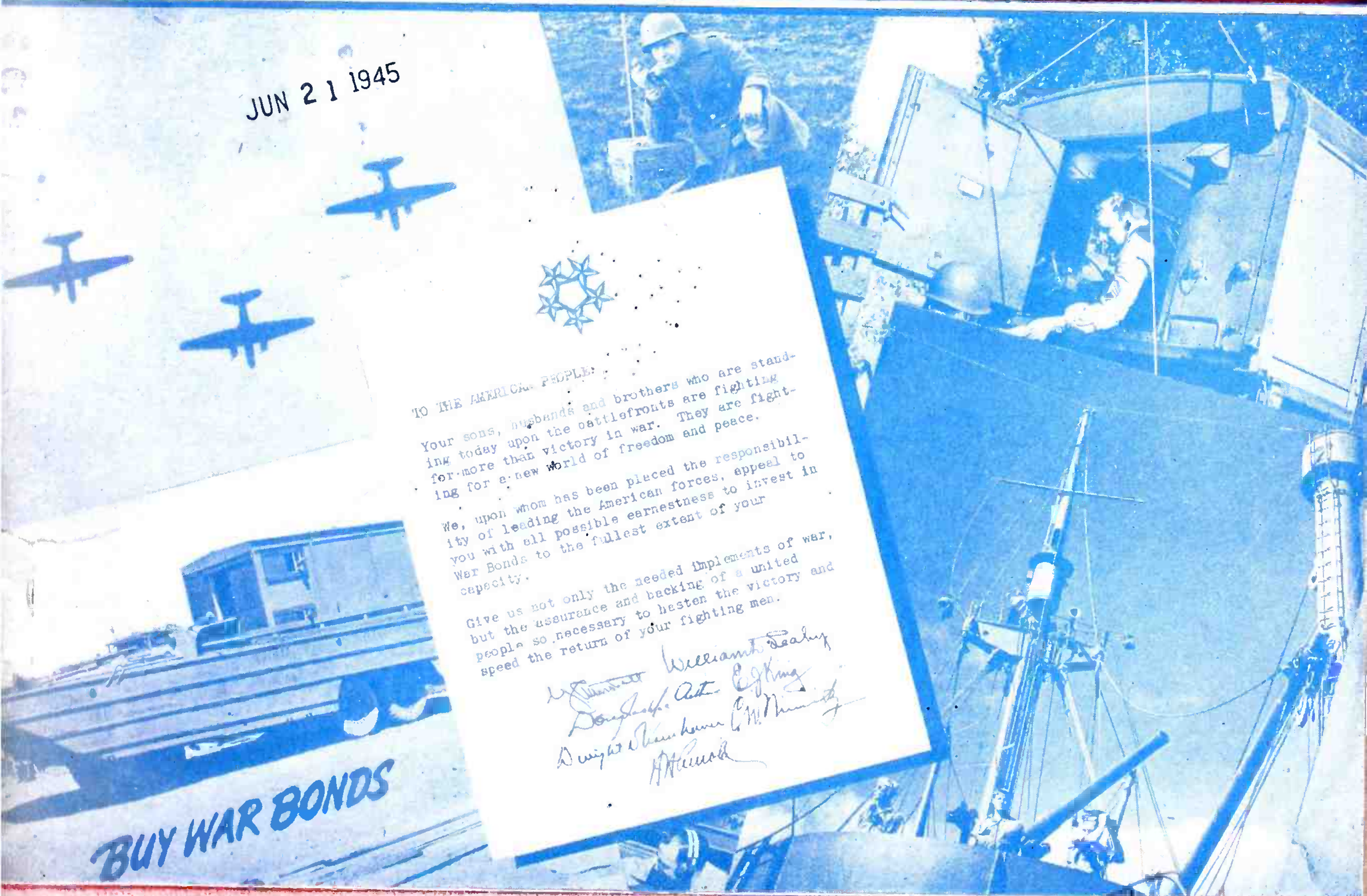
COMMUNICATIONS



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1945

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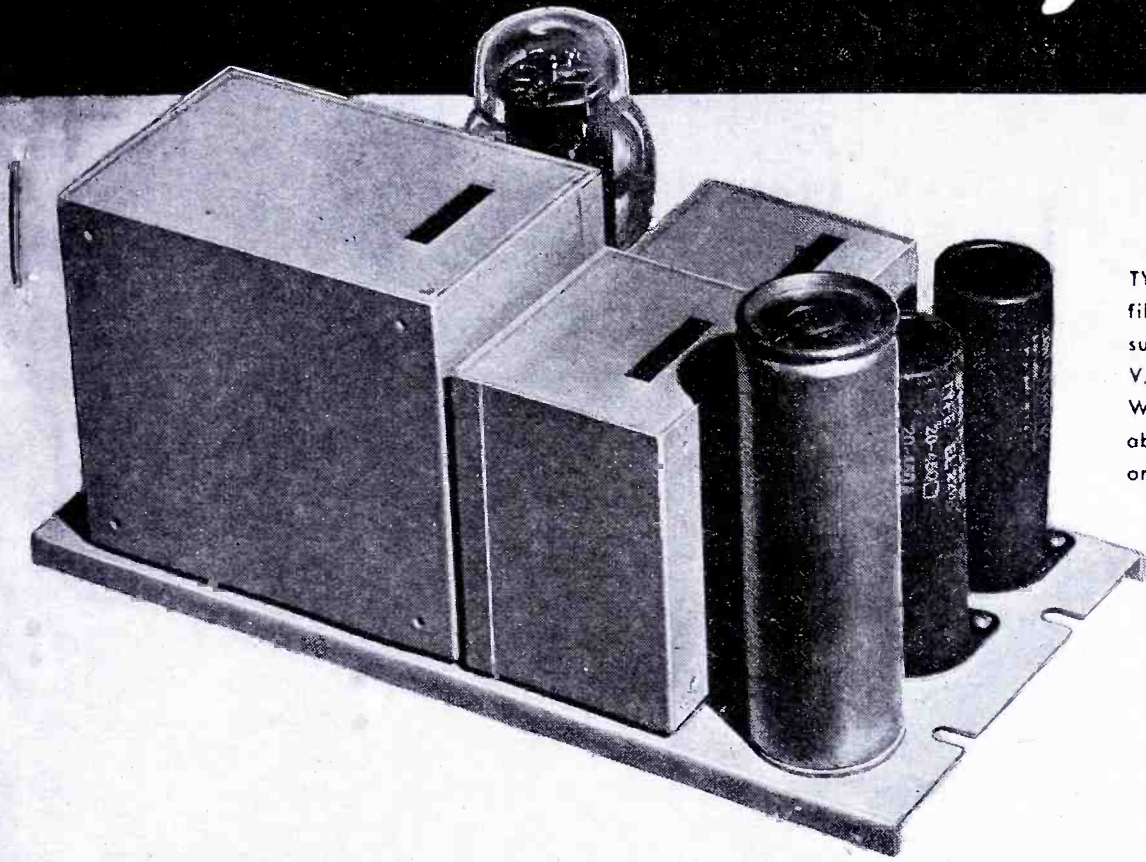
201 SERIES *Rectifiers*



TYPE 201A RECTIFIER. Designed to furnish filament and plate current to line amplifiers such as the Langevin 102 Series. Delivers 275 V. at 75 M.A., 6.3 V. at 8 A. Length 10 [illegible]/32". Width 5 7/32". Maximum height 6½" (5½" above, 1" below mounting chassis). Occupies one third Langevin Type 3A mounting frame.

Type 201 Series Rectifiers consist of Type 201A, described above, and 201B. Type 201A is supplied with a single filter stage, whereas Type 201B has a dual filter stage. Latter type designed to supply filament and plate power for quiet pre-amplifiers such as Langevin Type 106 or 111. In addition supplies associated line amplifiers such as Langevin 102 Series. These units possess excellent regulation and low ripple content.

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We See...

THE FINAL 25 TO 30,000-MC ALLOCATION REPORT, replete with refreshing news has been released by the FCC. Many new channel extensions have been granted to police, fire, railroads, power, highway mobile and rural telephone systems in the 25 to 162-mc bands. And definite assignments for f-m, television and facsimile in the 44 to 108-mc region have been set aside until the completion of a series of sporadic E tests during the summer. The test study committee will include government specialists with FCC chief engineer George P. Adair and his staff, and such industry experts as Major E. H. Armstrong, Dr. D. E. Noble, Dr. T. T. Goldsmith, Dr. W. R. G. Baker, Raymond Guy and Jack Poppele.

As an allocation guide, three 44 to 108-mc alternatives were offered by the FCC. In the first suggestion, f-m occupies the 50 to 68-mc bands; television, 68-74 mc and 78-108 mc; and facsimile, 48-50 mc. The second proposal places f-m in the 68 to 86-mc band; television, 44-56 mc, 60-66 mc and 86-104 mc; and facsimile, 66-68 mc. The third alternative places f-m in the 84 to 102-mc band; television, 44-50 mc and 54-84 mc; and facsimile, 102-104 mc. Incidentally television has been given a thirteenth channel at 174-180 mc, a band that originally had been assigned to air navigation aids.

Commenting on the f-m band proposals, the Commission said that 2 mc have been added contiguous to the band of 18-mc width wherever that band is finally placed. Initially this additional band will be available for stations offering a facsimile service exclusively, but eventually facsimile will move above 400 mc, and thus this 2-mc band will be available for f-m.

In the channel expansions we find that railroads received 60 channels instead of 33; police, 132 instead of 122; power, 31 instead of 21; rural telephones, 24 (sharing), whereas none had been assigned previously; and highway mobile, 40 in place of 24. Some of these channels will fall in the 74-78 or 104-108 mc bands, depending upon the final assignments in the 44 to 108-mc region.

According to the Commission, the f-m/television/facsimile allocation delay will not affect development or production, since but extremely limited receiver and transmitter production will be initiated before the year is out.

ENCOURAGING NEWS ALSO APPEARS IN THE 10-kc to 25-mc allocation proposal just released by the FCC. Standard broadcasting receives another channel . . . 540 kc. And direct international broadcasting will continue, with channels in 6 bands. . . . 6000-6200, 9.500-9700, 11700-11900, 15100-15300, 17700-17900, and 21500-21700 kc.

With the 44-to 108-mc decisions in the Fall and the final 10-kc to 25-mc report due then too, industry will probably have its frequency format for the years to come, before January 1, 1946 . . . a format that will probably introduce an interesting era for *communications*.—L. W.

COMMUNICATIONS

Including Television Engineering, Radio Engineering, Communication & Broadcast Engineering, The Broadcast Engineer. Registered U. S. Patent Office.
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MAY, 1945

VOLUME 25 NUMBER 5

COVER ILLUSTRATION

A vital War Bond message from our 5-Star Generals and Admirals.

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

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SYLVANIA NEWS
ELECTRONIC EQUIPMENT EDITION

MAY *Published by* SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa. 1945

SYLVANIA'S CHART AIDS STANDARDIZATION OF TUBES

Reference List Recommendations Reduce Radio Tube Types

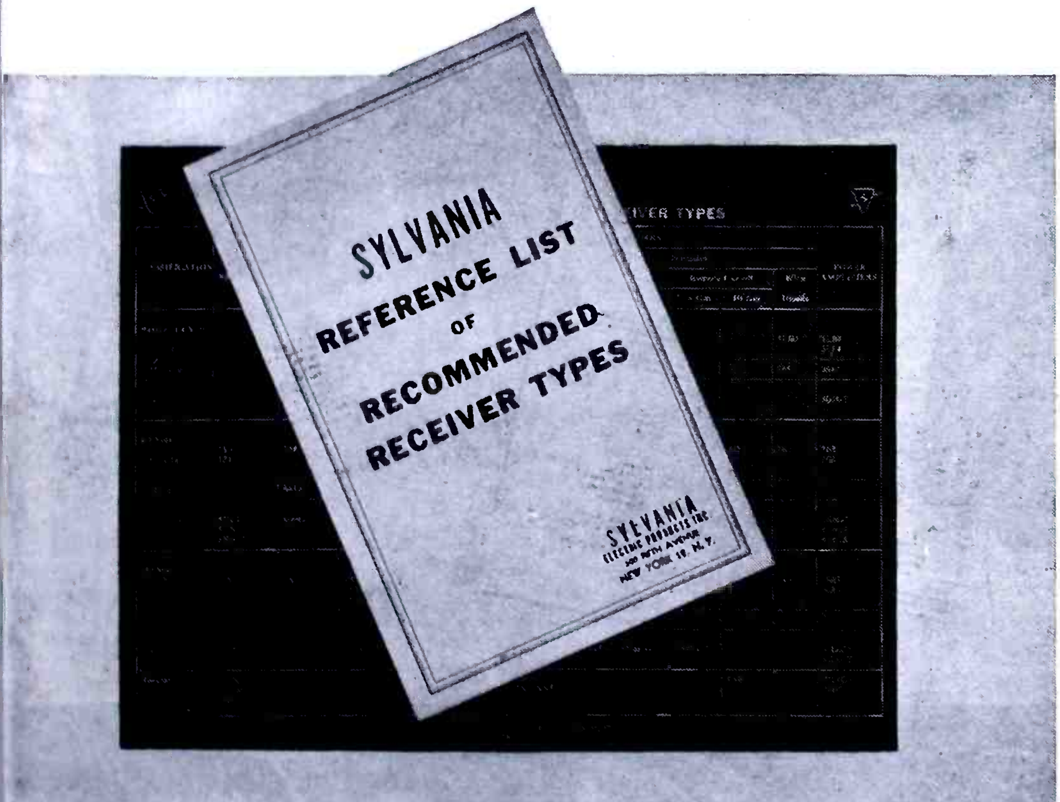
As an aid to the standardization of radio receiver tube types, Sylvania has prepared the chart reproduced below—another item in Sylvania's long-time program of technical assistance to the radio industry.

The number and variety of tube types have grown in recent years, and this trend has intensified war scarcities.

Naturally, it would seem to be advantageous to radio set manufacturers to further standardize tube selection and limit their variety. This would probably meet with approval in many parts of the radio industry, particularly among radio servicemen since they are in an active position when it comes to tube replacement and general radio set repairing.

(An indication of their opinion concerning tube types was revealed in Sylvania's survey in which 90.5% of the servicemen questioned said they would prefer fewer and simpler tube types.)

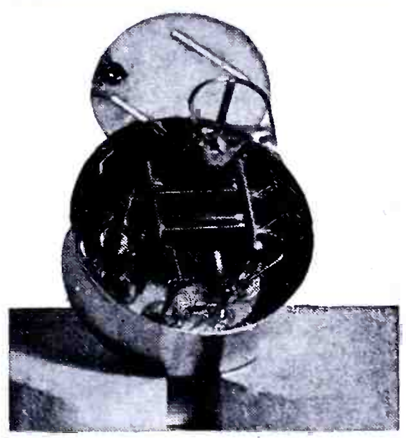
This handy reference chart will help smooth some of the wrinkles of the problem and act as a future guide. Write for it to Sylvania Electric Products Inc., 500 Fifth Ave., New York 18, N. Y.



Double Triode Tube Has Two Uses

Acts As Converter Or Amplifier

Sylvania's new high mutual conductance double triode tube—Type 7F8—is designed for use at frequencies up to 300 or 400 Mc.



With precautions the two sections may be used separately, saving space and the number of tubes required for a given performance since all the elements except the heaters are independent.

The cascade operation thus made possible is useful in u-h-f grounded grid and cathode follower amplifier service. It may also be used as a push-pull u-h-f amplifier.

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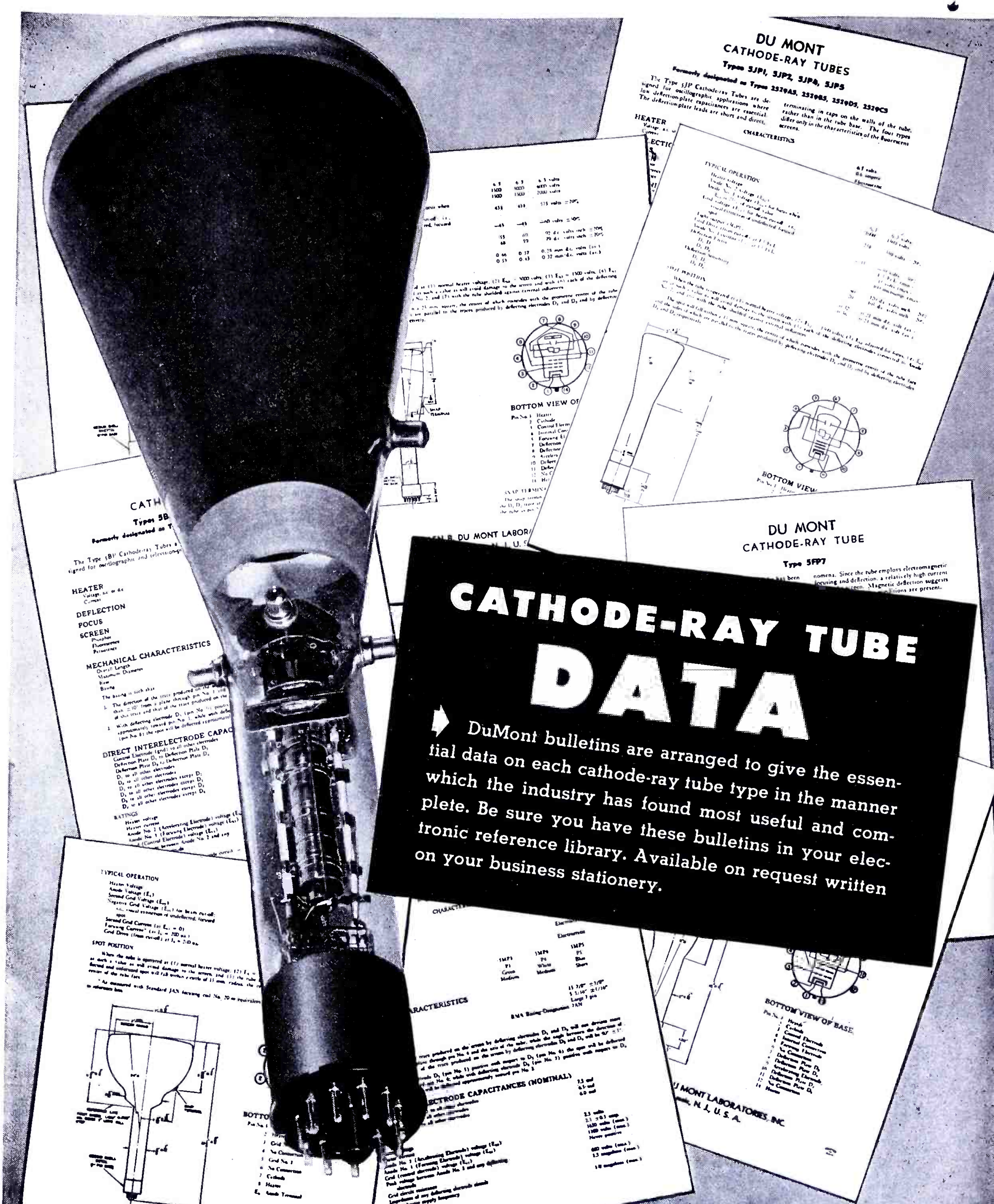

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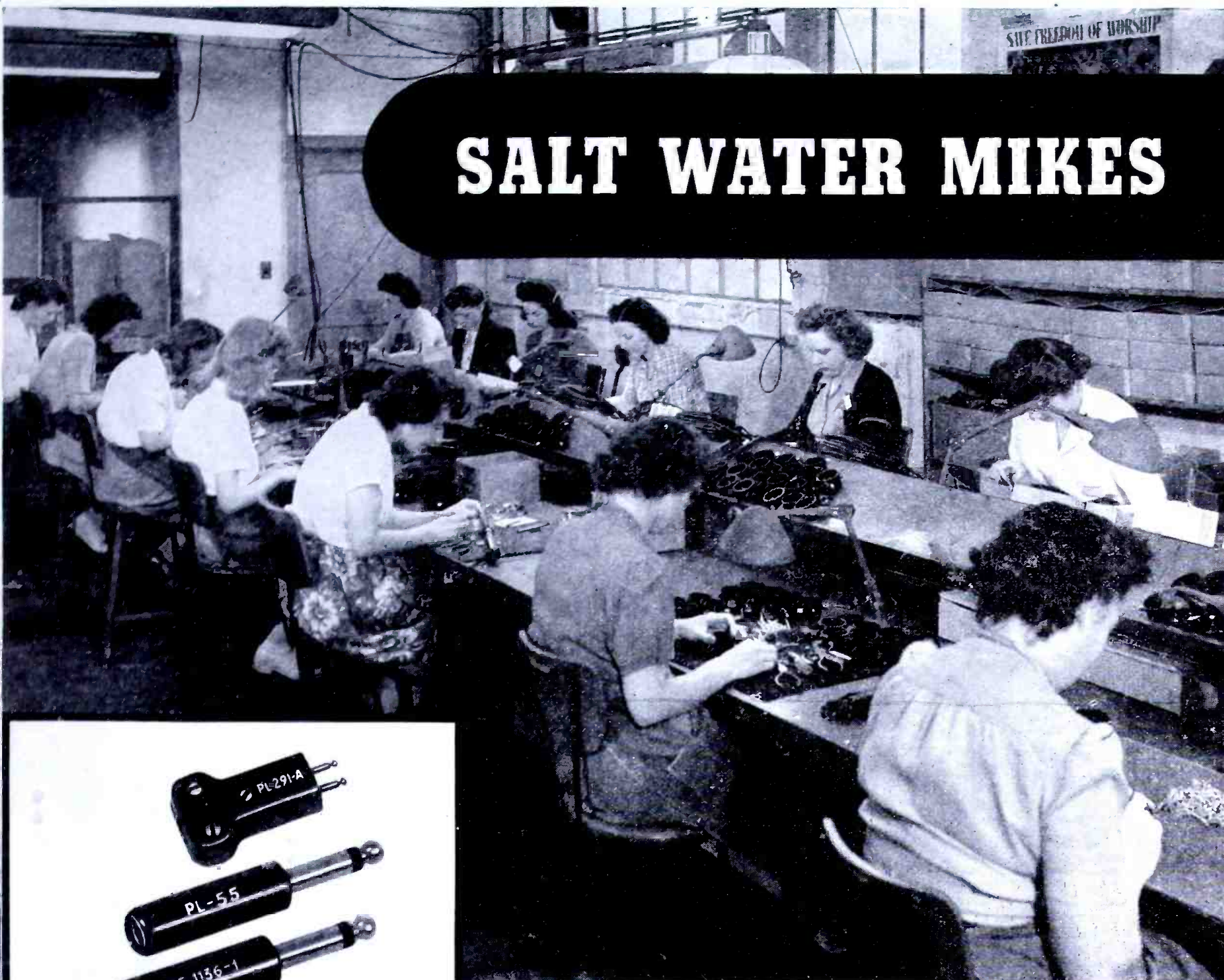

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Signal Corps · Navy Specifications

Types:	PL				NAF
50-A	61	74	114	150	
54	62	76	119	159	
55	63	77	120	160	1136-1
56	64	104	124	291-A	
58	65	108	125	354	No.
59	67	109	127		212938-1
60	68	112	149		

PLP		PLQ		PLS	
56	65	56	65	56	64
59	67	59	67	59	65
60	74	60	74	60	74
61	76	61	76	61	76
62	77	62	77	62	77
63	104	63	104	63	104
64		64			

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To aid the war effort, our engineers are available for consultation on any amplification problem. Until Victory, Eastern will continue to devote its resources to the design and manufacture of vital war equipment. Meanwhile, let us send you the next of a series of useful articles prepared by our engineering staff on the newest developments in amplification related to both sound systems and industrial instruments. Ask for Brochure 5-G.

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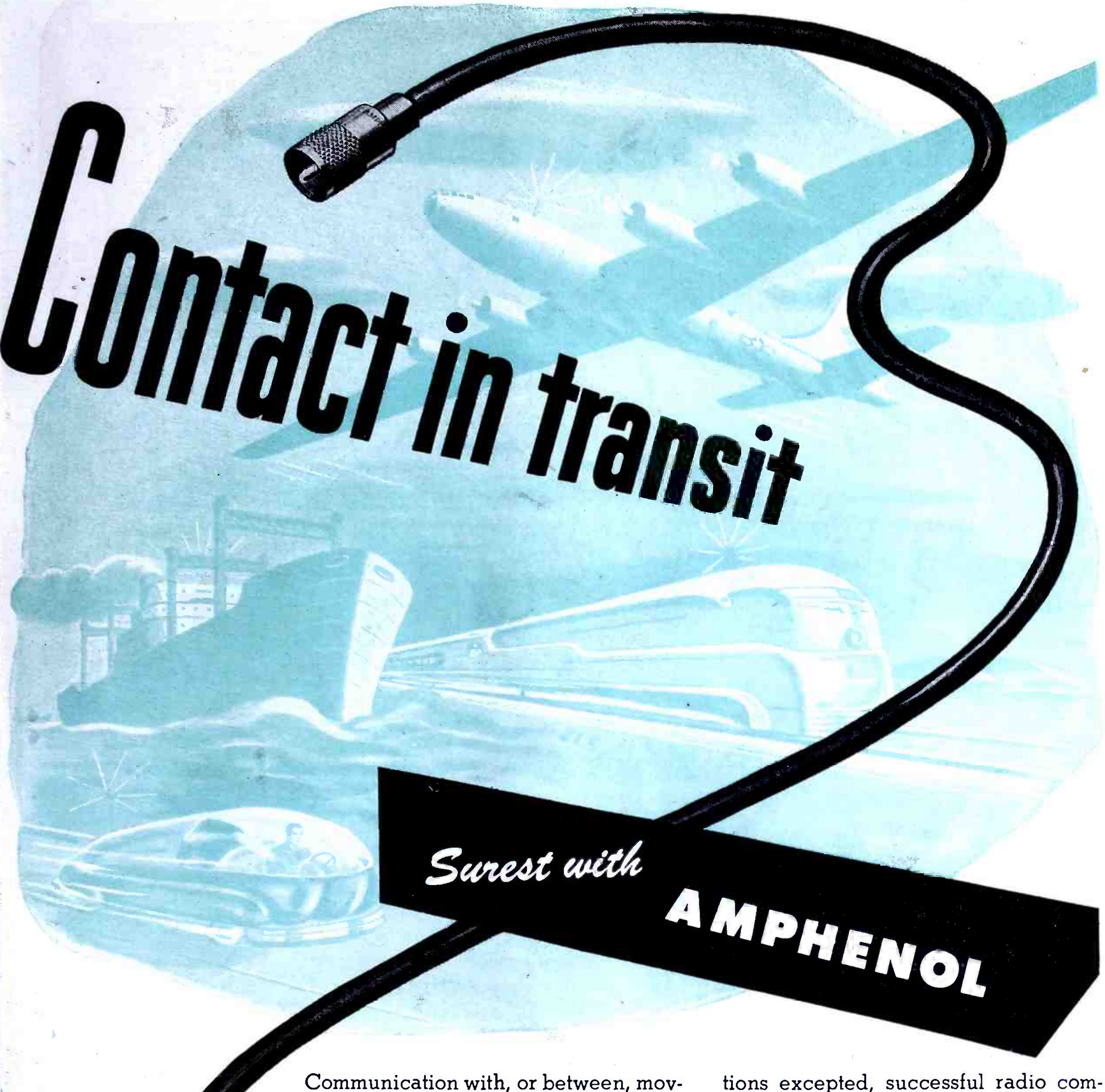

Communication with, or between, moving vehicles becomes more important as this Age of Speed advances. Every factor is vital which promotes clarity of transmission. When trains, taxis, ships and passenger cars can contact each other or their "home stations" at will, Amphenol Cable Assemblies, Connectors and Sockets will do their share to provide good electrical contact *within the equipment.* Atmospheric and static conditions excepted, successful radio communication in transit depends largely on low-loss stability and good design of the equipment's component parts. The name "Amphenol" indicates to the user that they have been designed, made and tested to give the best possible service in spite of interference, vibration and moisture. Detailed technical information on all Amphenol products in which you may be interested is available and will be sent on your request—ask for Catalog Section D.

