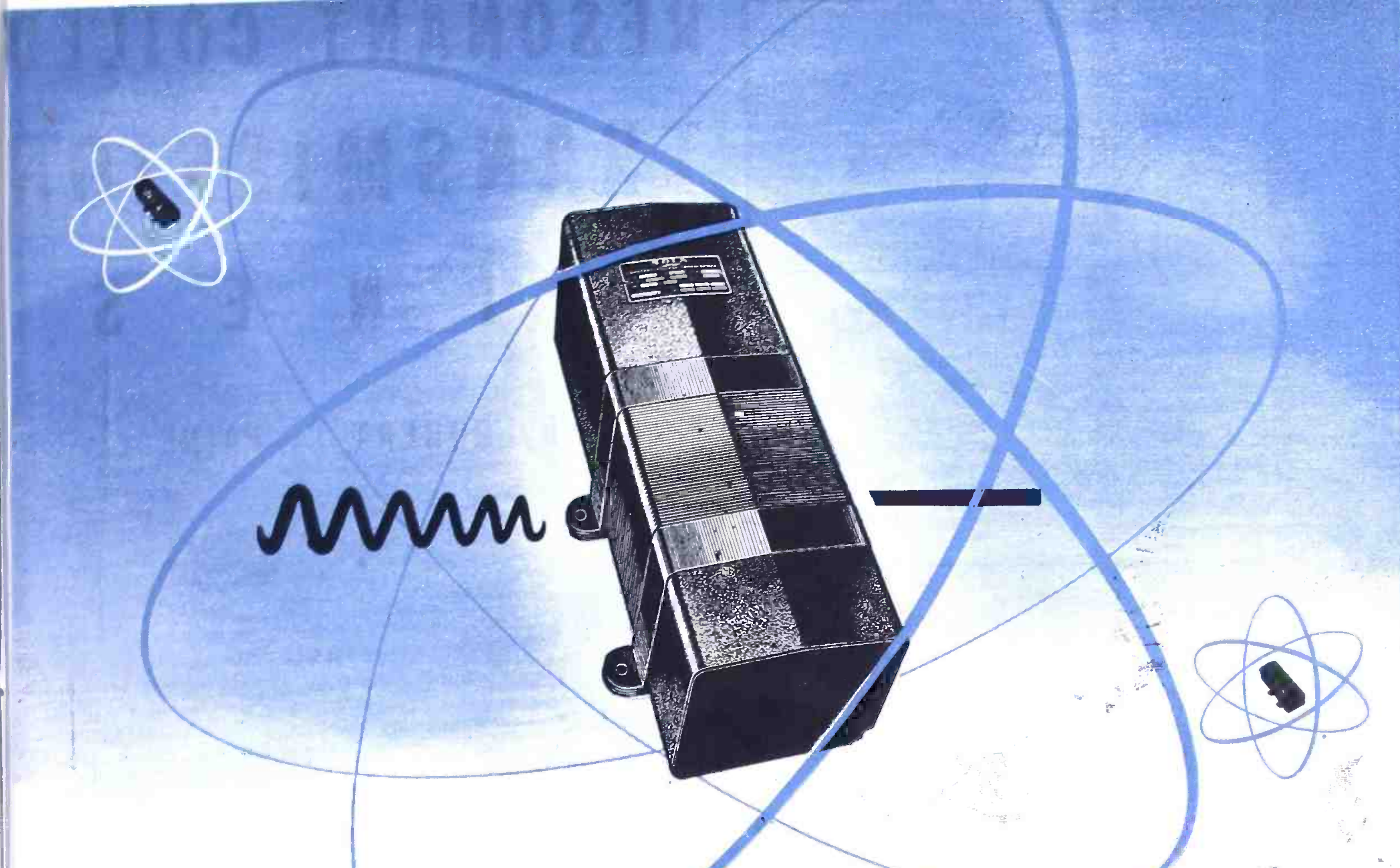
Figures 11 to 15 show transitron characteristics of 6L7G *(11)*, 6S7G *(12)*, 6C6 *(13)*, 1853 *(14)*, and 58 *(15*, tube 2).











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RESONANT COILED TRANSMISSION LINES

by ROBERT C. PAINE

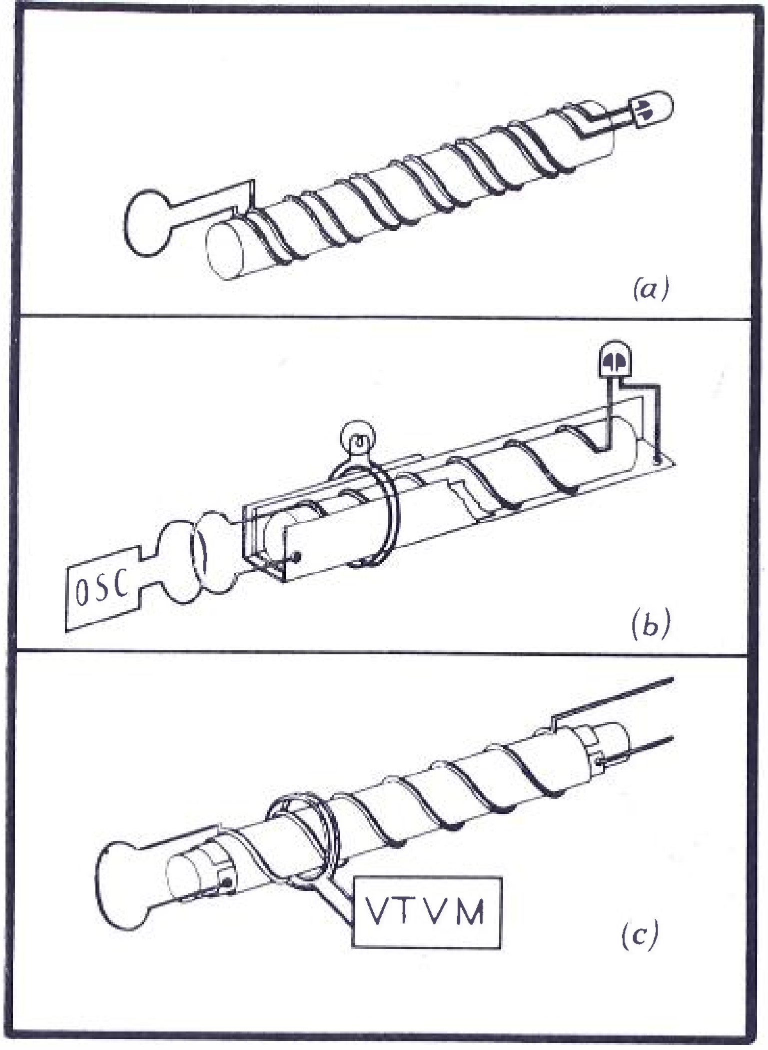


Figure 1
Coiled transmission lines for producing resonant effects at low frequencies. *(a)* A balanced line coiled in a spiral on a cylindrical support. *(b)* An unbalanced line with the grounded side of the line in the form of a trough. *(c)* An unbalanced line wound over the grounded element which has the form of a slotted cylinder.

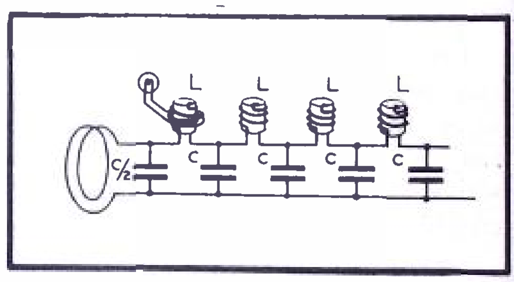
THE phenomena of reflection in transmission lines is extremely interesting. Interference of direct and reflected waves results in an effective voltage and current which varies along the line, reaching very high values at some points and very low values at other points. These effects can be observed by use of flashlight bulbs and neon lamps, as well as meters. The phenomena can occur at any frequency provided the line is long enough. Unfortunately, in the ordinary forms of lines, very high frequencies must be used to get these effects on a line short enough to be handled in an ordinary laboratory. At the voice frequencies used on telephony, a half wavelength may be over one hundred miles, and at medium radio frequencies it is measured in hundreds of meters. Only at very high frequencies do the ordinary forms of lines exhibit standing wave phenomena on lengths of a few feet or meters. To study reflection phenomena at the lower frequencies it is thus necessary to have forms of lines which can be more conveniently handled. Such lines are described in this paper.

The attenuation of a line is given as $\gamma = \alpha + j\beta = \sqrt{ZY}$. The angular change of phase per unit length of line is represented by β and if the losses of the line are low, β is proportional to $\sqrt{ZY}$, in which Z is the series impedance, largely inductive per unit length, and Y is the shunt admittance, largely capacitive. In a half-wave line β must equal π radians. To increase the value of β, per unit length, it is necessary to increase the series inductance or shunt capacity or perferably both. This can be done in several ways. One method is to form a parallel wire balanced line into a spiral. In this way more line can be contained in a given length.

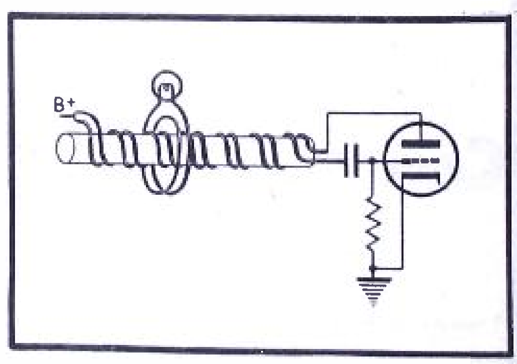
A balanced spiral type of line is shown in Figure 1a in which two close parallel wires are wound on a cylinder, with a greater spacing between spirals. One such line, for example, was wound on a cylinder, 2″ in diameter and 16″ long. Two no. 18 copper wires spaced about 1/16″, with a pitch of about ½″ between spirals, were wound on this form, a total of about 17 feet of line. This line was tested for quarter-wave-length resonance by loosely coupling its short-circuited end to an oscillator and connecting a small neon bulb across its open end. Quarter-wave-length resonance was found to occur at about 8.5 megacycles, at which frequency the rise in voltage at the end caused the neon bulb to light brightly.

An unbalanced line in compact form can be mad for low frequencies. This has several advantages over the balanced type for use with various types of indicators. One such line is shown in Figure 1b. In this arrangement a given length of wire is placed in a small space by winding it in a solenoid. At the same time the flux of the adjacent turns adds up to increase the inductance per unit length, making the given length of wire more effective. The capacity per unit length is made large by making the grounded conductor in the form of a trough, insulated by thin insulation (dielectric)

(*Continued on page* 48)



Figures 2 (top) and 3 (below)
Figure 2, a lumped reactance line for producing resonant effects at very low radio or audio frequencies. Figure 3, a balanced double-solenoid line connected as a ¼-wavelength for tuning an oscillator.



(*Continued from page 46*)

from the spiral winding. The grounded conductor can also have the form of a slotted cylinder into which the coil line is inserted with suitable insulation. This provides lower resonant frequencies and lower characteristic impedance. Current in such an unbalanced coiled line creates a field about it. This can be coupled to a small sliding coil which can be used conveniently with a small flashlight or pilot bulb as an indicator. As such a coil is passed along a line excited to resonance, the indicating unit lights up as it passes through current antinodes. The coil can also be connected to a vacuum-tube voltmeter or other type of meter for comparative measurements. Voltage antinodes can be explored by a neon bulb or voltage measurements can be made by a probe connected to an ordinary unbalanced vacuum-tube voltmeter. The current coil and pilot bulb can be placed so as to light up at a current antinode and the voltages explored with the experimenter's finger, *if a limited amount of power is being used.* As voltage antinodes are approached the pilot bulb will become dimmed or extinguished.

One line of the unbalanced type (Figure 1b) was constructed of no. 14 enameled copper wire wound in a solenoid of about ¾" diameter and 10½" long. This line had a characteristic impedance of about 350 ohms and exhibited quarter-wave resonance at about 2.8 mc. With its short circuited end loosely coupled to an oscillator and its far end open, it was easily operated at one-quarter, three-quarter and five-quarter wavelengths, or higher. With its far end closed, it was operated at one-half and a full wavelength, or higher.

Resonant frequencies can be further lowered by a line of the type shown in Figure 1c. This line has the solenoid wound over the grounded conductor to increase the capacity. The grounded conductor has a longitudinal slit to prevent its becoming a short-circuited cylinder, which would, of course, prevent resonance. One such line was formed by a solenoid of no. 18 enameled wire, wound on a thin dielectric over a ground conductor on a form about 13/16" in diameter and about 11½" long. This line resonated at about 900 kc for a quarter-wavelength. A similar line wound with no. 22 wire on a form 2½" in diameter and 10½" long resonated at about 160 kc for a quarter-wavelength.

These lines also can be used to check the effects of different terminations on reflection. The positions of the nodes as well as the voltage variations from

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(Continued from page 48)

point to point and standing-wave ratios can be measured with an electronic voltmeter. A capacitive load brings the first voltage node to less than 90°, or less than a quarter-wavelength from the load end, while an inductive load increases the distance to more than 90°. The attenuation of the line can also be found from voltage measurement. An indication of the order of attenuation is given by the voltage multiplication from the input to the output of a quarter-wavelength open end line.

A line of even lower frequency can be constructed with lumped constants of inductance and capacity (Figure 2.) If a sufficient number of elements are used, such a line can approximate a line with distributed reactance. To check the current in this type of line the inductances can be arranged so that a current pickup coil can be slipped over the end of any one of them and easily moved from coil to coil. One such line was constructed of 12 π sections, the inductances, L, being of 2500 microhenries and the capacities, C, of .0019 microfarads. This line was a quarter-wavelength, resonant in the audio frequency range at about 9000 cycles. At higher frequencies two or more current maxima could be observed. Due to the relatively high inductance and low capacity, this particular line had a characteristic impedance of about 1100 ohms.

A coiled line of particular interest is a balanced double solenoid line in which two solenoids are wound in two layers, one in each direction. No doubt many have a line of this kind on the laboratory shelf, because such a line, with the far end shorted, is an ordinary two layer solenoid coil. An experimental coil wound with two layers of no. 22 copper wire of about 90 turns each, on a form ⅝" diameter by 3½" long, was quarter-wavelength resonant (far end open, near end coupled to oscillator) at about 1250 kc. Such a line was used as the tuned line for a broadcast frequency oscillator, but connected in the conventional manner of a high frequency oscillator as shown in Figure 3. With the circuit oscillating, the current pickup coil indicated a current maximum near the low end of the *line*, oscillation being controlled by the quarter-wavelength mode. This type of line could also be used for selective coupling between tubes in an amplifier.

Current and voltage distribution on a resonant line provide many interesting effects. Figure 4 illustrates the results which can be expected in experiments on such lines. In this Fig

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(*Continued from page* 50)

ure, *I* represents current and *E* voltage values. In Figure 4a the quarter-wavelength resonant line open at the far end has a current maximum or antinode at the input end. A pickup coil here causes pilot lamp to glow. In Figure 4b, half-wavelength resonance, with the line closed at the far end, is shown. In this case there is only one voltage antinode, in the middle, but there is a current antinode at each end.

In Figure 4c the frequency has been raised to cause the open end line to resonate at three-quarter wavelength. In this condition there are two current antinodes and two voltage antinodes. In Figure 4d the closed end line is resonating at a full wavelength and there are three current antinodes and two voltage antinodes. The most convenient indicator of current in these experiments is the sliding coil and pilot bulb.

The idea of coiled lines is not entirely new. Somewhat similar *wave resonant coils* for more selective tuning of receivers were described by Louis Cohen.*

The author extends his sincere thanks to Mr. Cohen, who furnished a list of Cohen patents on coiled lines issued in 1920-1928.

**Circuit Tuning by Wave Resonance*, Louis Cohen, IRE Proc., Oct. 1929.

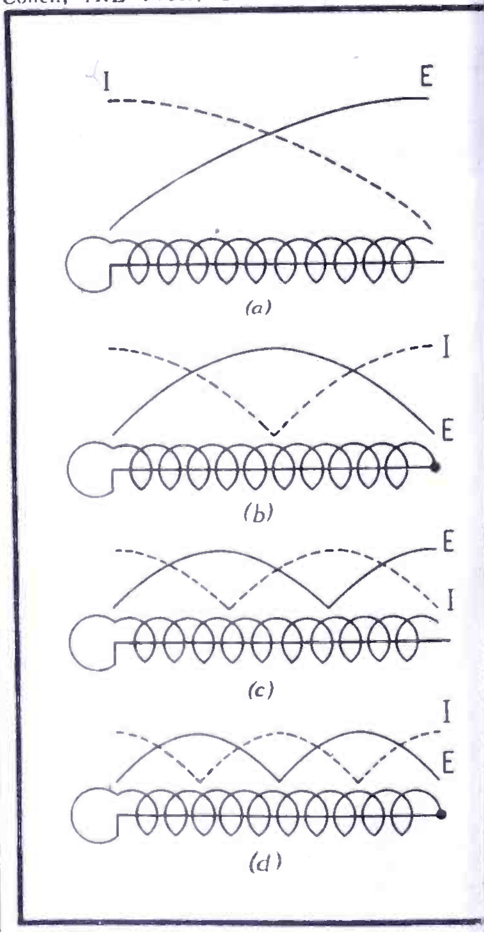

Figure 4
Voltage and current curves for resonant li[nes] showing nodes and antinodes. (*a*) Open-[end] line at frequency for ¼-wave resonance. [(*b*)] Shorted endline for ½-wave resonance. (*c*) O[pen] line at ¾-wave resonance. (*d*) Shorted line [at] full-wave resonance.

THE SCIENCE OF ELECTRONICS ALSO PROVIDES A NEW TRIUMPH IN ELECTRO-MEDICAL ANALYSIS AND LABORATORY RESEARCH . . .

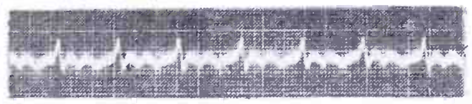

FIGURE A—Photographic Method

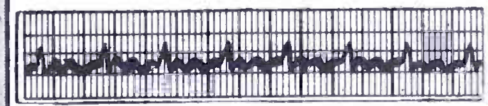

FIGURE B—EPL Method

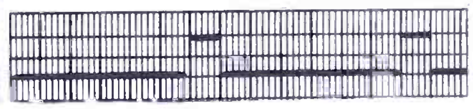

FIGURE C—Calibration

The exact similarity between the standard photographic cardiogram and the direct writing instantaneous cardiogram on this new EPL instrument is indicated in Figures A and B, which are records of the same subject taken a few minutes apart.

New EPL Direct-recording Electrocardiograph*

...giving instantaneous *standard* readings

- **Built to exacting laboratory standards after years of research**
- **Completely eliminates all photographic procedures**
- **Useful in the laboratory as well as a benefit to mankind**
- **Compact, lightweight, portable; simple and efficient in operation**
- **Cardiograph record appears instantaneously**
- **Built-in interference filter makes possible perfectly usable cardiograms in strong interfering electrical field**
- **Operates from any 110-120 volt, 60 cycle, AC service**
- **Uses no ink or other fluids**
- **High operating economy**

*PATENT PENDING

Note to
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of the
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We will gladly demonstrate this new Direct-recording Electrocardiograph before you at your convenience. We sincerely believe that this instrument can lend material assistance to the work that the Armed Services are now doing in the rehabilitation of wounded veterans.

For Laboratory Procedure

The recorder of this new Electrocardiograph may be used in conjunction with other equipment for laboratory research. It provides an amplifier and recorder which will give a graphic record between .1 cycle and 80 cycles per second at a sensitivity of 1 millivolt for 2 cms total deflection; or a range from zero to 80 cycles for 60 millivolts for 2 cms deflection. A high speed writer can be supplied which will extend the operating frequency to about 200 cycles. Because of the special damping circuit employed, excellent transient response is secured.

Although in the high sensitivity connection, the amplifier is not a true D-C amplifier, the phase correction is such that perfect square wave response from .25 cycles to 80 cycles is realized with the one millivolt sensitivity connection.

At present, deliveries will be made on priority only.
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NEWS BRIEFS OF THE MONTH . . .