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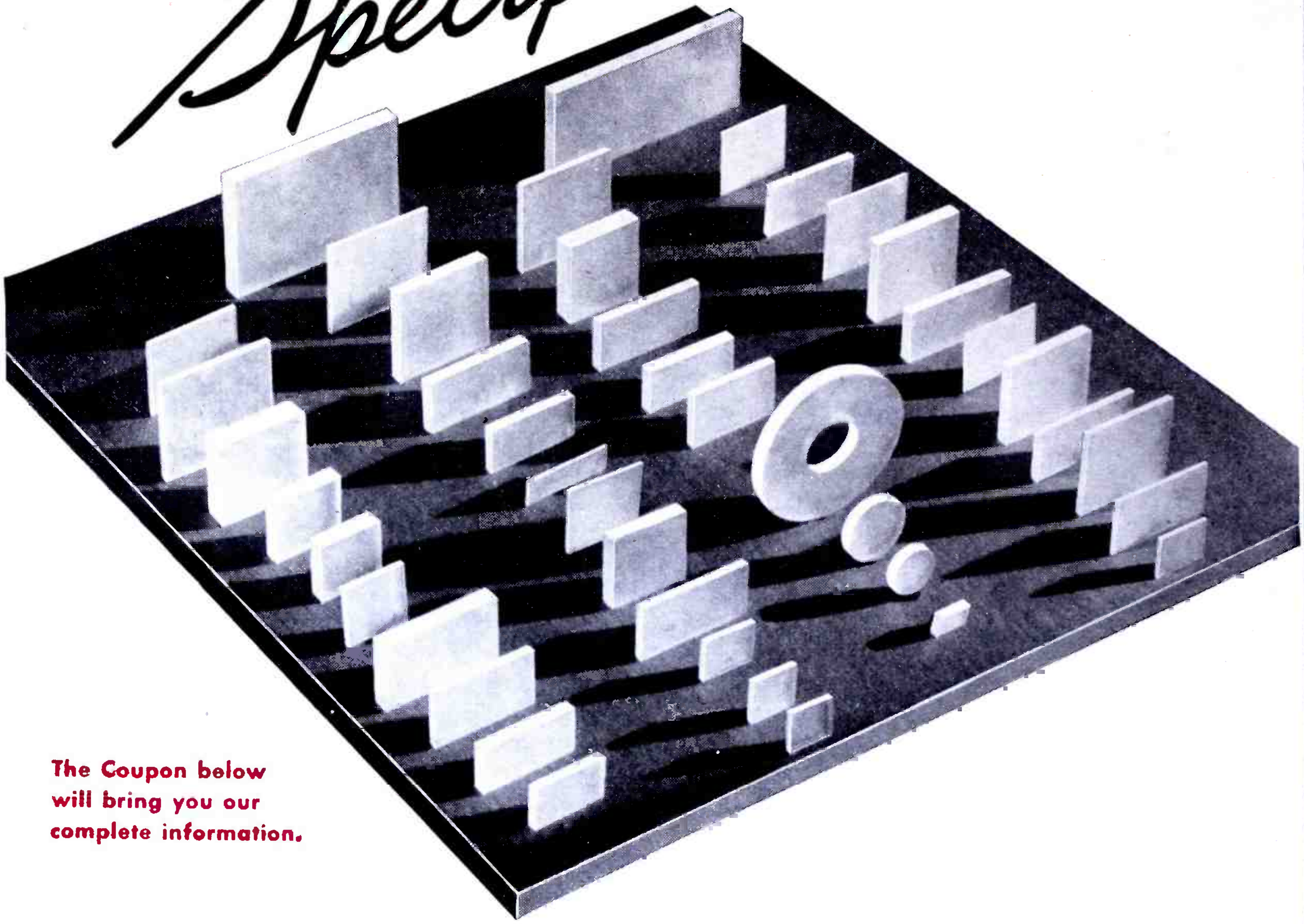

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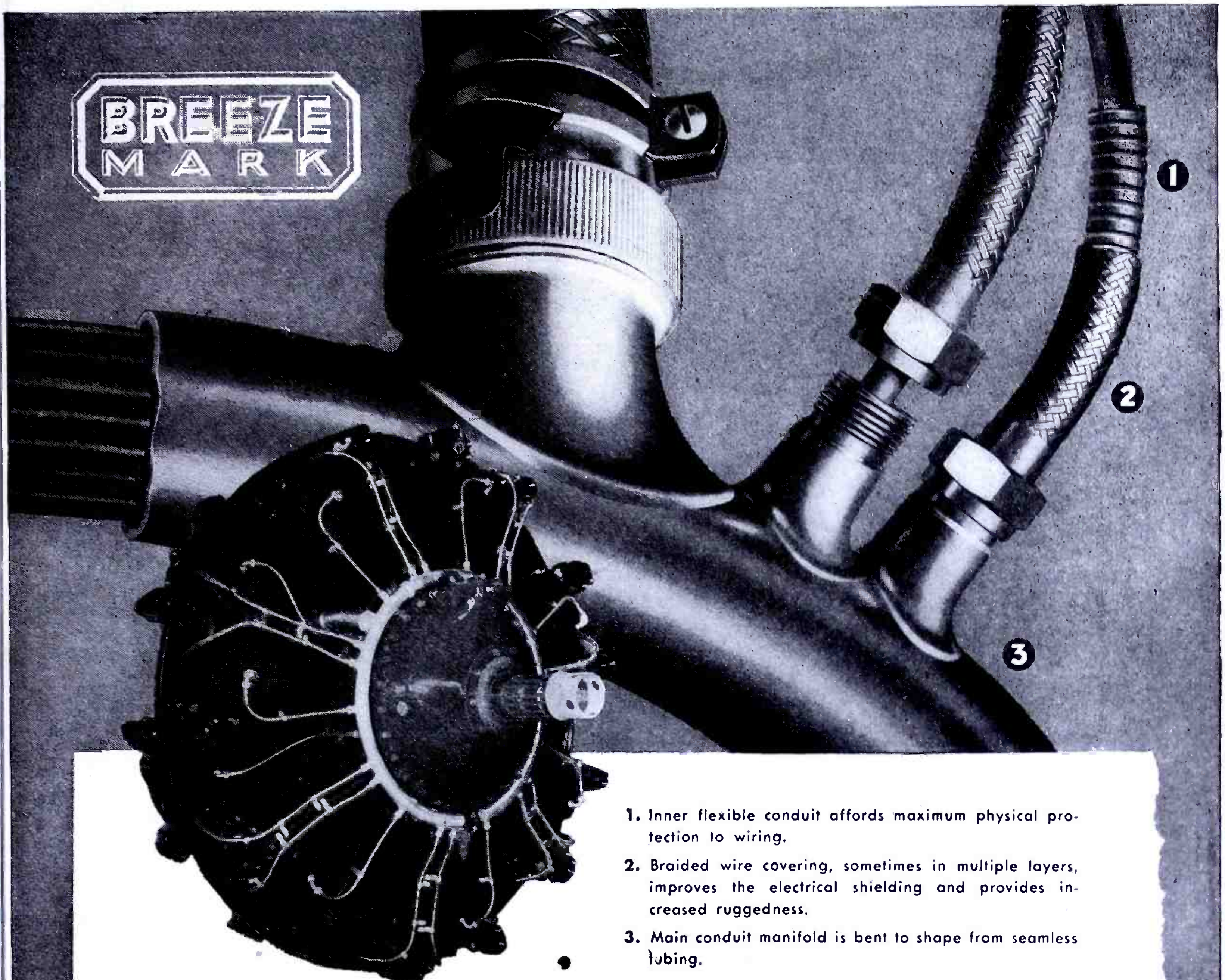

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Breeze Shielding is designed for ruggedness, resistance to vibration, and maximum isolation of high frequency interference. Each wire of the braided cover must be positively soldered at each connection, inner conduit must be tight to avoid electrical leakage, and fittings must be precision-machined for close fit and uniform pressure of contact faces.

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Breeze BREEZE MARK
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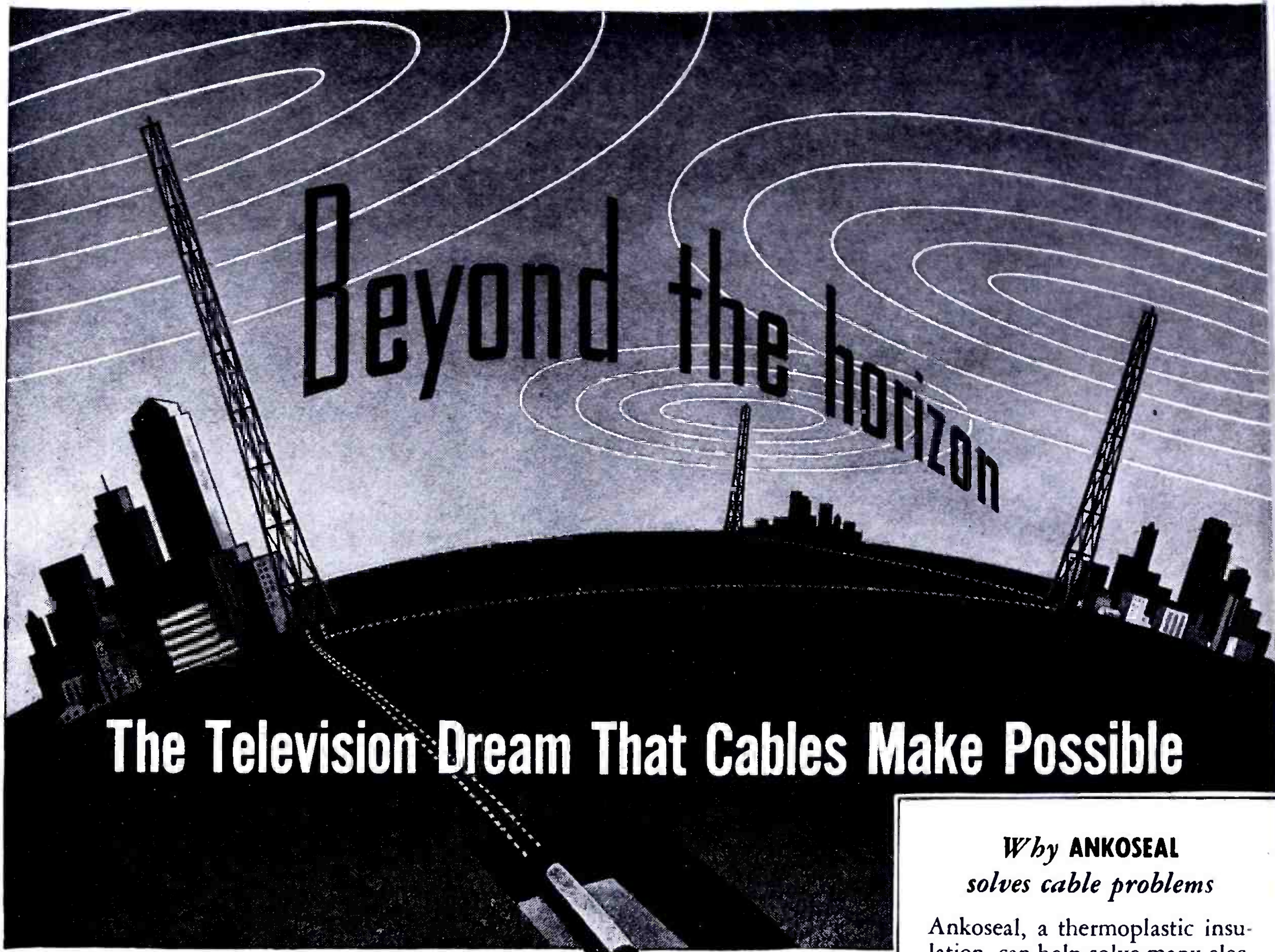

TELEVISION—sign and symbol of the age to come—is one of the wonders that specially designed cable transmission makes practical. For the quality and fidelity of the transmitted image depend largely on how well the cables are engineered and manufactured, from tiny cables in the broadcasting mechanism itself to the great coaxial cables linking city with city, making possible the television networks of the future.

Thus the "wireless age" as it develops will actually need more wires—and more complicated cables—to achieve its realization! And in the solution of these problems, new and more complicated cables will be required.

Today, we will undertake to engineer and manufacture the radio and audio cable requirements of any government agency or private concern in war work. Moreover, we look forward to solving many of the most difficult cable tasks in peacetime — as we have in wartime. The same laboratories, the same Yankee ingenuity that have helped to whip many of the difficulties involved in the communications requirements of our Army and Navy are prepared to function for industry — whatever the problems of today and tomorrow.

Why ANKOSEAL *solves cable problems*

Ankoseal, a thermoplastic insulation, can help solve many electrical engineering problems, now and in the future. *Polyvinyl* Ankoseal possesses notable flame-retarding and oil resisting characteristics; is highly resistant to acids, alkalies, sunlight, moisture, and most solvents. Polyethylene Ankoseal is outstanding for its low dielectric loss in high-frequency transmission. Both have many uses, particularly in the radio and audio fields. Ankoseal cables are the result of extensive laboratory research at Ansonia—the same laboratories apply engineering technique in the solution of cable problems of all types.

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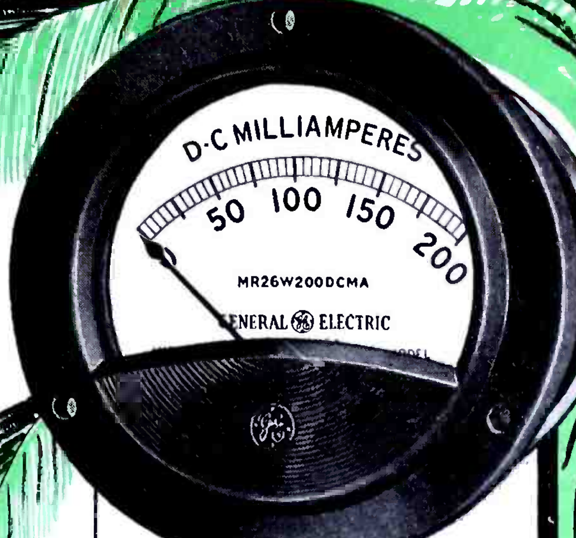

● The Pacific war area is probably the toughest instrument-proving ground in the world. To meet the requirements of such severe service, G-E engineers have designed a 2½-inch panel instrument that *IS hermetically sealed*. No detail has been overlooked to make this critical radio component impervious to the tropical conditions of high humidity, extreme temperature, and fungus growth.

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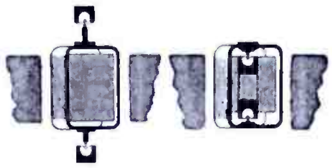
Type DW-62 radio-frequency ammeters and milliammeters

AN INTERNAL-PIVOT DESIGN



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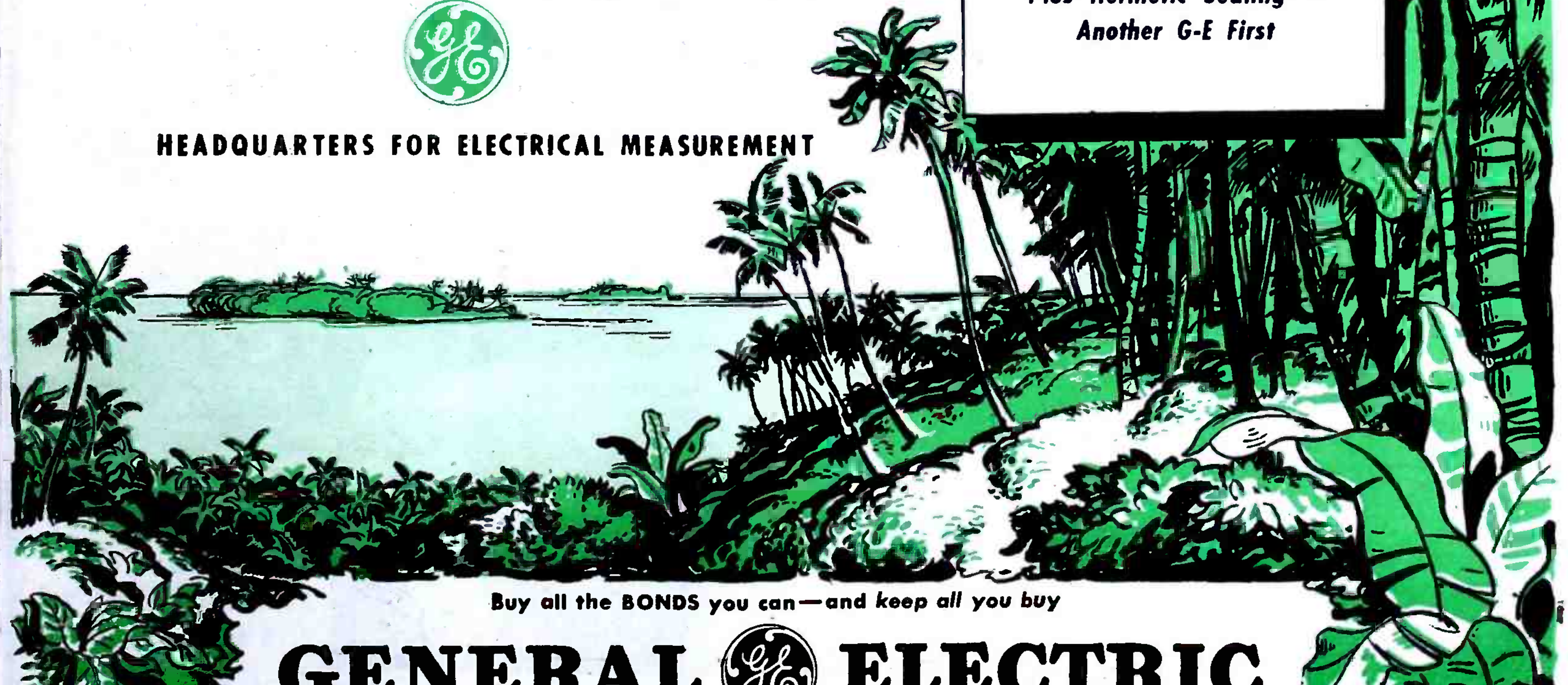

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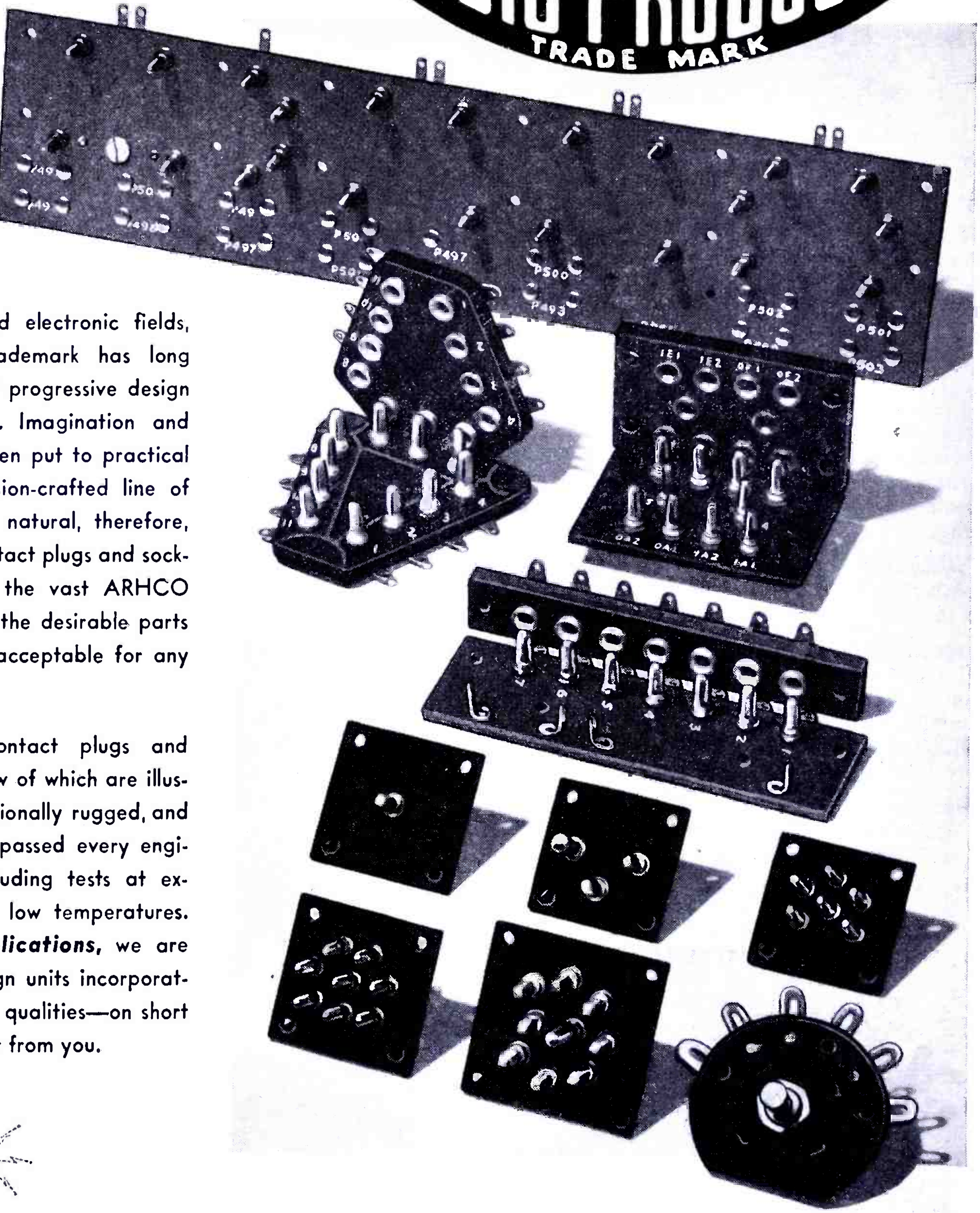

In the radio and electronic fields, the ARHCO trademark has long been a symbol of progressive design and manufacture. Imagination and foresight have been put to practical use in this precision-crafted line of components. It is natural, therefore, that our multi-contact plugs and sockets, members of the vast ARHCO family, should be the desirable parts they are, wholly acceptable for any application.

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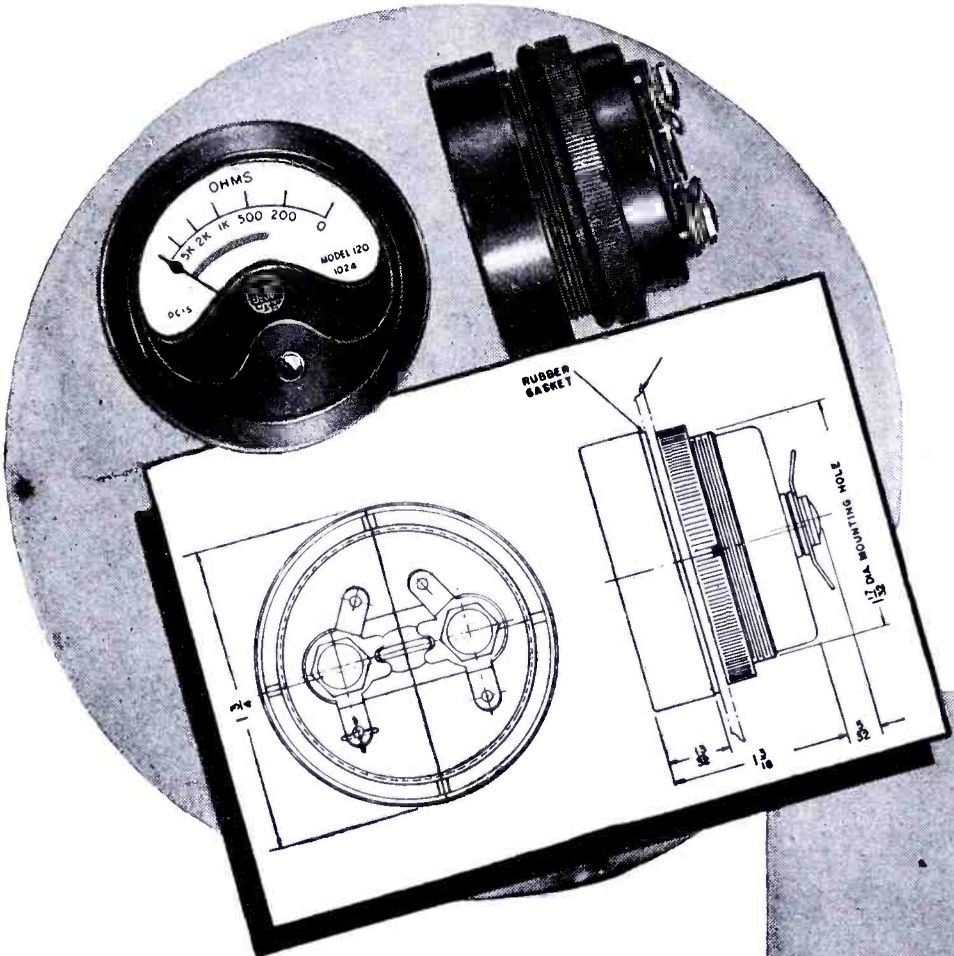

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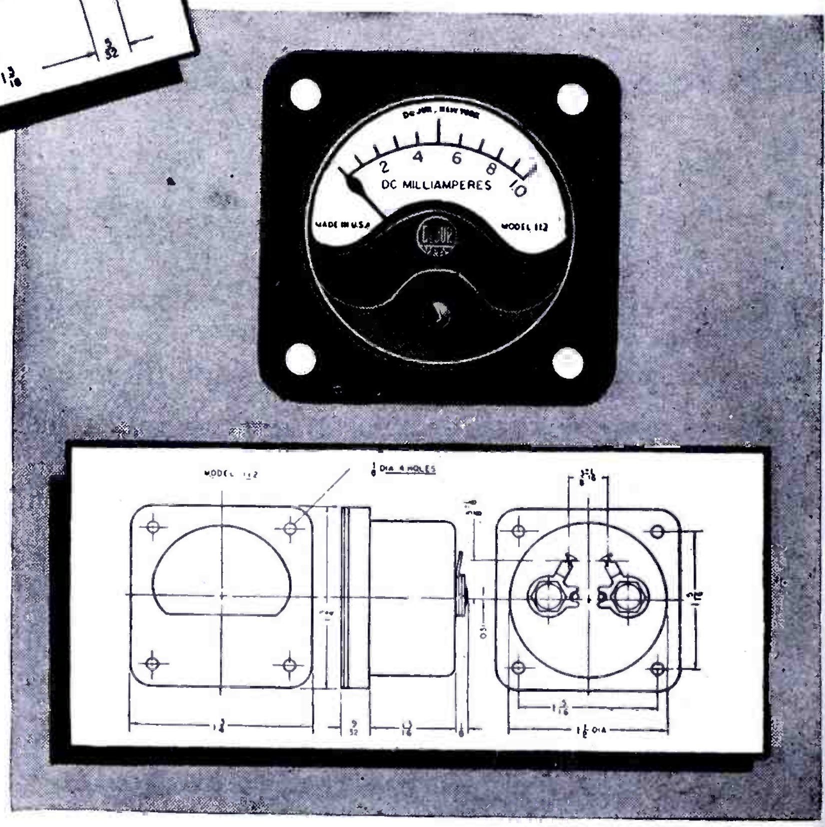
The smallest meter of its kind, built with the care and precision of all DeJur larger instruments. Sealed to sustain immersion in 30 feet of water for as many as 7 days without harm to the mechanism. If the glass breaks, the meter case is designed to seal the equipment against water seepage. Terminal studs are also waterproof sealed. Another advanced construction feature is the ring mounting which makes for quick and easy installation—no mounting holes or screws necessary, just tighten on with the ring. A.S.A. type movement. Built to exacting specifications.



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Entirely self-contained with built-in resistors and shunts. Available in wide variety of ranges. This model, too, may be immersed in 30 feet of water for 7 days without harm to the movement. In addition, it incorporates all other waterproof features of the Model 120. Though compact in size, no sacrifice has been made in quality of materials or construction details. It performs with high efficiency in a variety of applications. A.S.A. type movement. Built to exacting specifications.

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The 2C26A exemplifies Hytron's ability to build in soft glass, at high speed, and for economical prices, special purpose tubes. Hytron solved a tough problem for the Services by designing in the 2C26A a tube capable of performance and high ratings never before — or since — achieved in soft glass. This small tube — approximately the same size as the 50L6GT Bantam — is capable of delivering 2 KW of useful r.f. power at 200 megacycles. It replaces larger and much more expensive hard glass transmitting tubes which must be operated at much higher potentials.

HYTRON TYPE 2C26A

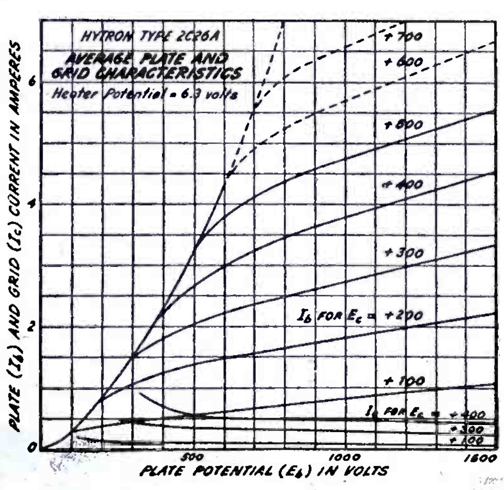
VERY-HIGH-FREQUENCY TRIODE PULSE OSCILLATOR

The Hytron type 2C26A is a special triode for use as a grid or plate pulse oscillator up to 300 megacycles. Its cathode is designed and processed to provide the extremely high peak plate currents required in pulse operation. Special top cap design permits use of the maximum potentials, without external voltage breakdown, at the higher altitudes. Other notable features are: convenient size, standard octal base, high-voltage internal ceramic insulators, and extremely rugged construction.

ELECTRICAL

Coated Unipotential Cathode

Heater Voltage	6.3 volts
Heater Current	1.1 amps.
Plate Dissipation	10 max. watts
Grid Dissipation	2.5 max. watts
Plate Potential (plate pulsed)	3500 max. peak volts
Plate Potential (grid pulsed)	2500 max. dc volts
Grid Bias	– 700 max. dc volts
Average Characteristics for	Eb:400V; Ec:-15V; Eh:6.3V
Plate Current	16 ma.
Amplification Factor	16.3
Transconductance	2250 micromhos
Average Direct Interelectrode Capacitances	
Grid-to-Plate	2.8 mmf.
Grid-to-Cathode	2.6 mmf.
Plate-to-Cathode	1.1 mmf.
Frequency for Maximum Rating	300 MC



MECHANICAL

Type of cooling	Convection
Base	Intermediate shell octal 8-pin phenolic
Top Caps	Skirted miniature with insulating bushing
Bulb	T-9
Maximum overall dimensions	
Length	3 11/16 inches
Seated Height	3 1/8 inches
Diameter	1 5/16 inches
Net Weight	1 1/2 ounces

2C26A IS ON THE ARMY-NAVY PREFERRED LIST

OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON

RADIO AND ELECTRONICS CORP.

ARMY E NAVY

HYTRON RADIO TUBES

MAIN OFFICE: SALEM, MASSACHUSETTS

PLANTS: SALEM, NEWBURYPORT, BEVERLY & LAWRENCE

FORMERLY HYTRON CORPORATION

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"Here's how Courtney checks up on Courtney!"

Alan Courtney

"...via a PRESTO recorder"

"An announcer must check up on his technique constantly," says Alan Courtney, popular announcer of WOV's *1280 Club* program. "My own way of doing this is to make frequent recordings of my voice on a portable PRESTO recorder. Then, by listening to the records, I can get an idea of how I sound to the radio audience. Naturally, the accuracy of the recording is of the utmost importance. I find a PRESTO recorder ideal for the work, because, even in amateur hands, it produces cuttings of uniformly high fidelity and clarity."

PRESTO sound recording and transcription equipment is used by major broadcasting companies, in industry, in schools and colleges, and by the Armed Forces. Every PRESTO unit, from the largest to the smallest, is a product of high engineering skill and uncompromising manufacturing standards. Write for information.

WORLD'S LARGEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT AND DISCS

PRESTO

RECORDING CORPORATION

242 West 55th Street, New York 19, N. Y.

Walter P. Downs Ltd., in Canada

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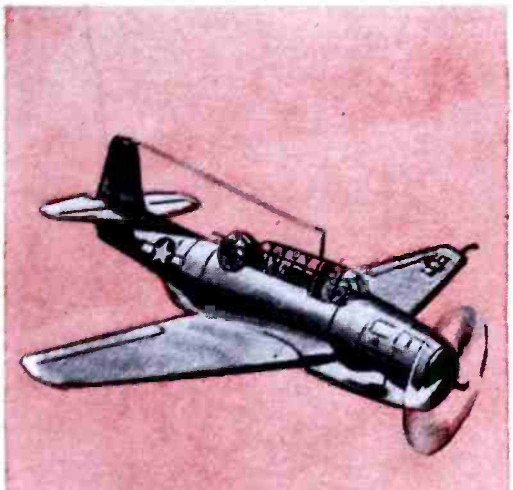
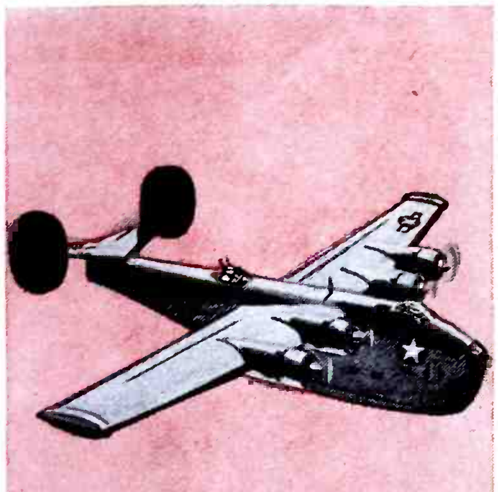
These U. S. Navy Planes Carry Collins Autotune Transmitters


GRUMMAN TBF AVENGER


PB2Y-3 CORONADO

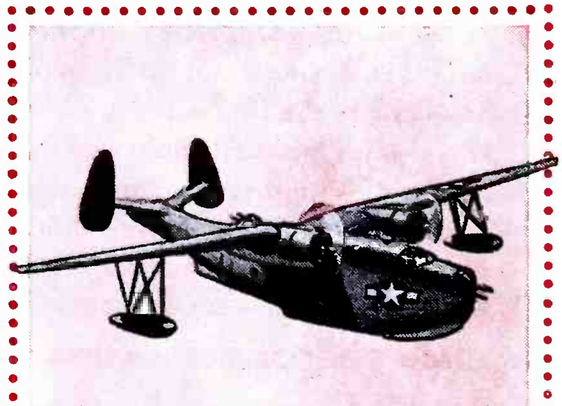

MARINE CORPS PBJ MITCHELL

The voice of thousands of Navy fliers

THE COLLINS ATC Autotune transmitter is regulation equipment for most two-place-and-larger types of Navy aircraft. It is the military successor of Collins airborne Autotune transmitters which were adopted by several of the great commercial airlines years before the war. Since Japan struck, the Navy has ordered many thousands. In advanced design and rugged construction, today's ATC reflects the lessons of war learned in every quarter of the world. It is a foretaste of the reliability and efficiency to be expected of Collins by commercial and private users after victory. Collins Radio Company, Cedar Rapids, Iowa; 11 West 42nd Street, New York 18, N. Y.


CURTISS SB2C-1 HELLDIVER


PB4Y-2 PRIVATEER


MARTIN PBM-3D MARINER

ARMY E NAVY

IN RADIO COMMUNICATIONS, IT'S . . . COLLINS

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Warnings against unstable voltages are unnecessary on equipment protected with built-in CONSTANT VOLTAGE

Unstable voltage on commercial power lines is so prevalent that many manufacturers of electrical and electronic equipment have found it necessary to warn their customers of its existence and its possible effects on the operation and efficiency of the equipment.

There is an easy and inexpensive solution to this important problem —specify a SOLA CONSTANT VOLTAGE TRANSFORMER as a component part of your equipment. There are several types of SOLA CONSTANT VOLTAGE TRANSFORMERS specially designed for this purpose—small, compact units in capacities ranging from 10VA to several KVA. Other capacities and designs can be custom built to your specifications.

Once installed in your equipment they require no pampering or supervision. They are fully automatic, instantly correcting voltage fluctuations as great as ±15%. They are self-protecting against short circuit.

No sales manager will overlook the added salability of a product that features this guarantee of performance, low maintenance cost and satisfaction to the user.

SOLA engineers with wide experience in the application of the SOLA CONSTANT VOLTAGE principle are available for consultation on details of design specifications.

SOLA Constant Voltage Transformers

To Design Engineers:

Complete, new hand-book of Constant Voltage Transformers available on request.

Ask for Bulletin ECV-102

Transformers for: Constant Voltage • Cold Cathode Lighting • Mercury Lamps • Series Lighting • Fluorescent Lighting • X-Ray Equipment • Luminous Tube Signs • Oil Burner Ignition • Radio • Power • Controls • Signal Systems • Door Bells and Chimes • etc. **SOLA ELECTRIC CO., 2525 Clybourn Ave., Chicago 14, Ill.**

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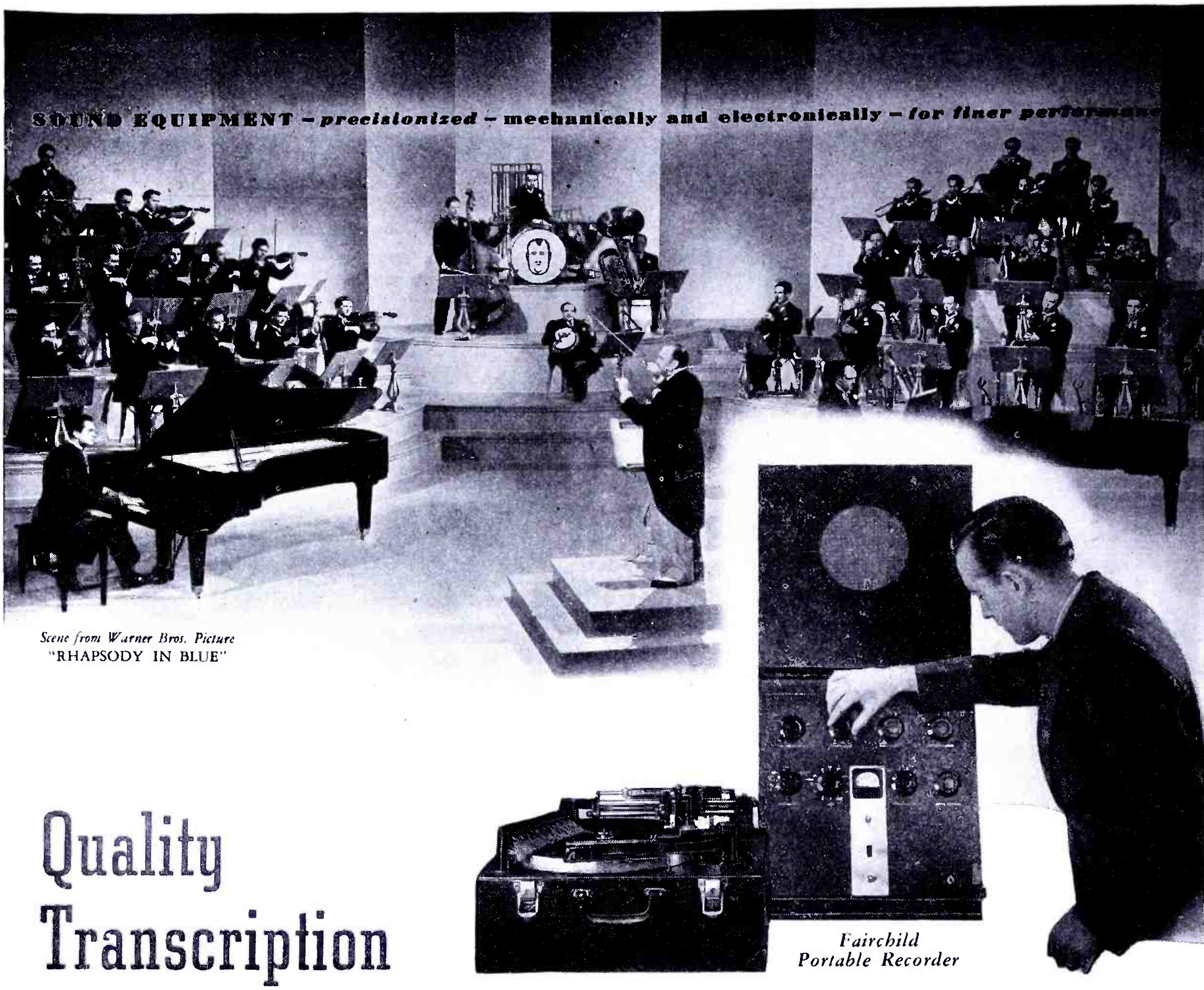

Scene from Warner Bros. Picture
"RHAPSODY IN BLUE"

Fairchild
Portable Recorder

Quality Transcription

... that keeps the original music and speech alive!

Your station announcer . . . not quality variation . . . should tell your listening audience whether your broadcast is a 'live' or 'recorded' program.

'Live' and 'recorded' quality should be practically indistinguishable!

Fairchild-built recording channels put the fundamental tone and all overtones up to 8,000 cycles on the record at full strength. The bass takes on the character of the individual instruments instead of the all-too-prevalent overall 'boom, boom' which leaves the listener wondering whether the recorded sound is string bass, brass horns, bassoon or drums.

At the other end of the sound spectrum, and throughout all intermediate ranges, Fairchild recorded sound comes back over good playback systems with absolute *naturalness*. No doubt remains in the listener's mind that he's hearing the 'live' qualities of the orchestra, band, or the even-more-difficult-to-record individual performances of the piano or pipe organ.

Fairchild Portable Recorder descriptive and priority data are available. Address *New York Office:* 475 - 10th Avenue, New York 18; *Plant:* 86-06 Van Wyck Boulevard, Jamaica 1, N. Y.

FCI

Fairchild CAMERA AND INSTRUMENT CORPORATION

SOUND EQUIPMENT

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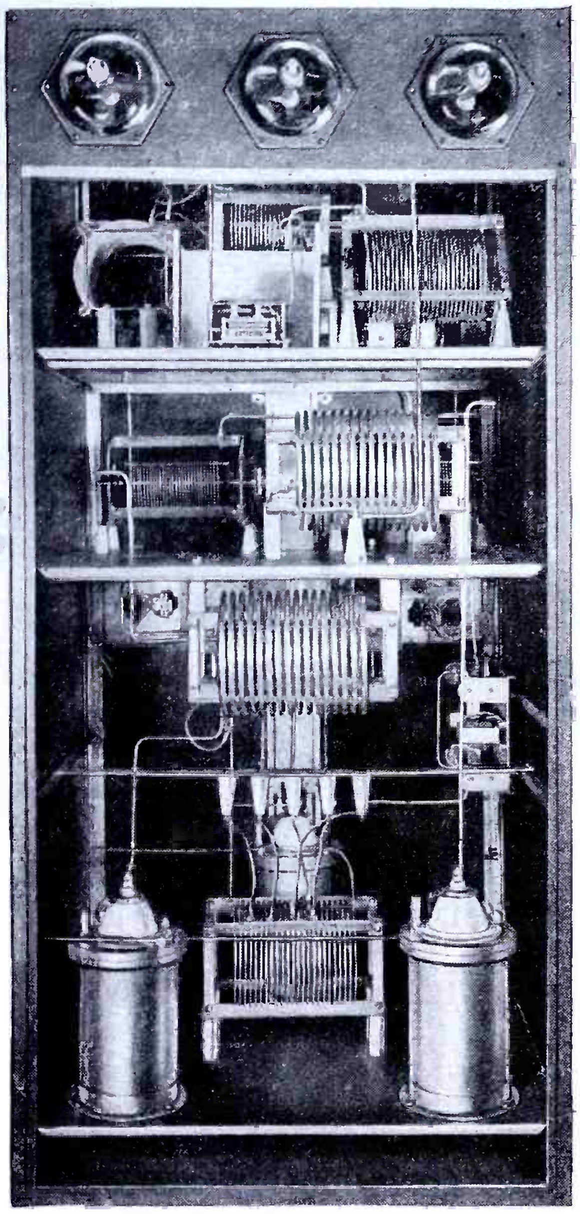
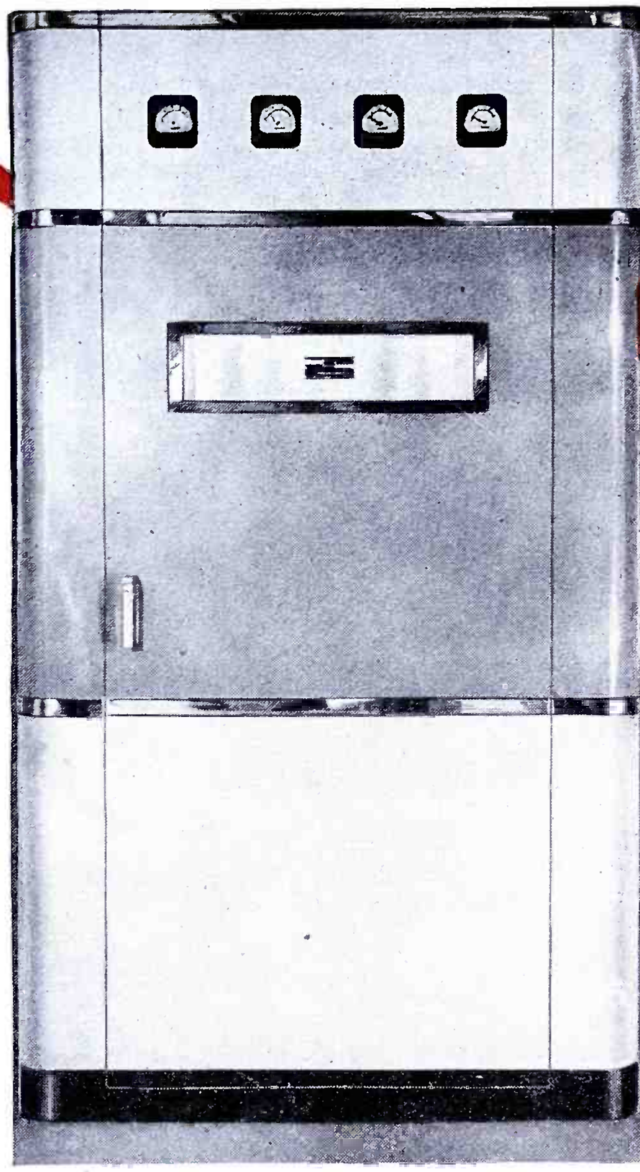
DIRECTIONAL ANTENNA EQUIPMENT





Johnson engineers have designed many highly successful installations of phasing and antenna coupling equipment to individual specifications. These units may be built to match any existing transmitter and thus become an integral part of your station. Let us help you and your consulting engineer plan your transmitting equipment for better market coverage. Orders received now will get first attention when priority restrictions are removed.

Here are two of the many installations of phasing equipment Johnson has furnished for Broadcast Stations, built to match existing equipment. Other items available from Johnson, made to individual specifications, are gas filled pressure condensers, coupling networks, tower lighting filters and special inductors.

JOHNSON
a famous name in Radio

E. F. JOHNSON COMPANY
WASECA, MINNESOTA

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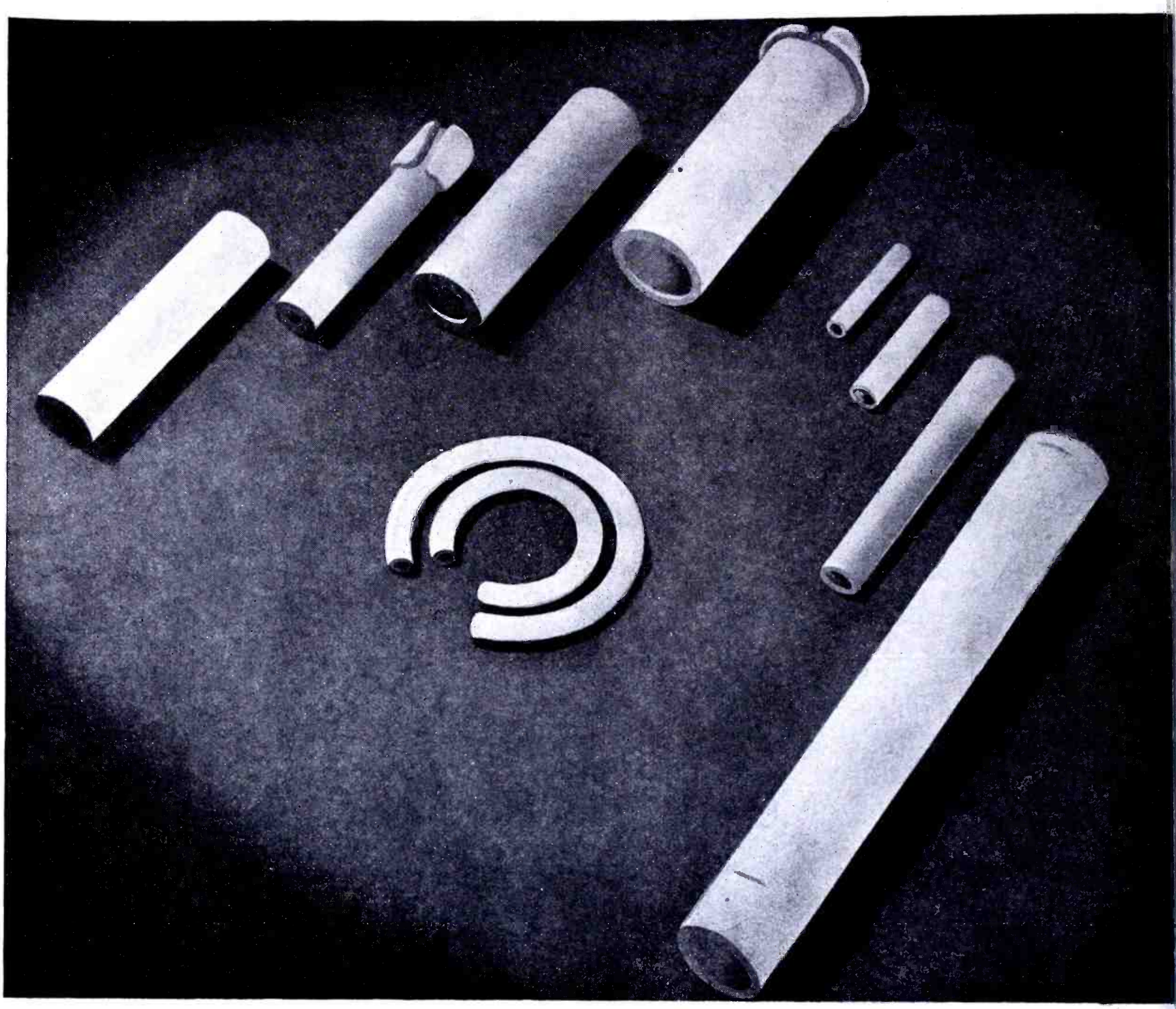

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Radio and Electronic Distributor Division

ARMY E NAVY

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WL WARD LEONARD
ACCEPTED MEASURE OF QUALITY

RESISTORS
RHEOSTATS
RELAYS

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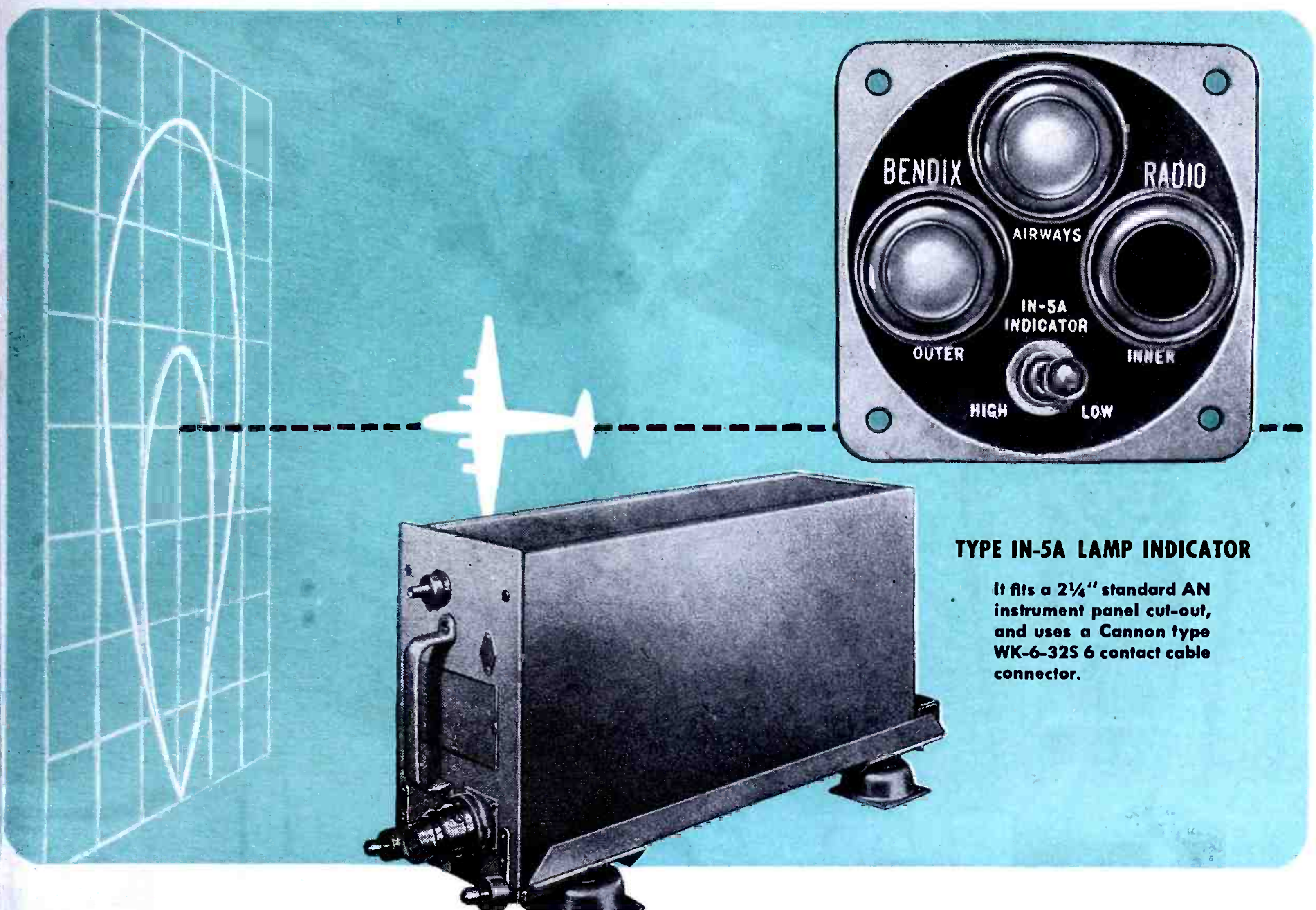
Presenting

A NEW 75 MEGACYCLE MARKER RECEIVER

Improved Indication at Low Battery Voltage—A new minimum in unwanted lamp operation—½ A.T.R. Size Case—Reduced Weight



TYPE IN-5A LAMP INDICATOR

It fits a 2¼" standard AN instrument panel cut-out, and uses a Cannon type WK-6-32S 6 contact cable connector.

Does your marker receiver give good indications when battery voltage drops to eleven (or twenty-two) volts? Does unwanted lamp operation confuse the pilot during instrument approaches? These difficulties have been eliminated in the design of the new Bendix Radio MN-53 marker receiver; and, in addition, valuable weight and mounting space have been saved.

This receiver is available in a number of different types. This same unit may be used with either twelve or twenty-four volt systems. A centralized radio power supply may be used, or an individual dynamotor may be plugged right into the unit. In addition there is a model that is both mechanically and electrically interchangeable with existing airline marker equipment.

Another feature of this new marker receiver is variable coupling of the intermediate frequency transformers. IF adjustment is thus greatly simplified and the desired band pass characteristic can be easily obtained.

For further information on this latest product of Creative Engineering, write direct to the Sales Department, Bendix Radio.

BENDIX IS A TRADE-MARK OF BENDIX AVIATION CORPORATION

Bendix RADIO DIVISION

BENDIX AVIATION CORPORATION, BALTIMORE 4, MARYLAND

STANDARD FOR THE AVIATION INDUSTRY

www.americanradiohistory.com

TYPES 274-A and 274-B FULL WAVE, HIGH VACUUM RECTIFIERS

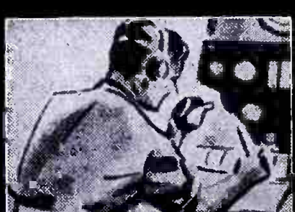
by

..post-war problem solvers!

Fundamentally, these E-E electronic tubes are representative of the research and engineering being projected into the industry's war effort. Basically, however, they are indicative of much more. For in the future, they hold great promise of material economies and advancements.

Industrial control, guidance, sorting, counting, indicating, detecting, protecting, etc., are but a few of the functions which will be undertaken by E-E 274-A and 274-B vacuum tubes. With ratings substantially higher than RMA 80, these tubes are recommended when higher DC currents are required. The two tubes are identical except for bases. Extensive in application, these high vacuum rectifiers widen the possibilities of potential uses, and draw closer the horizons of actuality, tomorrow. E-E Data Book on request.

Ruggedly designed, these E-E Rectifiers are suitable for portable and industrial applications.



Made in many types and capacities; these high vacuum units offer noise-free current supply.

ELECTRONIC ENTERPRISES

ELECTRONIC ENTERPRISES • INC

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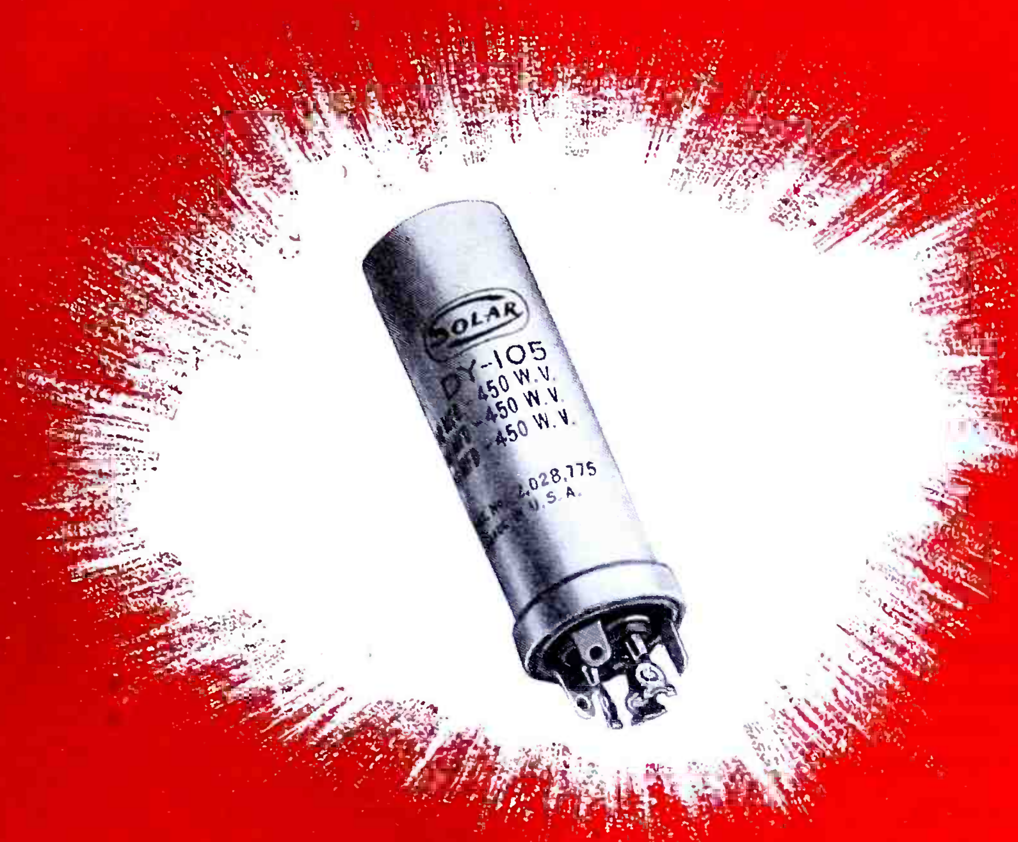

Trustworthy in every climate

SOLAR PRODUCTS

DRY ELECTROLYTIC CAPACITORS
WET ELECTROLYTIC CAPACITORS
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7435

SOLAR MANUFACTURING CORP.
285 MADISON AVE. • NEW YORK 17, N. Y.

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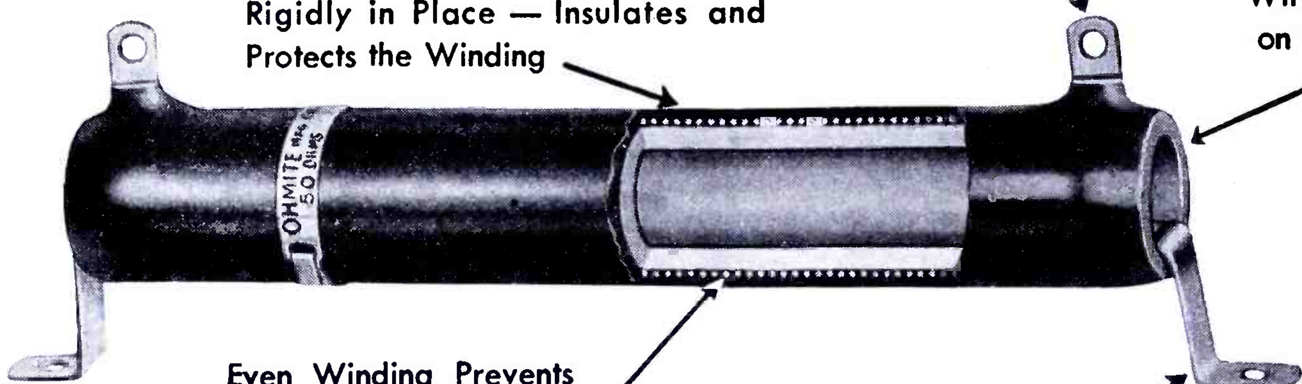
Why OHMITE *Resistors* PERFORM SO DEPENDABLY



Here you see a few of the important features that insure long life and trouble-free service in every Ohmite Resistor. In the lug type illustrated above, the resistance wire is both mechanically locked and brazed to copper terminal lugs to assure perfect electrical connection. Time-proved Ohmite vitreous enamel construction dissipates heat rapidly . . . withstands humidity. Today, Ohmite Resistors are extensively used in the Armed Forces, Industry, Communications, Research. *Made in a wide range of types and sizes* in stock and special units for every need. Consult Ohmite engineers on your resistor problem.