RADIO EXECUTIVES CLUB'S TELEVISION SEMINAR

A 14-week series of television lectures is being presented by the Radio Executives Club of New York, in NBC's Studio 6 A. The series of talks, under the chairmanship of M. B. Grabhorn, of the Blue Network, and coordinated by Richard Hubbell, will continue through August 24.

FCC Commissioner James L. Fly, NBC president Niles Trammell, and Dr. Alfred N. Goldsmith, chairman of RTPB panel one, spoke at the initial lecture, outlining their views of the postwar prospects of television.

At the second session, problems facing television in reference to standards and allocations were discussed by David Smith, director of research for Philco and chairman of RTPB television panel six, and Charles B. Joliffe, chief engineer for RCA Victor and chairman of the RTPB frequency allocation panel two.

Analyses of the television image of today and that expected in one, two and five years, were offered by Allen B. DuMont, president of the Allen B. DuMont Laboratories and Ralph Beal, research director for the RCA Laboratories, during the third session.

At the fourth meeting, the subject of commercial development of television in the next decade was covered by Edgar Kobak, executive vice president of the Blue Network. He spoke on home television broadcasting. Ralph B. Austrian, television consultant for RKO, discussed the development of theatre television.

Remaining lectures will cover every phase of the television art, including the effect of television on established industries such as advertising, radio, movies, legitimate theatre, and publishing; the nature and specific types of television programs; television studio design and production techniques; the merchandising of television sets and distributors' problems; and the publicity and public relations work which will be necessary to sell television to the public.

Speakers slated to discuss these topics include Paul Raibourn, director of television development for Paramount Pictures, Thomas F. Joyce of RCA Victor, Lewis Winner, editor of COMMUNICATIONS, Gilbert Seldes, CBS director of television programs, C. L. Menser, NBC vice president, Worthington Miner, manager of CBS television department, Edward C. Cole of the Yale Drama School, and others.

* * *

ELLIS OF WPB RETURNS FROM RUSSIA

Ray C. Ellis, director of WPB's radio and radar division, returned to Washington recently after a two-month trip in the Soviet Union. Mr. Ellis visited radio factories in Moscow and the Ural region to study development trends, products being manufactured, and organization and facilities. He also met with several Soviet officials, discussing their postwar radio and communication plans, and acquainting them with general production plans of the United States.

J. F. DRYER JOINS AMPEREX

John F. Dryer, Jr., has joined the engineering staff of Amperex Electronic Products, Inc., of 79 Washington Street, Brooklyn, N. Y. He will be engaged in the development of power and control tubes for use in industrial applications. Mr. Dryer was formerly president and chief engineer of Andrews and Perillo, Inc.

* * *

ASA WIRE-WOUND RHEOSTAT AND RESISTOR STANDARDS

The American Standards Association has announced completion of war standards on power-type wire-wound rheostats and variable wire-wound resistors.

The American War Standard Power-Type Wire-Wound Rheostats (C75.9-1944) may be had for 50 cents a copy, and the American War Standard Variable Wire-Wound Resistors (C75.10-1944) for 40 cents a copy from the American Standards Association, 29 West 39 Street, New York 18, N. Y.

* * *

FIFTEENTH ANNIVERSARY FOR GOAT METAL

Goat Metal Stampings Inc., Brooklyn, N. Y., an affiliate of the Fred Goat Company which was established in 1893, is now celebrating its fifteenth anniversary.

Walter Goat, son of Fred Goat, founder of the parent company, is president of the manufacturing organization. Edward F. Staver is secretary of the Goat organization and in charge of Goat Metal Stampings, Inc.

E. F. Staver

Walter Goat

NEW DATES AND HOTEL FOR EPEI CONFERENCE

The Electronic Parts and Equipment In-dustry conference will be held on Thurs-day, Friday and Saturday, October 19, 20 and 21, at the Stevens Hotel, Chicago.

* * *

PHILCO'S CARMINE VIEWS POSTWAR TELEVISION

Speaking before the Poor Richard Clu[b] at the Franklin Institute recently, Jame[s] H. Carmine, vice president in charge o[f] merchandising for Philco gave his view[s] on the television situation after the wa[r]. In his talk he stressed the fact tha[t] every major city in the country will hav[e] a television station as quickly as trans[-]mitter deliveries can be made, once th[e] FCC has set television standards. He als[o] demonstrated a new tube, the *Plan-[o]-Scope*, which he said eliminated bulbou[s] tube problems, by allowing wide ang[le] viewing and minimizing distortion ar[nd] light reflections.

* * *

McINTOSH AND BOLAND LEAVE WP[B]

Frank H. McIntosh, for the past tw[o] years assistant director and chief of th[e] domestic and foreign branch of WPB radio and radar division, and Fred [S.] Boland, chief of the program branc[h] have resigned from the WPB. Mr. Bo[-]land, who is now with Federal Telephon[e] & Telegraph Company, has been suc[-]ceeded by Lawrence A. Adams, former[ly] with the WPB research and statistics de[-]partment. John Creutz, chief of the tran[s-]mitter section, has taken over for M[r.] McIntosh, who is opening a Washingto[n] office as an industry consultant.

Other changes recently include the a[d-]dition to the WPB radio and radar sta[ff] of three former ANEPA men: Wesle[y] Smith, now head of the component r[e-]covery section; Kenneth Hathaway, r[e-]sistors division; and Robert G. McCurd[y] test equipment section.

Leo Holleran is now with WPB o[n] loan from RCA, as a consultant o[n] vacuum tube production, succeeding Jam[es] E. Wallen who has returned to priva[te] industry. W. E. Wilson, with WPB f[or] about a year, has been assigned to duti[es] relating to transformers; and M. J. M[c-]Nicholas has taken over the end-produc[t] branch.

* * *

ARRL OBSERVES CHINA AMATEUR RADIO DAY

Chinese hams, celebrating the first ann[i-]versary recently of China Amateur Rad[io] Day, received greetings from thirt[y] thousand American amateurs, members [of] the American Radio Relay League. T[he] messages were delivered by George W. Bailey, ARRL president, and Kenne[th] B. Warner, the League's general manag[er] and secretary, in an OWI short-wa[ve] program transmitted from San Francis[co] stations KRCA and KWID.

Chinese hams, who have been allow[ed] to stay on the air throughout the w[ar] were congratulated by Mr. Bailey f[or] their coordinated efforts.

* * *

WGN, BALABAN & KATZ JOIN TBA

Three applications for membership ha[ve]

(*Continued on page* 56)

NEWS BRIEFS

(*Continued from page* 54)

been approved by the Television Broadcasters Association, Inc., 500 Fifth Avenue, New York City. The new members include WGN, Inc., the *Chicago Tribune* station which has filed an application for a television station in Chicago; and the Balaban & Katz Corporation, owners and operators of television station WBKB in Chicago. General Electric Company, which holds an active membership in TBA, was granted an affiliate membership for its electronics department.

* * *

WPB RESTRICTS USE OF RADIAL TYPE BEARINGS

Due to a shortage of the radial type bearings manufactured by the Miniature Precision Bearing Company of Keene, New Hampshire, the WPB has issued a ruling which restricts the use of these bearings in new or additional applications. The restriction is covered by Direction 2 to Table 12 of General Scheduling Order M-293, and relates to bearings nos. 2, 2½, 3, 4, 5, NM4, and NM5.

* * *

MECK PROMOTES WILLIAM MONTGOMERY

William Montgomery, production coordinator for John Meck Industries, Plymouth, Indiana, has been named executive engineer, and will represent the company in contacts with government agencies.

* * *

WESTINGHOUSE BUYS KEX

Station KEX of Portland, Oregon, an affiliate of the Blue network, was purchased recently by Westinghouse Radio Stations Inc. from the publishers of the *Portland Oregonian.* The sale of KEX was in compliance with the recent FCC order which limits ownership by a single operator to one standard broadcast station in a community. The *Oregonian,* which has been operating this station for the past twelve years, also owns and operates Portland's station KGW.

Lee B. Wailes, manager of Westinghouse Radio Stations, Inc., will be in charge of KEX, following FCC's approval of the sale.

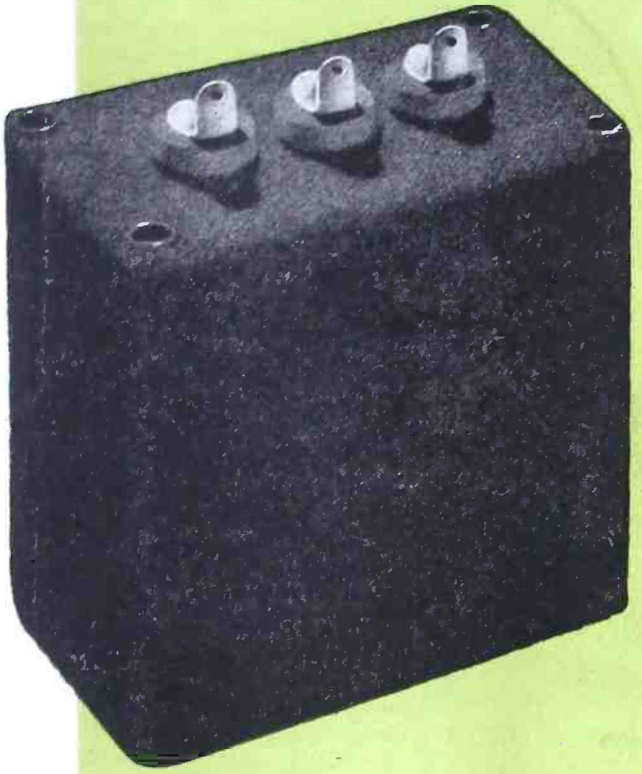
* * *

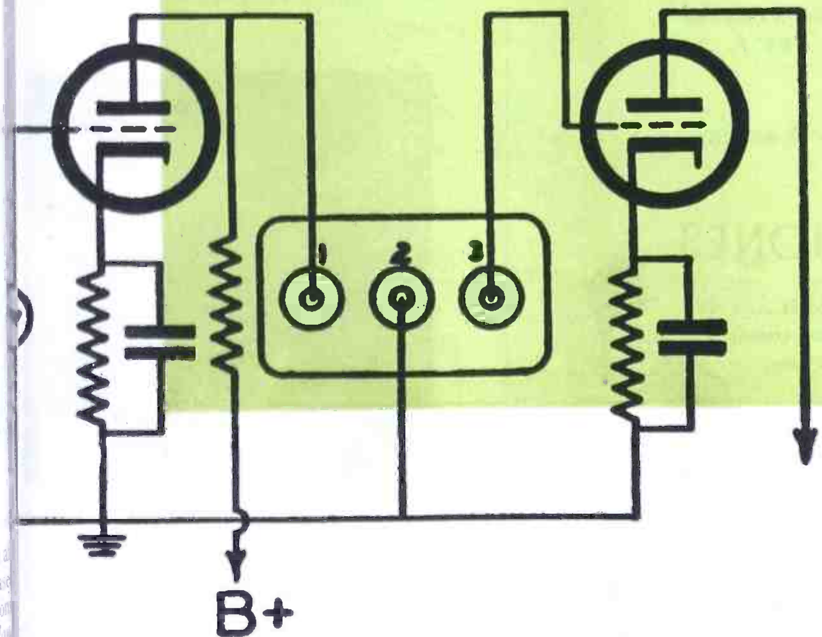
SPI BOARD ELECTS CLARK OF FORMICA

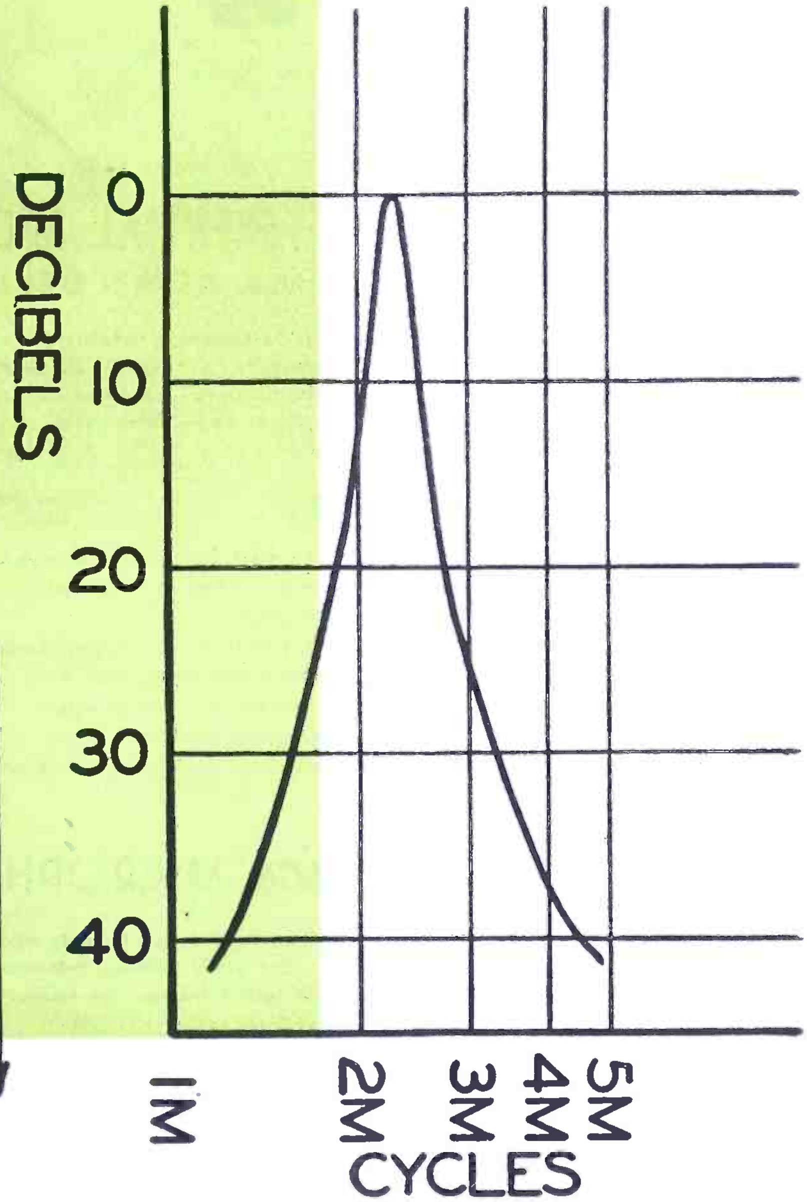
The Society of the Plastics Industry has announced the election of Formica vice president George H. Clark as director of the SPI. Mr. Clark is also associated with the research and testing program of

(*Continued on page* 58)

INTERSTAGE FILTERS BY







Interstage filters lend themselves to effecting gain simultaneously with their frequency discrimination. The unit illustrated is a band pass unit which provides a 2:1 step-up ratio, with band pass attenuation of 40 DB per octave. This unit employs a dual alloy magnetic shield which reduces inductive pick-up to 150 Mv. per gauss. The dimensions in its hermetically sealed case are 1½ x 2½ x 2½. Filters of this type can be supplied for any band pass frequency from 200 to 10,000 cycles.

May we cooperate with you on design savings for your application . . . war or postwar?

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

NEWS BRIEFS

(*Continued from page* 56)

the laminated plastics section of the National Electrical Manufacturers Association.

* * *

HOFFMAN RADIO ADDS ENGINEERS

Four senior engineers and a production supervisor have been added to the staff of Hoffman Radio Corporation, Los Angeles. The new engineers are Donald M. Campbell, formerly electronics engineer with Bell Aircraft; Jay L. Taylor, with Colonial Radio Corporation for more than fifteen years; William W. Wells, whose past experiences cover work with Universal Microphone, Colonial Radio, and Marine Radio; and William J. Green, formerly with Radiobar Company and Philco.

Roy Deane, superintendent of the former Grigsby-Grunow Company for five years, has been appointed production supervisor.

* * *

EARL SAYRE TO P. R. MALLORY

P. R. Mallory & Company of Indianapolis has appointed Earl R. Sayre as application engineer. Mr. Sayre was formerly with Arrow-Hart and Hegeman Electric Company.

* * *

SHAFFER AND KOETKE NOW WITH STANCOR

Grant Shaffer, previously electrical engineer for Jefferson Electric Company, Underwriters Laboratories, and the city of Chicago, is now sales manager i[n] charge of the jobber division of Standar[d] Transformer Corporation, Chicago.

Norman A. Koetke, new Stancor mer[chandise] manager, is in charge of th[e] development of national market policie[s].

* * *

CBS ORDERS G. E. U-H-F TELEVISION TRANSMITTER

The Columbia Broadcasting System re[vealed] recently that it had placed an ord[er] with General Electric for a 1-kw ultr[a] high frequency experimental televisio[n] transmitter to be installed alongside i[ts] present WCBW transmitter in the spi[re] of the Chrysler building. Frequenci[es] used will be around 400 mc. The order [is] subject to the grant of an experiment[al] license by the FCC, as well as to th[e] lifting of military secrecy on various wa[r]time developments in tools and techniqu[es] and the restrictions on materials and ma[n]power which prevent G.E. from imm[e]diate work on the transmitter.

CBS states that it plans to broadca[st] simultaneously over both its present a[nd] its new transmitters, offering a compar[i]son of the prewar and postwar televisio[n] images.

* * *

G. W. DENISE TO LITTELFUSE

Garet W. Denise has been named gener[al] manager of plant operations of the Ch[i]cago plant of Littelfuse, Inc., 4757 Ra[v]enswood Avenue. Mr. Denise, recent[ly] with Republic Aviation Corporation, w[as] previously associated with Ditto, Inc. [as] plant production engineer, and wi[th] Temple Radio Corporation as operatio[ns] manager.

* * *

GROUP INSURANCE FOR AEROVOX EMPLOYEES

The employees of Aerovox Corporati[on], New Bedford and Taunton, Massach[u]setts, are now covered by a group insu[r]ance plan which has been underwritt[en] by the company.

* * *

MACKEY NOW EDITOR OF SYLVANIA NEWS

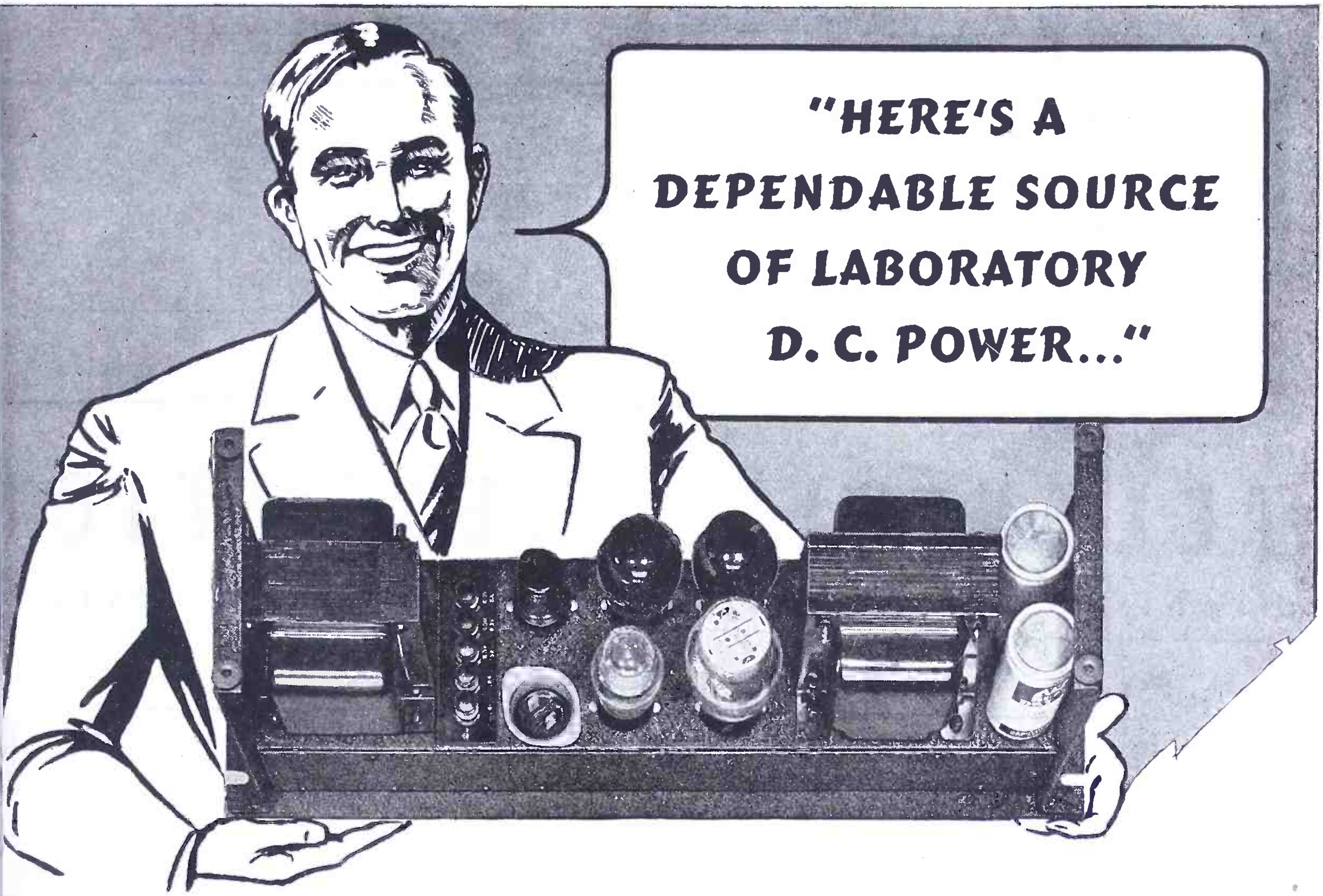
Richard G. Mackey has succeeded Richa[rd] Merrill as editor of *Sylvania News*, ho[use] organ of Sylvania Electric Products In[c.], 500 Fifth Avenue, New York. Mr. M[er]rill has been transferred to the compan[y's] industrial relations department.