OHMITE MANUFACTURING COMPANY
4869 FLOURNOY ST., CHICAGO 44, U. S. A.

Write on company letterhead for Industrial Catalog and Engineering Manual No. 40. Gives helpful information on resistors, rheostats, chokes, tap switches.

Be Right with OHMITE
RHEOSTATS • RESISTORS • TAP SWITCHES

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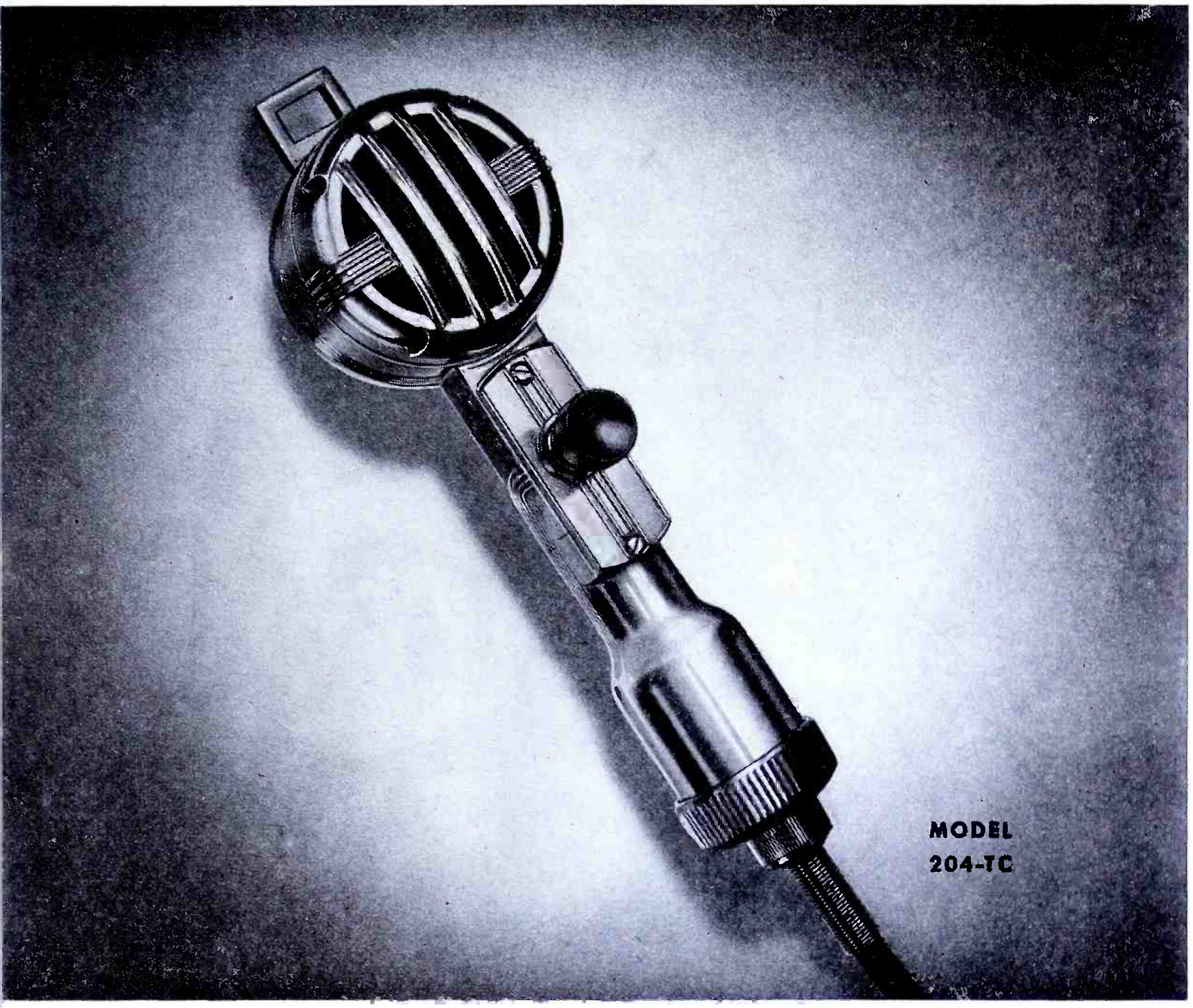

DYNAMIC HANDI-MIKE

TECHNICAL DATA
MODEL 204-TC

IMPEDANCE: 35-50 Ohms.

FREQUENCY RESPONSE: 200-7500 Cps.

OUTPUT LEVEL: Into 50 ohm input; 44 db below 6 milliwatts for 100 bar signal.

SWITCH: Type "T." Press-to-talk. Vertical toggle with snap action.

CORD: 6 feet long. Rubber jacketed. 2 Conductor and shield.

CIRCUIT: Two wires direct to microphone. Switch "makes" independent circuit. For use in connection with control circuit of transmitter or other relay operated device.

DIMENSIONS: Length overall 8 inches, head diameter 2¼ inches.

SHIPPING WEIGHT: 2 pounds.

There are seven other dynamic handi-mike models from which to make a selection.

Universal Handi-Mikes have been, through these years of progress in Radio-Electronics, as common a part to specialized sound equipment as the vacuum tube is to your home radio. The same microphone restyled and redesigned progressively has met the wanted need of a rugged hand held microphone. The Handi-Mikes are now available in both carbon and dynamic microphones with a variety of switches and circuits from which to choose.

UNIVERSAL MICROPHONE COMPANY
INGLEWOOD, CALIFORNIA

REPRESENTATIVES: New York, Chicago, Kansas City, Cleveland, Boston, Tampa, Houston, Philadelphia, Detroit, Seattle, St. Paul, Salt Lake, Los Angeles, San Francisco, and Asheville.

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FROM COMPONENT...TO COMPLETE STATION

A vital link in a long chain of equipment . . . from microphone to antenna . . . the lead-in cable plays an important part in dependability of operation.

Federal's Intelin Cables *are* dependable. They've proved that in broadcast and military installations all over the world . . . standing up under severe operating conditions . . . in all kinds of climate.

And that's typical of *all* Federal broadcast equipment. From lead-in cable to complete station, it has earned a reputation for *performance* because it's *built to stay on the air.*

Amplitude Modulation, Frequency Modulation, and Television . . . for quality, efficiency, dependability . . . look to Federal for the finest in broadcast equipment.

FEDERAL TELEPHONE & RADIO FTR

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark 1, N. J.

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SIMPLE—ISN'T IT?

—yet, sealed for all time!

MARION

Glass-to-Metal Truly Hermetically Sealed 2½" and 3½" Electrical Indicating Instruments

A One-piece drawn steel cup-shaped case with high frequency induction soldered Kovar glass bead terminals. Black phosphate finished to meet 200 hour salt spray test.

B Marion Alnico magnet and moving system, with hardened beryllium copper instrument frame.

C Lithographed metal scale plate, individually printed.

D Double thickness glass window with Corning Glass Works metallized band on rim — high frequency induction soldered to steel case.

E Aluminum cover plate and flange, with anodic black satin finish.

"How is it done?" — this is the question on the tongues of hundreds of engineers from coast-to-coast. A simple basic design in conjunction with electronic production methods is the answer. And with it comes the final solution to the problem of completely tropicalizing electrical indicating instruments. There are no rubber gaskets and no cement seals. These instruments can be immersed in boiling brine or frozen in a cake of ice, for weeks, without deterioration of their seals or harm to their operating efficiency. And they are *positively* interchangeable: Type HM 2 with AWS Types MR 24 and 25 and Type HM 3 with AWS Types MR 34 and 35. Available in all DC ranges, for present or postwar applications. Write for additional information.

SPECIAL NOTE:* *Marion Glass-to-Metal Truly Hermetically Sealed Instruments cost no more than standard unsealed instruments.

MARION ELECTRICAL INSTRUMENT CO.
MANCHESTER, NEW HAMPSHIRE

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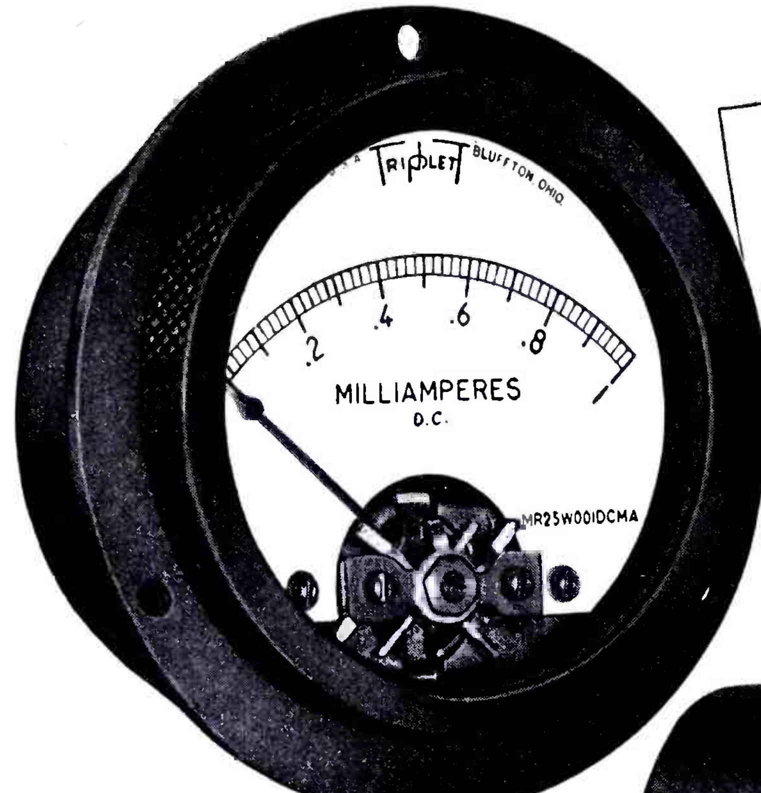
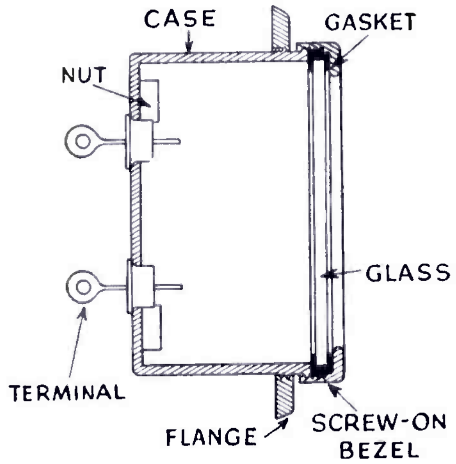
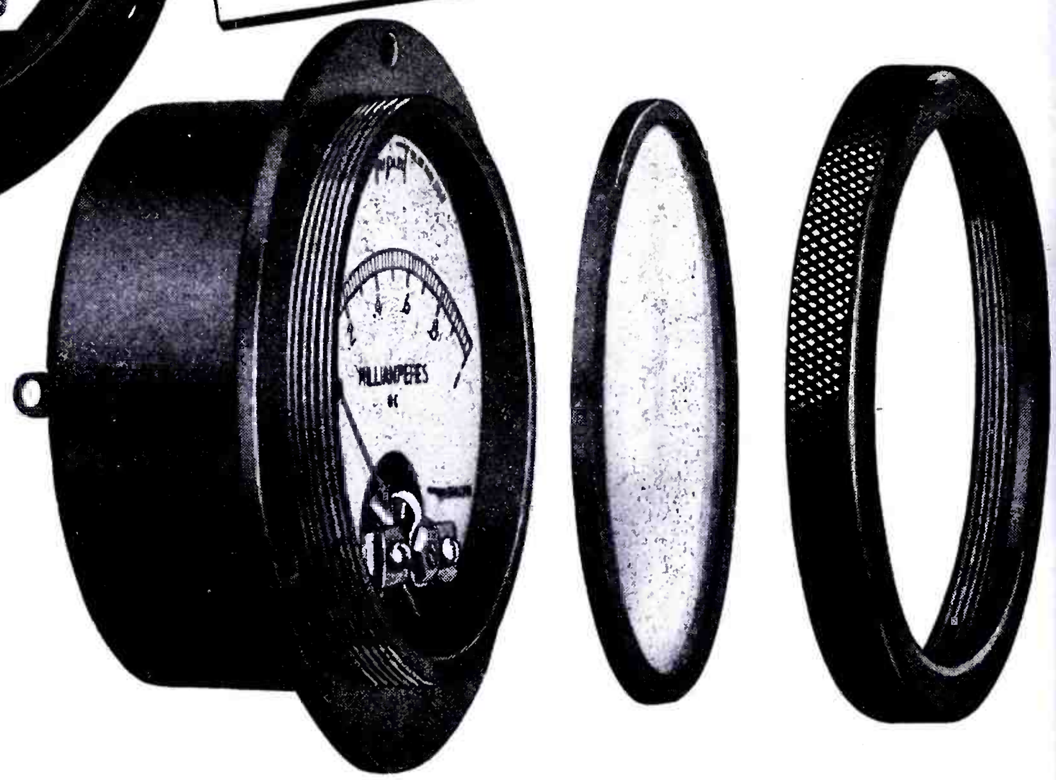


INTRODUCING THE NEW TRIPLETT LINE OF HERMETICALLY SEALED INSTRUMENTS





ALL THE FEATURES of STANDARD INSTRUMENTS RETAINED
Withstands submersion tests at 30 feet

A screw-on bezel provides uniform pressure for hermetically sealing the glass to the case. The gasket is pressed into every crevice around the edge of the glass and the top of the case, where the permanent seal is made.

Tempered glass window and ceramic sealed terminals are used.

The knurled screw type bezel permits servicing when necessary and resealing without replacing a single part or the use of special tools or equipment.

Complete dehydration of the interior is readily accomplished by recognized temperature difference method (the bezel loosely attached for the escape of all moisture, after which the bezel is tightened to make the permanent seal). Interior is completely dry at slightly above atmospheric pressure.

These instruments comply with thermal shock, pressure and vibration tests. They also are resistant to corrosion. Instruments conform to S.C. No. 71-3159 and A.W.S. C-39.2-1944 specifications.

Furnished in 1½", 2½" and 3½" metal cases with 1/16" thick walls, in standard ranges. D.C. moving coil, A.C. moving iron and thermocouple types.

Write for circular

Precision first ... to last

STANDARDS ARE SET BY TRIPLETT

Triplett

ELECTRICAL INSTRUMENT CO. BLUFFTON, OHIO

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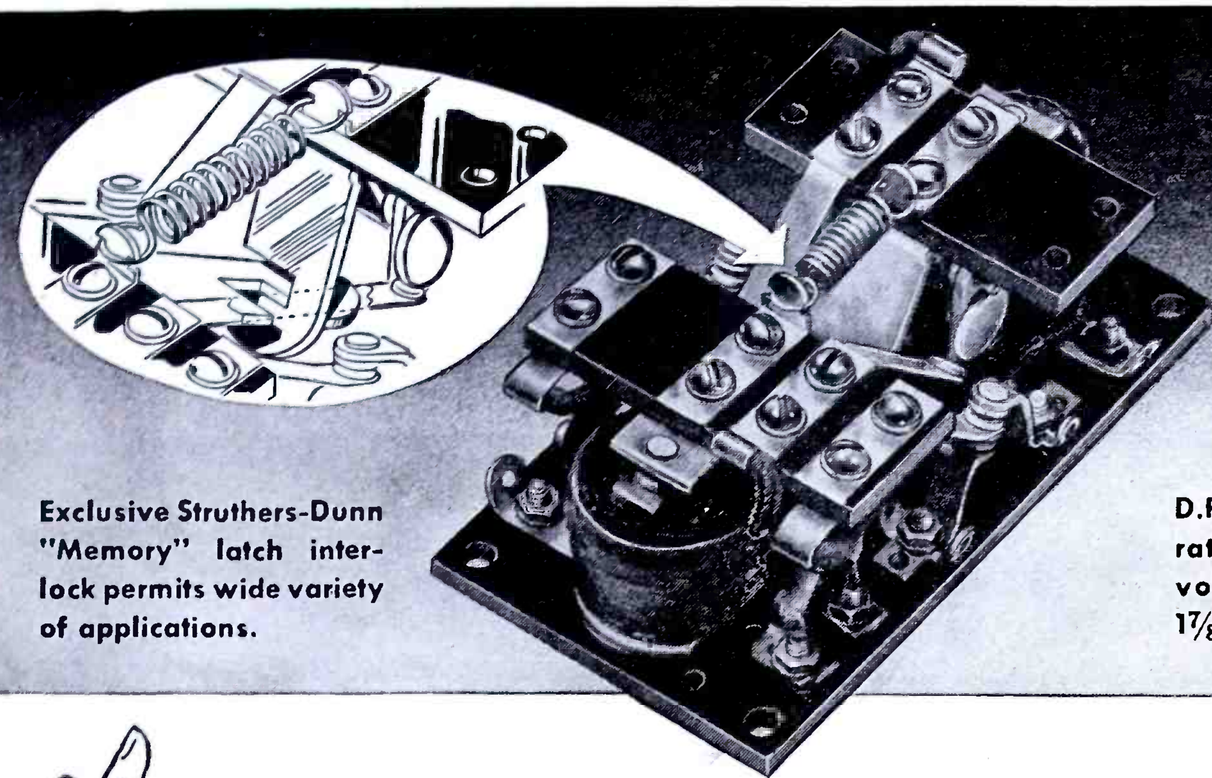

Exclusive Struthers-Dunn "Memory" latch interlock permits wide variety of applications.

TYPE 50XBX103

D.P. D.T. main contacts, rated 6 amps. at 24 volts DC. 3 7/16" long; 1 7/8" high; 1 5/8" wide.

A New Struthers-Dunn
"MEMORY" RELAY SERIES

Simplified Interlock—Symmetrical Design

Sturdily constructed to aviation specifications, and of immensely simplified design, Series 50XBX 2-coil Relays are an important addition to the well-known line of Struthers-Dunn "Memory" types. A new style positive interlock between the two symmetrical operating elements represents latch-in relay construction in its simplest, most dependable form. This latch requires no extraneous parts other than integral extensions of the sturdy coil "armatures" themselves. It operates positively from a momentary impulse and a minimum of power. Application of power to one coil latches the contacts into one position. Power then applied to the other coil throws the contacts into a latched-in second position. A third "unlatched" position, valuable for certain applications, can be obtained by energizing both coils simultaneously.

The 50XBX design makes it easy to obtain make-before-break, or break-before-make contact combinations. Contacts do not interrupt the coil circuit until the "throw" is entirely completed and contacts are locked in the new position.

Struthers-Dunn Memory Relays of this general type are produced in ratings from 6 to 200 amperes or more, and with practically any desired contact arrangement. Standard types provide for two auxiliary contacts, one in each coil circuit. The use of auxiliary contacts makes it possible to obtain operation over an extremely wide range of voltages, a-c or d-c.

STRUTHERS-DUNN, INC., 1321 Arch Street, Philadelphia 7, Pa.

STRUTHERS-DUNN
5,288 RELAY TYPES

STRICT ENGINEERING OFFICES: ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DALLAS • DENVER • DETROIT • HARTFORD
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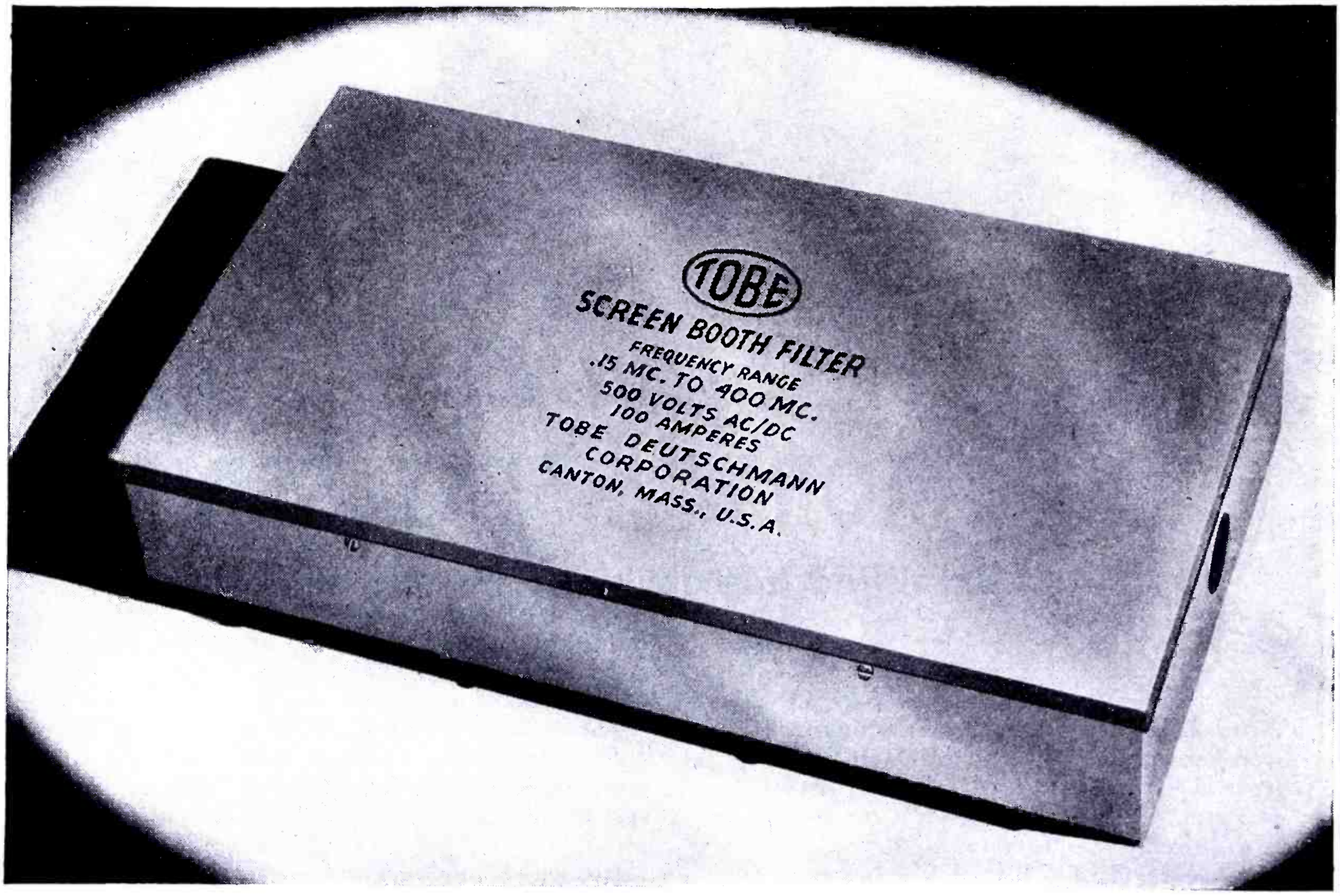
AWAY AHEAD!

TOBE LEADS IN NOISE ELIMINATION



NEW SCREEN BOOTH FILTER

HERE is more evidence of Tobe's Leadership in the noise elimination field. This remarkable SCREEN BOOTH FILTER is designed for use in laboratory testing rooms, including those already shielded to prevent outside electrical interference. It is attached to the power line at the point of entrance into the booth, and is designed to eliminate troublesome interference which might upset vital testing work. *Note the exceptional frequency range,* from .15 MC to 400 MC.

CONTAINER DIMENSIONS

Length	20 1/16"	Height	4 1/8"
Width	7 15/16"	Weight	35 lbs.

Whenever your problem is connected with eliminating electrical interference, the name to remember is . . . TOBE! We have a great inventory of knowledge on this subject, backed by 17 years' experience. Your inquiries are welcome at any of our offices. Investigate the applications you can make of TOBE Filters, including the unusual SCREEN BOOTH FILTER described on this page.

TOBE DEUTSCHMANN CORP., CANTON, MASS.

SUPPRESS MAN-MADE RADIO STATIC
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FILTERIZED

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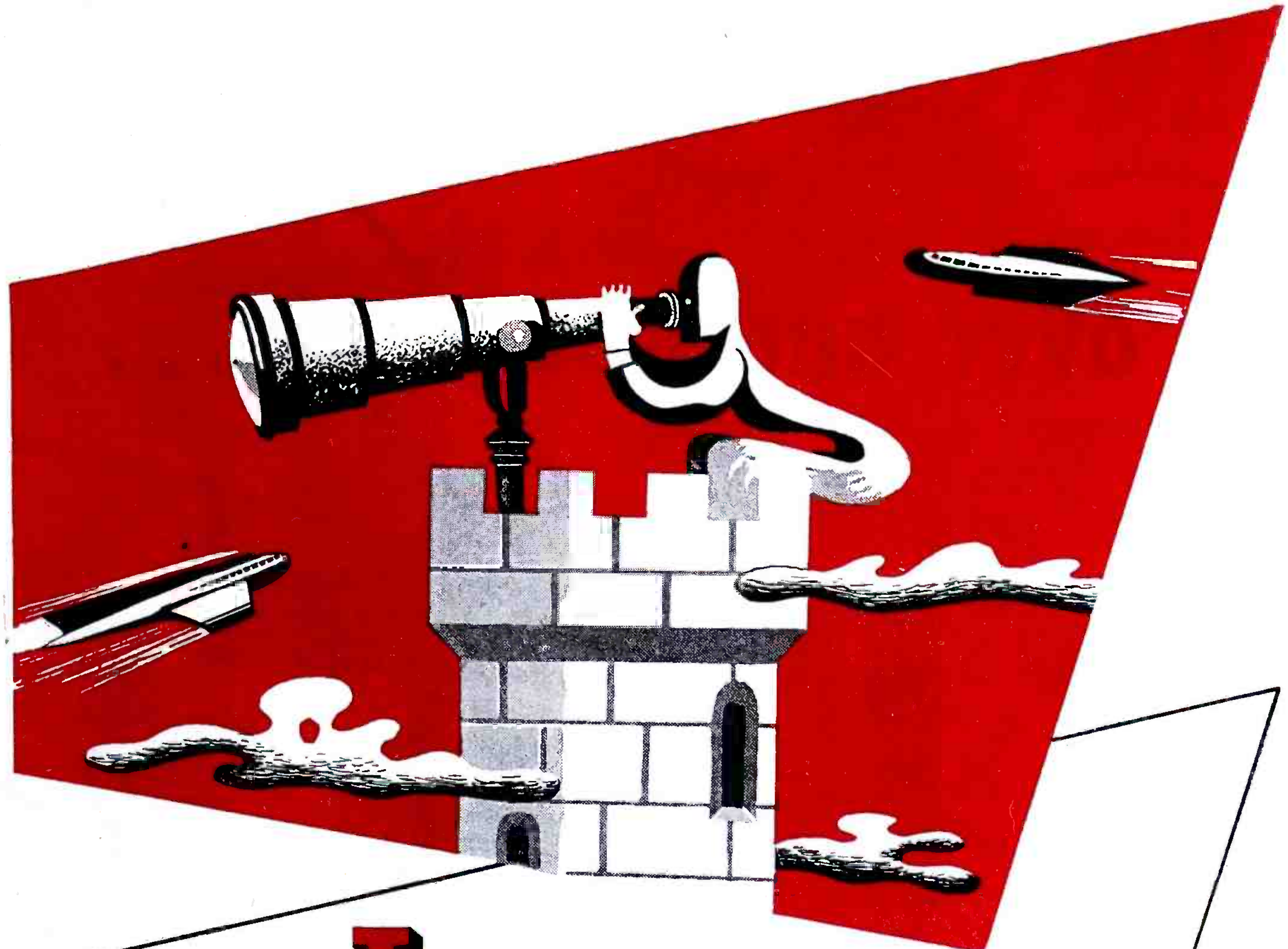

I vory tower . . . with a view!

Aireon engineers are not in any sense prima donnas. But we *do* provide them with the sort of seclusion that promotes constructive thinking...an isolated building of 22,000 square feet, equipped with the latest and finest scientific apparatus, given over exclusively to research and development. A place where you can hear a kitten pound its feet. This partly accounts for the fact that, of twenty-eight *major* electronic products, turned out by our Electronic Division, *twenty-four* were largely designed from the ground up and converted into production realities by **Aireon** engineers. The regenerative force of research is responsible for the steady progress of **Aireon** in the electronics field. Supporting it are manufacturing facilities groomed for the mass production of precision products. Our executives are ready to discuss your plans for today and tomorrow—our engineers and plants to carry them out. A call to any one of our offices will bring results.