* * *

RAYTHEON CHANGES NAME

The Raytheon Production Corporati[on], 55 Chapel Street, Newton 58, Mas[sa]chusetts, has announced the compan[y's] change of name to Raytheon Manuf[acturing]

(*Continued on page* 78)



The HARVEY Regulated Power Supply 106 PA

You'll find it ideal for operation with pulse generators, measurement equipment, constant frequency applicators, amplifiers and any other equipment requiring a constant flow of D. C. voltage.

Designed to operate from 115 volts A. C., the HARVEY 106 PA has a D. C. voltage output variable from between 200 to 300 volts and accurately controllable *to within one per cent.* A model of efficiency and convenience, it has separate fuses on each transformer primary as well as the D. C. output circuit: pilot lights on each switch; a D. C. voltmeter for measuring output voltage and a handy two-prong plug or binding posts to permit easy hook-up.

For complete information on this precision-built, thoroughly dependable source of constant voltage, write for the new HARVEY Regulated Power Supply bulletin. Address your requests for this useful new bulletin to

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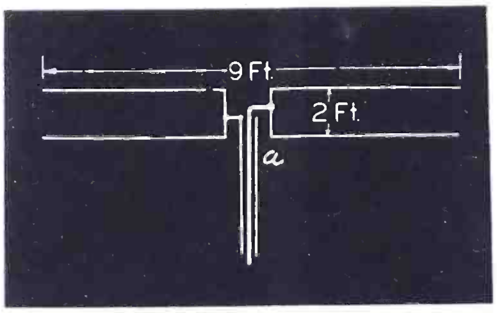
HARVEY UHX-25

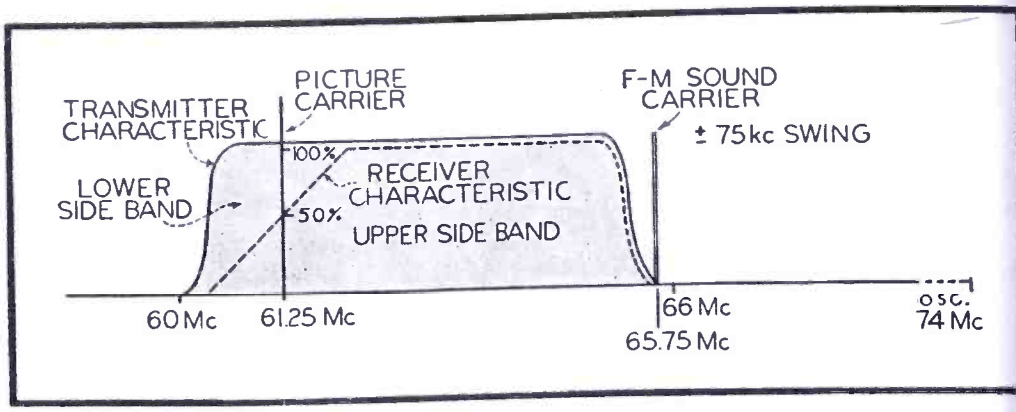
A 25-Watt General Purpose Radio Telephone Transmitter

Available for operation between 1.5 M.C. and 30 M.C.

HARVEY "AMPLI-STRIP"

FOR I-F AND AUDIO AMPLIFICATION





Figures 1 (above) and 2 (right)
Figure 1, antenna for four-television channel reception; *a* is a coaxial feeder. Figure 2, receiver characteristics with properties for channel two; sound i-f equals 8.25 mc, video i-f equals 12.75 mc.

TELEVISION RECEPTION

Highlights of AIEE-IRE Television Lecture

Presented by Dr. T. T. Goldsmith

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 lectures presented by J. E. Keister and H. D. Fancher of G. E., and Dr. P. C. Goldmark of CBS appeared in the May issue. A digest of another lecture in this series by Dr. T. T. Goldsmith of DuMont Labs appears below.*

A BRIEF analysis of early television systems was presented by Dr. Goldsmith as the preface to his lecture. He discussed the basic wired system with a photocell at the transmitter wired to its corresponding lamp at the receiver, where over 100,000 elements were required. Dr. Goldsmith then recalled the Nipkow disc of 1884, with selenium and Kerr cells, using a workable system of 60 lines at a frequency of 15 per second with manual synchronization. An early cathode-ray system invented by Swinton in 1911 was well covered, too.

Dr. Goldsmith began his discussion of modern receivers with antenna considerations, showing a simple antenna for satisfactory reception of four television channels, Figure 1. He explained that a similar structure with the two sections shorted will act as a very effective reflector if placed ¼-wavelength behind the antenna. The short connects the sections at the center (where the feeder is connected to the antenna).

The feeder or transmission line from the antenna to receiver which, Dr. Goldsmith reminded us, is usually many wavelengths long, is a very important part of the system. A mismatch between antenna and line causes spurious signals which make clear pictures impossible. A coaxial cable is the most satisfactory feeder which, at present, costs a minimum of 12 cents per foot, said Dr. Goldsmith. In making an installation of a receiver it is very useful to provide communication between an observer at the receiver and the man making the antenna installation. In this way, explained Dr. Goldsmith, the antenna may be placed at the optimum position and direction for as many stations as are on the air locally.

Discussing propagation, Dr. Goldsmith covered briefly the properties of very high frequencies, their tendency to follow the curvature of the earth to a certain extent, and their refraction at long distances under certain weather conditions. For completely satisfactory reception the range does not greatly exceed the horizon, he said. The height of the receiving antenna determines the horizon, a height of 30′, causing a six-mile extension in the range. The evils of multi-path transmission were explained with the aid of slides which showed various types of ghosts caused by different times of travel between transmitter and receiver. These ghosts may be either positive or negative depending upon the phasing.[1]

Analyzing television receivers, Dr. Goldsmith pointed out the difficulty of covering the entire band of 50 to over 250 mc continuously. Although 17 channels were assigned it was conventional to cover only 5 channels which were set to local stations, pushbuttons being used for tuning in many sets. Dr. Goldsmith pointed out that th same mixer stage is used for vide and audio with a single oscillator.

The r-f stage consists of a 6AC7 c 1852 tightly coupled to the antenn Tight coupling is a feature of televisio receivers, he said, the r-f transforme being tuned for midband, with a doub hump to take care of a 5-mc chann for picture and sound. A tertiary win ing is often used to help broaden th bandwidth, and damping resistors a also used. Figure 2 shows the receiv characteristics, with dimensions fo channel number *2*. In eliminating th lower sideband half the transmitted e ergy is lost, necessitating twice th amplifier gain. Dr. Goldsmith note that this was not serious compared the requirement of passing an 8-m band which would be required wi the transmission of both sideban

In present receivers the i-f gain p stage is approximately 6, Dr. Gol smith pointed out, five stages bei employed. Midget tubes are popul because their low input and outp capacities more than make up for t smaller G_m. Trap circuits are used one or two i-f stages to keep t sound carrier out of the video cha nel, an 8.25-mc trap being used f the receiver station's own sound wh a 14.25-mc trap takes care of the sou from the adjacent channel. The amplifier delivers a volt or two to t diode detector, which must be heav loaded with 2,000 to 3,000 ohms swamp the effect of stray capaciti Dr. Goldsmith showed the comparis of this low efficiency detector with typical radio detector operating int

(*Continued on page* 89)

[1]*Television Coverage*, COMMUNICATIONS, pp. 34-92; December, 1943.

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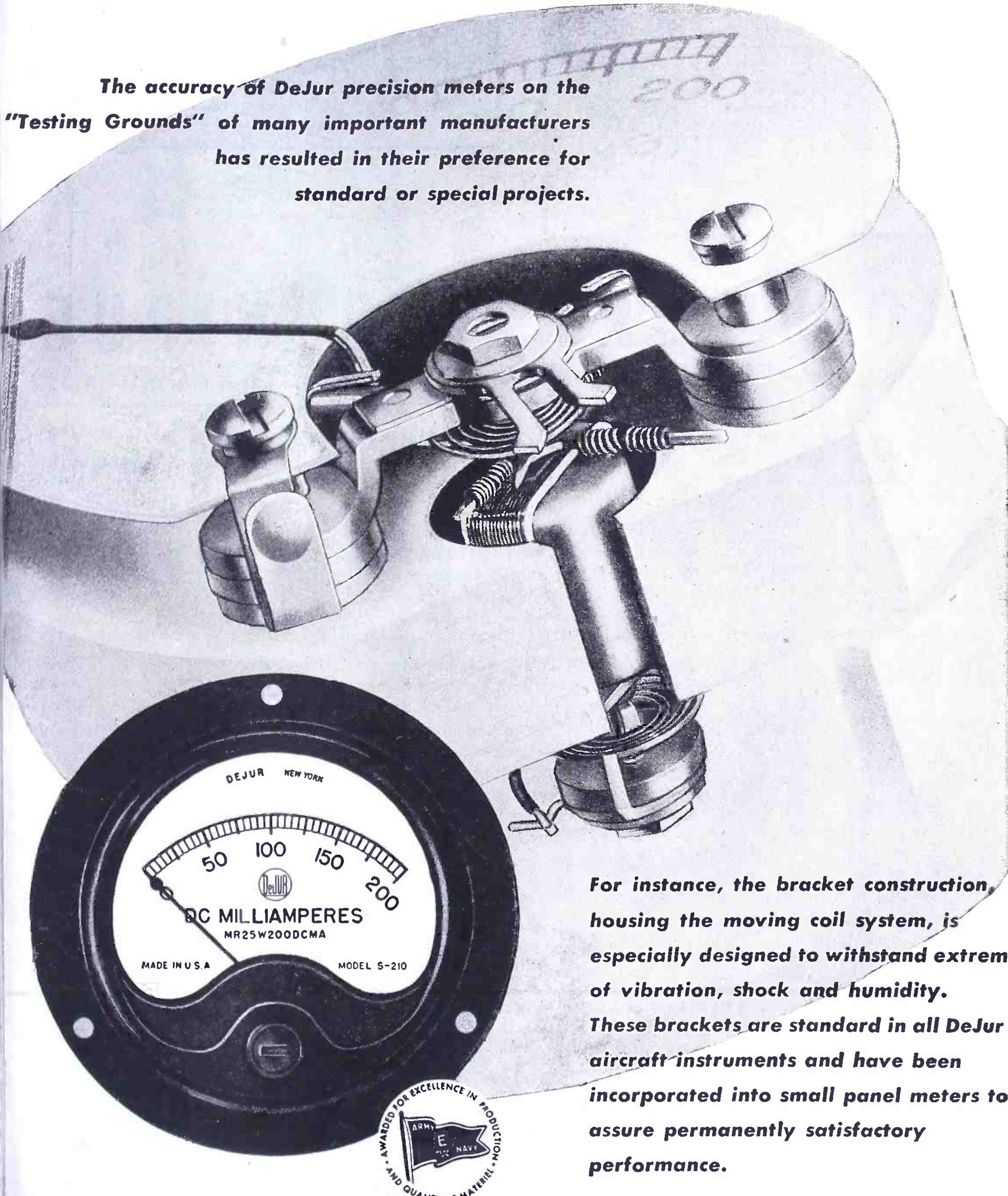

For instance, the bracket construction, housing the moving coil system, is especially designed to withstand extremes of vibration, shock and humidity. These brackets are standard in all DeJur aircraft instruments and have been incorporated into small panel meters to assure permanently satisfactory performance.

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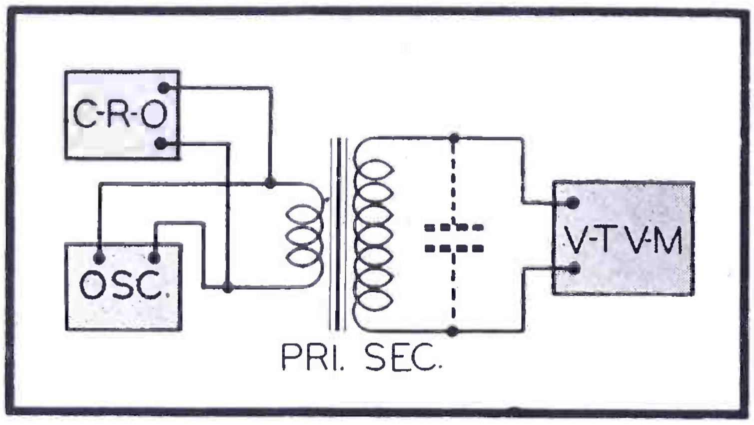
Figure 1
Method adopted to judge operating characteristics of transformers on power frequencies.



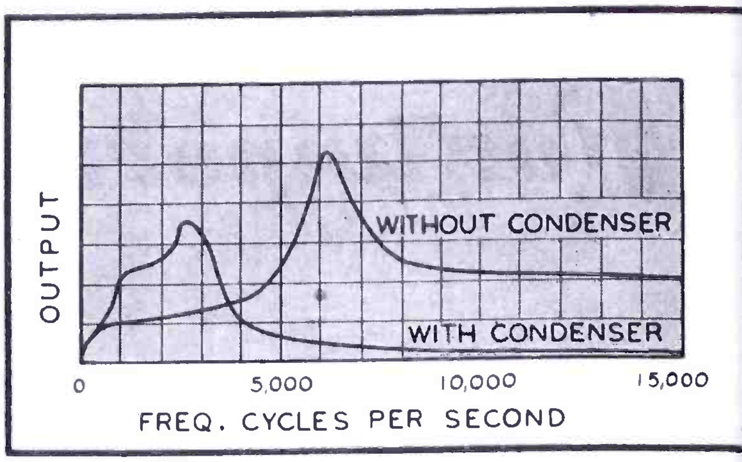


Figure 2
Plot obtained from method shown in Figure 1, indicating shifting of resonant peak.

LABORATORY TECHNIQUES

Developed For ESMWT Communication Courses

by THOMAS A. BENHAM
In Charge of Radio, Dep't of Physics, Haverford College

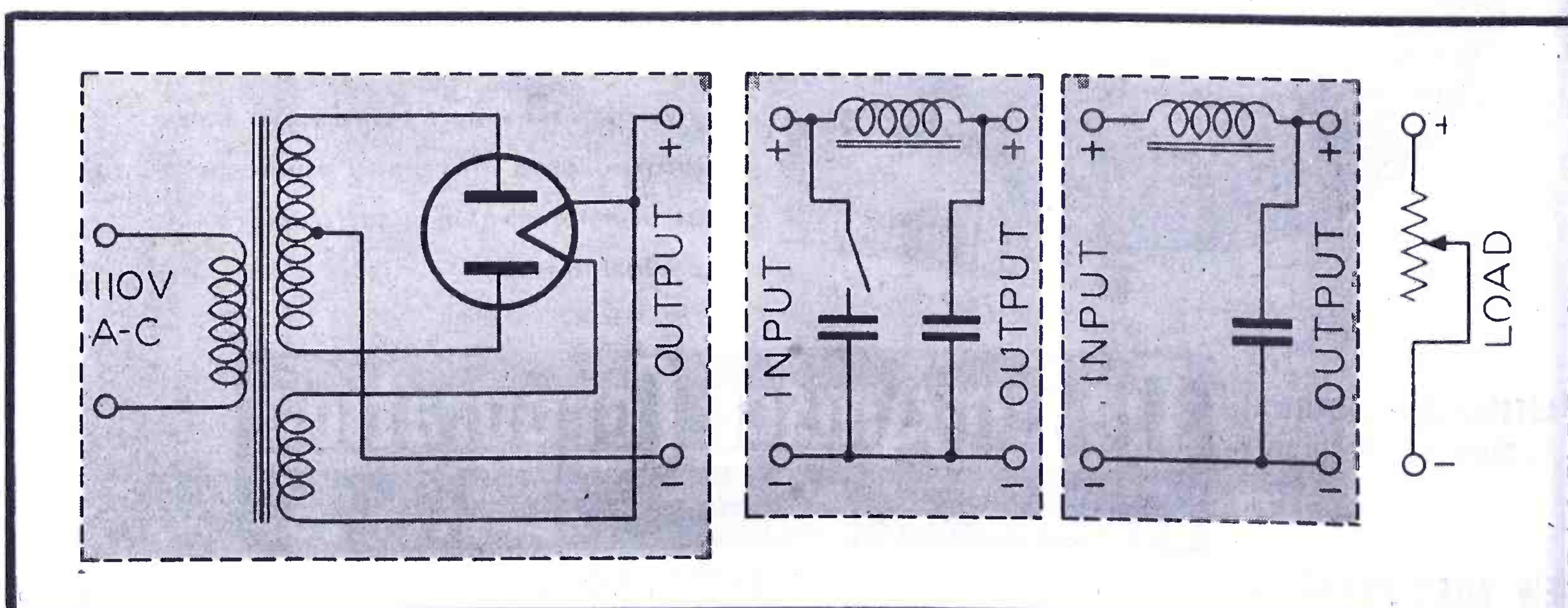
THE expansion of the ESMWT program, featuring radio, has extended activity in this art, particularly at Haverford College. As a result of the Government courses, already presented six times, many improved laboratory techniques have been evolved, techniques that have simplified analyses of a variety of projects. Some of these techniques are presented in this paper.

To gain additional performance data on transformers operating at power frequencies, a method, shown in Figure 1, was conceived. Prior to connecting the equipment, one volt is applied to the vertical plates of the cathode-ray oscillograph, and the gain adjusted to give a convenient deflection. This adjustment is not disturbed throughout the rest of the experiment. The primary voltage is then kept constant at one volt as indicated by the *standard* deflection on the c-r-o. The vacuum-tube voltmeter will then provide the output voltage across the secondary. In this way, the step-up ratio of the transformer can be determined at some frequency such as 500 cycles. Then the frequency of the oscillator is varied from 50 to 15,000 cycles keeping the input voltage constant and recording the output. A condenser having a capacity of .0005 mfd or thereabouts is connected across the secondary and the procedure repeated. When these data are plotted, the shifting of the resonant peak can readily be seen, as shown in Figure 2. If this transformer is used in an amplifier circuit, the plate resistance of the tube associated with the primary will reduce the effective *Q* and hence lower the magnitude of the resonant peak.