Aireon MANUFACTURING CORPORATION

Formerly *AIRCRAFT ACCESSORIES CORPORATION*

Radio and Electronics • Engineered Power Controls

NEW YORK • CHICAGO • KANSAS CITY • BURBANK

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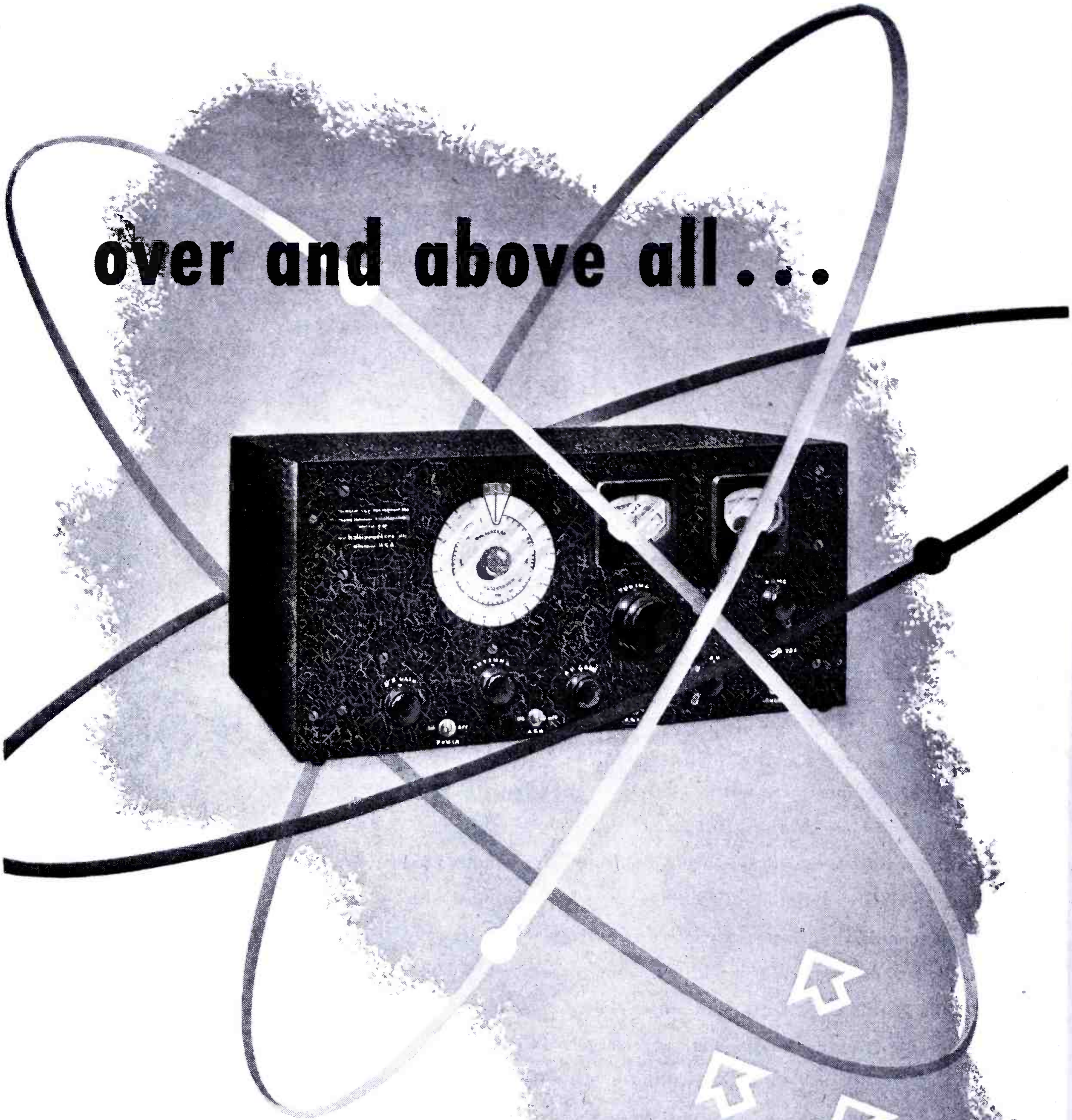
over and above all . . .



For very high frequency work . . .

Hallicrafters S-37 stands over and above all. Providing both AM and FM reception on all frequencies from 130 to 210 Mc., it covers a higher range than is available in any other commercially built receiver. The development is typical of the ingenuity and resourcefulness that Hallicrafters bring to the ever-new problems in electronics and communications. Forward looking technicians in these fields must look to Hallicrafters for instruments that will chart the new directions.

Model S-37 . . . The highest frequency range of any continuous tuning commercial type receiver.

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Buy a War ARMY E NAVY *Bond Today!*

hallicrafters RADIO

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

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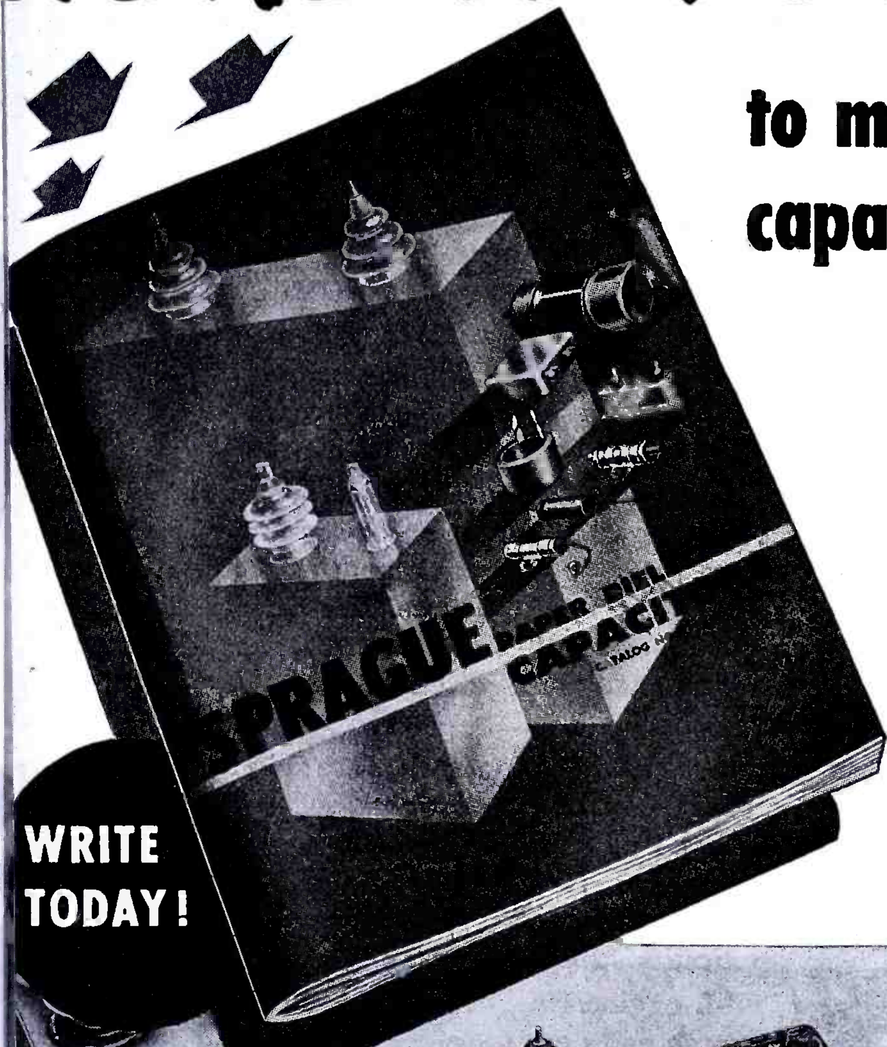
HERE IS YOUR GUIDE

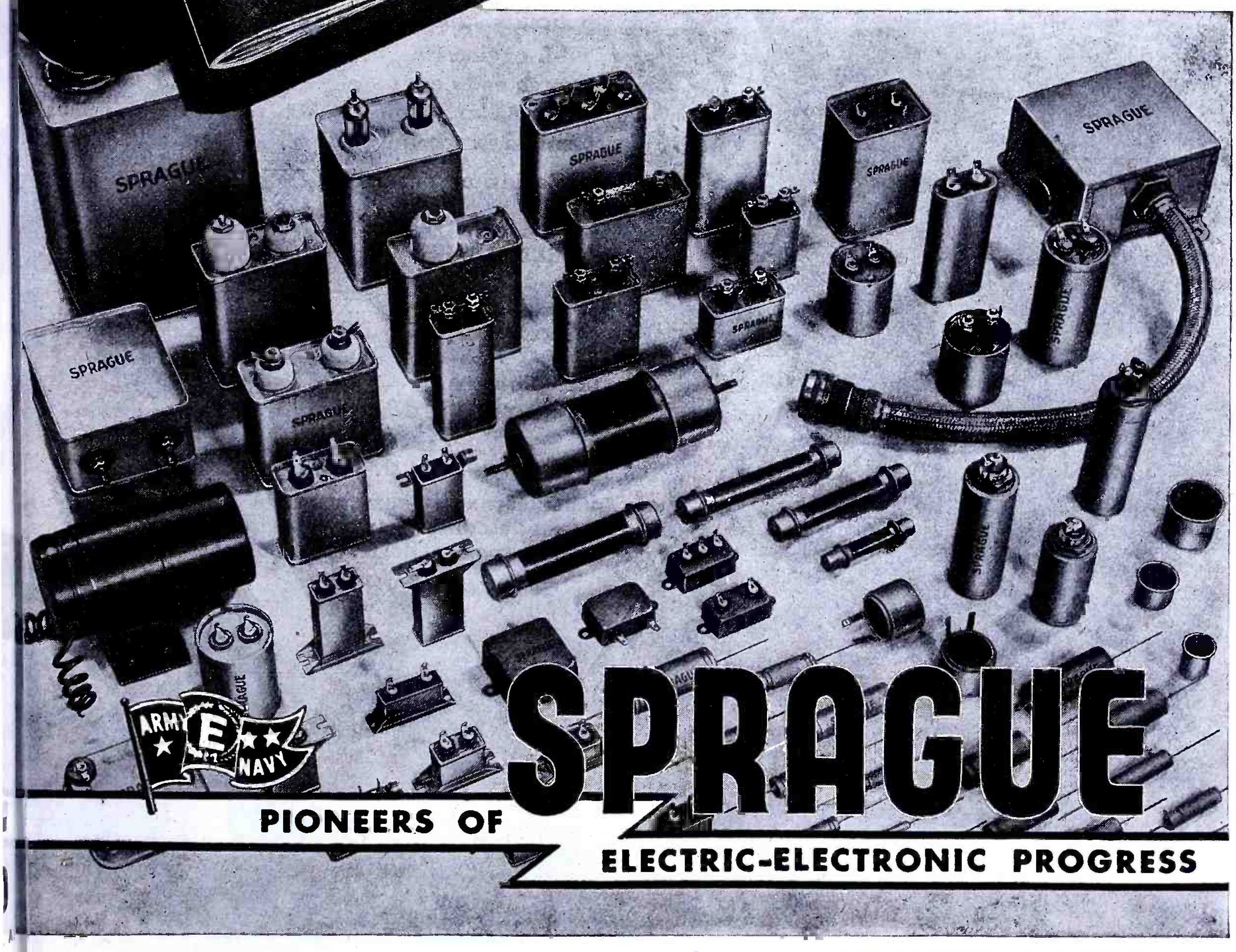
to modern paper dielectric capacitor selection and use



Months of painstaking work have gone into making this 56-page Sprague Catalog a complete guide to the design and engineering possibilities inherent in today's greatly enlarged line of Sprague Paper Dielectric Capacitors in hundreds of standard and special sizes and types.

Write for your copy today. You'll find it unsurpassed as a guide to the exact matching of up-to-the-minute Capacitor requirements!

SPRAGUE ELECTRIC CO.
North Adams, Massachusetts



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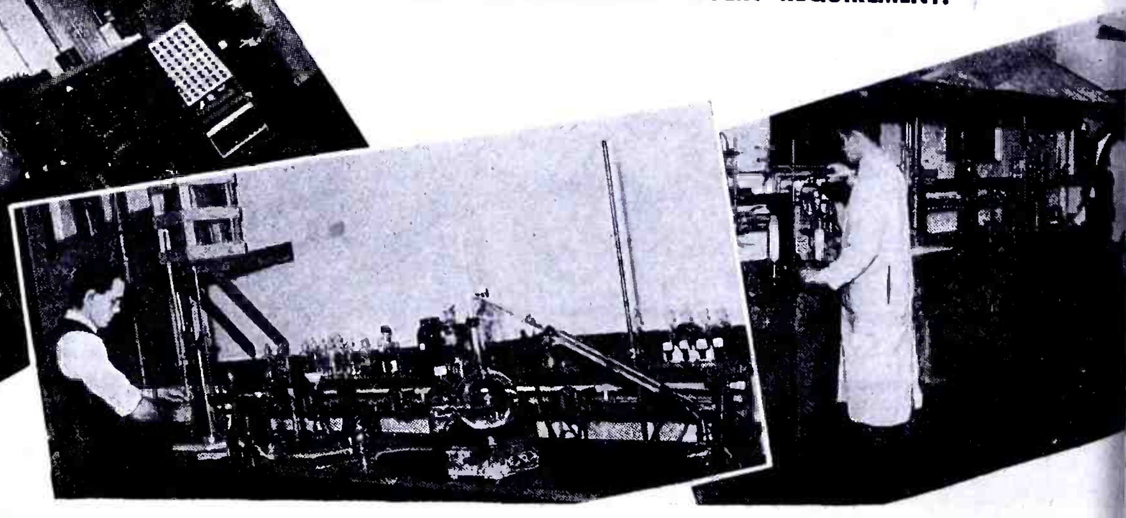

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ble high vacuum is essential to the ction of an electron tube if it is to uniform, predictable performance. But is much more to the process of getting uum than just pumping.

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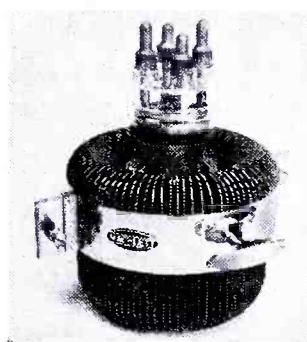

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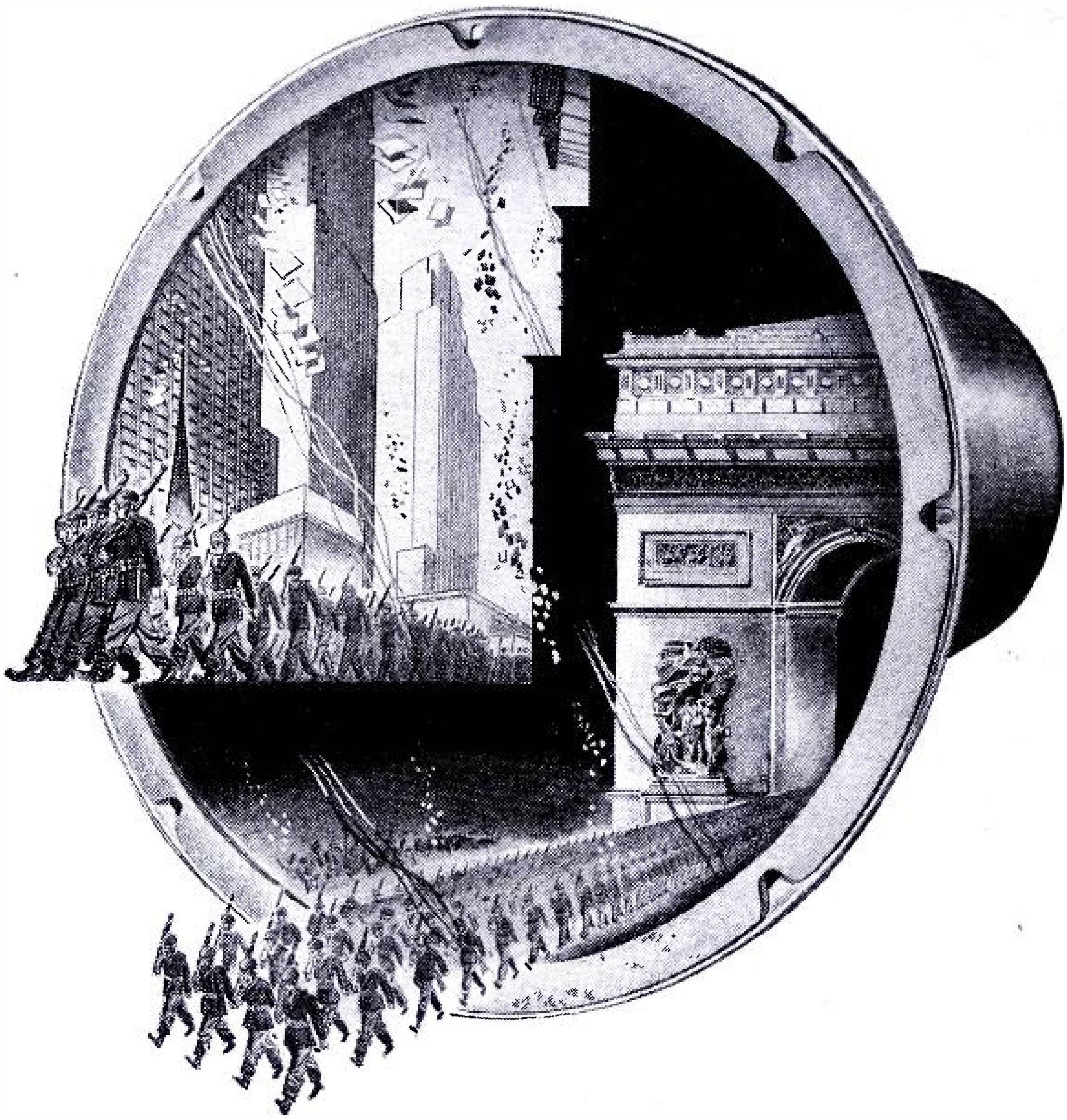

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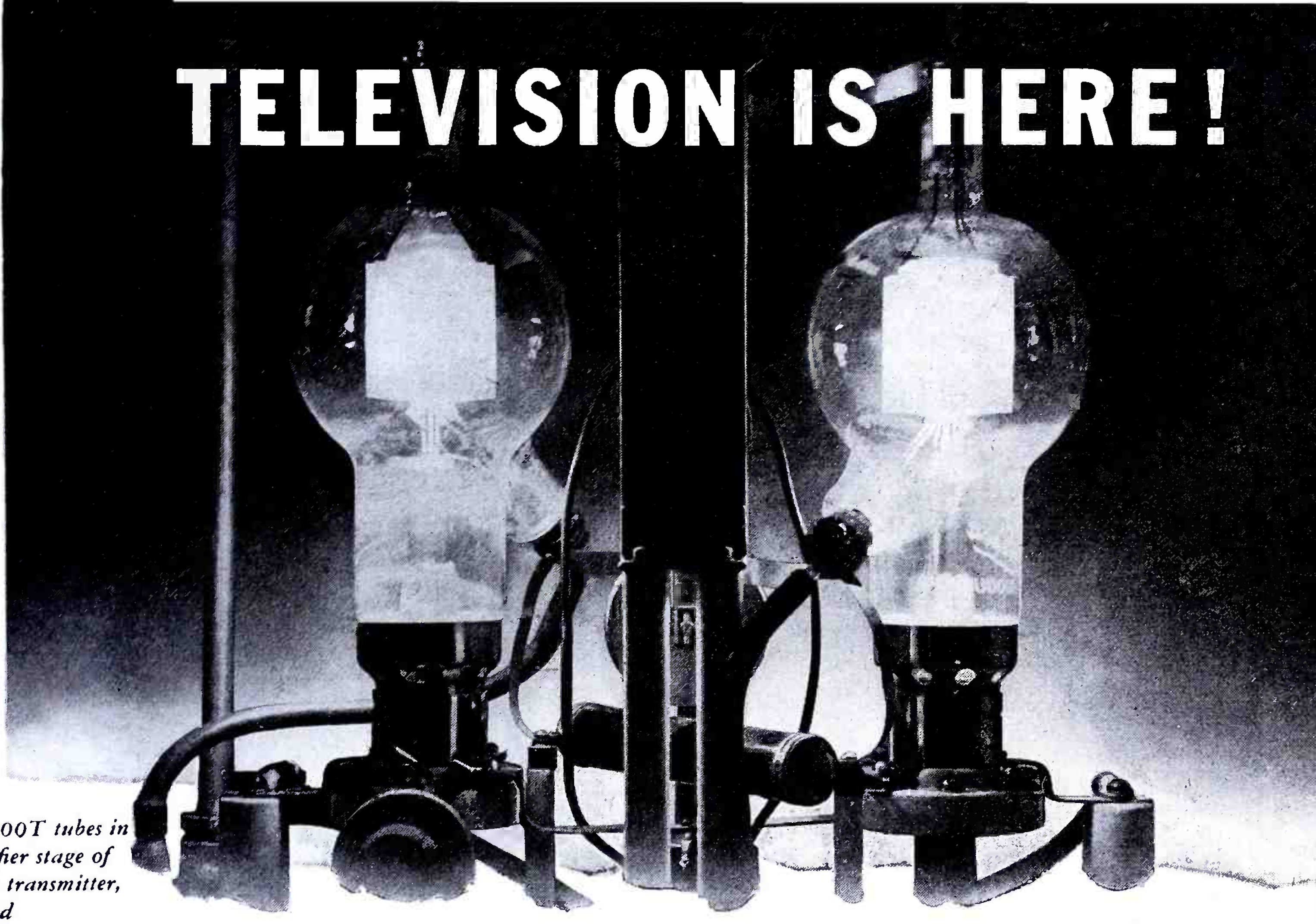

Eimac 1000T tubes in an amplifier stage of W6XAO transmitter, Hollywood

At Don Lee Hollywood... Station KTSL using EIMAC TUBES *since* 1938

'ulia Lee Wright, noted Home Economics)irector of "The Family Circle" magazine eing interviewed, and telecast revealing ricks of her trade.

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Work on television station W6XAO (Commercial station KTSL) began in November 1930; and thirteen months later, Dec. 23, 1931, it was on the air on the ultra high frequencies, the first present day television to operate on schedule. Today the station occupies elaborate copper sheathed studios which stand 1700 feet above Hollywood with an antenna on a 300-foot tower.

The program log shows almost every type of presentation. Highest in interest and achievement are the remote pick-ups and special event broadcasts made simultaneously or recorded on film for release later. Studio presentations, especially those directed to war activities, have become a duration standard.

Under the direction of Harry R. Lubcke, television station KTSL will be in daily schedule immediately after the war. Mr. Lubcke says: "We have been using Eimac tubes in our television transmitter since about 1938 . . . We have found them good and reliable performers . . . their design is such that a favorable ratio of power output to tube and circuit capacitance is obtained . . . we look forward to using new Eimac tubes which may be forthcoming."

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COMMUNICATIONS

LEWIS WINNER, Editor

* * MAY, 1945 * *

Typical communications-equipped power company service truck.

COMMUNICATIONS' ROLE IN ELECTRIC UTILITY SYSTEMS

by S. J. COMBS

Communications Engineer
RCA Victor Division, RCA

THE furnishing of electrical energy for the production of heat, light, and power is appropriately termed a *public* utility. Few services contribute so greatly and intimately to the necessities, safety, comforts, entertainment, and general welfare of the average person.

Thus the management, engineering staff, operating personnel, and maintenance crews of an *electric utility* have a tremendous responsibility toward their customers and the public in maintaining a continuous supply of electric power. Any interruption of power results not only in loss of productive capacity, inconvenience, and dangers to life and property for the consumers but also entails extraordinary expense, inconvenience, and loss of revenue and prestige for the *utility* itself.

It is therefore important to utilize a communications system that will facilitate operation and maintenance. The extensiveness of such a system increases in proportion to the complexity of the power circuits and size of the geographical area covered.

In recent years electric service has expanded in rural and less thickly populated areas. Industry has also become more decentralized, requiring the

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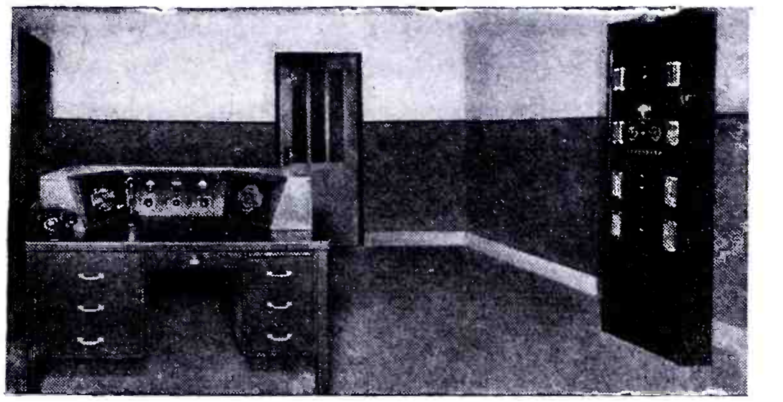

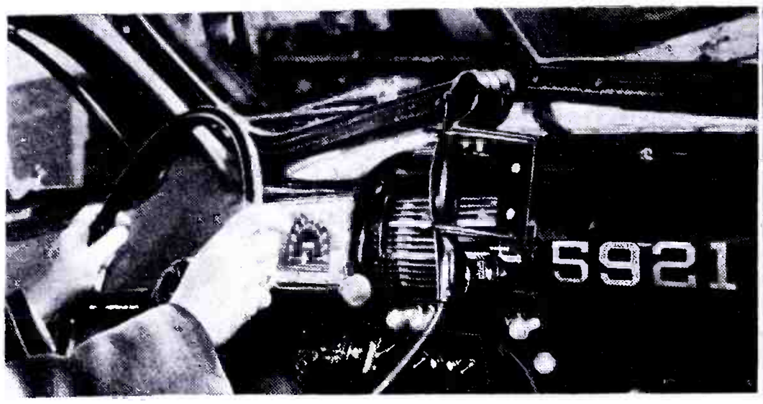

Left, fixed station, with necessary receivers, microphone, measuring unit, transmitter controls, etc. At right, loudspeaker, microphone and control equipment in power service patrol car.

expansion of electric power lines to fulfill its needs. As separate systems expanded to occupy and serve contiguous and sometimes overlapping territories, inter-connections were made between the different systems to achieve greater reliability and efficiency of operation.

The load on the communication facilities of a modern electric utility operating over large territories, serving millions of consumers, utilizing billions of dollars worth of equipment, and interconnecting with other systems, is multiplied many times over the requirements of a simple system. It was early realized that reliable communications should be maintained over such an extensive area only through the medium of radio. Other media of communication which depend upon land lines or the power lines themselves are subject to frequent interruption by storms, lightning, hurricanes, earthquakes, floods, and other such disturbances at the very times when reliable communications are most urgently needed. Wired communications are also subject to disruption due to less publicized causes (but well known to the electrical maintenance engineer) such as icing conditions, felling of trees across lines, vehicles hitting poles, malicious damage, negligence of other construction crews, short circuits, and ordinary *wear and tear*. The station radio equipment itself is made entirely independent of land lines and outside power sources through the provision of emergency power supplies consisting of gas-driven generators or storage batteries with converters. Electric power lines often traverse remote, scarcely accessible regions where wired communication facilities do not exist or are not practical to erect; in such situations portable-mobile radio is the only feasible means of communication.

Radio in one form or another has been used by the electric utilities for over twenty years and early passed from the experimental stage to become an established service. Operations from coast to coast in all types of climate (hot, cold, dry, humid) and over varied terrain (flat, rolling, hilly, mountainous, wooded, prairie) have proved highly successful. This adaptability to local conditions is accomplished by proper choice of frequencies which have been, and will continue to be, available.

At first only two channels near 3,000 kc were available in this country, but in 1936 representatives of the electric utilities appealed to the FCC, and on the basis of demonstrated need were authorized to share seventeen special emergency channels with other utilities. As of September 1944, there were over 750 stations being operated by approximately 50 electric utility companies. A further appeal was presented to the FCC at the allocations hearings during September-October 1944. The Commission released a proposal[1] allocating fifteen channels between 25 mc and 42 mc and five channels between 156 mc and 162 mc for the exclusive use of the power utilities (electric, gas, water, and steam). Allocations in the 10-kc to 25-mc band, scheduled for early release,[1] will undoubtedly include additional frequencies.

Initial use of radio by the electric utilities involved point-to-point communications between fixed locations; headquarters control, hydro plants, sub-stations, distribution and switching centers, etc. Mobile units in the form of service trucks and inspectors' cars were then equipped with transmitting and receiving equipment which enabled them to carry on two-way communications with the fixed locations and in some instances with one another. The value of *three-way* communications of this type can be readily appreciated in the coordination of operational functions.

Amateur radio operators, or *hams*, have received wide publicity by often providing a community or whole area isolated by flood, hurricane, earthquake, storm, or other catastrophe with the only means of communications with the outside world, sending out information regarding the stricken region and directing relief and rescue operations. Electric utilities have found radio to be of comparable benefit in similar emergencies. Additionally, the mobile units (otherwise entirely out of communication with headquarters, except for the possibility of finding a telephone) are instantly in touch with headquarters if the units are provided with radio. Crews of expertly trained men with their trucks and equipment are immediately available when most needed and can be placed *at the right place at the right time*.

On a typical field emergency, incomplete information is usually received via telephone from someone near the scene. A repair crew with truck must be located and dispatched. Provision for immediate availability of emergency crews may necessitate retention of one or more crews near headquarters at all times, as experience has shown that trouble may develop at several points during a storm or other wide-spread disturbance. The crew arrives at the scene, appraises the situation, and invariably will need to contact headquarters for additional help, materials, switching of circuits, etc. The public must be protected from live wires, poles must be removed from traffic lanes, and, of course, electric service must be restored with a minimum of delay. Valuable time is consumed in hunting telephones and dispatching messengers to attain the necessary coordination with headquarters and other crews.

Radio-equipped service trucks and other mobile units may be kept in active service at all times yet remain instantly available for emergency assignments. Communications directly between crews in trouble-shooting or switching long lines is of utmost value. Abnormal conditions, which if not corrected, may result in serious emergencies, can be quickly investigated and corrected. Better coordination is provided to prevent improper energizing of power circuits with probable injury to personnel.

To illustrate the frequent and almost constant use of radio facilities, a summary of some of the cases that occurred on the system of an electric

[1]See p. 2, this issue, for final report data.

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power company operating in a typical area are offered. During eight months of 1944, 524 emergency cases occurred which involved services to important consumers or hazards to the public. In all of these cases, radio communication was of great advantage in restoring service and protecting the public. In 158 cases, service to war industries was interrupted. There were 90 instances during which high-voltage wires were down and endangered public life and property, and 86 instances where wires interfered with fire department operations. Sixty-four emergencies were occasioned by poles being broken off by vehicles. In 12 cases broken wires interrupted service to large areas. Power to public water and sewer pumps was interrupted on three occasions. There was one interruption of service to a hospital and 110 miscellaneous cases of a more local nature, but still very important to the consumers involved. The foregoing occurrences are practically routine in the operation of the average company and do not include results of major disturbances like floods, hurricanes, etc.

To the writer's knowledge, every electric utility that has had experience with radio communications in any form has considered the investment technically and economically sound.

Under rules and regulations applicable to *Special Emergency Service,* the use of radio has been restricted to *an emergency jeopardizing life, public safety, or important property.* It is now apparent that the use of radio by electric utilities will be permitted on all operations essential to the rendition of efficient service and will not be limited to so-called *emergency* cases. A word of caution is in order as only essential communications pertaining to the conduct of the electric system will ever be tolerated at any time. However, such relaxation will permit use of radio in performing preventive functions through a more efficient routine inspection and maintenance schedule leading to the correction of abnormal conditions prior to the eventual emergency.