One of the questions most frequently asked is: "How does a power-supply work?" This particular topic, as a matter of fact, is treated less seriously in most courses than many equally important subjects. With this in mind, a demonstration was developed to point out some of the more important features of d-c power-supplies. Figures 3 and 9 show the diagram and photograph of the apparatus. In the initial step, the unit is used first with no filter. A full wave of the power frequency is shown on the oscillograph then follows the pattern which results from half-wave and full-wave rectification. The oscilloscope is provided with a *gain control* calibration so that it is possible to determine the crest value of alternating voltages. The filter elements are then added one at a time

(*Continued on page* 64)

Figure 3
Demonstration unit used to judge power supply characteristics.



LAB TECHNIQUES

(*Continued from page 62*)

and readings of ripple voltage, a-c and d-c output voltage and current are taken as the load is varied. By using a-c and d-c current indicators in series in the load circuit, it is possible to show the effect of the a-c component on the effective output current. By using an inductance alone in the filter, a condenser alone, single section choke input, single section condenser input and two sections of choke and condenser input, a fairly complete picture of the function of each component in power-supply circuits is gained.

Studying Characteristics of 6H6

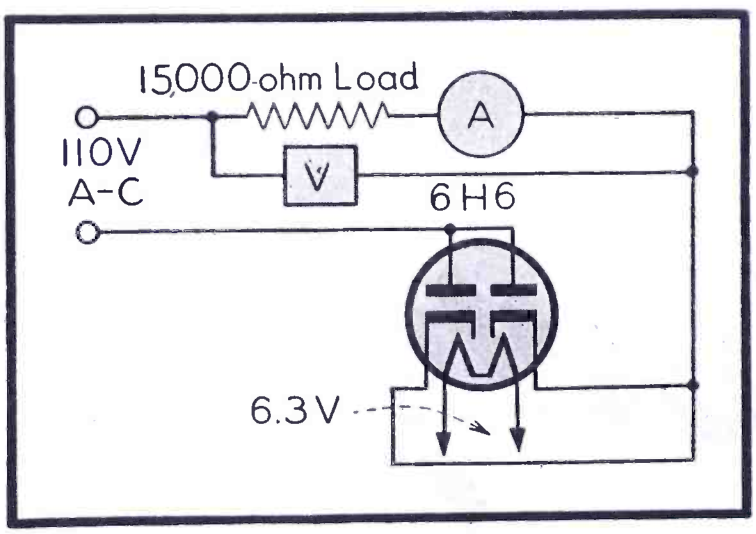
When the characteristics of the 6H6 diode are being studied, there is an opportunity to try the tube as a half-wave and full-wave rectifier. Figures 5 and 6 show the two circuits that we used to make this study. A D'Arsonval voltmeter is employed to measure the rectified output so that the difference between the average values of the two types of rectification may be appreciated. It must be pointed out, however, that the voltage applied to the tube in Figure 6 is only half that in Figure 5. For this reason, the load voltage appears to be the same but the following analysis makes the difference clear. The applied voltage has the form $E = E_m \sin \theta$. But for the half-wave rectification, only the positive half-cycle is effective in producing an output. Since the meter reads the average value, we have

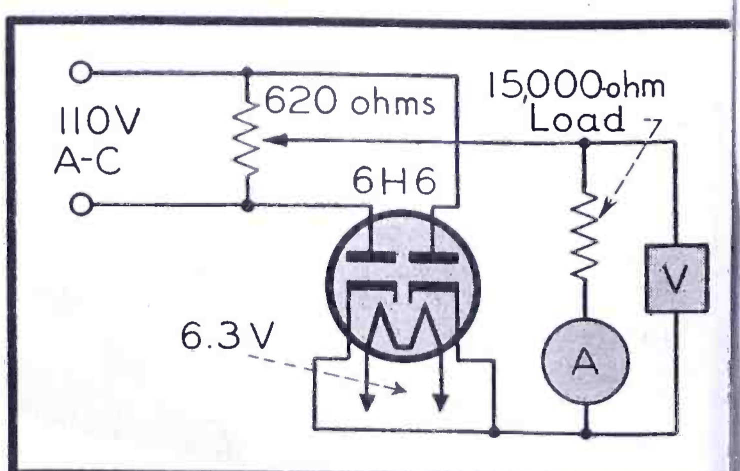
$$E_a = \frac{1}{2\pi}\int_0^{\pi} E_m \sin\theta = E_m/\pi = 0.138\, E_m.$$

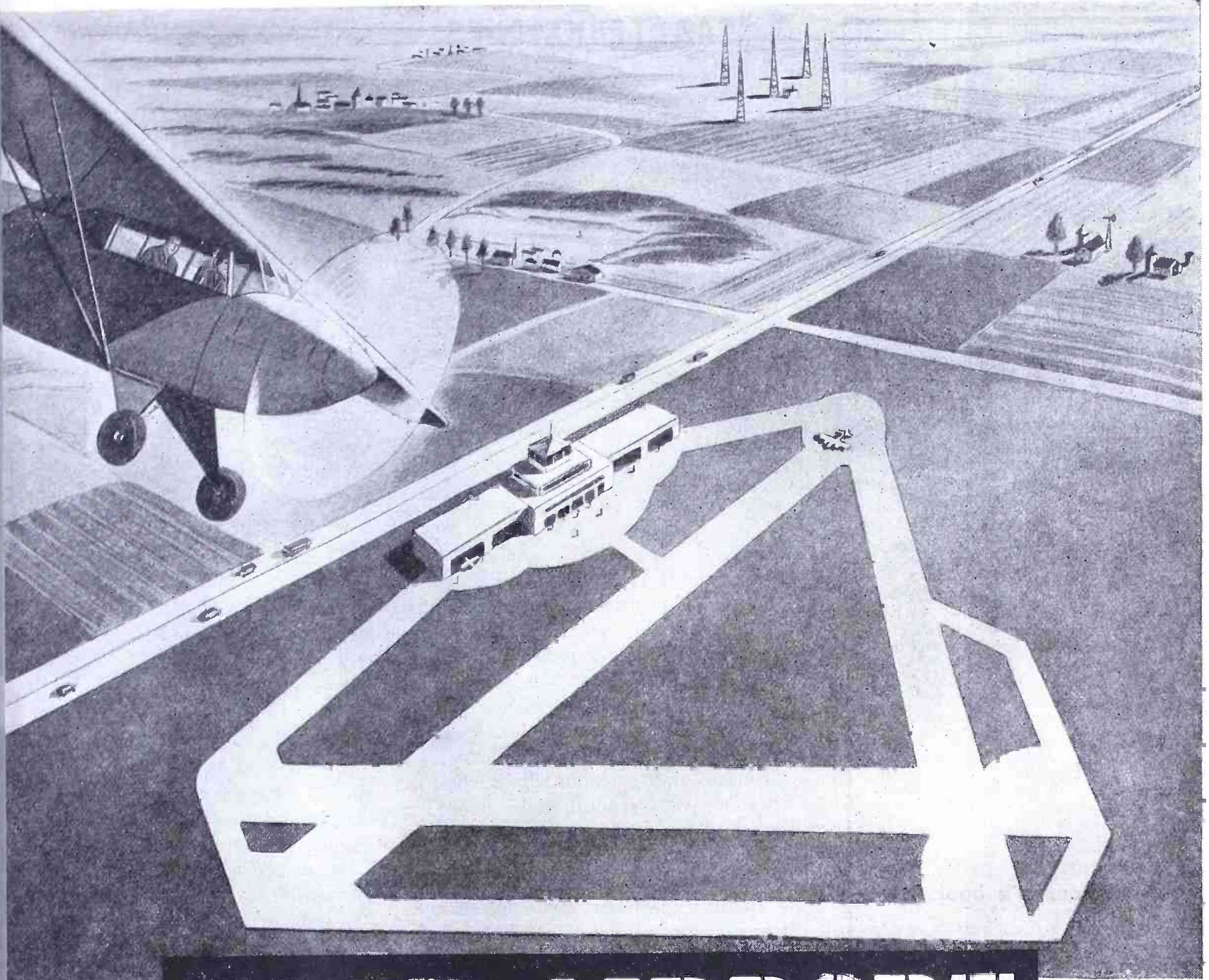
If the line voltage is 115 v. rms, $E_m = 1.414 \times 115 = 162.5$ and the average value of the load voltage is 51

(*Continued on page 66*)

Figures 5 (left, below) and 6 (below)







LAB TECHNIQUES

(*Continued from page* 64)

v. minus the drop in the tube. However, for full wave,

$$E_a = \frac{1}{\pi}\int_0^\pi E_m \sin\theta = 2E_m/\pi = 0.636\ E_m.$$

For the same voltage applied to the tube, the average value of the load voltage would be twice that for half-wave, but the potentiometer, which is connected across the line in order to obtain the center-tap required for full-wave rectification using only one twin diode, reduces the applied voltage by a factor of 2. This factor of 2 can, of course, be regained through the use of a voltage-doubling circuit. The effect of placing a 4-8 mfd condenser across the load is also analyzed with this method. In addition, the *stopping potential* is measured for the 6H6 tube to demonstrate the velocity of emission of thermionic electrons. Of course, this quantity is not determined accurately because it is practically impossible with the available apparatus and time to take the contact potential difference into account. The value of *stopping potential* observed is about 0.6 volt. From this the observer can calculate the maximum velocity of the electrons leaving the cathode.[1]

In the experiment on tuned air-core transformers at radio *frequencies*,[2] the procedure provides for gaining a curve of secondary current versus frequency or separation since it is important to know something about the manner in which the primary current varies. With this in mind, a second current indicator is coupled to the primary after the secondary current curves have been obtained, and the procedure repeated. In the case where the coupling is set at predetermined values and the frequency of the voltage applied to the primary varied, it ca[n] be observed that the primary curre[nt] curve breaks into two peaks before th[e] secondary curve. This is shown [in] Figure 7. The three sets of curv[es] represent coupling less than critica[l], critical and maximum possible cou[p]ling. At critical coupling, the se[c]ondary response is seen to be one pea[k] while the primary already has spl[it] into two peaks.

The equation for the primary curre[nt] is given by[3]: $I_p = E_p/(Z_p + Z_c$ where the subscript, *p*, stands fo[r] primary and Z_c is the impedanc[e] coupled into the primary by the sec[ondary]; $Z_c = (\omega m)^2/Z_s$, where *m* [is] the mutual inductance, $\omega = 2\pi$ tim[es] the frequency, and Z_s is the impedanc[e] of the secondary circuit.

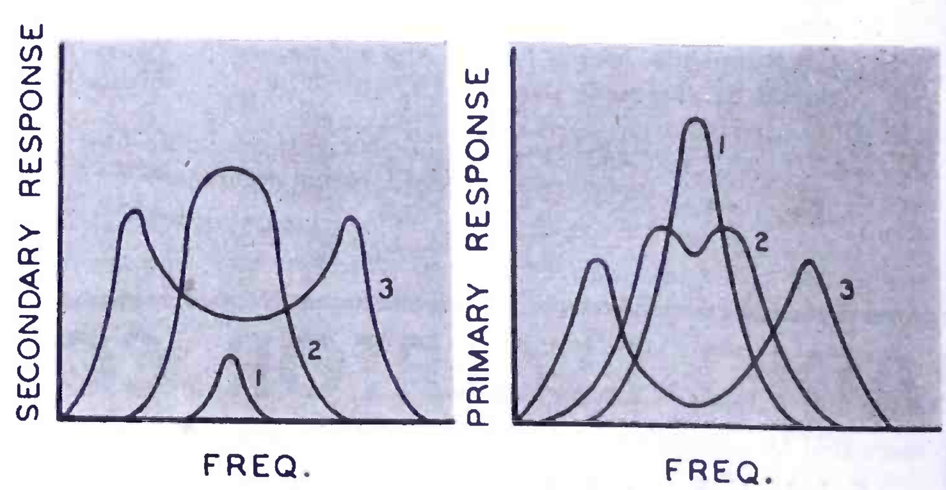
The secondary voltage is: $E_s =$ $-j\omega m I_p = -j\omega m E_p/(Z_p + \omega^2 m^2/Z_s$ The secondary current is then: $I_s =$ $E_s/Z_s = -j\omega m E_p/(Z_s Z_p + \omega^2 m^2)$. Z and Z_s are given by: $Z_p = R_p$ - $j(\omega L_p - 1/\omega C_p)$, and $Z_s = R_s$ - $j(\omega L_s - 1/\omega C_s)$.

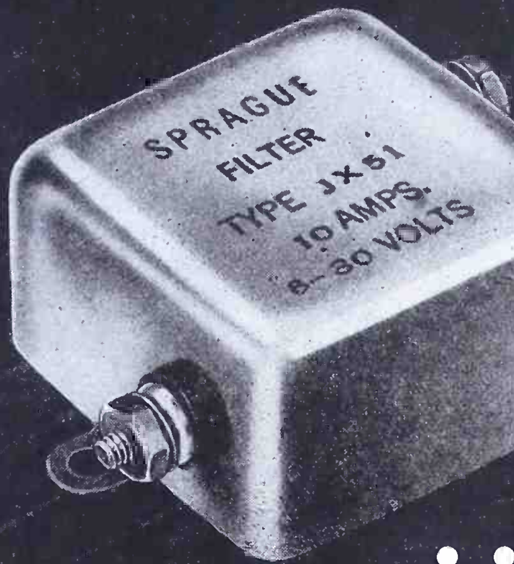
To show qualitatively the impor[tance] of shielding, we place variou[s] shields between the primary and sec[ondary] and note their effect on the sec[ondary] response. Observers note tha[t] a large shield reduces the respons[e] practically to zero while a small shiel[d] has only a partial effect.

The *line of zero coupling* is als[o] investigated[4] in our lab work. In th[is] experiment, we assume that two coi[ls] are located with their axes paralle[l]. We then determine if there is som[e] position for coil 2, relative to coil [1] where no current will be induced in [it]. This would be the case if the lines o[f] magnetic flux from coil 1 cut throug[h] the axis of coil 2 at right angles, Fig[ure] 8. Coil 1, which has a curren[t]

(*Continued on page* 68)

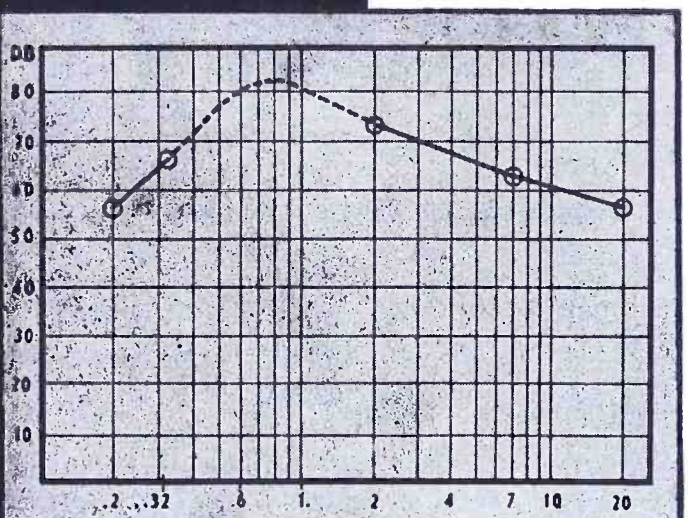
Figure 7





......RADIO NOISE SUPPRESSION PROBLEMS *Answered*

POWER EQUIPMENT (25 to 400 ampere ratings)—For heavy-duty radio noise suppression service, Sprague offers a standard Filter line to match exacting military specifications (Wright Field 32331). Long service has proved their ability to answer problems of noise suppression on airplane motors, generators, inverters, and similar equipment.



ATTENTION CURVE
for Sprague Type JX-51 10 ampere filter with unshielded leads. Weight .37 lb., overall size, 2¾" x 2" x 1⅛".

LOW CURRENT APPLICATIONS (25 amperes and less)—Although designed to the same performance specifications as the foregoing heavy-duty line, sizes and weights of these Sprague Type JX Filters have been reduced. High attenuation characteristics assure high-fidelity radio reception under adverse conditions of man-made interference. They are exceptionally compact, mount in any position, have negligible power consumption, and operate efficiently over a broad temperature range.

Whatever your radio interference suppression problem "ASK SPRAGUE." A broad background of experience in this field over many years covers almost every type of equipment—military, naval, industrial, or home.

SPRAGUE ELECTRIC CO., North Adams, Mass.
(Formerly Sprague Specialties Co.)

ARMY E NAVY

SPRAGUE

CAPACITORS · KOOLOHM RESISTORS

LABORATORY TECHNIQUES

(*Continued from page* 66)

through it will be similar to a bar magnet with poles *M* and $-M$.

Suppose we indicate that the distance between these equivalent poles is 2L and the distance between centers of the coils is R, and then let the angle between *R* and the axis of coil *1* be θ. Then the magnetic potential at *2* due to the two poles of the equivalent magnet is: $V = M/(R - L\cos\theta) + -M/(R + L\cos\theta) = 2ML\cos\theta/(R^2 - L^2\cos^2\theta)$. Now if the assumption can be made that *R* is much larger than *L*, $V = 2ML\cos\theta/R^2$. But if the origin of a rectangular set of axes *X, Y,* is at the mid-point of coil *1* with the X-axis along the axis of the coil, then the coordinates of the center of coil *2* are *x*, *y*, and $\cos\theta = x/R = x/(x^2 + y^2)^{1/2}$. And the potential is: $V = 2MLx/(x^2 + y^2)^{3/2}$.

So that the flux can cut the axis of coil *2* at right angles, the X-component of the flux at *2* must be zero. Hence: $dV/dx = 2ML(2x^2 - y^2)/(x^2 + y^2)^{5/2} = 0$. Since *M* and *L* are not zero, $2x^2 - y^2$ must equal zero. Hence, $2x^2 = y^2$. This is the equation of two straight lines, $y = \pm\sqrt{2}x$, having slopes of $\pm\sqrt{2}$. This means that if coil *2* is located anywhere on a line making an angle of $\theta = \tan^{-1} \pm\sqrt{2}$ or $\theta = \pm 54°44'$, there will be no current induced in coil *2*. By rotating these lines around the X-axis, the zone of zero coupling turns out to be a cone with its apex at the center of coil *1*.

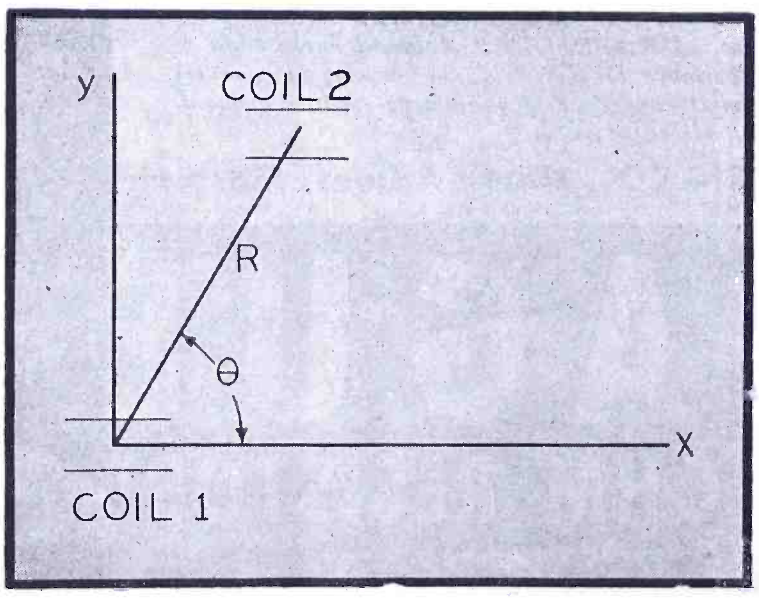


Figure 8
Line of zero coupling plot. Two coils with their axes parallel are assumed in determining this *line*.

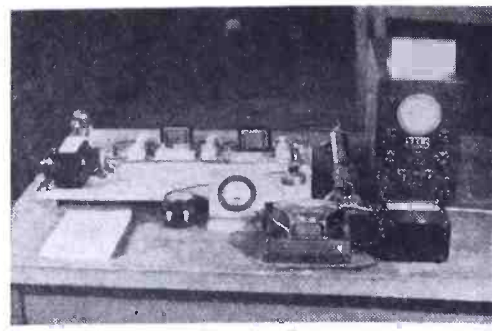


Figure 9
The power-supply setup used to demonstrate some d-c power supply properties

The determination of the angle experimentally is interesting. The results lie between 53° and 57°. The inconsistency probably is due to the relatively large dimensions of the coils compared with their separation. The separation is limited by the sensitivity of the current indicator in the secondary circuit. We found an old type broadcast receiver in which the principle of zero coupling was used in place of shielding. This was used to show a practical application of the theory.