Without waiting for relaxation of operating regulations, the electric utilities, based upon their own experience, have positively indicated that their use of radio communications will be tremendously expanded as soon as materials and manpower are released for the purpose, upon the conclusion of the war. Testimony has been presented to the FCC indicating an increase of 800 per cent in the installation of radio transmitting and receiving equipment within the next five years. These units will be installed in fixed locations, maintenance and repair trucks, cars operated by inspectors, meter readers, and supervising officials, airplanes, and helicopters. Portable equipment will be carried by individuals and crews on foot.

The war has speeded development and application of relay, portable, walkie-talkie, and handie-talkie equipments, and has furthered the investigation of the higher reaches of the frequency spectrum. These and other radio services not heretofore extensively utilized by the electric utilities will be quickly adopted in the postwar period:

(1)—*Portable, walkie-talkie, and handie-talkie units.* These will prove to be of value in areas inaccessible to mobile units for the coordination of field operations through open fields, hilly country, and marsh areas. Construction crews will welcome this needed communication facility.

(2)—*Radio Relay.* Automatic, unattended relay stations will extend communications ranges and overcome *dead* spots. Extremely efficient directional antennas operating on higher frequencies will reduce power supply requirements and make such operation entirely practical and dependable.

(3)—*Remote Control.* Radio circuits will be used to control remotely located apparatus and to transmit metering and alarm signals, when other means of control and transmission are inadequate or non-existent. Thus, the conditions at remote hydro plants, substations, and switching points may be followed and controlled from headquarters by radio.

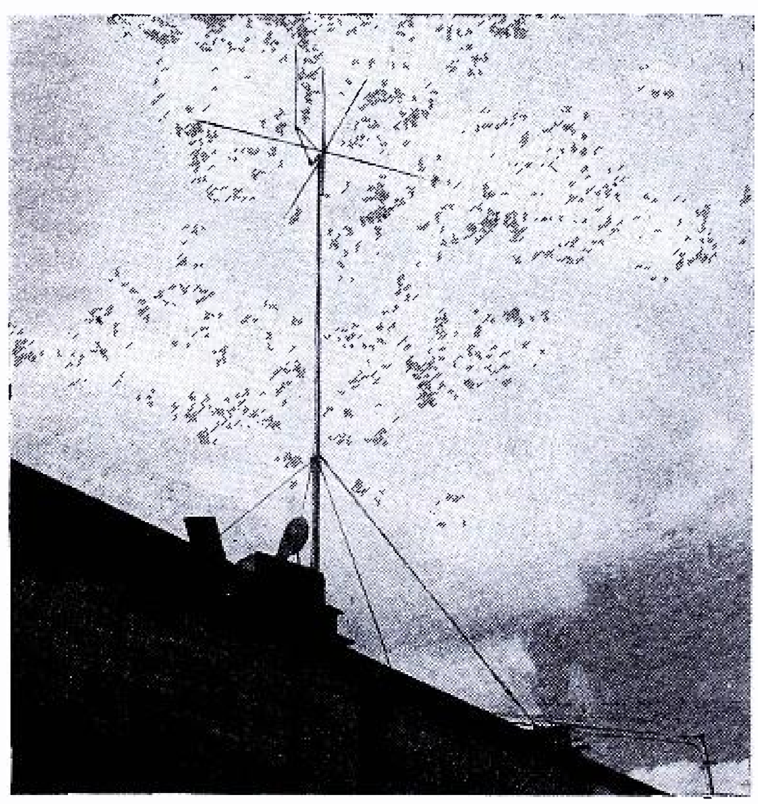
(4)—*Selective Calling.* Through the use of this device, calls or alarm signals can be transmitted to selected receivers to the exclusion of all others. The receivers may be called individually or in predetermined groups. An alarm such as a red light or horn can be actuated to demand the attention of persons in the vicinity of the receiver.

(5)—*Facsimile.* Page facsimile transmits drawings, circuit diagrams, charts, sketches, pictures, typed messages, etc., in page form. Tape facsimile accommodates plain or coded messages on a tape. The *copy* appears in written form preventing misunderstandings and misinterpretations, and may be filed for future reference. Facsimile receivers may be left unattended for reasonably long periods of time and the message will be available on the return of the employee.

(6)—*Multiplexed Circuits.* Multiplexing permits simultaneous transmission of two or more independent signals over one radio channel, thus performing more functions with a given amount of radio equipment and employing the minimum of frequency channels.

As rapidly as they are available, the above mentioned features and services can be added to a basic system consisting of fixed and mobile stations initially installed for voice or c-w transmissions only. Portable, radio relay, remote control, and multiplexing devices will undoubtedly operate on the higher frequencies only. However, these services will ordinarily supple-

(*Continued on page* 81)



Typical v-h-f antenna used in utility communication systems. A reflector is employed in this setup for beaming purposes.

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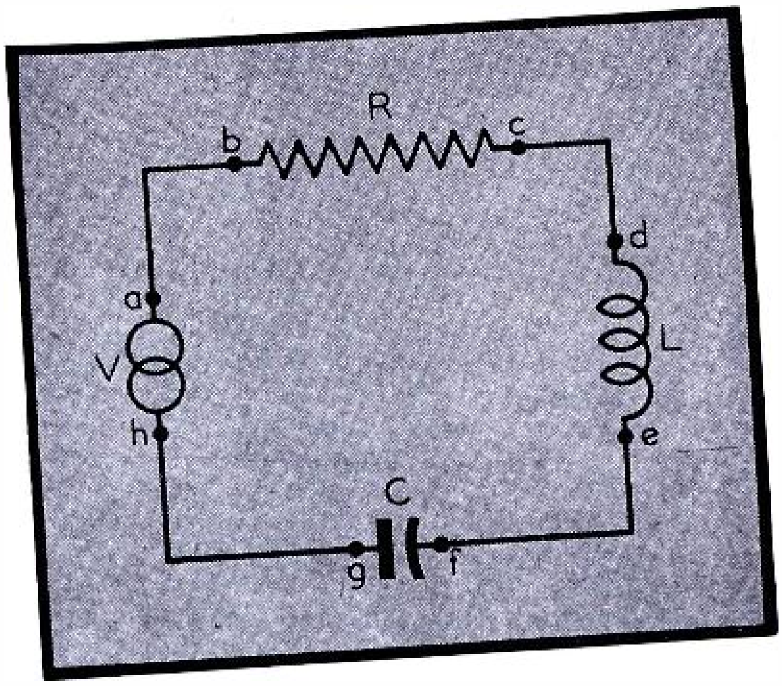

IN this paper, the authors derive the circuit equations from the general equations of Maxwell. They emphasize that the circuit equations are completely included in Maxwell's equations, but are limited in their application because of certain simplifying restrictions, which are analyzed. With these restrictions in mind, it is shown that the circuit equations are applicable at micro-wave frequencies if properly handled.

Figure 1
An electric circuit, consisting of a pure resistance *R*, pure inductance *L*, and pure capacitance *C*, connected by the leads of zero impedance.

CORRELATION OF FIELD AND CIRCUIT THEORY

by L. L. LIBBY AND N. MARCHAND

Senior Engineers
Federal Telephone and Radio Laboratories

IN this paper field and circuit theory analyses are correlated. The field theory analysis covers applications of the field equations of Maxwell to specific problems and their solutions. The circuit theory data provides solutions of problems wherein applied voltages, currents and circuit impedances are involved. For convenience only a-c solutions will be considered.

Thus, the correlation between Kirchoff's circuit equations and the following equations of Maxwell will be demonstrated:

$$\text{Curl } \mathbf{H} = \mathbf{i} + j\,\omega\, k_e\, \epsilon_o\, \mathbf{E} \qquad 1a$$

$$\text{Curl } \mathbf{E} = -j\,\omega\,\mu\,\mu_o\,\mathbf{H} \qquad 1b$$

$$\text{Divergence } (k_e\,\epsilon_o\,\mathbf{E}) = \rho \qquad 1c$$

$$\text{Divergence } (\mu\,\mu_o\,\mathbf{H}) = 0 \qquad 1d$$

where $\omega = 2\pi$ times the frequency f

- $\mathbf{H}$ = magnetic field intensity vector
- $\mathbf{E}$ = electric field intensity vector
- k_e = dielectric constant of medium relative to free space
- ϵ_o = dielectric constant of free space = 8.854×10^{-12} farad/meter
- μ = permeability of medium relative to free space
- μ_o = permeability of free space = 1.257×10^{-6} henry/meter
- ρ = electric charge volume density
- $\mathbf{i}$ = conduction current density

It can be shown that the circuit equations can be derived from the original field equations of Maxwell by making certain simplifying restrictions. However, in practical applications, it is important to know which problems require the application of Maxwell's equations for their solutions and the results that can be expected, as distinguished from problems which can be solved more readily by the direct application of the restricted circuit theory.

Scalar and Vector Potentials

The electric field intensity $\mathbf{E}$ in Maxwell's equations is the total intensity that exists at the point in question. This total intensity represents an equilibrium condition of electric forces and will be shown to be made up of the applied field from external sources and the field resulting from currents and charges in the circuit or system under consideration. The total field is related to the conduction current density $\mathbf{i}$ and the conductivity of the medium σ by Ohm's law for differential space

$$\mathbf{i} = \sigma\,\mathbf{E} \qquad 2$$

In order to obtain $\mathbf{E}$ in terms of currents and charges in a given system, it is necessary to obtain the general solution of Maxwell's equations for the electric field intensity at the point. This is best done by obtaining the solution in terms of the vector potential $\mathbf{A}$ and the scalar potential Φ where

$$\mathbf{E} = -\text{grad}\,\Phi - j\,\omega\,\mu\,\mu_o\,\mathbf{A} \qquad 3$$

This equation is obtained by applying the theorem stating that if a vector field has no divergence, that vector field is the curl of some other vector field[1]. Since $\mathbf{H}$ has no divergence there exists a vector $\mathbf{A}$ so that the curl of $\mathbf{A}$ is equal to $\mathbf{H}$. Substituting this relationship into Maxwell's equation *1b*

$$\text{Curl } \mathbf{E} = -j\,\omega\,\mu\,\mu_o\,\text{Curl } \mathbf{A} \qquad 4$$

(*Continued on page* 76)

[1]H. H. Skilling, *Fundamentals of Electric Waves*, John Wiley, 1942.

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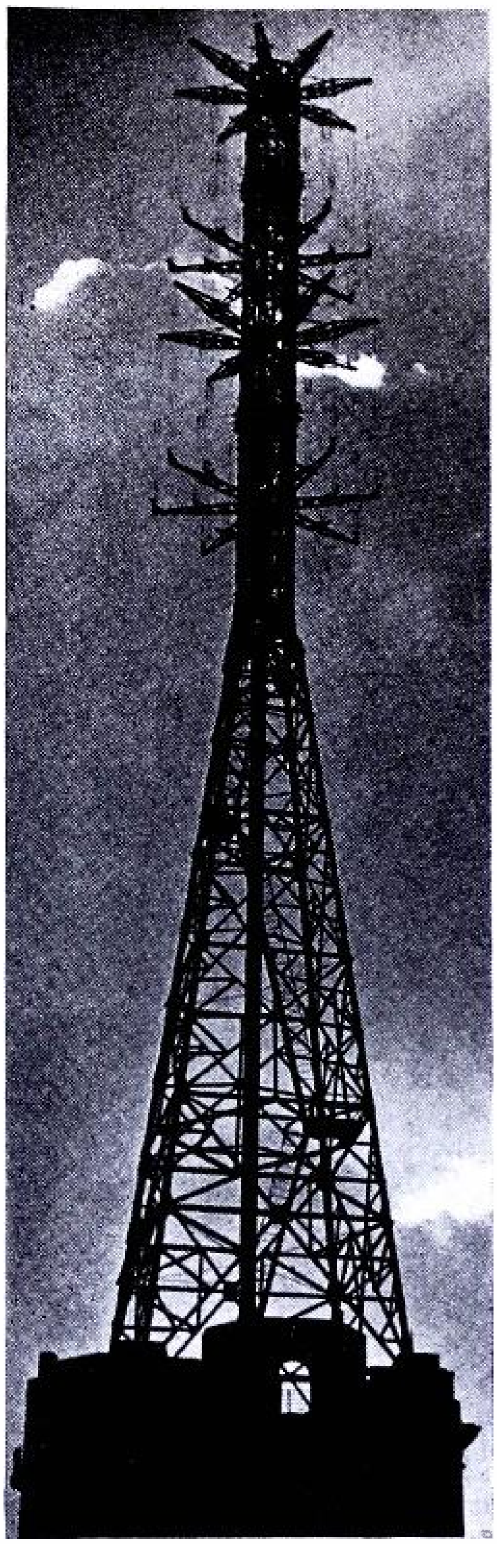


The antenna mast of the BBC television station at Alexandra palace in England.
(*Courtesy BBC*)

BRITAIN'S TELEVISION

by ALAN HUNTER
London, England

TELEVISION in Britain should start up again after the war more or less where it had to leave off. That is the first step urged by an expert committee, the Hankey Commitee, who prepared a report for the British government.

The urgent demands of war halted all organized television research in the United Kingdom.

Up to that moment British television engineers had been most active.

1939 Equipment

Prior to 1939, the London television service was radiated from the heights of a northern suburb, Alexandra Palace, with v-h-f video and audio. Video signals were transmitted on 45 mc. and the audio signals went out on 41.5 mc. For video, the peak radiation power was 17 kw; audio used 3 kw.

The Marconi-EMI system was used, and unlike the American system, emitted *positive* images.

Signals from the two transmitters were radiated from separate antennas. The video antenna was mounted above the audio system unit on a steel lattice mast, 600 feet above sea level.

The standards of picture transmission were 405 lines, 50 frames interlaced, providing 25 complete picture frames per second. Experience showed that interlaced scanning almost entirely eliminated the early film problem flicker.

The average range of the Alexandra Palace television station was found to be about 35 miles, depending on the degree of local interference.

The cameras used at Alexandra Palace were developed from the Zworykin iconoscope. For outside work a Super Emitron was used.

For inside scene work, two complete studios, similar to film studios were used. In addition, film television was also employed.

For outside activities mobile television units with three cameras were used.

These units could be linked with the main transmitter by either cable or radio. A special wide-frequency television cable was laid around the center of London to take in the West End theaters, main rail terminals, Houses of Parliament and other key points likely to be the scene of good television *shots*. An interesting development, providing for transmission over 2 to 3 miles of ordinary telephone cable, had also proved quite effective.

The mobile transmitters operated on 64 mc; power was 1 kw. Flexible antennas that could be extended to 100′ heights were used.

Interference from automobiles was the most serious limiting factor in television reception before the war; to a lesser degree, electrical machinery and medical apparatus. Accordingly the Hankey Committee has strongly urged powers for the Postmaster-General to suppress such interference.

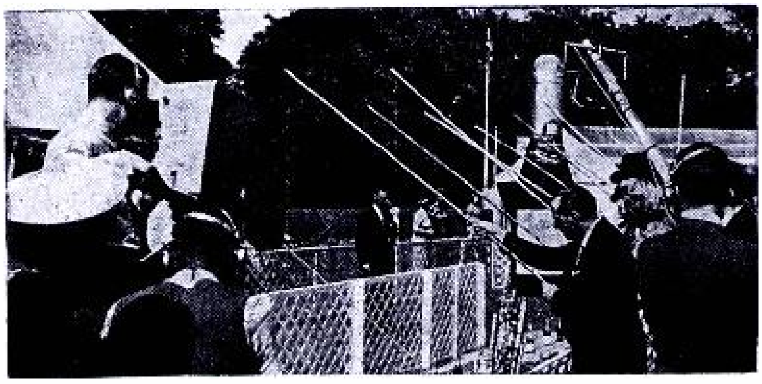
Early British Television Service

The Committee estimated that the London television service could be re-established within nine months or a year of VE day. It urged that plans be made to extend the service as soon as possible to the six largest provincial cities in the Kingdom, relaying the London program either by v-h-f radio links or by specially designed cable.

There are, of course, inherent limitations in a 405-line television system. Eventually, it is felt, television must at least approach if not equal the standard of films, with higher lineage, perhaps up to 1000 lines.

There is also every reason to expect color and sterescopic television.

Parallel with the expansion of the present 405-line system, the Hankey



Televising an English garden party with a special outdoor scene camera.
(*Courtesy BBC*)

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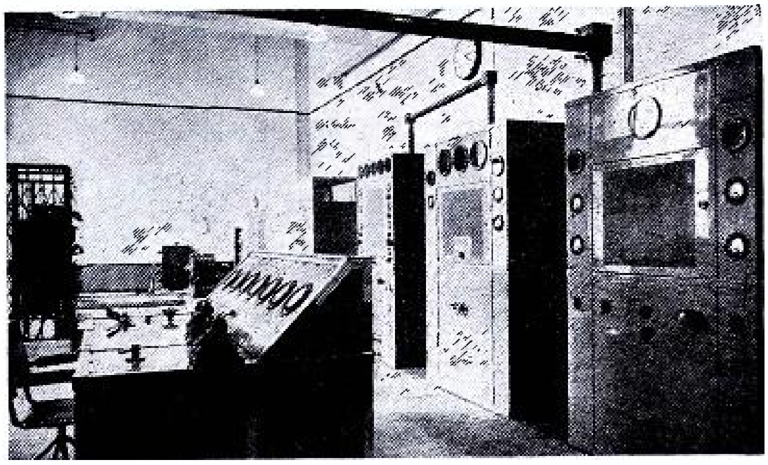
POSTWAR PLANS



Audio equipment at Alexandra palace. At left, foreground, control table; center background, drive unit and low-power h-f stage; center right, final power amplifier; right, modulator; left background, power switchboard.
(*Courtesy BBC*)

Committee urged *vigorous* research n a radically improved system of elevision, just as soon as technical taffs can be released from war jobs.

This improved system could be ransmitted side by side with the existing system, for some years at least, naking use of a common program.

If the government adopted this plan of television development, the prewar ervice could be reintroduced in a comparatively short time.

The Hankey Committee touched ightly on the postwar possibilities of elevision in the film theatres. A few heatres in London had already been wired for large-screen television when war broke out. The consensus is that ilm houses will hesitate to use television until a high-definition system has been fully developed.

The question of definition leads, inevitably, to a consideration of international standards.

Even in the infancy of the television science, variations had begun to appear. In the United States, 525-lines were used. And it appears as if this lineage will be used for a period in the postwar era, too. It would not be difficult to adjust the British prewar standards to conform to American standards, but that in itself would not make British and American television apparatus interchangeable. For one thing, the picture signals in the two systems are transmitted with opposite polarities; and then again the frequency of the electrical supply in the two countries is not the same.

But the Hankey Committee urged, nevertheless, that the ideal of international standardization of television should be kept constantly in mind. As a first step it suggested an international agreement on television frequency bands as early in the postwar period as possible.

International Problems

While many years will elapse before it may be possible to beam pictures from U. S. to England, international hookups in Europe will be possible. Relays that could link London with, say, the provincial city of Birmingham could, by the same token, link London with Paris. Thus the problem of international television standards is by no means academic.

The problem of financing television has yet to be solved. In Britain, it appears as though the early postwar years of television may be financed as before, by a treasury grant to the British Broadcasting Corporation, out of revenue from radio licenses. The Hankey Committee visualized the BBC as the operator of the television service.

The London television station before the war cost about $1,800,000 a year to run. After the war, it is estimated, this would go up to about $4,000,000 a year, rising with the expansion of the television network to something like twice that figure. This would be quite apart from a capital outlay of at least $6,000,000.

Licensing Arrangements

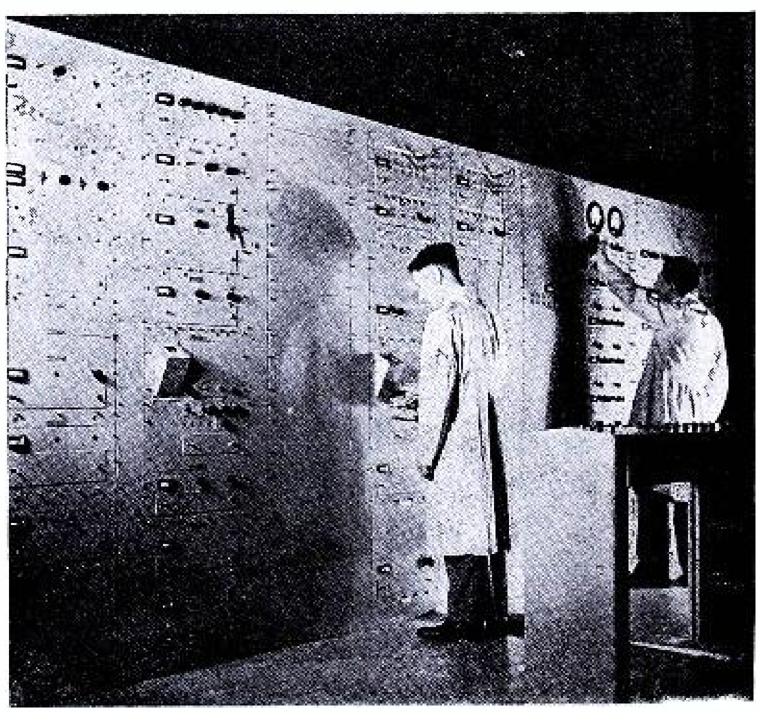
The Committee urged that British television should become self supporting as soon as possible, suggesting that set owners should pay a $4 a year license in addition to the $2 a year paid for standard broadcast service.

Whether television should eventually be financed by commercial sponsors, was not discussed by the Hankey Committee.

It is possible to be somewhat specific about the postwar prices of television receivers in Britain. It is estimated, that a receiver offering an 8″ x 10″ picture will sell for $300; a 4″ x 5″ picture model would cost $180. These were roughly the prices ruling before the war (there were incidentally about 20,000 sets in use).

Committee Membership

The Hankey committee consisted of seven members, which included: Lord Hankey (chairman); Sir Stanley Angwin, engineer-in chief, General Post Office; Sir Noel Ashbridge, deputy director-general, BBC; Sir Edward Appleton, secretary of the Department of Scientific and Industrial Research; Sir Raymond Birchall, director-general, General Post Office; Professor J. D. Cockcroft, Air Defense Research and Development Establishment, Ministry of Supply; W. J. Haley, director-general, BBC; and R. J. P. Harvey, asssistant secretary of the Treasury. W. J. Haley succeeded R. W. Foot, formerly director-general of the BBC, upon his resignation from that post.



In the Alexandra palace video control room. At right, Emitron-camera amplifiers. At left, synchronizing oscillators.
(*Courtesy BBC*)

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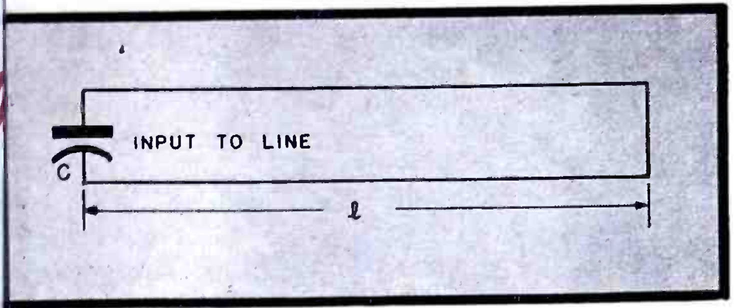
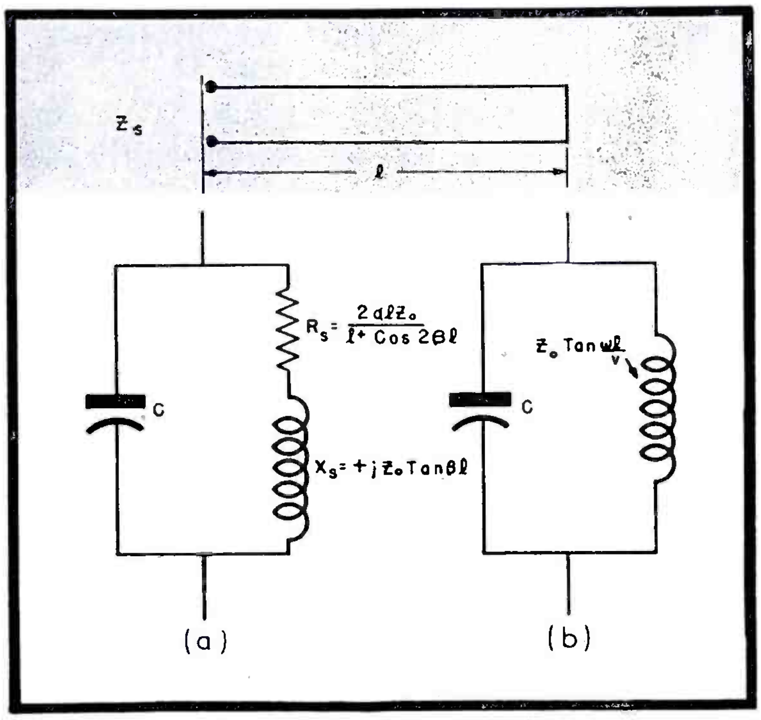


Figures 1 (left) and 2 (below)

Figure 1, transmission line shorted at the receiving end and shunted by lumped capacitance. Figure 2, equivalent circuits of line shorted at remote end, and input end shunted by lumped capacitance.



n this paper, Prof. Brown offers a raphical and practical method of de-rmining the frequency of resonant ne oscillators by approximation of mplex methods and mathematics. est data are presented to illustrate w the approximations compare with tual empirical evidence.

REQUENCY OF CAPACITANCE TUNED INES AND RESONANT LINE OSCILLATORS

by HUGH A. BROWN*

Professor of Electrical Engineering
University of Illinois

SECTIONS of transmission lines are frequently used as inductive reactances to form resonant cir-its at u-h-f. The tuning is done by rying the length of the line or by rying the value of the capacitor hich is used to shunt the line. For given shunting capacitance or a ven length of line it is ofen desirable find the resonant frequency of the e shunted by the capacitor. In the se of resonant line oscillators, the rasitic tube capacitances shunt the sonant line sections, and the problem determining the oscillator frequency · a given line length often proves to quite difficult.

apacitance Tuned Lines

Graphical Solution. An elementary conductor transmission line with its mote end short circuited, and unted by a capacitance C at the in-t end, is shown in Figure 1. As-ming that the spacing of the wires the line is small and that the re-ltant radiated field is negligible, we can express the input impedance of the line by the conventional formula

$$Z_s = Z_o \tanh(\alpha + j\beta)l \qquad 1$$

where: Z_o = characteristic impedance

α = attenuation constant, and is nearly equal to $\frac{R_1}{2Z_o}$, where R_1 is the effective resistance per unit length of line. Formulas for R_1 are found in many handbooks, and textbooks.

β = phase constant of the line and is equal to $\omega\sqrt{LC}$ to a very close approximation, where L and C are the inductance and capacitance respectively *per unit length* of line; f is the frequency. $\omega = 2\pi f$.

We regret to announce that Professor Brown died on February 25 shortly after presenting this paper for publication. Professor Brown was in charge of the radio courses in the college of engineering, at the University of Illinois.—Ed.

Transformation of *1* yields the complex form

$$Z_s = Z_o\left(\frac{\sinh 2\alpha l + j\sin 2\beta l}{\cosh 2\alpha l + \cos 2\beta l}\right) \qquad 2$$

The attenuation α is usually made low by proper design and equation *2* becomes approximately

$$Z_s \cong Z_o\left(\frac{2\alpha l + j\sin 2\beta l}{1 + \cos 2\beta l}\right) \qquad 3$$

$$\cong \frac{2\alpha l Z_o}{1 + \cos 2\beta l} + jZ_o\tan\beta l \qquad 4$$

assuming that Z_o is a pure resistance equal to $\sqrt{L/C}$.