---

[1] $\frac{1}{2}mv^2 = Ve/300$ or $v = \sqrt{2Ve/300m}$ where *m* is the mass of the electron (9.11×10^{-28} gm.), *v* is the velocity in cm/sec, V is the *stopping potential* in volts, and *e* is the electronic charge (4.80×10^{-10} esu) which gives $v = 5.94 \times 10^7\sqrt{V}$.

[2] Caldwell, C. W., *Laboratory Manual for Fundamentals of Radio,* Experiment 9, Prentice Hall, Inc.

[3] Terman, F. E., *Radio Engineering,* 2nd Ed., pp. 72-85, McGraw-Hill Book Co.

[4] Everitt, W. L., "*Communication Engineering,* p. 631, McGraw-Hill Book Co.

ERRATA

S. L. CHERTOK of the American Standards Association has pointed out that a minor error appeared in Paul B. Wright's paper, *Evolution of the DB and VU,* Part II, May, 1944, p 80. The response-frequency characteristic was stated incorrectly as indicating the "accuracy" of the vu instrument. The correct word to use is "sensitivity."

Incidentally, the ASA Standards on vu and db contain invaluable reference data. The standards of db and vu Electrical Indicating Instruments, and American Recommended Practice for Volume Measurements of Electrical Speech and Program Waves, appear in C39.2-1944 and C16.5-1942 respectively.

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

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

At the VWOA, IRE, RC of A and ARRL *Oldtimers Meeting* in N. Y. City, June 7.

RADIO'S oldtimers, members of the *VWOA*, IRE, ARRL and Radio Club of America, joined in on an *Oldtimer's Meeting* at the Hotel Martinique, New York City, on June 7, to chat about radio yesterday and today.

Master of ceremonies was our own George H. Clark, who presented a brief history of the first wireless club in America, the Society of Wireless Telegraph Engineers, founded by John Stone Stone in Boston in 1907. The charter members of this club were Mr. Stone and his co-workers E. R. Cram, F. A. Kolster and G. H. Clark.

George told us that the Wireless Institute was formed in New York in 1909 by Bob Marriott with a membership consisting chiefly of members of the United Wireless Telegraph organization. Together with Marriott at the inception of the Wireless Institute were pioneers Lloyd Espenschied, Alfred Goldsmith, G. W. Pickard and E. J. Simon. The two organizations merged in May 1912 forming the present IRE with Bob Marriott as first president.

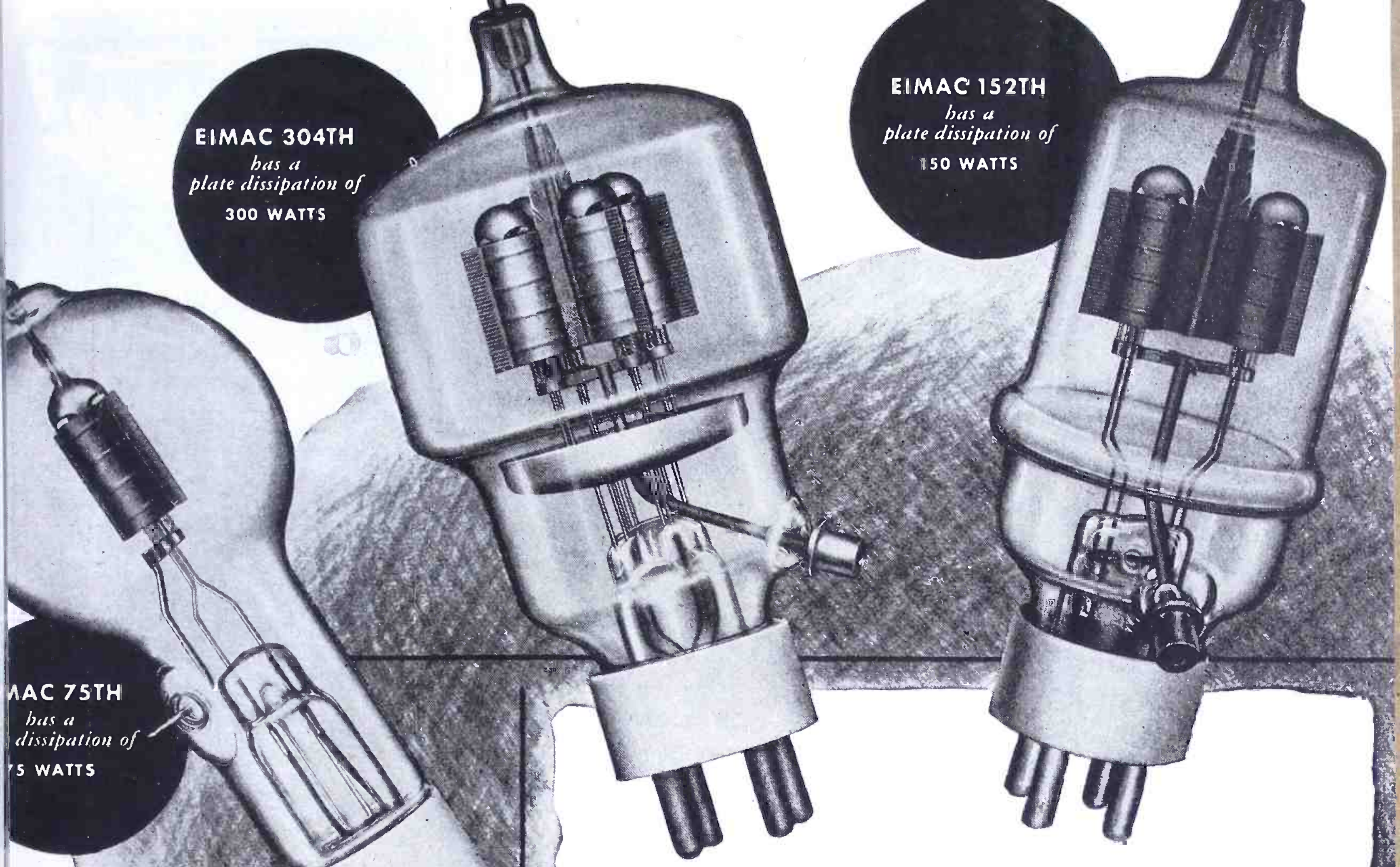
Among the *oldtimers* who were at the meeting were Haraden Pratt, vice-president and chief engineer of Mackay Radio; R. A. Heising of Heising modulation fame, a former president of IRE; Paul Godley, who as the representative of American amateurs caught the first amateur radio signals from America at Androssan, Scotland; Ben Miessner; Lloyd Espenchied, chairman of the New York Section IRE; C. F. Elwell, maker of first Poulsen arcs for our Navy and at present a civilian expert with the United States Navy; Ted McElroy; Ed Content, WOR assistant chief engineer; Dr. E. F. Armstrong; Lt. Commander Arthur Van Dyck, USNR; Professor L. Hazeltine; G. W. Pickard; K. B. Warner; R. H. Marriott; A. J. Costigan, and W. J. McGonigle.

Personals

WE have received many *V*-mail letters from the radio personnel of the Armed Forces asking about membership in VWOA. We're mighty proud of this interest. Among those who wrote in were Chief Radiomen C. R. Spicer and R. P. Herzig, somewhere in the Pacific, each of whom has had over twenty years professional radio experience. . . . G. B. Angle, Officer-in-Charge of Coast Guard operations at the Hialeah, Fla., plant of Tropical Radio requests all interested in reactivating the Miami chapter of VWOA to contact him. . . . Our heartfelt congratulations to Dr. Edwin H. Armstrong upon the award to him of the first Chief Signal Officer's Certificate of Appreciation "for loyal and patriotic services rendered the Signal Corps of the Army of the United States in the accomplishment of its vital mission during a period of national emergency. . . . Hal Styles, chairman and co-founder of the Los Angeles chapter of VWOA, one of our earliest members, is running for Congress. He won his place on the Democratic ticket on May 16, 1944, representing the 15th Congressional district in California. The entire VWOA membership joins in wishing Hal success at the polls in November.

In Memoriam

ONE of radio's outstanding statistical experts, Harry Coulter, comptroller of the Radiomarine Corporation of America, died recently. He was an early member of our association, a director for some years, and always helpful in fiscal matters. We are certain our membership joins with the officers and directors in tendering sincere condolences to his family. He was a grand person.

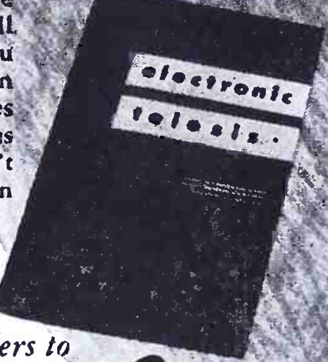


First Public Appearance
of these 5 EIMAC tubes

Eimac has never stopped development of new vacuum tubes. While many types must still be kept secret for military reasons the five here presented can be announced. Full technical data is available now on these five as well as new information about the entire Eimac line. Write today for your copies.

Get your copy of
ELECTRONIC TELESIS

A sixty-four page booklet that will assist engineers in explaining the fundamentals of electronics to the layman. Copies will be mailed to you without obligation . . . additional copies for your associates upon request. Don't delay! The edition is limited.



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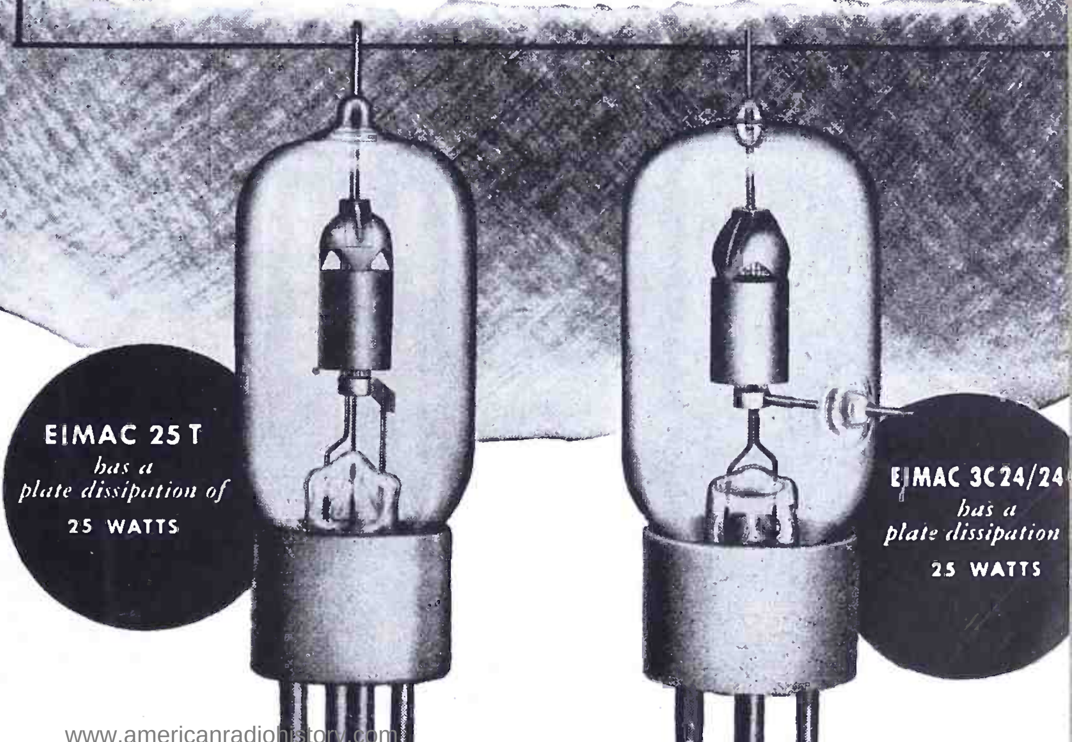


THE INDUSTRY OFFERS . . . —

ACRO MINIAC SNAP-SWITCH

Enclosed snap-action switches, 17/64" thick, 13/16" high, and 1 13/16" long are being manufactured by the Acro Electric Company, 1319 Superior Avenue, Cleveland 14, hio. Uses rolling spring principle. Enclosed in a bakelite case with 4 mounting holes, 3/32" diameter. Actuation is with a stainless steel pin plunger. All parts are non-corrosive and all contacts are of fine silver. Main blade, contact blade, and rolling spring are of beryllium copper. Rated at 15 amperes, 115 volts a-c. Furnished in single pole, normally open and normally closed, double throw. Designed to permit leaf type or overtravel plunger type actuators to be attached to the case.

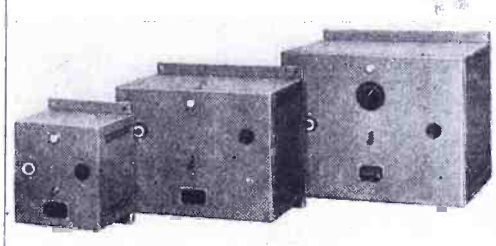
* * *

FEDERAL POWER SUPPLY UNITS

Selenium rectifier power-supply units of 1, 5 and 10 amperes at 115 volts d-c, have been added to the power supply equipment line by Federal Telephone and Radio Corporation, Newark, New Jersey.

The units are designed for wall or bench mounting. They are equipped with a 6-foot input lead with male connector and a standard convenience receptacle for the output. The 10-ampere unit is furnished with an 11-point selector switch for maintaining 115 volts from no load to full load.

Powered by convection-cooled Federal selenium rectifiers.



* * *

BURNDY WATER-SEAL ELECTRICAL CONNECTORS

To provide a water seal for cable ends, Hysealugs have been developed by Burndy Engineering Co., Inc., 107 Bruckner Blvd., New York 54, New York. The connectors are said to be made from pure copper and silverplated. The barrel of the Hysealug is indented onto the conductor while the shroud is compressed over insulation to form a water-tight cable-end seal. Installation is made with a Burndy hypress and a dual die which indents the connector and compresses the shroud in one operation for cables up to 1000 mcm.

* * *

SCHERR OPTI-FLAT

An optically polished glass master surface plate that is said to be flat to an accuracy of 50-millionths of an inch, has been produced by The George Scherr Company, 200 Lafayette Street, New York 12, N. Y.

The plates, which are called **opti-flats,** are said to be resistant to abrasion. They are 2" thick for the 12" and 3" thick for the 16" size to prevent warpage and breakage. They are inspected by means of optical flats by

light interference methods. Opti-flats are annealed.

* * *

RCA MINIATURE THYRATRONS, TRANSMITTING TRIODES AND MULTIPLIER PHOTOTUBES

A quartet of tubes, including a forced-air-cooled transmitting triode and a miniature ½-ounce thyratron have been announced by RCA.

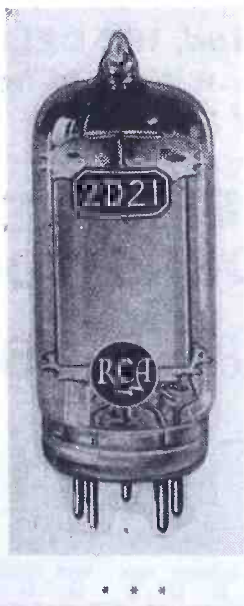
The forced-air-cooled tube, 9C22, and its "sister" tube, the water-cooled 9C21, are both suited for use in the class B modulator stage and in the plate-modulated class C final amplifier stage, as well as in large units for high-frequency heating.

A pair of either type are said to have ample power-delivering ability for the final stage of a 50-kilowatt broadcast transmitter. For industrial heating applications, a pair of 9C22's, operated as unmodulated class C oscillators, are said to provide an output up to 130 kilowatts, while a pair of 9C21's under the same conditions will furnish up to 200 kilowatts. These new types may be used with maximum ratings at frequencies up to 5 megacycles, and with reduced ratings at frequencies up to 25 megacycles.

The new thyratron, 2D21, is said to carry 0.1 ampere plate current continuously, and for periods up to 6 seconds out of 30 will safely carry 0.5 ampere. Uses xenon filling instead of mercury vapor.

The fourth tube is a 9-stage multiplier phototube, 931-A, which is said to be capable of amplifying signals up to 200,000 times and more.

Operated at 100 volts per stage, the 931-A has a sensitivity of 2 amperes per lumen, or more than three times that of the 931, which it supersedes.



* * *

G. E. ELECTRONIC RELAY

An electronic relay for amplifying limited current transmitted by delicate control contacts or high resistance circuits has been announced by the industrial control division of G. E.

Operated by any material having a resistance of from 0 to 500,000 ohms, or even greater if necessary. The relay is said to be especially suitable for controlling liquid levels in tanks and boilers, sorting metallic parts by size, de-

THE INDUSTRY OFFERS . . .

(*Continued from page 73*)

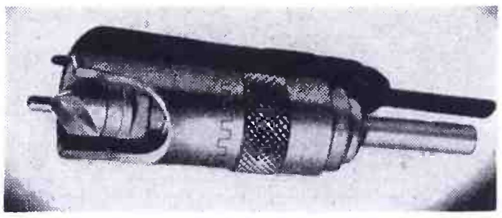
tecting broken threads in textile machines, and as a limit switch requiring extremely light pressure to operate.

* * *

AIRCRAFT TOOL COUNTERSINK

To permit countersinking in close quarters, a micro-set stop countersink, model 400-A, with cutaway skirt has been announced by Aircraft Tools, Inc., Los Angeles. The cutaway skirt feature is said to make it possible to countersink in corners, next to joints, on plate nuts, etc.

Has a split collet type shaft, which allows usage of various cutters and pilots, full ball thrust bearing, positive sight adjustment in increments of .002", and lock spring in sight adjusting sleeve.



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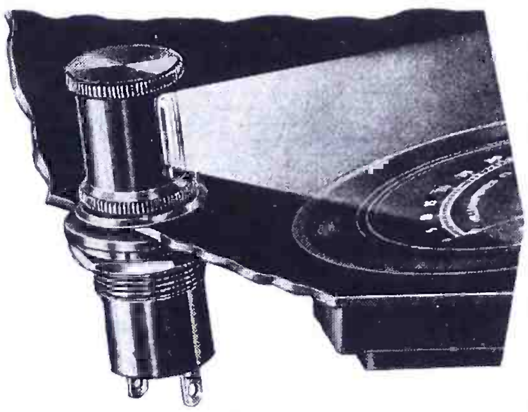
DIALCO PANEL LIGHT ASSEMBLY

Panel light (light-shield) assembly has been produced by the Dial Light Co. of America, Inc., 900 Broadway, New York 3, N. Y.

The light has a knurled head, rotatable 360°. Lamp housing is made of Navy specification bakelite sealed with bakelite varnish, while the head is made of brass and may be finished with any desired plating. Lamp socket accommodates miniature bayonet base lamp. Requires an 11/16" panel hole for mounting.



* * *

SHALLCROSS WIRE-WOUND SURGE RESISTORS

For x-ray and other high-voltage applications, the Shallcross Manufacturing Company, Jackson and Pusey Avenues, Collingdale, Pa., have developed wire-wound surge resistors, type 290. Suitable for high-resistance units capable of handling high voltage, while dissipating normally 200 watts.

Resistors are wound on non-hygroscopic ceramic forms with insulated nicrome wire, single layer space-wound. The wire is protected with a finish that is said to reinsulate, resist heat and assure operation at 450° F. Any resistance from 1,000 to 3,000,000 ohms are available.

* * *

ARPIN RECTIFIERS

Rectifiers, type 869-B, with a maximum peak inverse anode voltage (25-150 cycles)—10 amperes, and average anode current at 2.5 amperes (in-phase filament excitation) have been developed by Arpin Manufacturing Co., 422 Alden St., Orange, New Jersey. Typical conditions in a single phase, full-wave circuit (2 tubes): a-c input voltage, 7070 (rms per tube); a-c output voltage, 6360; maximum d-c load current, 5 amperes. Tubes feature oversize cathode shield, and an edgewise-wound ribbon filament of a new alloy which is said to provide cathode with large emission reserve.

* * *

RGP PORTABLE SUPER TESTER AND POCKET MULTITESTER

A tester that is said to be equivalent to 27 individual instruments has been produced by Radio City Products [illegible] est 20 Street, New York 1, N. Y. Features of tester, model 422, are . . . current measurements in both a-c and d-c up to 25 amperes, voltage measurements in both a-c and d-c up to 5,000 volts, high voltage not applied to selector switch nor to general test circuits, 3" square meter with movement of 200 microamperes or 5,000 ohms per volt sensitivity on d-c voltage measurements. Resistance measurements up to 10 megohms. Supplied with batteries in natural wood case, 6½" x 7" x 2¾".

A pocket multitester, model 420, 6⅜" x 3½" x 3", that weighs 25 ounces is also announced by RCP. Meter movements are said to be guaranteed to be accurate to within 2%. Voltage multipliers are metallized matched pair resistors having a tolerance of 1%.

[illegible] meter has a 0-400 microampere range. Output meter, db meter, milliammeter and ohmmeter are said to provide a total of 23 ranges. Voltmeter, a-c/d-c, up to 5,000 volts at 1,000 ohms per volt sensitivity. Supplied in a hardwood case, with batteries.

* * *

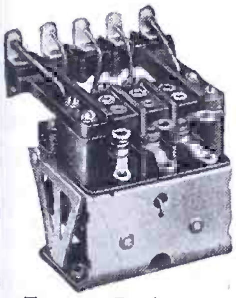
G-M IMPROVED MULTI-POLE D-C RELAYS

An improvement in the sensitive type "27" multi-pole relays has been announced by G-M Laboratories, Inc., 4300 North Knox Avenue, Chicago 41, Illinois.

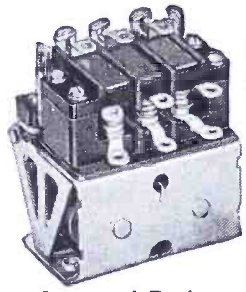
The top contact structure has been redesigned on the 3, 4 and 5-pole relays. Formerly, all coil and blade contact terminals were located on an overhanging bakelite bracket. Relays with the new top contact structure require considerably less mounting space.

Depending upon available power and on coil and circuit characteristics, contact capacity ranges up to 10 ampere continuous at 30 volts d-c on inductive (motor) circuits based on operation at 53,000 feet altitude.

Coils are both varnish and vacuum-wax impregnated and all metal parts are either non-corroding or are heavily plated. Ambient temperature range minus 40° to plus 90° C. Weight 4½ to 6½ ounces, depending upon number of poles.



Former Design



Improved Design

* * *

CANNON AN3101 CONNECTORS

A connector, type AN3101, that has been designated a **receptacle** since it has a male coupling thread sim[illegible] types AN3100 and AN3102, has been announced by Cannon Electric Development Company, 3209 Humboldt Street, Los Angeles 31, California.

AN3101 is a mating (cord) connector for AN3106 and AN3108. In appearance, it resembles an AN3100 without a mounting flange. The length is same as AN3100.

The AN3101 uses the same end bell and assembly nut as is used on AN3106 in conjunction with a special barrel which houses a standard AN pin or socket insert assembly. The insert is retained within the barrel by using the same standard insert retaining ring as used on Cannon standard type AN fittings.

Shell material is aluminum alloy, with sand blast and lacquer finish except on bonding surfaces. Threads have thread lubricant.

* * *

COLONIAL PULSE GENERATOR

A pulse signal generator of d-c pulses, derived from an internal sine-wave audio oscillator providing pulses at 500 or 5000 cycles

(*Continued on page* 76)

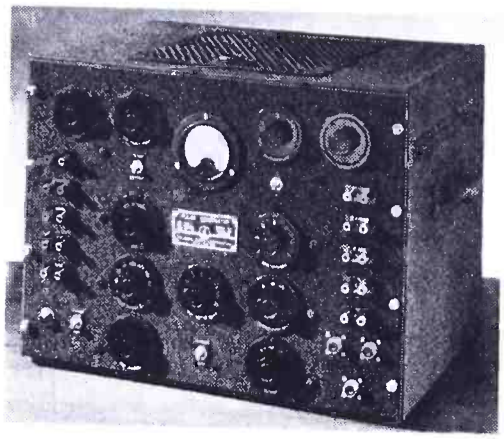
THE INDUSTRY OFFERS . . .

(Continued from page 75)

is now available from Colonial Radio Corporation, 254 Rano Street, Buffalo 7, New York.

With external audio oscillator, pulses may be obtained from 50 to 20,000 cycles. Amplitude and time duration of pulses is continuously adjustable over a wide range; output polarity is either positive or negative. Amplitude adjustable by means of an attenuator and read directly from an output meter and multiplier. Marker circuit, superimposing one megacycle sine wave on pulse, serves to check time duration calibration and time axis. Output impedance consists of 100-ohm termination at end of 3-foot cable.

Also provided is a negative pulse of 30 to 100 volts at higher output impedance, modulator stage, sine sweep voltages, and expanded sweep voltages for short time pulse observation. An advance positive pulse is also provided. Available only for 115 volts 60 cycle, a-c supply.



* * *

BIRTCHER TUBE CLAMPS

Birtcher stainless steel tube clamps are now available from the George S. Thompson Corporation, 5240 Huntington Dr., Los Angeles, 12, Calif., sole licensees of The Birtcher Corporation.

George S. Thompson, formerly vice president of Birtcher Corporation, is president and general manager of the Thompson Corporation. John Thompson is vice president and Arthur Bruce, secretary.

* * *

CETRON CE-200 and CE-201

Improved models of the CE-200 and CE-201 mercury vapor 2-ampere full-wave rectifier tubes are now available from the Continental Electric Company, Geneva, Illinois. Suitable for applications up to about 250 volts d-c.

Both tubes have identical electrical characteristics, the difference between them is in the basing. CE-200 has a standard 4-pin base and the CE-201 a special long-pin industrial base.

* * *

RCA PLASTIC MOLDING OVEN

An automatic electronic oven for pre-heating of plastic materials to ready them for the molding process, is now available from the RCA Victor division of RCA.

To pre-heat plastic preforms for molding with the unit, the operator places the preform on the bottom electrode, then closes a counter-balanced lid, automatically bringing a retracting upper electrode into contact with the work, and presses the starter button. The top electrode mounting and operating mechanism is designed to permit the electrode to seat flat and exert uniform pressure on any thickness of preform within its operating range. At the end of the heating cycle, the pre-set timer automatically opens the lid and shuts off the power.

Generator in the unit delivers up to 2000 watts of power, or 6800 btu per hour, into a dielectric load of average characteristics, with an input of approximately 4.5 kilowatts maximum and a line voltage of 200-240 volts, 50-60 cycle, single phase. Ultrahigh operating frequency (of approximately 27.4 megacycles). An r-f filter is included to guard against radio-interference radiation via the power circuits. Also has an automatic filament voltage regulator, capable of handling a line voltage range of 190 to 260 volts. Two infra-red lamps are installed in the heating chamber to provide auxiliary radiant heat and prevent cooling of the preform surfaces by the surrounding air. Equipped with two 833A oscillators, four 8008 rectifiers, and two 2050 control tubes.

The cabinet is 50" high, 30" wide, and 24" deep, and weighs about 800 pounds.

* * *

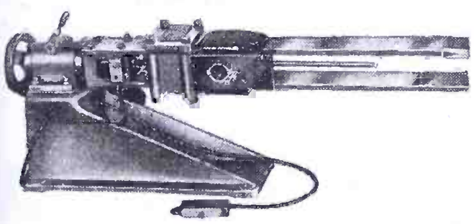
KURMAN VIBRATION TEST

A vibration tester employing the tuning fork principle and a variable frequency from 20 to 70 cps, has been announced by Kurman Electric Company, 35-18 37 Street, Long Island City 1, N. Y.

Variable amplitude and variable frequency direction is also provided. Direction of vibration can be changed while tests are under observation. Capacity up to 5 pounds.

Two objects can be tested at the same time. Vibration acceleration is provided to 30 G. plus. Frequency change is motor operated; resonant conditions are said to be instantly detected. 75 watts are required for maximum test conditions.

Can be mounted on any bench. Available in two models, V 101, stationary yoke, providing up and down vibrations, and V102, rotable yoke, providing vibrations in any directions through 360°.

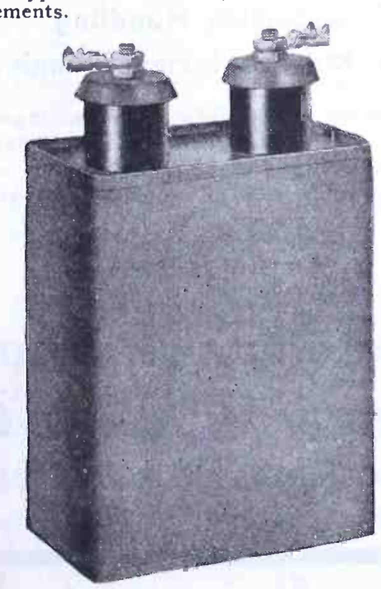


* * *

CAPACITRON OIL-TYPE CAPACITORS

A complete line of rectangular oil-type capacitors has been announced by The Capacitron Company, 318 W. Schiller St., Chicago 10, Illinois. Made in standard container sizes and in voltage ratings up to 6000 volts, d-c working.

Capacitron bulletin 104 lists all pertinent data including capacities, voltage ratings, container sizes, types of terminals, and mounting arrangements.



NEWS BRIEFS

(*Continued from page* 58)

turing Company, Radio Receiving Tube Division. No other organizational change is involved.

* * *

NSMPA SCREW-MACHINE INFORMATION SERVICE

A free information service, which should aid buyers of screw machine products to locate available machine capacity, has been set up by the National Screw Machine Products Association, 13210 Shaker Square, Cleveland 20, Ohio. Member companies of the Association are reporting machine capacity available now, and that expected to be available in the near future.

* * *

DR. TOWN PROMOTED BY STROMBERG-CARLSON

Dr. George R. Town has been promoted to the post of research and engineering manager of the Stromberg-Carlson Company, Rochester, New York. Dr. Town, who joined the company in 1936 as a research engineer, was formerly associated with Leeds & Northrup Company of Philadelphia, and the Arma Engineering Company of Brooklyn, New York.

* * *

WALLACE TO REPRESENT GHIRARDI BOOKS ON WEST COAST

Don C. Wallace of 4214 Country Club Drive, Long Beach 7, California, has been appointed west coast sales representative for the *Ghirardi* radio books which are published by Murray Hill Books Inc., 232 Madison Avenue, New York 16. Mr. Wallace's territory includes Arizona, California, Idaho, Nevada, Utah, Oregon and Washington.

* * *

WESTINGHOUSE TO MAKE RECEIVERS

When war conditions permit, Westinghouse Electric & Manufacturing Company will again be producing home radio receiving sets. The company discontinued home receiver production in 1928.

* * *

ADDITIONAL PLANT FOR HOFFMAN

A cabinet factory at 6623 Stanford Avenue, Los Angeles, has been purchased by Hoffman Radio Corporation.

* * *

LLOYD AND PORTER TO N. A. PHILIPS

The North American Philips Company Inc., 100 East 42nd Street, N. Y. 17, has announced the appointment of Warren D. Lloyd as commercial manager of its medical department which manufactures x-ray equipment, and T. R. Porter as technical commercial man on high frequency heating. Mr. Lloyd, who was New York office manager for the G.E. X-ray Corporation for the past fourteen years, will be located at the Philips plant in Mt. Vernon, New York. Mr. Porter, for the past eight years with Westinghouse, will work from the company's New York City headquarters.

* * *

SADENWATER EASTERN RCA BROADCAST S-M

Harry Sadenwater is now eastern sales manager for Radio Corporation of America, with offices at RCA's sales headıarters, 411 Fifth Avenue, New York ity. In his present capacity Mr. Sadenıater will be responsible for the sale of ·roadcast transmitters and associated ıuipment to eastern radio stations.

* * *

IEW REPS FOR CANNON ELECTRIC

'he Cannon Electric Development Comıany of Los Angeles has appointed five ·w engineering representatives. These ıclude Wright Engineering at 6109 North Ieridian Street, Indianapolis 5, Indiana; ranklin Sales Company, Central Savings ank, Denver 5, Colorado; Bruner Corıration of 418 West North Avenue, Iilwaukee 12, Wisconsin; Southern Selrs of 918 Union Street, New Orleans 3, Louisiana; and Mountain States Enıneering Company, 215 West Second, alt Lake City 1, Utah.

James L. Wright, Jr., Wright Eng.

* * *

IAJOR ROTE APPOINTED TO SA COMMITTEE

Iajor George A. Rote of the engineering ɔard at Fort Belvoir, Virginia, has been ppointed a member of the American tandards Association's committee on ıandardization of vacuum tubes for inıstrial purposes.

* * *

IEACHAM OSCILLATOR ANALYSIS N G.R. EXPERIMENTER

'he April issue of *The General Radio xperimenter,* contains a simplified verıon of Meacham's oscillator in an article ıtitled, "A Bridge-Controlled Oscillaır." Also in this issue is a reprint of The Effect of Humidity on Electrical Ieasurements," which appeared in an arlier issue.

* * *

NSULINE WINS "E"

'he Army-Navy "E" has been awarded ɔ the Insuline Corporation of America, ong Island City, N. Y.

* * *

INION CARBIDE ELECTS SUBSIDIARY COMPANY PRESIDENTS

Iew presidents have been named for xteen subsidiary companies of Union arbide and Carbon Corporation, 30 East 2 Street, New York City. The presients elected are: James W. McLaughlin ır the Bakelite Corporation; John R. Van 'leet, U. S. Vanadium Corporation; John). Swain, Electro Metallurgical Sales Corɔration; Dr. Joseph G. Davidson, Carıide & Carbon Chemicals Corporation ınd Carbide & Carbon Chemicals Ltd.;

(*Continued from page* 81)

NEWS BRIEFS

(*Continued from page 79*)

Stanley B. Kirk, Linde Air Products Company, Prest-O-Lite Company Inc., Dominion Oxygen Company Ltd., and the Prest-O-Lite Company of Canada Ltd.; Arthur V. Wilker, National Carbon Company Inc. and Canadian National Carbon Company Ltd.; Francis P. Gormely, Electro Metallurgical Company, Electro Metallurgical Company of Canada Ltd., Haynes Stellite Company, Michigan Northern Power Company, and Union Carbide Company of Canada Ltd.

* * *

"E" FLAG TO PRICE BROTHERS COMPANY

The Army-Navy "E" flag was awarded recently to Price Brothers Company, Frederick, Maryland.

* * *

NEW VICE PRESIDENTS FOR PEERLESS

H. M. Bateman and Mrs. E. M. Aalberg were elected vice presidents recently of Peerless Electrical Products Company, Los Angeles.

* * *

UNIVERSAL MICROPHONE IN SIGNAL CORPS DISPLAY

A pictorial display of the history of communications has been set up in the Chicago Army Signal Corps' permanent exhibit of electronics, by Universal Microphone Company, Inglewood, California.

* * *

MOORE RCA LATIN AMERICAN DIRECTOR

Fred A. Moore has been appointed regional director for Radio Corporation of America in Latin America. Mr. Moore was previously head of Corporacion de Radio de Chile, RCA's subsidiary in Chile.

Other foreign appointments include Carlos Touche, president of RCA Victor Argentina, Buenos Aires; L. A. Humphries as general manager of Corporacion de Radio de Chile, Santiago; and Harold R. Maag as general manager of RCA Victor Mexicana, Mexico City.

* * *

ROCHESTER AIEE ELECTS STROMBERG-CARLSON ENGINEERS AS OFFICERS

Two engineers of the Stromberg-Carlson Company were elected officers of the Rochester, New York, section of the American Institute of Electrical Engineers. Oliver L. Angevine was named hairman, and Ernest B. Kempster Jr. was named vice chairman-secretary.

* * *

R. O. DRIVER NOW DRIVER CO. PRESIDENT

W. B. Driver has resigned as president of the Wilbur B. Driver Company, Newark, New Jersey, to become chairman of the board. His son, Robert O. Driver, who has been with the company for the past ten years, becomes president.

William J. Wind, who has been with the company since its beginning, has been elected vice president in charge of production. Sidney A. Wood, formerly sales manager, is now vice president in charge of sales. Karl R. Tallau, with Driver since 1936, becomes the company's secretary and treasurer.

* * *

W.E. TO BEGIN CIVILIAN TELEPHONE PRODUCTION

An announcement from Western Electric indicates the company will manufacture eighty per cent of the 800,000 civilian telephone sets which the WPB authorized recently for annual production. This is the first order allowing resumption of telephone production since the complete shutdown in 1942. Delivery of the new phone sets is expected to begin in the fall.

* * *

RAINIER PROMOTED BY SYLVANIA

H. H. Rainier has been promoted from manager of the east-central division, to assistant manager of distributor sales of Sylvania Electric Company's radio division. Mr. Rainier will be located at 135 South LaSalle Street, Chicago.

* * *

CROWE AWARDED "E"

Crowe Name Plate & Manufacturing Company of Chicago was awarded the Army-Navy "E" flag recently. Presentation of the flag was made by Col. John G. Salsman, USA, district supervisor of the AAF Matériel Command.

* * *

FRANKLIN CATALOG

A 48-page catalog has been issued by A. W. Franklin Manufacturing Corporation, 175 Varick Street, New York 14. Presented are photographs, charts, tables and diagrams on a variety of laminated and molded sockets for power, receiving,

(*Continued on page* 82)

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POLISHING UP QUARTZ

Staff Sergeant Norman Graber, of Brooklyn, N. Y., grinding and polishing quartz at a depot in England.

NEWS BRIEFS

(*Continued from page* 81)

cathode-ray, glass and metal tubes. Shown too are miniature moulded battery sockets, ceramic type u-h-f, octal sockets, etc. Crystal holders and many types of strips, boards, switches and plugs are also described.

* * *

ASA ANNOUNCES NEW SYMBOLS

New standards of graphical symbols of electronic devices for drawings is outlined in the current issue of *Industrial Standardization*, house organ for American Standards Association, 29 West 39 Street, New York 18. The symbols are pictured and described in an article by W. L. Heard of Bell Laboratories.

* * *

N. A. PHILIPS QUARTZ MANUFACTURE BOOKLET

A 40-page illustrated booklet, entitled *How Quartz Crystals Are Manufactured*, has been released by North American Philips Company, Inc., 100 East 42 Street, New York.

The booklet is a reprint of five articles written by Sidney X. Shore, senior engineer of the company's crystal division, that appeared recently in COMMUNICATIONS.

Subjects covered are inspection, grading and classification of quartz; orientation of crystals; sawing and orientation devices; lapping and finishing; and crystal testing.

* * *

BULLETIN ON OSCILLOGRAPH AS PRODUCTION TOOL BY DU MONT

The use of the oscillograph to check design and production of vibrators is discussed in a recent issue of the Du Mont Oscillographer (Vol. 6, Nos. 3, 4, 5, 6).

Wave forms of synchronous and nonsynchronous vibrators are shown, in addition to circuit diagrams and photos of equipment in operation.

* * *

MAGNETRON OSCILLATOR DATA

A 30-page bulletin entitled *Magnetron Oscillator for Instruction and Research in Microwave Techniques*, by J. Tykocinski Tykociner and Louis R. Bloom, has just been issued by the Engineering Experiment Station of the University of Illinois. Described is a reliable microwave oscillator for the range of frequencies from 1700 to 5000 megacycles, corresponding to wavelengths 17 to 6 centimeters, which is convenient in laboratory work for instruction as well as research.

Until September 15, 1944, or until the supply available for free distribution is exhausted, copies may be obtained without charge upon application to Engineering Experiment Station, Urbana, Illinois.

* * *

MUHLEMAN JOINS ERWIN, WASEY

M. L. Muhleman has joined Erwin, Wasey & Co., in an executive capacity in the electronics division. He will devote his efforts largely to the advertising and market research of the North American Philips Company.