The equivalent parallel circuit formed by the transmission line and shunting capacitance is illustrated by (a) of Figure 2. The frequency for conventional or phase resonance, i.e.,

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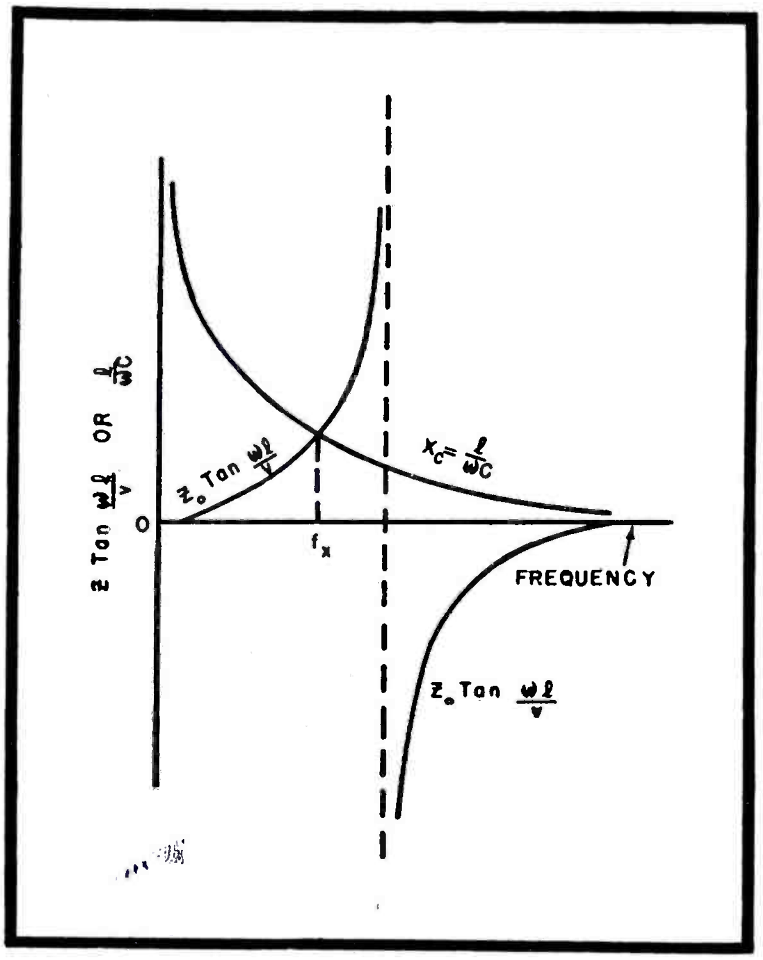
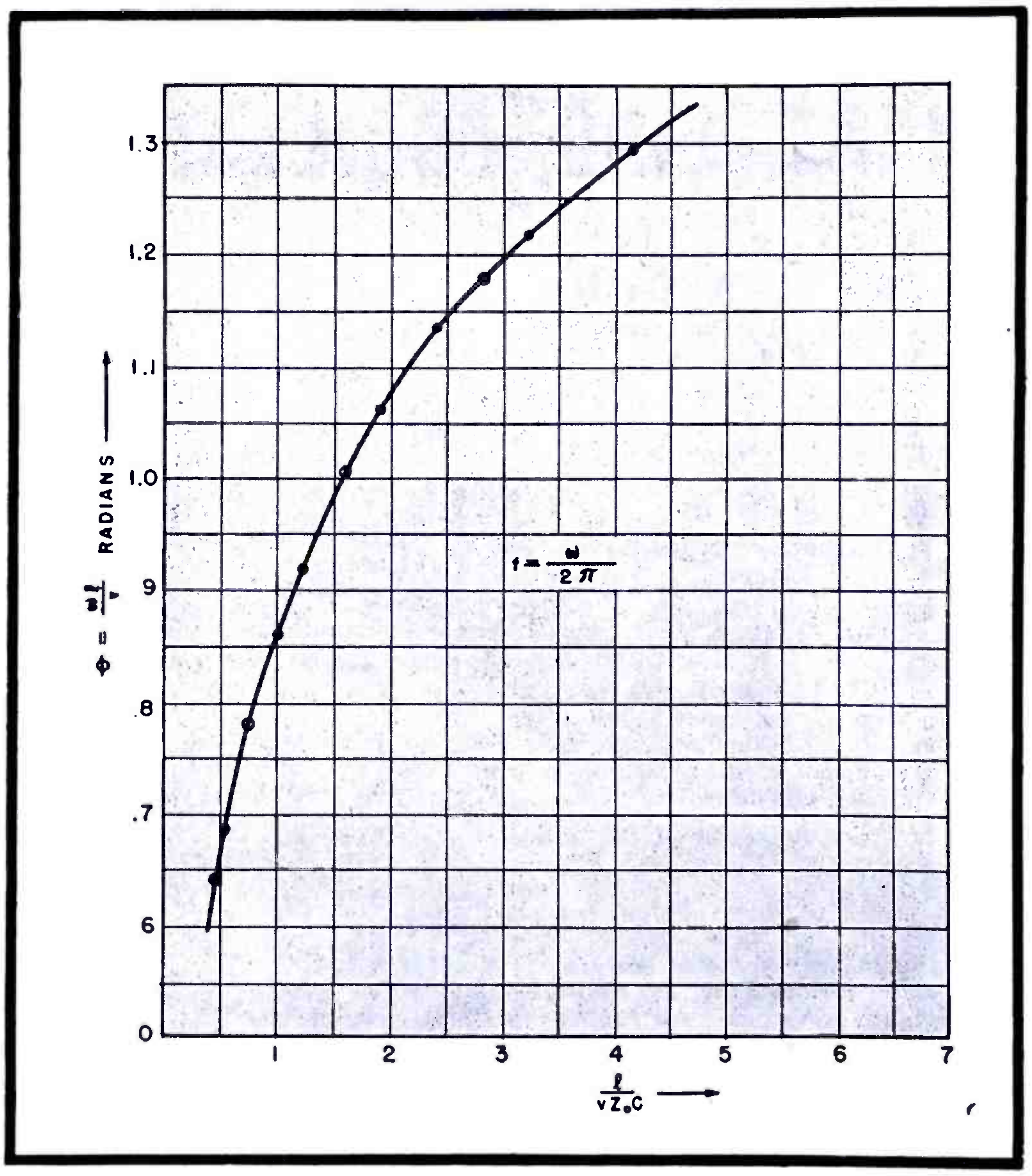


Figure 3
Graphical determination of resonant frequency of capacitance resonated line circuit.

Figure 4
Graph of equation 8 or 6 for solving capacitance resonated lines for resonant frequency when receiving end of line is shorted.



unity power factor of this type of c cuit is found in the usual manner, equating the susceptances of the t branches, and solving. But when inductive reactance, and resista have the values shown in (*a*) Figure 2, the mathematical difficult are tremendous; a rigorous solution quite impossible, and an approxima solution is also quite involved.

It is a well known fact that the of the inductive branch, formed by t shorted transmission line, who length is somewhat less than a quart wavelength, is very high. At u-h-f t Q of an open wire line with conduct spacing, which is small compared the wavelength, is far superior to t usual lumped inductance coil.[5] Wi such a high Q of the inductive branc the error made when the resistance assumed zero in finding the resona frequency is extremely small, far b low slide rule errors. Therefore w can set up the parallel circuit, shown in (*b*) of Figure 2. Fro equation 4, the input reactance to th line is, to a very close approximatio

$$X_s = + j Z_0 \tan \beta l = j Z_0 \tan (\omega l \sqrt{LC}$$

$$= + j Z_0 \tan \frac{\omega l}{v}.$$

where: $\omega = 2 \pi f$ and the phas velocity $v = \frac{1}{\sqrt{LC}}$ to a very close ap proximation when the conductor re sistance is low and radiation is negligible. In the simplified circuit of (*b*) of Figure 2 we have resonace when the reactances of the two parallel branches are equal, or

$$Z_0 \tan \frac{\omega l}{v} = \frac{1}{\omega C} \qquad 6$$

This equation cannot be directly solved for ω, or for the frequency, f. A graphical solution can, however, be used, plotting values of the left side and right side of the equation for assumed values of Z_0, C, l, and $v = 3 \times 10^{10}$ cm/sec, against varying values of frequency, as abscissae, and selecting the value of f as given by the intersection of the two curves as illustrated in Figure 3. However, this is a tedious procedure.

Let us instead substitute the series for $\tan \frac{\omega l}{v}$ in equation 6. This gives the equation

[5]L. E. Reukema, Electrical Engineering, p. 1006; Aug. 1937.

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$$\frac{1}{\omega Z_0 C} = \frac{\omega l}{v} + \frac{1}{3}\left(\frac{\omega l}{v}\right)^3 + \frac{2}{15}\left(\frac{\omega l}{v}\right)^5 + \frac{17}{315}\left(\frac{\omega l}{v}\right)^7 + \ldots \quad 7$$

where $\frac{\omega l}{v} < \frac{\pi}{2}$

Multiplying each side of *7* by $(\omega l/v)$, we have

$$\frac{l}{v Z_0 C} = \left(\frac{\omega l}{v}\right)^2 + \frac{1}{3}\left(\frac{\omega l}{v}\right)^4 + \frac{2}{15}\left(\frac{\omega l}{v}\right)^6 + \ldots \quad 8$$

For u-h-f the term $l/v Z_0 C$ will have values, usually less than 10. Also, since C is used to tune the line to resonance, the length of the line need only be always less than $\lambda/4$; λ = wavelength.

Then $\frac{\omega l}{v} < \frac{\omega \lambda}{4 v}$,

but $\frac{\omega \lambda}{4 v} = \frac{2 \pi f \lambda}{4 \lambda f} = 1.57$

or $\frac{\omega l}{v} < 1.57$

These are convenient values to plot for use in a convenient graphical solution. We can then assume a set of values for Z_0 and C, and calculate l for varying values of f, using equation *6*, and a table of tangents. With these data we can plot the curve shown in Figure 4. This is a graph of equation *8*. The independent variables, l, Z_0 and C are in the abscissa values. For any selected values of l, Z_0 and C we can find $\omega l/v$, and hence f, from this graph. As an example, let

l = 9.5 cm
Z_0 = 188 ohms
C = 2.08 mmfd
v = 3×10^{10} cm/sec

Using Figure 4, we find that $\omega l/v = 0.794$, and f = 400 megacycles. We can check this result by using the 400-mc frequency, and determining the required value of line length l by using equation *6* and the table of tangents. In fact the above given values for Z_0 and C were used in calculating the data for Figure 4. Then C was changed to 11.4 mmfd and calculations made for 4 values of f, and results were plotted on the curve sheet of Figure 4. The circled dots show that the results lie on the original curve. A typical example with check calculations will illustrate the use of the graphical method.

Assumed data

l = 100 cm
C = 25 mmfd
Z_0 = 75 ohms
v = 3×10^{10} cm/sec

$$\frac{l}{v Z_0 C} = \frac{100 \times 10^{12}}{3 \times 10^{10} \times 75 \times 25} = 1.780$$

On the curve of Figure 4 the ordinate corresponding to abscissa of 1.78 is 1.04.

Hence $\frac{\omega l}{v} = 1.04$

and $f = \frac{\omega}{2\pi} = 49.7$ megacycles

As a check on this result, we can solve equation *6* for line length l using a table of tangents, and a 49.7-mc frequency.

$$\tan \frac{\omega l}{v} = \frac{1}{\omega Z_0 C} = \frac{10^{12}}{6.28 \times 49.7 \times 10^6 \times 75 \times 25} = 1.710$$

From table of tangents of angles,

$\tan^{-1} 1.71 = 59.67° = 1.041$ radians

$\frac{\omega l}{v} = 1.041$ or

$$l = \frac{3 \times 10^{10} \times 1.041}{6.28 \times 49.7 \times 10^6} = 100 \text{ cm}$$

This checks with the assumed value of l. Even though the accuracy of the graphical method is not great, we can make two or three trials, varying l or C slightly as we desire obtaining answers from which we can extrapolate the more correct answer.

Approximate Solution with Formulas

It may be preferable, or in some cases it is more accurate, to use an approximate mathematical formula to determine the frequency of the capacitance resonated line. As previously stated, Figure 4 is a plot of equation *8*; the power series on the right side of the equation is of course convergent as long as $l/v Z_0 C$ has a finite value. If the value of this term is small, the series converges rapidly. Let us assume that it converges so rapidly that only the first two terms of the series need be used to solve for ω or f. Then equation *8* is simplified to

$$\frac{l}{v Z_0 C} = x + \frac{x^2}{3} \quad 9$$

where $x = \left(\frac{\omega l}{v}\right)^2$ *9a*

Solving the above quadratic for x, then using *9a*, we obtain

$$f = \frac{\omega}{2\pi} \cong \frac{3 \times 10^{10}}{6.28\, l}\left[\sqrt{\frac{3\, l}{(v Z_0 C)} + \frac{9}{4}} - \frac{3}{2}\right]^{1/2} \quad 10$$

with an error of less than 1.0% when $\frac{l}{v Z_0 C} < 0.56$ and an error of less than 2.0% when $l/v Z_0 C$ does not exceed 0.77. These error limits were determined by making a set of calculations of frequency, and then checking by recalculating l using equation *6*.

Another approximate solution is obtained by letting $l/v Z_0 C = w$ and $\omega l/v = x$. Then from *6*

$x \tan x = w$

and if $\tan x = y$

then $y \arctan y = w$

We can then use a power series for the arctangent and state that[1]

$$f = \frac{1}{2\pi}\sqrt{\frac{v}{Z_0 l C}}\left[1 - \frac{l}{6 v Z_0 C} + \frac{.0306\, l^2}{v^2 Z_0^2 C^2} + \ldots\right] \quad 11$$

When $\frac{l}{v Z_0 C} < 0.77$ the above formula gives negligible error and the error becomes 2% when $\frac{l}{v Z_0 C}$ = 1.25, and 4% when the latter term is increased to 2.35. Equation *11* is very useful, as it will be found that many of the u-h-f capacity-resonated transmission line tank circuits are designed so that $\frac{l}{v Z_0 C} < 1.25$. An approximate series form solution of equation *8* was developed from the series for tan x, but it does not yield as accurate a formula as that of equation *11*. Inspection of the curve of Figure 4 reveals that for values of $l/v Z_0 C$ less than 0.6, the slope of the curve becomes so steep that the

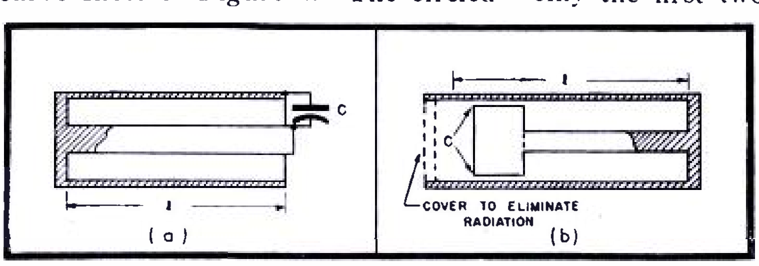

Figure 5
Concentric lines resonated by unsymmetrical capacitance (*a*), and by symmetrical capacitance (*b*).

[1]The writer is indebted to Professor W. J. Trjitzinsky of the Mathematics Department, University of Illinois, for this solution.

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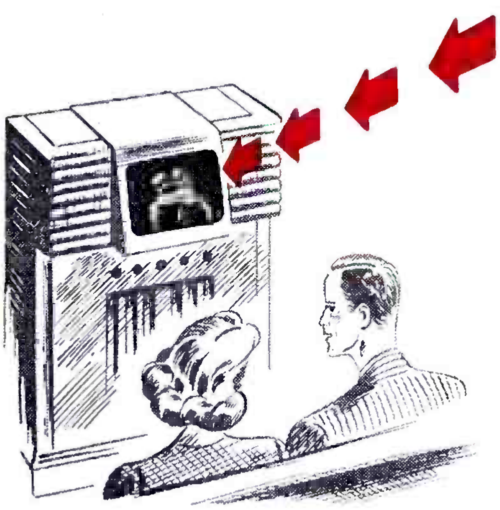

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observational error in using the curve becomes quite appreciable, and it is therefore preferable to use equations *11* or *10* for better accuracy.

Capacitance Resonated Coaxial Line

When a coaxial line is used as the inductance element of a resonant circuit we, of course, have lower attenuation and higher Q than for the 2-parallel wire open line. It is customary to use a shorted section of coaxial line, as shown in (*a*) of Figure 5.

The losses from radiation are very low. For these circuit elements the length l is less than $\lambda/4$ as in the case of the 2-wire line. The length may be made twice this value and the remote end of the coaxal tube left open, but radiation from the open end may be quite serious. Symmetry is an important factor in u-h-f transmission line circuit elements. In the case of the 2-parallel open wire type of line we can connect a small compact lumped capacitor across the open end and have a *symmetrical system*, as shown in Figure 1, assuming that the *circuit* is in free space, or that the plane of the parallel-wire line circuit element is parallel to a plane earth. If one wire of the line is closer to earth than the other, the currents in the two wires are unequal, resulting in added radiation loss. If a small capacitor is connected to the input end of a coaxial line as shown in (*a*) of Figure 5, the circuit will not be truly symmetrical, especially if the inner and outer diameters are rather large and the frequency is *very high*. The resulting dissymmetry will be due to the connections of the capacitor to almost a point location on the edges of the coaxial inner and outer metal tubes, and the currents flow from the connection points around to opposite sides of the coaxial line tubes. This may result in a noticeably different line impedance than that normally expected. A symmetrical arrangement for a lumped capacitor connected to a line is shown in (*b*) of Figure 5. This arrangement has been used as the frequency control element in transmitters[2]. The undesirable effects produced by driving a symmetrical dipole antenna with an unsymmetrical coaxial line have been explained[3]. Another important consideration in design of transmission line type circuit elements is the ratio of conductor spacing to length. The elementary conventional transmission line equations and hence the much used expressions for line reactance, resistance, etc., are based upon the assumption that the ratio of conductor spacing to line length is so small that *end effects* are negligible. It is easily appreciated that these end effects are not negligible in some of the designs of resonant line tank circuits, lecher wire systems and coaxial wavemeters now in use. The term *end effects* is applied to the effect of the magnetomotive force produced by the current flowing in the short-circuiting disk or bar at the end of the line, or the effect of the fringing electric field near the end of an open-circuited line.

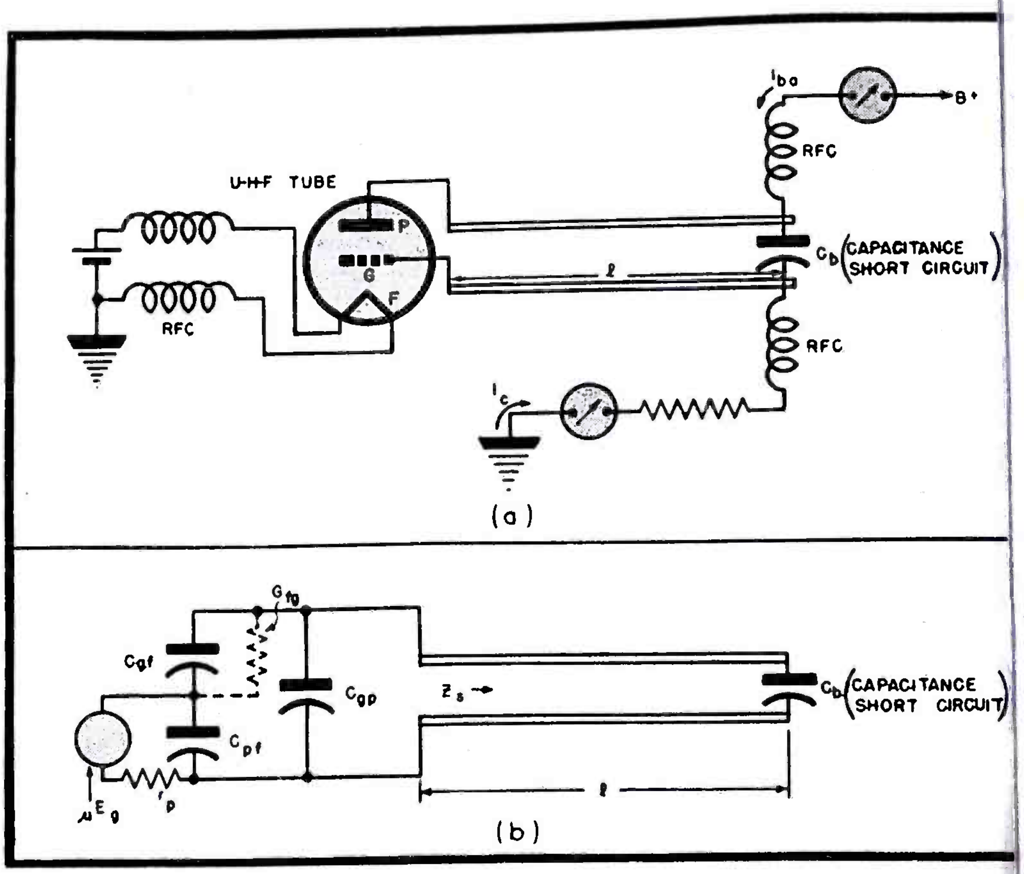

Figure 6
Grid-plate resonant line oscillator and its elementary equivalent circuit. In (*a*), quarter-wave resonant lines are preferable to filament chokes at frequencies above 450 mc.

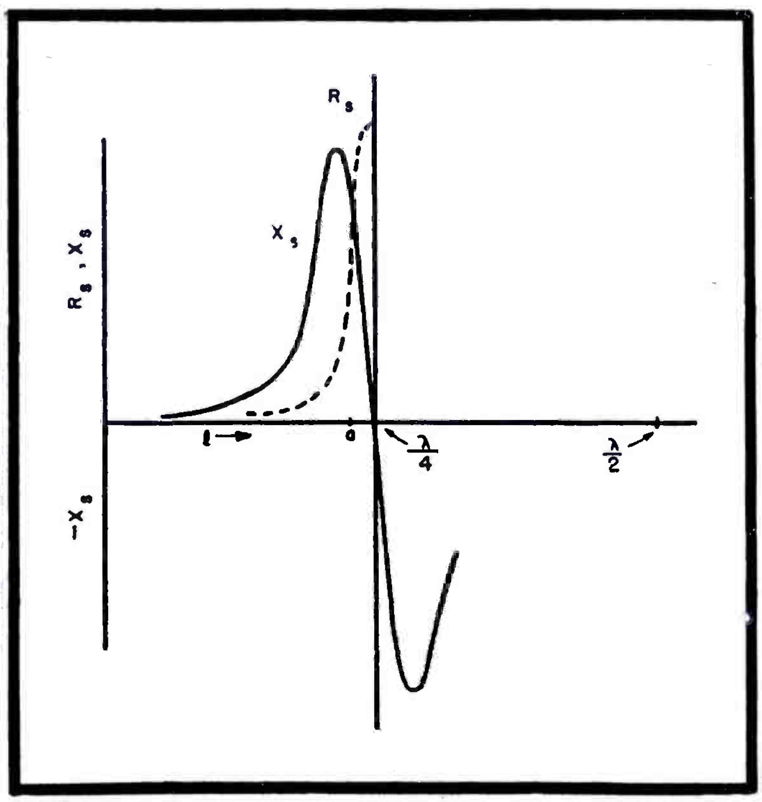

Figure 7
Input resistance and reactance of transmission line with receiving end short circuited.

Frequency Calculation for Grid-Plate Resonant Line Oscillator

Relation of Oscillator Frequency to Circuit Parameters. In Figure 6, (*a*) shows the circuit of the well-known resonant grid-plate line oscillator, and in (*b*) is shown the elementary equivalent circuit in which the tube has been replaced by its electrode capacitances, and an equivalent driving voltage act-

(*Continued on page 90*)

[2]C. W. Hansell and P. S. Carter, Proc. IRE, pp. 597-619; April, 1936.
[3]Ronald King, Proc. IRE, pp. 634-636; Nov. 1943.

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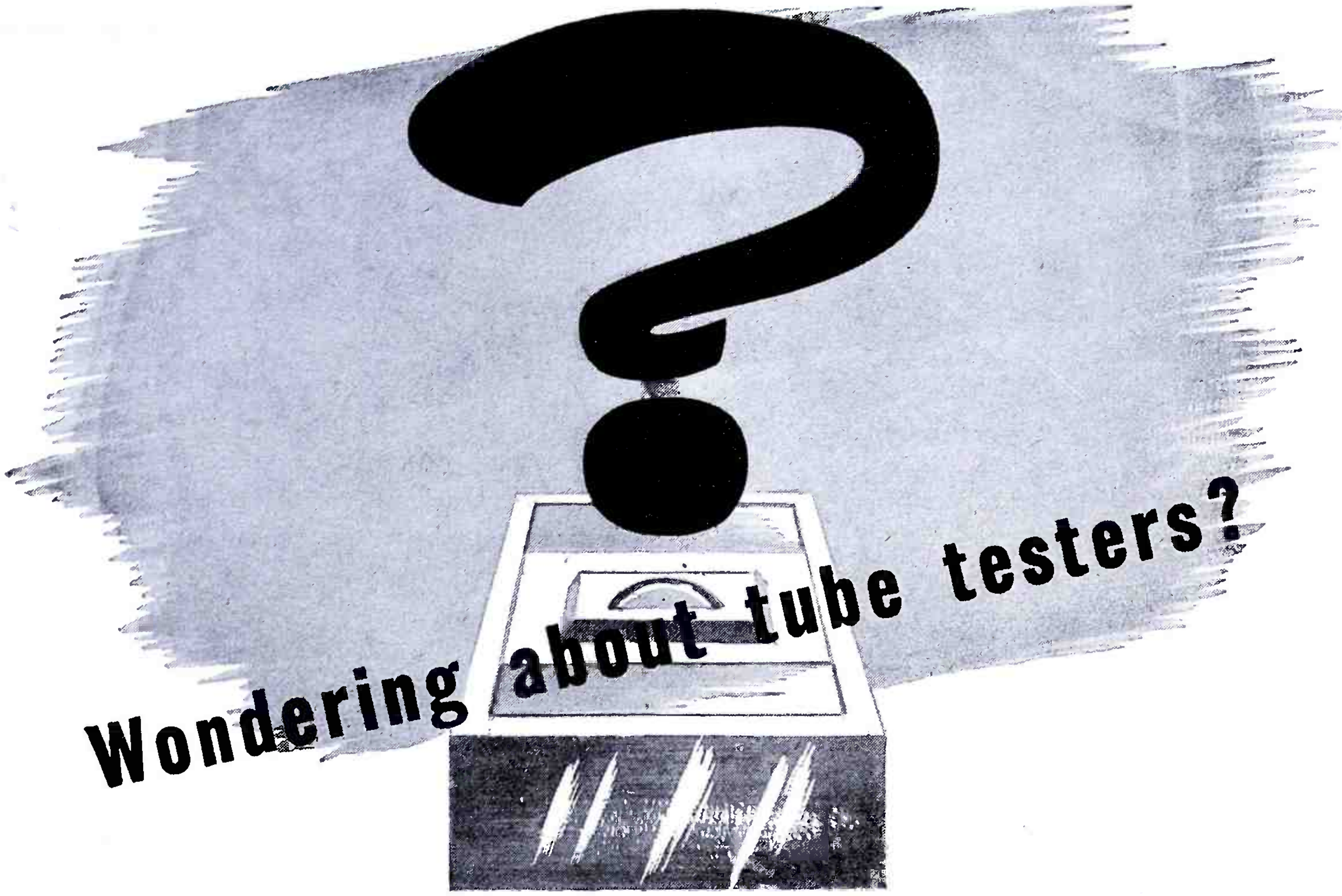

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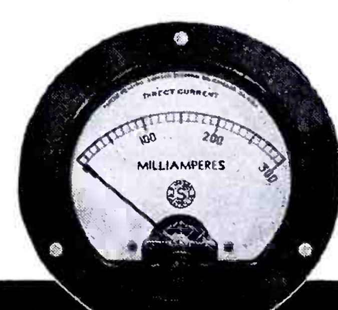

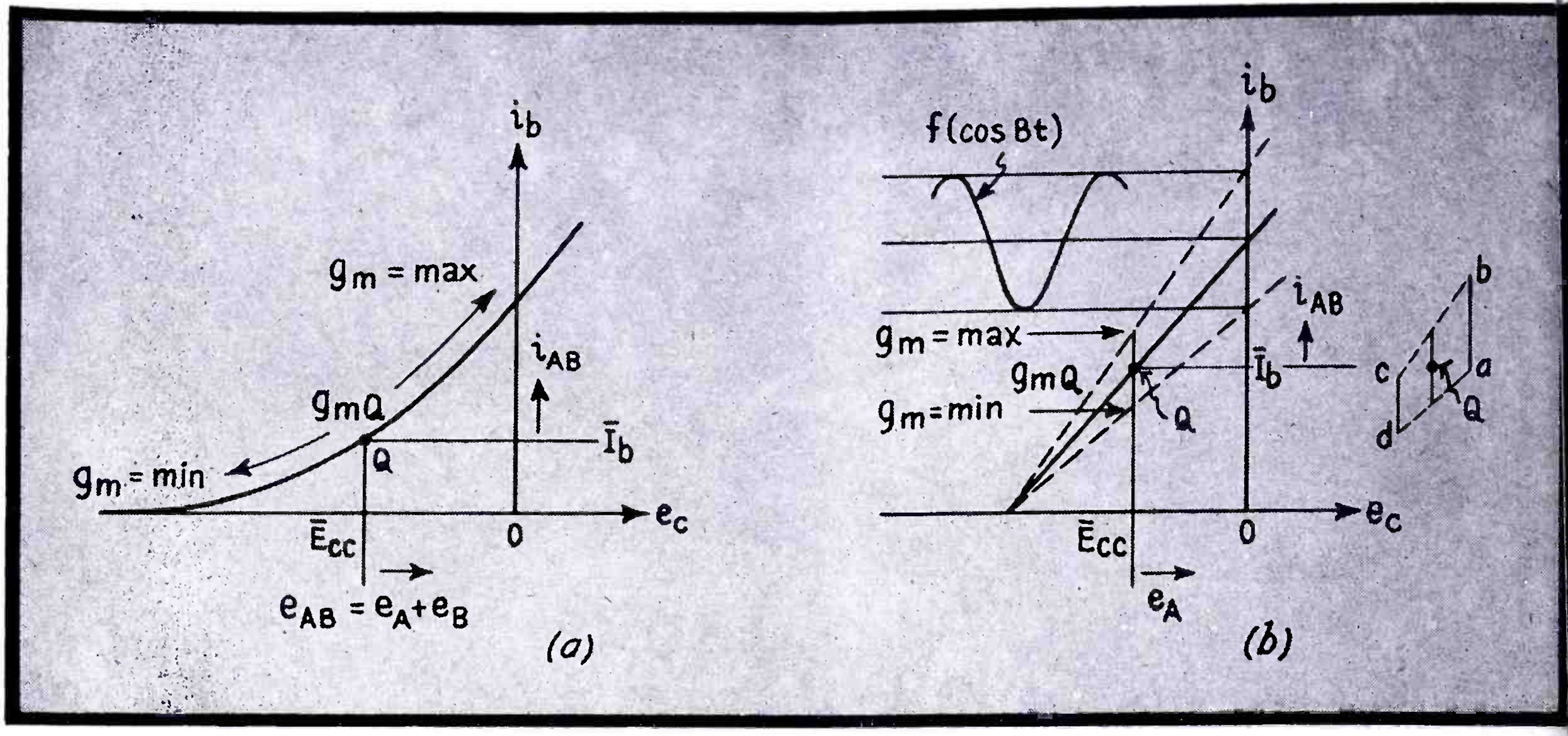

Figure 4

In (a), we have the i-e characteristic of a single input mixer (sliding Q-point or fixed path of operation). In (b) we have the i-e characteristic of a double input mixer (shifting Q-point or changing path of operation).

FREQUENCY CONVERSION CIRCUIT DEVELOPMENT

[*PART TWO OF A TWO-PART PAPER*]

by HARRY STOCKMAN

Cruft Laboratory, Harvard University

FOR a better understanding of the converter situation around 1930 let us briefly review the development of the radio receiver. From its very origin the superheterodyne had to compete with the tuned-radio-frequency receiver. Around 1925 this receiver often had the form of a neutrodyne with two or three tuning dials compared with the two dials of the superheterodyne. Both types of receivers were occasionally manufactured with some sort of crude single-dial tuning, but as a rule verniers were also provided, since the tracking of the circuits was poor. With or without a single dial a large superheterodyne compared favorably with a large neutrodyne from the point of view of ease of tuning. There were exceptions to the contrary, however, one reason for the inferiority of some superheterodynes being that there were two possible settings on the oscillator dial for each station. In addition image interference occurred in superheterodynes, while t-r-f receivers were free from such interference.