* * *

CRYSTAL DATA IN BSTJ

In the April issue of the *Bell System Technical Journal* appear two papers on quartz crystals. One is by H. J. Mc Skimin and s entitled "Theoretical Analysis of Modes f Vibration for Isotropic Rectangular Plates Having All Surfaces Free". The ther paper, entitled "Principles of Mounting Quartz Plates" is by R. A. Sykes. The issue also contains a discussion of the "Magnetically Focussed Radial Beam Vacuum Tube" by A. M. Skellett.

* * *

RHOMBIC ANTENNA DESIGN PAPER IN AWA REVIEW

Dr. W. G. Baker's paper on A Chart for Rhombic Antenna Design appears in the March, 1944, issue of the Australian engineering magazine, the *AWA Technical Review*. Dr. Baker, who is with the Marconi School of Wireless, presents a chart for the design of rhombic antennae to solve problems including the angle of maximum radiation at any wavelength, the wavelength of maximum radiation at any angle of elevation, and the best proportions. The results obtained apply only in the vertical plane containing the principle diagonal.

In this issue also appears a paper by . B. Rudd on *Theory and Design of R-F Transformers*.

* * *

ESPEY WINS WHITE STAR

The Army-Navy white star has been added to the "E" flag of the Espey Manufacturing Company of New York.

* * *

AEROVOX ENGINEERING BULLETINS

An interesting bibliography covering high-frequency measurements appears in the eighth issue, volume fifteen, of the *Aerovox Research Worker*. Issues nine and ten discuss an *Audio Amplifying Testing Unit*. Number eleven of this series contains an analysis of *Paper Capacitors As Mica Capacitor Substitutes*.

* * *

HUTCHINS RETURNS TO NATIONAL UNION

Henry A. Hutchins, on leave of absence from National Union Radio Corporation for the past twenty months with the U. S. Navy, has returned to his post at N. U.

He resumes his sales executive activities at the N. U. offices in Newark, N. J.

* * *

AMPEREX WINS WHITE STAR

The Army-Navy white star for the "E" flag has been granted to the Amperex Electronic Products, Inc., of 79 Washington Street, Brooklyn, N. Y.

* * *

MAJOR HAISH TO REPLOGLE COMPANY

Major T. A. Haish, who recently resigned from the USA V-Loan Division, is now with D. E. Replogle & Company as assistant to Mr. Replogle. His headquarters are at the company's recently opened New York City offices at 1819 Broadway.

The Replogle Company will specialize in electronic consulting engineering.

TECHNICAL NOTES

Excerpts from New Home Study Lessons Being Prepared under the Direction of the CREI Director of Engineering Texts

The Iconoscope

This month CREI is publishing the third and final article of a series on the iconoscope. This is one of a series of interesting technical articles appearing each month in the CREI NEWS, official organ of the Capitol Radio Engineering Institute.

This final article analyzes the action of the iconoscope when a scene is optically focused on it, together with a discussion of the advantages and disadvantages of this type of pickup device. Altogether, the reader will have a good physical picture of the Action of the iconoscope from these articles.

At some later date, the technical staff of CREI intends to present an analysis of the action of the orthicon.

Since the appearance of these technical articles in the CREI NEWS, copies have been very much in demand. *Write at once for the July issue which includes this final article on the iconoscope.* Also indicate if you would like to be placed on our mailing list to receive the CREI NEWS each month. There is no charge or obligation.

Those who are already receiving this monthly magazine can further benefit from it by writing to The Editor and suggesting technical topics they would like to have discussed. We are anxious to make the CREI NEWS interesting and of service to you.

★ ★ ★

The subject of "The Iconoscope" is but one of many that are being constantly revised and added to CREI lessons by A. Preisman, Director of Engineering Texts, under the personal supervision of CREI President, E. H. Rietzke. CREI home study courses are of college calibre for the professional engineer and technician who recognizes CREI training as a proven program for personal advancement in the field of Radio-Electronics. Complete details of the home study courses sent on request . . . *ask for 36-page booklet.*

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PUNCH IN HOLES INDICATED FILE IN YOUR NOTEBOOK

LOUDSPEAKER COMMUNICATIONS

(*Continued from page* 35)

speech transmission system, is that there is invariably some source of interfering noise present. Under some conditions this noise is of a predominately low frequency character, and at other times it is composed chiefly of higher frequencies. It is generally, although not always, predominant in some portion of either of these regions. Thus by using the minimum band for speech, a great deal of the interfering noise spectrum is automatically kept out of the system. Accordingly, additional reduction in harmonic generation is obtained and the effects of intermodulation of noise and signal, which are very often present when interfering noises are allowed to pass through audio systems, are also reduced.

In cases where there are strong signals such as whistles and the like, particularly in the low frequency region, a great deal of interference is caused due to the masking effect described and investigated by Fletcher[2]. For example, if these tones are allowed to pass through a system and out of the reproducer without attenuation, in addition to causing overloading effects in the amplifier system as described above, they will tend to mask out the other signals or speech in the listener's ear.

The undesirable reverberation effects referred to before are also greatly reduced by limiting the frequency band to just that necessary. When speech is reproduced, for instance, in a below-deck compartment, some portions of the low frequency sound occur at the natural resonant periods of the compartment. These frequencies are not only over accentuated, but the hangover effects due to long reverberation time are increased to such an extent that the intelligibility of speech is seriously reduced. Similar effects are encountered in talking-back over the system from the same location.

Not only is it of great importance to restrict the frequency band, but it is desirable that the overall response have an increase in amplification with increasing frequency. Wegel and Fletcher[2] found that the maximum ear sensitivity occurs in the region of 3,000 cycles, so that it is important to have a rising amplification up to this frequency at least (Figure 3.). Measurements show that the speech power in the voice drops off from 1,000 cycles as the frequency rises, the vowel sounds having the greatest power are in the region of 1,000 cycles, the voice consonants with less power are in the 2,000-cycles region, and ie unvoiced consonants with the least ower in the higher frequencies appear from 3,000 to 5,000 cycles.

It should therefore be desirable, and iis is proved in actual practice, to ive the frequency response continue rise, preferably to at least 3,000 cles. The degree of rise varies with e application, the design of loudeakers, amplifiers, and microphones, d the minimum quality requirements any, but the rise should be between db and 10 db per octave. These lues have been verified in surveys ade by the writer with acoustic uipment of known characteristics d amplifiers equipped with caliated networks, permitting adjustment the response in both directions of ansmission until optimum results ere obtained.

As the conventional radio or publicldress type loudspeaker is not suitble for efficient talk-back, one of the reatest problems in building up a sucssful talk-back system is obtaining eaker-microphones that will have the roper response in both directions of ansmission. The fundamental theory loudspeaker and microphone design iows that the mechanical requireents of the moving systems of a loudeaker and of a microphone respecvely, are conflicting. The power reuirements of the two are also vastly ifferent. In the loudspeaker the phycal masses, etc., are much greater and s a result, the mass reactance at the igher frequencies tends to produce a nsiderable loss. However, both the ormal increase of acoustic pressure ith frequency on the axis of the udspeaker, due to the sharpening of ie directivity characteristic from a ource whose size is greater than the avelength of sound radiated, and the reak-up of the driven diaphragm so iat its effective mass is less at the igh frequencies, tend to compensate r this loss. The loudspeaker degner endeavors to take as great adantage as possible of these compenting factors, to effect a uniform xial pressure output.

When, however, the loudspeaker is sed as a microphone, these compenting effects are not present; hence, ie output falls with frequency. There , for example, no appreciable reducon of mass reactance due to break-up f the vibrating system because the stem is not being driven as in the ase of the loudspeaker. The whole ibrating system tends to act as a pison with a considerable mass and the esulting speech intelligibility is quite oor. By proper balance of the design onstants of both the vibrating system

(*Continued on page* 86)

(*Continued from page* 85)

and of the radiating device (horn the requirements as a microphone a more nearly met than in a convention loudspeaker. Various sizes of lou speakers designed and tested by th writer for use in marine talk-bac communication systems have co firmed these design principles. Th average response of a typical unit bo as a loudspeaker and as a talk-bac *microphone* are shown in Figure In using a talk-back loudspeaker this type in a practical system, a re ular microphone is used at the *com mand* locations (such as in the whee house) to drive the amplifier, and th loudspeaker is automatically connect to the amplifier output. The micr phone may have a reasonably flat slightly rising frequency respon characteristic in the range of 500 4,000 cycles, but frequencies below 50 cycles are largely eliminated eith by the design of the microphone by equalizer circuits well forward the amplifier. Otherwise the low fr quencies will overload the amplifi stages. Under these conditions, th overall response for talk-out is shown in the loudspeaker curve Figure 4, assuming the amplified re sponse is also flat. It might be though that it would be sufficient to have th amplifier response rising with fre quency, but it is far preferable to hav it designed into the loudspeaker that the amplifier is not required t produce an appreciable amount of ad ditional power at the higher frequen cies.

When the speaker is switched t the talk-back connection, the loud speaker now functions as a micro phone since it is connected to the am plifier input. A small *receivin* reproducer located at the *comman* position is connected at the same tim to the amplifier output so that th person at this location can hear th answers coming through from the out side talk-back loudspeaker. The re sponse of this loudspeaker as a micro phone, Figure 4, does not over-accen tuate the low frequencies as much a would a conventional loudspeaker use as a microphone. It is still, howeve very desirable to cut out a great pro portion of the low frequencies belo 400 or 500 cycles.

The receiving reproducer's charac teristics are shown in Figure 5. Thi further reduces the undesirable lov frequency reproduction and boosts th consonant region up to 3,000 cycles. I has been shown in practice that it i desirable in the receiving reproducer t further attenuate, gradually, frequen

(*Continued on page* 90)

THE TRANSITRON

(*Continued from page 44*)

me principle, produces an increase flow to grid *2*. In this manner a aracteristic of approximately the me shape is produced regardless of hether an a-c voltage is active in the ode circuit and a condenser is used couple grid *2* to grid *3* or d-c voltes are used, as in Figure 8. Use the circuit of Figure 8 simplifies e problem of obtaining the characistics considerably.

The characteristics are valid for demining not only the magnitude of e tuned circuit constants required to rmit oscillation, but serve in selectg the proper d-c supply voltages for timum oscillating conditions[1]. To eet these conditions the supply voltes should be chosen to place the opating point at the center of the negae sloped portion of the characteristic shown by point *0* in Figure 1. This ll yield the best waveform and optium constancy of frequency and nplitude of oscillation with respect to riations in circuit and other paramers.

Since, as explained above, oscillans will not be sustained unless the ned circuit resonant impedance is at last equal to the negative reciprocal the slope of the transitron characristic at the operating point, it is of alue to the designer to know the ansitron characteristic of the tube lected for the oscillator. As an aid in lecting the proper tube, characteriscs of some of the more common types, amely the 6J7G, 6K7G, 6L7G, 6S7G, C6, and the 1853 are presented in igures 9 to 14 respectively.

Returning to Figure 5, it will be en that the parameter determining e family of characteristics is the agnitude of the blocking voltage E_{32}. ach individual curve was taken by tting E_{32} at the constant value inditated alongside the curve and varying e anode voltage E_2. In these curves e plate voltage is held fixed. In ractice the anode voltage, E_2, is set at e value corresponding to the center f the negative sloped portion of the haracteristic selected. A blocking conenser is used in place of the blocking oltage E_{32} and a negative bias aproximately equal to the difference beween E_{32} and E_2 is applied to grid *3* hrough a high resistance. To determine the minimum value of L/RC reuired to sustain oscillations, it is necssary only to measure the slope of the haracteristic at the operating point nd equate the reciprocal to the value /RC.

We note in Figure 5 that for the ase of the largest characteristic, for

(*Continued on page 88*)

(*Continued from page 87*)

which $E_{s2} = 150$ volts, the minimum value of L/RC to sustain oscillations will be approximately 3200 ohms. Inspection of the curves shows that this value increases as the anode voltage is decreased (and with it E_{s2}) until for the case where $E_{s2} = 10$ volts, L/RC must equal or exceed 25,000 ohms for the circuit to oscillate. In the latter case, as is evident from the characteristics, the amplitude of oscillation will be considerably smaller than for the previous case.

The characteristics of all tubes shown, with the exception of the 6L7G, are such that any of them would make good transitron oscillators. The 6L7G, with the supply voltages as selected in Figure 11, would not make a strong oscillator, for its miniature characteristics indicate that only a small swing in amplitude would be required to meet the condition of equation *1*. Another disadvantage of the 6L7G is that it has a fairly low slope at the center of its characteristic so that it will not sustain oscillations in a low impedance circuit. For the $E_{s2} = 90$-volts curve, the minimum average negative resistance is of the order of 10,000 ohms. The 6S7G, on the other hand, has a very steep slope and will oscillate with a low impedance tuned circuit. The reciprocal of the slope at the center of the $E_{s2} = 110$-volts curve is only 1500 ohms.

The curves of Figure 15 compared with those of Figure 6 show the difference to be expected in characteristics of two tubes of similar type. Both families of curves were taken on type 58 tubes with identical d-c supply voltages. While the complete family of the curves of Figure 15 is displaced slightly below and to the left of those of Figure 6, we see that the corresponding curves have approximately the same slope at their center. Also the anode voltage, E_2, corresponding to the center of any characteristic is approximately the same for both tubes. Replacing one tube by the other in a transitron oscillator should not show any serious difference in performance either in ability to oscillate with low impedance tuned circuits or in waveform or amplitude of output.

Credits

Acknowledgement is made to E. A. Lambert, former graduate student at Lehigh University, Bethlehem, Pennsylvania, for assistance in obtaining data on some of the characteristics described herein.

In a paper to follow shortly, the effect of varying the plate and control grid voltages on the current-voltage characteristics and the resulting effect on the per ormance of the transitron, will be described.

ibliography

[1]Cledo Brunetti, *The Transitron Oscil-tor*, Proc. IRE, Vol. 27, pp 88-90; Feb. 939.

[2]F. E. Terman, *Radio Engineers Hand-ook*, McGraw-Hill Book Co.; 1943.

[3]Cledo Brunetti and Eric Weiss, *Theory nd Application of Resistance Tuning*, roc. IRE, Vol. 29, pp. 333-344; June 941.

[4]Cledo Brunetti and J. S. Waldschmitt, *roperties of Negative Inductance*, COMUNICATIONS, Vol. 22, pp. 14-18, 84-86; une 1943.

[5]L. C. Verman, *Negative Circuit Con-ants*, Proc. IRE, Vol. 19, pp 676-681; pril 1931.

[6]H. Mouradian, *Long Distance Trans-ission Problem*, Jour. Frank. Inst., Vol. 07; Feb. 1929.

[7]A. T. Starr, *Electric Circuits and ave Filters*, Pitman Publ. Co.

[8]O. S. Puckle, *Time Bases*, John Wiley Sons; 1943.

[9]Cledo Brunetti, *Clarification of Aver-ge Negative Resistance with Extensions f Its Use*, Proc. IRE, Vol. 25, pp 1595-516; Dec. 1937.

[10]Cledo Brunetti, *A Practical Negative esistance Oscillator*, Rev. Sci. Inst's, ol. 10, pp 85-88; Mar. 1939.

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TELEVISION RECEPTION

(*Continued from page* 60)

00,000-ohm load. The 2,000 ohm ideo load is about equal to the diode esistance, if not lower.

Dr. Goldsmith explained that the de-ector output is split up to provide rightness control for the cathode-ray ube, line synchronizing and frame syn-hronizing, in addition to the video ignal. The grid of a typical c-r tube equires a 40-volt swing to cover the ull range of brightness. This swing s provided by a direct-coupled ampli-ier consisting of a medium power tube nd a high power (receiving) tube. he top 25% of the signal voltage is sed to set the d-c level. Sawtooth os-illators are used for both horizontal nd vertical scanning with frequencies f 15,750 and 60 cycles respectively. Amplifiers biased beyond cutoff let nly synchronizing pulses through hich trigger the oscillators, keeping hem in step. The ideal sawtooth, said r. Goldsmith, should take 100% of he time for the useful forward trace nd 0% for the retrace or flyback. Actually, the horizontal oscillator takes 2% for retrace, the vertical 5%.

Dr. Goldsmith next described elec-rostatic and magnetic cathode-ray ubes of the direct view type. He said hat the electrostatic type was more lexible, but at the expense of having more internal components. Having mall capacities in the deflection plates, hey were suitable for frequencies up

(*Continued on page* 91)

LOUDSPEAKER COMMUNICATIONS

(*Continued from page* 86)

cies below 2,000 cycles at the rate of about 6 db per octave, to make up for the preponderance of these frequencies in the characteristic of the outside talk-back speaker. This can be seen from its response as a microphone. We can accomplish this in the input or low level circuits of the amplifier, and

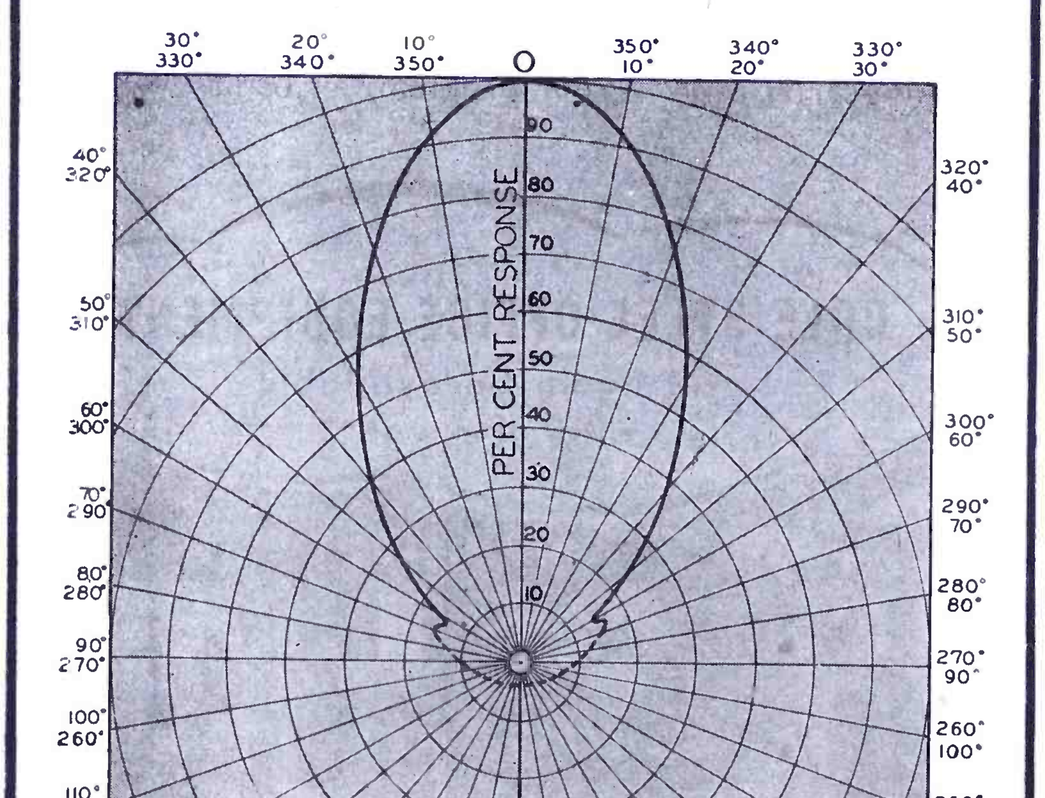

Figure 7

by suitable equalizers; these equalizers, of course, being switched in automatically in the correct position for either the talk-out or the talk-back condition. A block diagram of a system incorporating these features appears in Figure 6. The system is designed to give the over-all response, frequency attenuation, equalization, etc., in accordance with the requirements described. Other features of the amplifier and the design of the relay circuits used for switching the acoustic apparatus to the input or to the output as required, are specially designed for systems of this type to avoid noise, oscillation, acoustic clicks, etc., which a conventional public-address system would produce if it were used for this kind of talk-back loudspeaker communication system.

Finally, the results obtained with a talk-back system depend upon the manner in which it is installed, particularly in regard to the proper location of the talk-back reproducers. In actual operation many factors affect the results, such as the surrounding noise level which may be due to a variety of causes, either on shipboard or in the vicinity adjacent to the ship. Refraction and diffraction effects also affect the pickup of speech and sounds outboard.

Another useful property of talk-back loudspeaker systems is that of determining the direction of sounds and voices. This can be done quite well by using loudspeakers with good directivity characteristics, such as the one shown on the polar distribution curve, Figure 7, and mounting them in movable searchlight stands to permit easy orientation. It is possible by proper design of the loudspeaker horns to make them exceptionally directional. When greater directivity is required, a large mouth diameter compared with the wavelength of the lowest frequency to be picked up, is necessary, or reproducers with annular radiating horns may be used.

In many of the applications, the talk-back pickup is considered even more important than the ability to project the voice adequately, as that is the only method by which the human voice can be transmitted over comparatively large distances without the necessity of the talker being equipped with some kind of apparatus. Talk-back pickup naturally varies a great deal with the atmospheric and noise conditions encountered, but with properly designed equipment it affords a considerable advantage over that obtained with the human ear alone.

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[6]A. J. Sanial, *Concentric Folded Horn Design*, Electronics, Jan., 1939.

TELEVISION RECEPTION

(Continued from page 89)

00 mc and, therefore, were suitable monitoring the carrier. Getting the gnetic deflecting tubes to operate perly is quite a job but, once the s are designed, few troubles are ountered. This type permits higher m currents and, consequently, ghter images. Also, the deflecting le is much wider than the electro- ic type—approximately 55° against . Dr. Goldsmith showed an an- gy between cathode-ray electron op- and a single lens standard optical tem, noting that the magnification o, if pushed too far, resulted in ocussing near the edges of the een, Figure 3.

The color of cathode-ray screens is important subject. Dr. Goldsmith lained that the Willemite screen sisting of a mixture of green, yel- and blue produced green pictures was the most efficient transducer general work. For television, white tures were preferred, said Dr. Gold- th. These are obtained by a mix- e of red, green and blue fluorescent terials.

Dr. Goldsmith noted a definite trend ard projection receivers which of- ed many interesting technical prob- ns, particularly that of brightness. said tubes for theatres would prob- y require 70 kilovolts and a 5-ma m. The life of such a tube may be y 50 hours or so, which may be suf- ent if the price can be kept down.

Static	Magnetic
7000 volts at 5 ma for well-regulated beam supply, the beam drawing 0.1-0.2 ma.	The same.
400 volts at 150 ma for small amplifier tubes.	400 volts at 250 ma, the extra current being required by the deflecting coils.
*1500 volts at 20 ma for the special power tubes driving the deflecting plates.	(See note below.)

*This voltage is required because a resistance-coupled power amplifier must be used to provide sufficient voltage swing with the very wide video band. The horizontal amplifier requires a larger tube than the vertical. A tube like the 6V6 built for high voltage breakdown is used. A similar tube is required for magnetic deflection because, although the plate voltage is only 400, the surge currents generate voltages of about 1500.

Figure 3
Comparison of electrostatic and electromagnetic tubes.

TANK DESIGN

(*Continued from page 38*)

rier point, or no modulation. This work is not attempted in this brief paper; however, few elementary considerations must be made.

For $\omega = 2\pi f_r$, $f_r = 796$ kc. Let us assume that for high fidelity performance, the maximum modulation frequency is 7500 cycles. Then for the elementary or simple tank circuit of Figure 2, wherein $Q_e = 12$,

$Q_e = 12.18$ at $796 + 7.5$ kc for Figure 2

and

$Q_e = 12.16$ at $796 + 7.5$ kc for Figure 1

Hence the Q_e of the $L - C_2 - R_2$ branch of the π network changes from 12 to 12.16 when the frequency changes from 796 kc to the highest sideband value, 796 + 7.5 kc. This estimate assumes no appreciable increase in the radio-frequency resistance of the high-*Q* tank coil *L*. It is well known that the effective *Q* of the inductive (or capacitive) branch of the tank circuit (Q_e) must be not less than *10* or *12* to obtain the required *fly-wheel effect*, so that the amplitude of the tank current does not appreciably decrease during intervals between impulses of plate current, especially when the angle of current flow is small.[2] On the other hand, it is essential that Q_e be not higher than *12* or *15* in order that the load impedance r_b be nearly constant throughout the frequency side band spectrum, $f_r \pm f_m$. Also Q_e must be low so that the amplitude of the tank current may decrease as rapidly as the modulating voltage decreases during the modulation cycle.

Figure of Merit

Newhouse[3] and Osborne[4] state that for determining the figure of merit of the tank circuit for the operating frequency band, it is necessary to calculate the quantity Q_o, the ratio of the reactance to resistance of the entire resistance of the circuit, including the apparent interval resistance of the tube. To do this, the circuit must be redrawn, as in Figure 3. By using Thévenin's theorem, R_{bP} and branch *mn* are changed to a series impedance Z_s, as shown in (*b*), Figure 3. Then for the circuit of Figure 2, according to Newhouse

$$Q_o = \frac{X_s}{R_s} \cong \frac{R_{bP}\,X_e}{R_{bP} + X_e^2} \qquad (16)$$

to a close approximation. X_e is the total reactance (inductive) of branch *mn*.

R_{bP} is not the conventional alternat-

(*Continued on page 94*)

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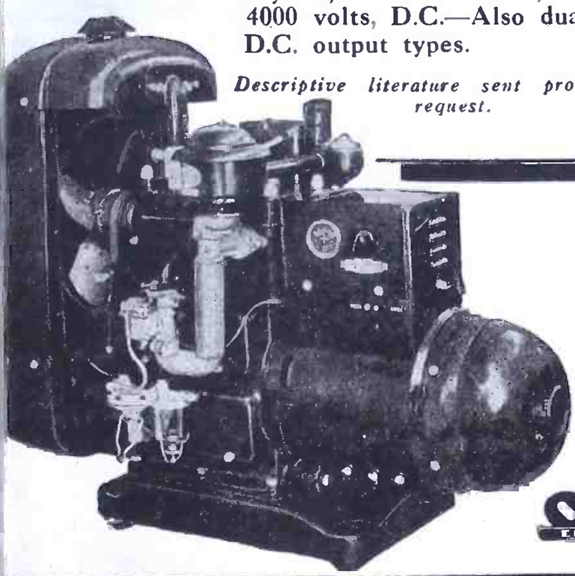

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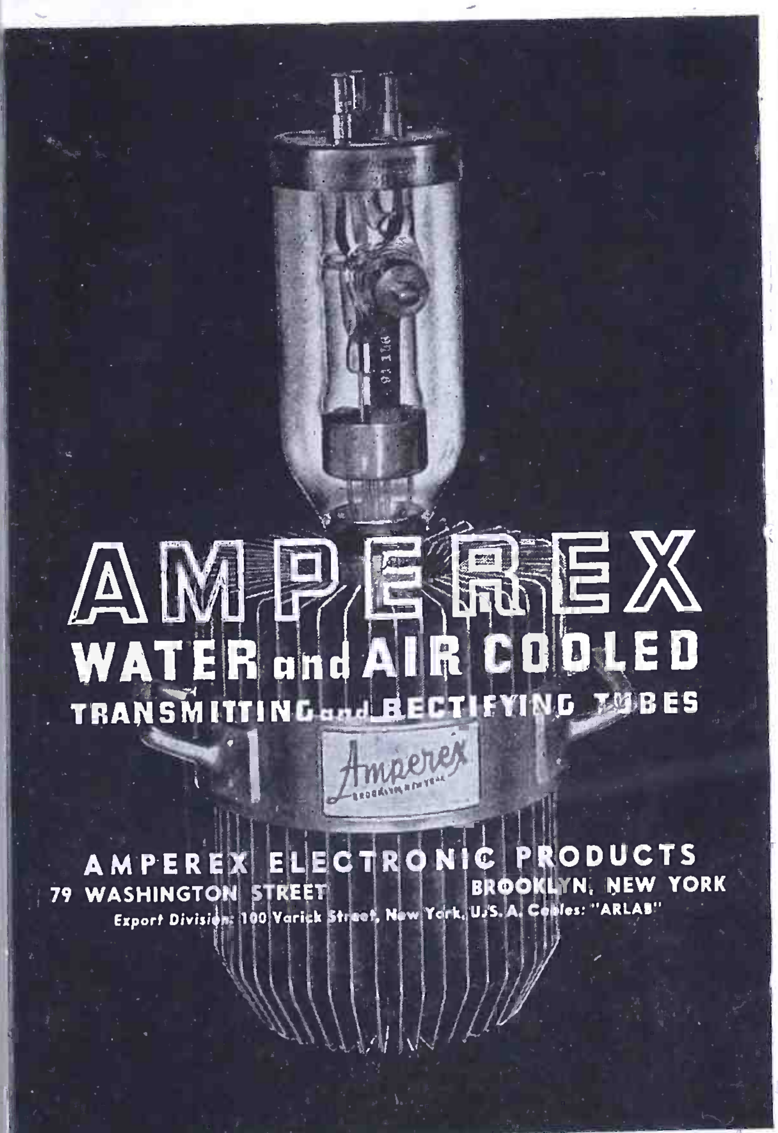

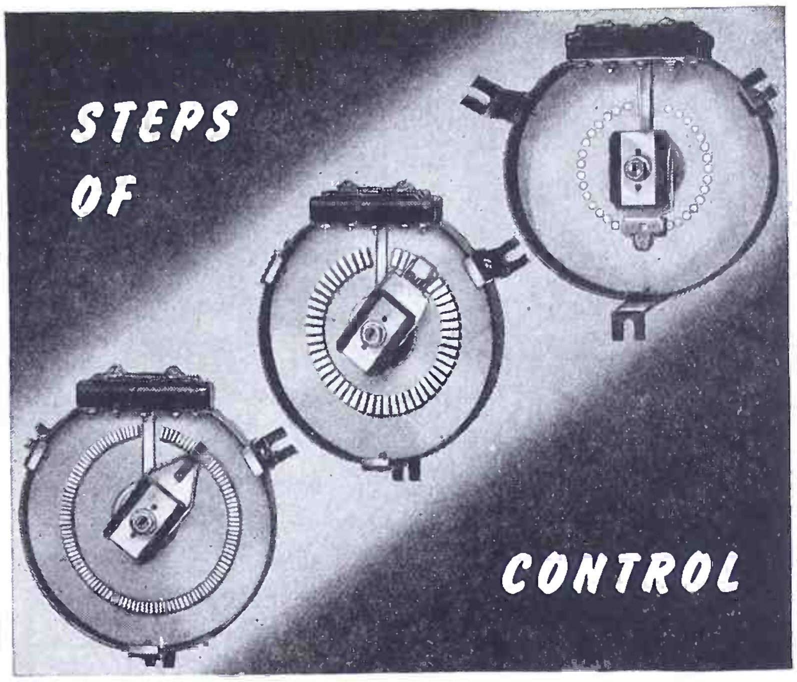

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TANK DESIGN

(*Continued from page 92*)

ing plate resistance, r_p, of the tube, but is given by

$$R_{bP} = \frac{P_b}{P_T} r_b \qquad (17)$$

where P_b is the power loss in the tube, and P_T is the tube power output, i.e., delivered to the tank circuit. Equation 17 may be put in the form

$$R_b = \left(\frac{1}{\xi_b} - 1 \right) r_b \qquad (18)$$

where ξ_b is the plate efficiency of the tube. Taking the case of $Q_e = 12$, and assuming a plate efficiency of $\xi_b = 75\%$, X_e is obtained from the bottom line of Table 1, and

$$Q_o = 3.8$$

Newhouse points out that in present practice this is usually small compared to the Q of the inductive branch (or Q_e) in most amplifiers. We also learn that

$$Q_o = \frac{f_r}{f_2 - f_1} \qquad (19)$$

where $f_2 - f_1 = 2\Delta f$, twice the frequency change needed to reduce the power 50% in a series resonant circuit. If equation *19* is used to solve for $f_2 - f_1$ when $Q_o = 3.8$, and $f_r = 796$ kc, we obtain 210 kc or a 105 kc change in frequency to produce half power, or 3 db down from the f_r level.

To estimate the degree of harmonic suppression for the case of a class *C* amplifier would require the determination of the amplitude of the second harmonic of the plate current for an assumed angle of flow, using the Fourier series method. This may be readily done for a given tube and π network tank, but is too lengthy a project to carry out in this paper. However, if we assume a class *B* amplifier with plate current pulses that are half sine waves, we can calculate the approximate second harmonic output. Following the method of Osborne[5], we shall multiply the per cent second harmonic component of the plate current, as determined with Fourier series derivation, into the complete plate circuit impedance at double frequency. Figure 4 shows the complete circuit including the apparent tube plate resistance, as previously explained.

Fourier series analysis gives, when I_{pm} is the amplitude of the half sine wave plate current pulse,

$I_{p-1} = \frac{1}{2} I_{pm}$ . . . . for the fundamental frequency component of plate current

$I_{p-2} = \frac{2}{3\pi} I_{pm}$ . . . . for the second harmonic component

assuming $I_{p-1} = 1$ ampere, P_T is 10 kilowatts at fundamental frequency, f_r. Expressing the second harmonic as a

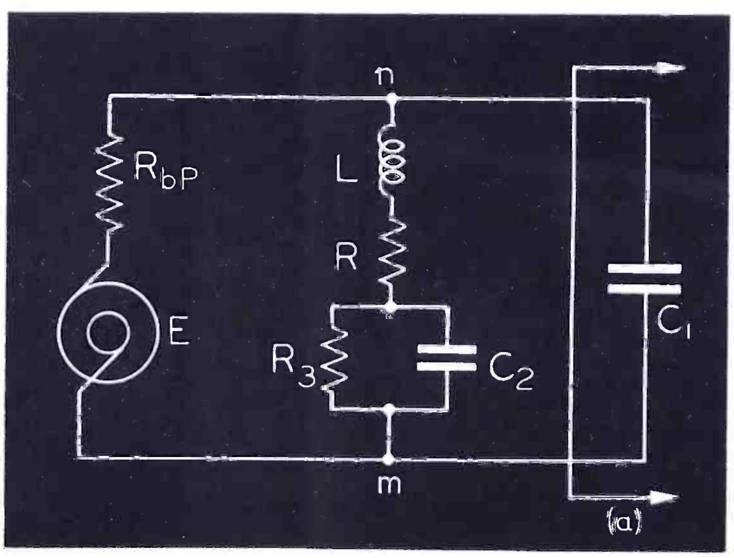
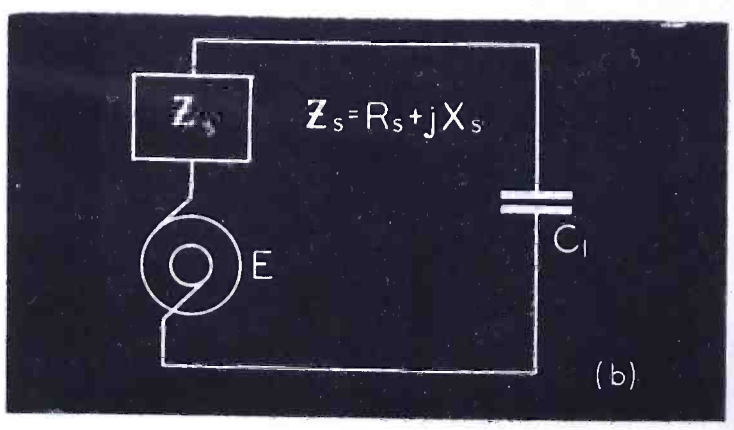
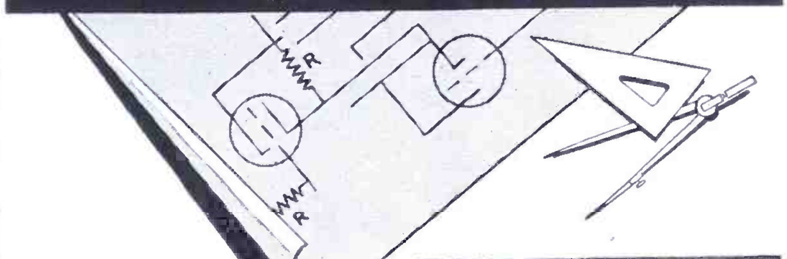


Figure 3
Equivalent circuit obtained with Thévenin's theorem for calculating Q_o.





percentage of the fundamental frequency component,

$$\% I_{p-2} = 42.5$$

The impedance of the complete circuit, looking to the right in Figure 4, is calculated by the ordinary methods and is given (Z_i) in the Figure. The power consumed in this impedance is

$$P_i = (.425)^2 \times (3300 + 45)$$
$$= 598 + 8.1 \text{ watts at } 2\omega$$
$$= 2 \times 5 \times 10^6 = 10^7.$$

Causes of Losses

The first figure, 598 watts, is the loss on the tube plate due to the second harmonic, and 45 watts represents the loss in the π network and load circuit, R_0. Using equation *15* for the tank circuit efficiency, gives for the second harmonic *output*, 7.7 watts, as compared to 9580 watts, fundamental frequency output. It is to be noted that the loss in the tube due to the second harmonic component is *considerable* (598 watts), and is *not* negligible, as is the case for the tank-load circuit.

While limits must be set for $\dfrac{1}{\omega C_1 R_e}$ or Q_e, fixing the values of C_1, C_2 and *L*, we note from examination of Table 1 that changing Q_e between the allowable limits (*10-15*), has a profound effect on the values of the π network components. Therefore, for any one value of r_b (a certain tube type and load), Q_e may be varied, and the lowest per cent second harmonic output may be found for resulting values of C_1, C_2 and *L*, as Q_e is varied between allowable limits.

Bibliography

[1]L. S. Nergaard, and B. Salzberg, Proc. IRE, Vol. 27, p. 579; Sept. 1939.

[2]D. C. Prince & F. B. Vogdes, *Vacuum Tubes as Oscillation Generators*, General Electric Company, pp. 37-38; 1929.

[3]Arvid B. Newhouse, *Power Amplifier Plate Tank Circuits*, Electronics Engineering Manual, Vol. III, pp. 150-153.

[4]Perry H. Osborn, *A Study of Class B and C Amplifier Tank Circuits*, Proc. IRE, Vol. 20, pp. 813-834; May 1932.

[5]W. L. Everitt, *Communication Engineering*, McGraw-Hill Book Co., pp. 54-60.

[6]C. G. Dietsch, *Suppression of Transmitter Harmonics*, Electronics, Vol. 6, pp. 167-169; June, 1933.

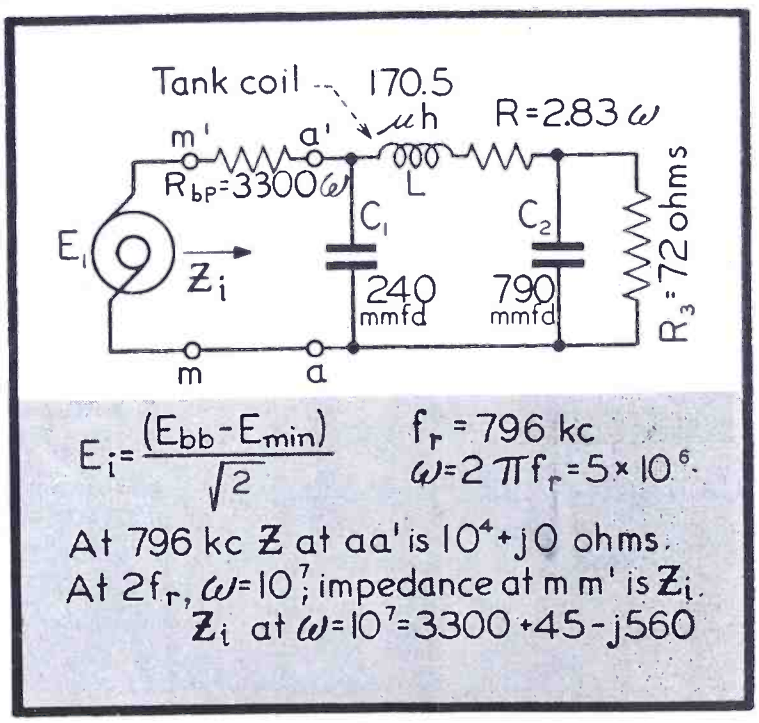


Figure 4
Complete tube plate-tank-load circuit for Q_e = 12.

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