The advantages of the early superheterodyne were comparatively high sensitivity and selectivity; the outstanding disadvantage, whistles and spurious responses that occurred all over the dials. Further disadvantages of the superheterodyne were its high cost and its size. As most trouble could be located in the frequency converter, it was evident to set designers all over the world around 1930 that improving the superheterodyne was merely a question of improving the frequency converter. There were the old demands on efficient tracking, so that single dial tuning could be used to advantage, the demand for elimination of the separate local oscillator in cheap receivers, and the demand for the elimination of whistles and spurious responses. In addition there appeared new demands as a result of the general progress in radio reception; for example, efficient and suitable automatic-volume-control necessitating avc bias on the mixer or converter tube as well as on high-frequency amplifier tubes. Further, there was a trend toward the short-wave bands, where converter circuits generally behaved much less satisfactorily than at broadcast frequencies.

Through the use of cathode-injection of double-grid tubes, and of various screen-grid-tube applications in the converter stage, the tube and set designer had become aware of the disadvantages of circuit coupling and the advantages of electron coupling. Around 1930 converters without intentional circuit coupling appeared, the circuits being treated in detail in the literature of this period. Mixer tubes with several grids were developed, such as the well-known *pentagrid* mixer used in this country, and converter tubes, in which the first two grids with the cathode, provided the electrode system for the local oscillator. These latter tubes with a sixth grid added as suppressor, were manufactured by Philips and Telefunken in Europe, and under the name of *octodes* were used by European set manufacturers (1935). So-called triode-hexodes and triode-heptodes were manufactured in Europe as well as in America and become widely used. They are in principle two tubes put in the same envelope, utilizing a common cathode arrangement.

As far as the principle is concerned, the mixing action in electron-coupled

(*Continued on page* 82)

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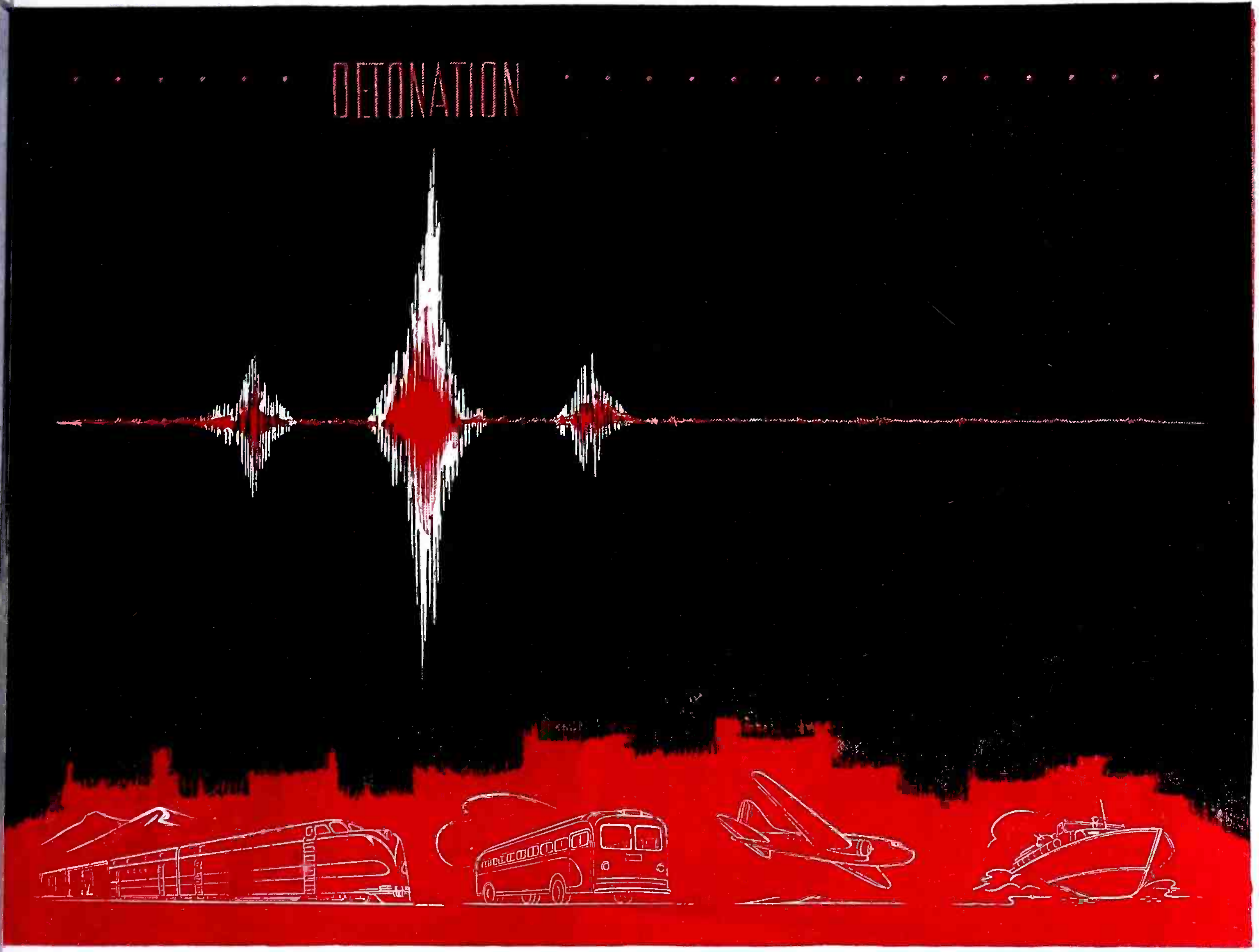

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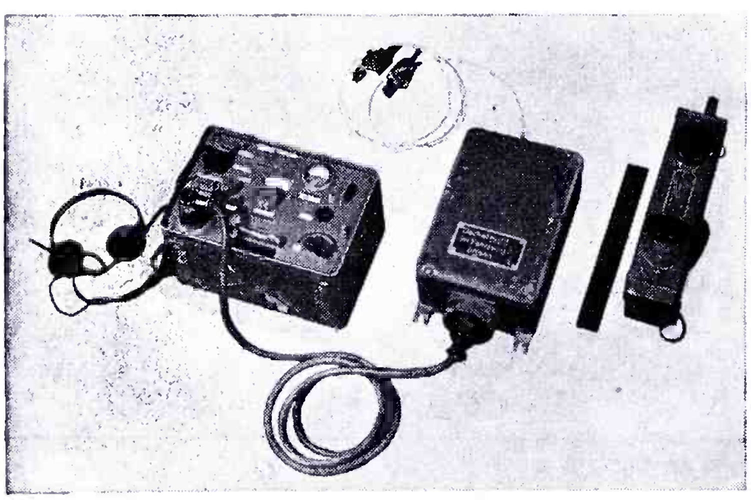
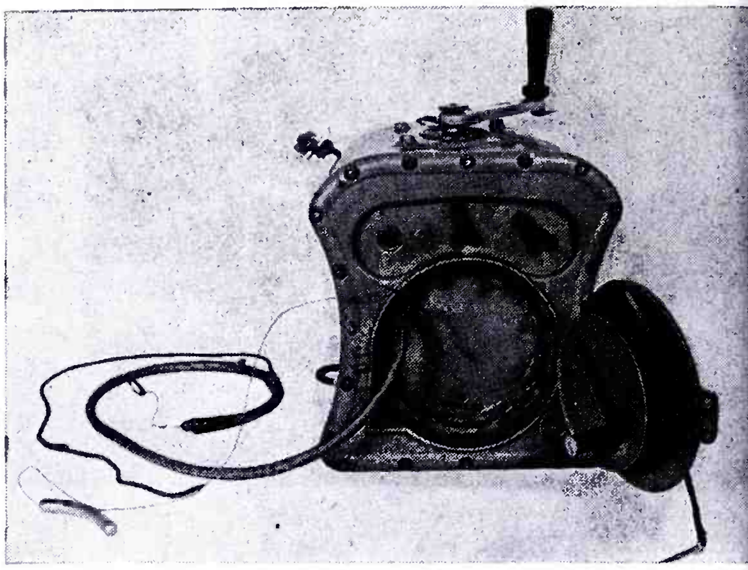
GERMAN AND JAPANESE COMMUNICATIONS EQUIPMENT

(Photos Courtesy U. S. Signal Corps)

German tuned r-f 4-tube (triodes) battery-operated man-pack receiver used for interception and monitoring. Plug-in coil units cover ranges from 100 kc to 7.7 mc, approximately. Receiver, batteries, headphones and accessories are contained in a single portable case.

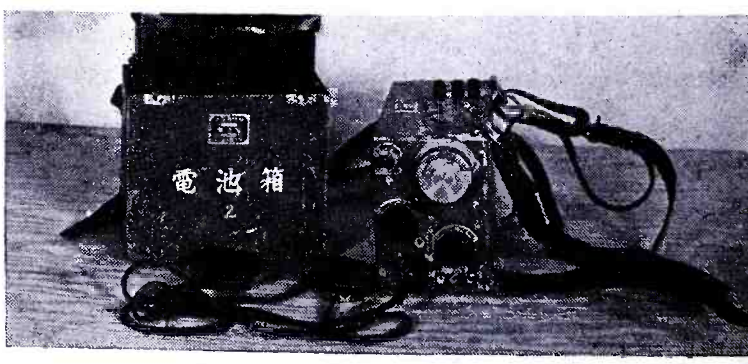
German transceiver (left) used in reconnaissance vehicles. Operated from car battery via dynamotor. Uses 8 tubes, all but the output tube being of the same type. Provides ten channels in 24-mc band. No crystals are used. Designed for voice communications only, and normally used with a loudspeaker. Note size comparison with U. S. handie-talkie at right, which offers superior service.





German emergency rescue transmitter for lifeboat use. Requires a balloon or kite to support antenna wire. Power and automatic keying obtained by cranking generator handle, protruding from top of case. Transmission is c-w or i-c-w on 500 kc.

Japanese walkie-talkie. Uses three battery-operated twin-triodes. Frequency range is 2500-4500 kc. Crystal control is optional. Provides c-w or phone transmission. Separate power supply with 1.5 volt *A* and 135 volt *B* batteries. In operation the unit is suspended from shoulders and supported on chest of operator. Uses a short whip antenna.



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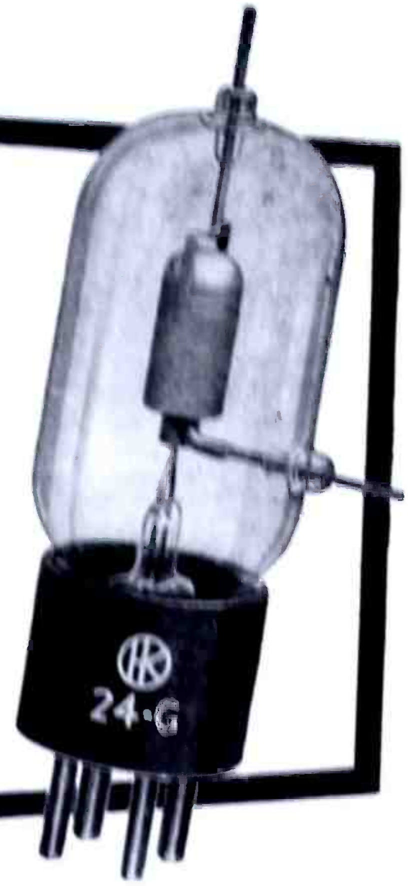
These 22 *Gammatron* types are being standardised by HEINTZ AND KAUFMAN LTD.

Heintz and Kaufman Ltd. is coming to the aid of equipment designers and manufacturers by standardising the physical and electrical characteristics of 22 types of Gammatron tubes. These types will conform to Joint Army-Navy Specifications, where applicable.

So design your circuits around these Gammatrons—with the assurance that they will always meet the same high standards, and always be readily available, thus making unnecessary the problem of redesigning equipment because of changes or variations in tube types.



14 TRIODES

TUBE TYPE	PLATE DISSIPATION
K-24	25 watts (Grid lead to base)
K-24G	25 watts (Grid lead through envelope)
-54	50 watts
K-254	100 watts
K-354C	150 watts (Low Amplification Factor)
K-354E	150 watts (High Amplification Factor)
-454L	250 watts (Low Amplification Factor)
-454H	250 watts (High Amplification Factor)
K-654	300 watts
-854L	450 watts (Low Amplification Factor)
-854H	450 watts (High Amplification Factor)
-1054L	750 watts
-1554	1000 watts
-3054	1500 watts

1 PENTODE

-257B Plate Dissipation, 75 watts (Beam pentode)

4 RECTIFIERS

-253	Inverse Peak Volts, 15,000
-953B	Inverse Peak Volts, 30,000
-953D	Inverse Peak Volts, 75,000
-953E	Inverse Peak Volts, 150,000

3 IONIZATION GAUGES

VG-2 VG-24G VG-54

REPLACEMENT *Gammatron* TUBES

The following Gammatrons will be made available primarily for replacement use. Design engineers are asked to consider recommended standardised types when designing new equipment.

REPLACEMENT TUBE TYPE	DESCRIPTION	RECOMMENDED STANDARDIZED TUBE TYPE
HK-354	Triode, grid lead to base pin, ratings same as HK 354C	HK 354C HK 454L HK 454H
HK-354D	Triode, Medium Amplification Factor	HK 354C or E HK 454L or H
HK-354F	Triode, High Amplification Factor	HK 354E
HK-257A	Beam Pentode	HK 257B
HK-153	High Vacuum Rectifier, inverse peak volts, 8000	HK 253
HK-54S	Triode, Same as HK 54 except fil. current is 3.35 instead of 5 amps.	HK 54
HK-3054A	Triode	
HK-3054B	Triode	

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Gammatron Tubes

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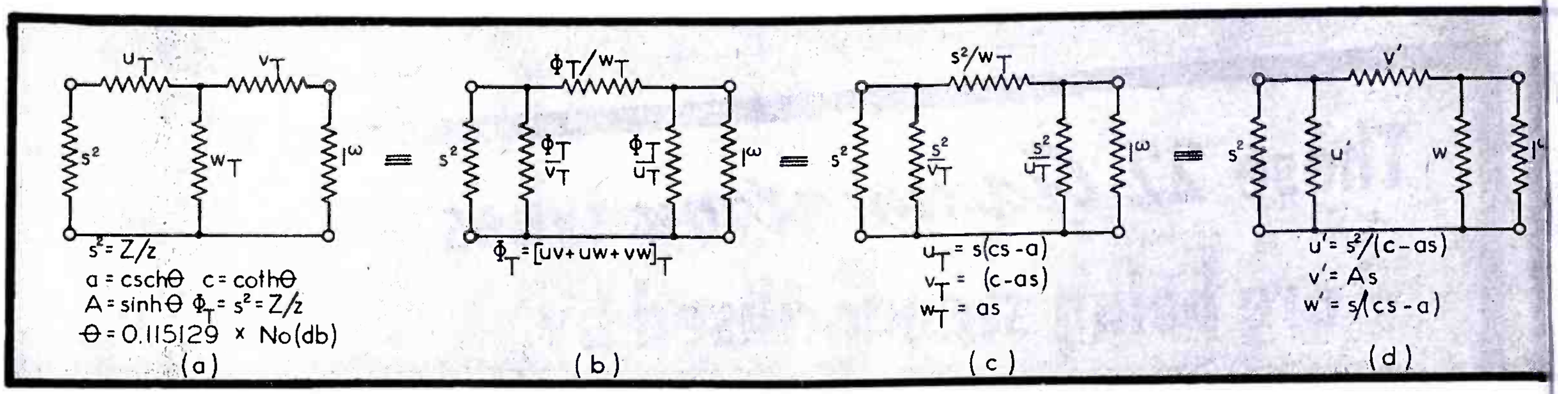

Figures 1*a*, *b*, *c* and *d*

Transformation of the unit T network to the unit π network by means of the equivalences shown in *Part I* of this series of papers. The impedance values are found by multiplying each element and termination by z, the value of the smaller of the network image impedan

RESISTIVE ATTENUATORS PADS AND NETWORKS

An Analysis of Their Theory and Desig

[PART FOUR]

by PAUL B. WRIGHT
Communications Research Engineer

In *Parts I, II and III* of this series of papers, the author outlined the fundamental methods of procedure to be followed in the design of attenuating networks of the purely resistive type. Derivations of the basic formulas upon which these designs are built were given for the *series, shunt, series and shunt, T and L-taper types of networks.* Methods were shown for the design of these networks by the so-called *Normalizing* process. A complete set of three tables of *The Hyperbolic Functions of a Real Variable* in small increments from 0 to 150 db was presented with one set appearing in each of *Parts I, II and III.* Charts were shown in *Parts II and III* which gave all of the necessary explicit design information for the *series, shunt, series and shunt, T, bridged-T, π, multiple-bridge and lattice* types of networks.

In this installment, derivations and formulas are given for the *π, multiple-bridge and lattice* networks. A key or *master* chart is presented, providing all of the relationships between the *hyperbolic, exponential, algebraic and symbolic* functions used throughout this series. Charts for the *lattice to T* equivalences are also offered. By degeneration of the lattice, all of the standard network forms are seen to be merely special cases of this more general type of network.

The formal design of the delta or π network, as it is commonly called, may follow the same pattern applied to the *T* network in *Part III*.[1] The method used for the solutions of the network elements involved setting up three independent relationships between the parameters of the network, the image propagation function and the terminating impedances. The solutions for the elements of the *T* network by algebraic processes are straightforward. However, for the π network, the algebra becomes much more involved when solving the general equations in a similar manner to that used for the *T* network.

A simpler and more direct approach to the solutions for the elements of the π network is found by making use of the *T* to π equivalence transformation shown in *Part I*[2], and by using the symbolical form of notation given for the unit *T* network in Figure 2 of Part III.

The transformation of the unit *T* to the unit π network shown in Figure 1*a* of this paper gives the necessary equations for equivalence to exist between the networks at all frequencies for which the assumption of lumped circuits constants is valid. The transformation equations are

$$u' = \Phi_T/v_T \quad 1; \qquad v' = \Phi_T/w_T \quad 2;$$

$$w' = \Phi_T/u_T \quad 3;$$

where:

$$u' = u/z; \quad v' = v/z; \quad w' = w/z,$$

$$\text{and} \quad \Phi_T = (uv + uw + vw)_T \quad 4$$

The unit *T* equations in terms of the symbolical notation used throughout the series of tables and charts are

$$u_T = cs^2 - as \quad 5; \qquad v_T = c - as \quad 6;$$

$$\text{and} \quad w_T = as \quad 7$$

where: $s^2 = Z/z$, the ratio of the image impedances of the network; $a = \text{csch}\,\theta$; $c = \coth\theta$, and $\theta = 0.115129 \times \text{No. (db)}$ loss of the network.

Substituting *5*, *6* and *7* into equation *4*, we find that

$$\Phi_T = Z/z = s^2 \quad 4a$$

By using equations *5*, *6* and *7* in *3*, *1* and *2* respectively, the element values for the π network on the unit impedance basis are obtained immediately in the symbolical form. For $s^2 = Z/z \geqq 1$,

$$u' = s^2/(c - as) \quad 9; \qquad v' = s/a = As \quad 10$$

$$\text{and} \quad w' = s/(cs - a) \quad 11$$

Tabulations for the element values of both the *T* and π networks were offered in the charts and tables in Part III.[1]

The relationships existing between the symbolical, algebraical and the hyperbolical forms of expression for the parameters of the network are supplied by the multiple headings in the *Tables of Hyperbolic Functions of a Real Variable* which appeared in the first three parts of this series. These have been summarized into a *key sheet* so that the various mathematical forms can be found without referring from one table to another to determine their interrelationship. Refer

[1]Jan., 1945, COMMUNICATIONS.
[2]Aug., 1944, COMMUNICATIONS.

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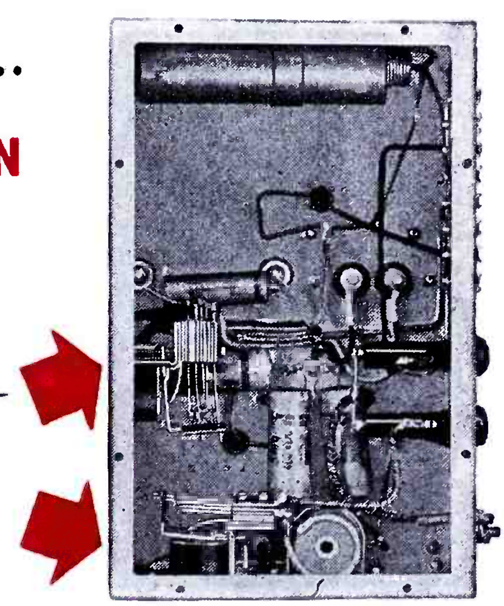
relays
IN MARINE COMMUNICATIONS

From ship to ship and from ship to shore—whether on war craft or on peacetime boats of commerce and travel—marine radio communications equipment plays a major role. Leading manufacturers of such equipment use Relays by Guardian, two of which are shown installed in the DC power supply unit of the HT-11 Radiophone manufactured by the Hallicrafters Company, Chicago.

hallicrafters
RADIOPHONE

Hallicrafters HT-11 Radiophone Unit Showing DC Power Supply



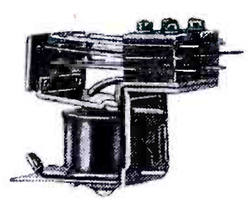
for Automatic Control of Electrical Circuits...

THERE'S A *Relay* BY GUARDIAN

In this application one Guardian relay in its normal position feeds the input of the Vibrapack for receiving purposes. On the changeover from receiving to transmitting it disconnects the Vibrapack and simultaneously energizes the other relay. This in turn connects the Dynamotor input and output circuits.

Both relays are Guardian Series 115 with double wound coils for operation on 6 or 12 volts D.C. with the 6 volt winding in parallel and the 12 volt winding in series. It is a small, compact relay, ideal for use where space is limited.

Its use in Marine Radiotelephone is but one illustration of the many applications of relays in radio and electronic equipment. For complete description of numerous types of Relays by Guardian, write for Guardian's new Catalog No. 10.



Series 115 DC Relay

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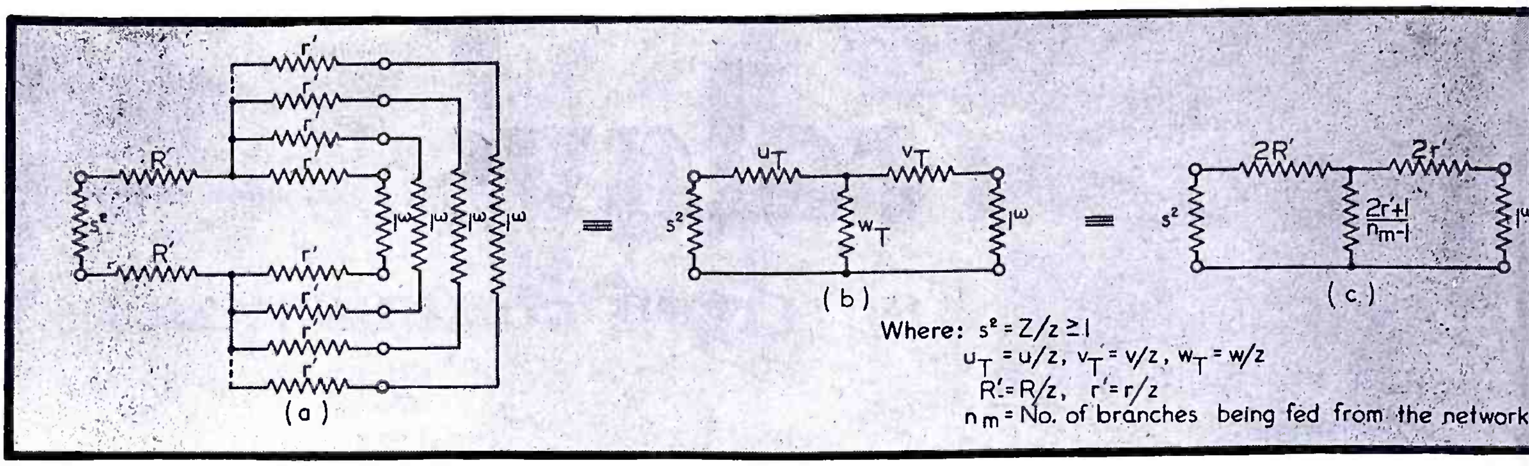

Figures 2*a*, *b* and *c*

Transformation of the balanced *multiple-bridge* to an equivalent unbalanced *T* structure. All networks are shown on a *normalized* or unit impedance basis.

ence can therefore be made directly to the *key sheet* which acts as a *master sheet* or key to unlock and expose all of the network mathematical functions at a glance.

From the *key sheet* and equations *9, 10* and *11,* the algebraic and hyperbolic forms of the unit elements of the π network may be written by direct substitution, providing

$$u' = s^2 \frac{k^2 - 1}{k^2 + 1 - 2ks} \qquad 12$$

$$v' = s \frac{k^2 - 1}{2k} \qquad 13$$

$$w' = \frac{k^2 - 1}{k^2 + 1 - 2k/s} \qquad 14$$

and

$$u' = s^2/(\coth\Theta - s\ \mathrm{csch}\,\Theta) \qquad 15$$

$$v' = s\ \sinh\Theta \qquad 16$$

$$w'\ s/(s\ \coth\Theta - \mathrm{csch}\,\Theta) \qquad 17$$

For the special, but common case of equal terminations, the network becomes a symmetrical one with the shunt arms equal to each other. On the unit basis, for this case, $s^2 = 1$, and equations *9* to *17* reduce to the simple forms of

$$u' = w' = d' = (k+\text{-})/(k-1) = \coth\frac{\Theta}{2} \qquad 18$$

$$v' = A = (k^2 - 1)/2k = \sinh\Theta \qquad 19$$

The element values of the π network on a full impedance basis are found by multiplying each side of equations *9* to *19* by the smaller of the terminating impedences, *z*. The results were tabulated in the *charts* accompanying *Part III.*[1]

All definitions for the functions used in equations *9* to *19* are supplied in the *key sheet.*

π *Network Power Transmission Loss*

The power delivered to a unit network from a constant voltage generator producing a unit current through the image impedance termination, s^2, is

$$P_Z = e^2 z/s^2 \qquad 20$$

and the power delivered to the unit ohm load after passing through the unit network is given by

$$P_z = e^2_z \qquad 21$$

The power transmission ratio is therefore,

$$\frac{P_Z}{P_z} = \frac{1}{s^2} \frac{e^2 z}{e^2_z} \qquad 22$$

The voltage across the network input of Figure 1 is

$$e_Z = u' i_u \qquad 23$$

and that across the output is

$$e_z = w'\ i_w \qquad 24$$

while the currents are, respectively

$$i_u = i_Z\ Q'/(u' + Q') \qquad 25$$

and

$$i_w = u'\ i_z/((w' + 1)(u' + Q')) \qquad 26$$

for the currents through the two shunt elements of the network, where:

$$Q' = v' + (w'/(w' + 1)). \qquad 26a$$

Using equations *25* and *26* in *23* and *24,* then dividing the resultant equations term by term, the voltage ratio is obtained as,

$$\frac{e_Z}{e_z} = \frac{Q'}{Q' - v'} \qquad 27$$

By substitution of equations *26a* and *27* into *22,* the power ratio is obtained in terms of the network parameters and the terminations. This procedure gives

$$k^2 = \frac{P_Z}{P_z} = (v'w' + v' + w')^2/(sw')^2$$
$$= ((1 + v' + (v'/w'))^2/s^2 \qquad 28$$

Extracting the positive square root, since the power ratio as shown in *28* is equal to or greater than unity, and making use of the definition of the transmission loss on a power basis, of

$$db = 10\ \mathrm{Log}_{10}(P_Z/P_z)$$
$$10\ \log_{10} k^2 = 20\ \mathrm{Log}_{10}\, k \qquad 29$$

the power transmission loss is found by substitution of equation *28* into *29,* giving

$$db = 20\ \mathrm{Log}_{10}\ ((1 + v' + (v'/w'))/s) \qquad 30$$

When the full values of the elements are used instead of the unit values, *30* becomes

$$db = 20\ \log_{10}\ ((1 + v/w + v/z)\,1/s) \qquad 31$$

When the terminations are equal, $s = 1$, and equations *30* and *31* become

$$db = 20\ \mathrm{Log}_{10}((1 + v' + (v'/w')) \qquad 32a$$

for the unit network terminated at e[ach] end with one ohm, and

$$db = 20\ \mathrm{Log}_{10}(1 + (v/w) + (v/z))$$

for the full valued network terminated [at] each end with *z* ohms.

π *Network Minimum Loss*

Minimum loss for the π or delta t[ype] of network is obtained when the i[m]pedance of the shunt arm adjacent to [the] larger termination for the network [is] made equal to infinity, or open circuit[.] Applying this condition to equation [..] the denominator must equal zero, or

$$c - as = 0$$

from which, by definition from the *k[ey] sheet,*

$$\coth\Theta = s\ \mathrm{csch}\,\Theta$$

giving

$$\coth\Theta = s = B$$

Squaring each side of this equation,

$$\cosh^2\Theta = s^2 = Z/z = B^2 = E$$

Since

$$\cosh^2\Theta - \sinh^2\Theta = 1$$

and

$$\epsilon^{\theta} = k = \cosh\Theta + \sinh\Theta$$

the relation is found of

$$\sinh\Theta = (s^2 - 1)^{1/2}$$

and hence, from *35, 38* and *39,* the fun[c]tion

$$k = s + (s^2 - 1)^{1/2}$$

The minimum loss in decibels is o[b]tained from equations *29* and *40,* givi[ng]

$$db = 20\ \mathrm{Log}_{10}\ (s + (s^2 - 1)^{1/2}) \qquad 4[1]$$

It should be noted that this is iden[ti]cally the same equation which was fou[nd] for the minimum loss of a *T* pad; ther[e]fore, the minimum loss π network or p[ad] is also a degenerated network which h[as] become an L-taper pad of ***type 3.*** Th[e] *L*-taper pad was shown with all per[ti]nent design information in the cha[rt] accompanying *Part II.*[3] The equatio[ns] tabulated there were derived in *A[p]pendix 3* of *Part III.*[1]

The impedance ratio for a given min[i]mum loss pad which will match both [of] its terminations on an image impedan[ce]

[3]Oct., 1944, COMMUNICATIONS.

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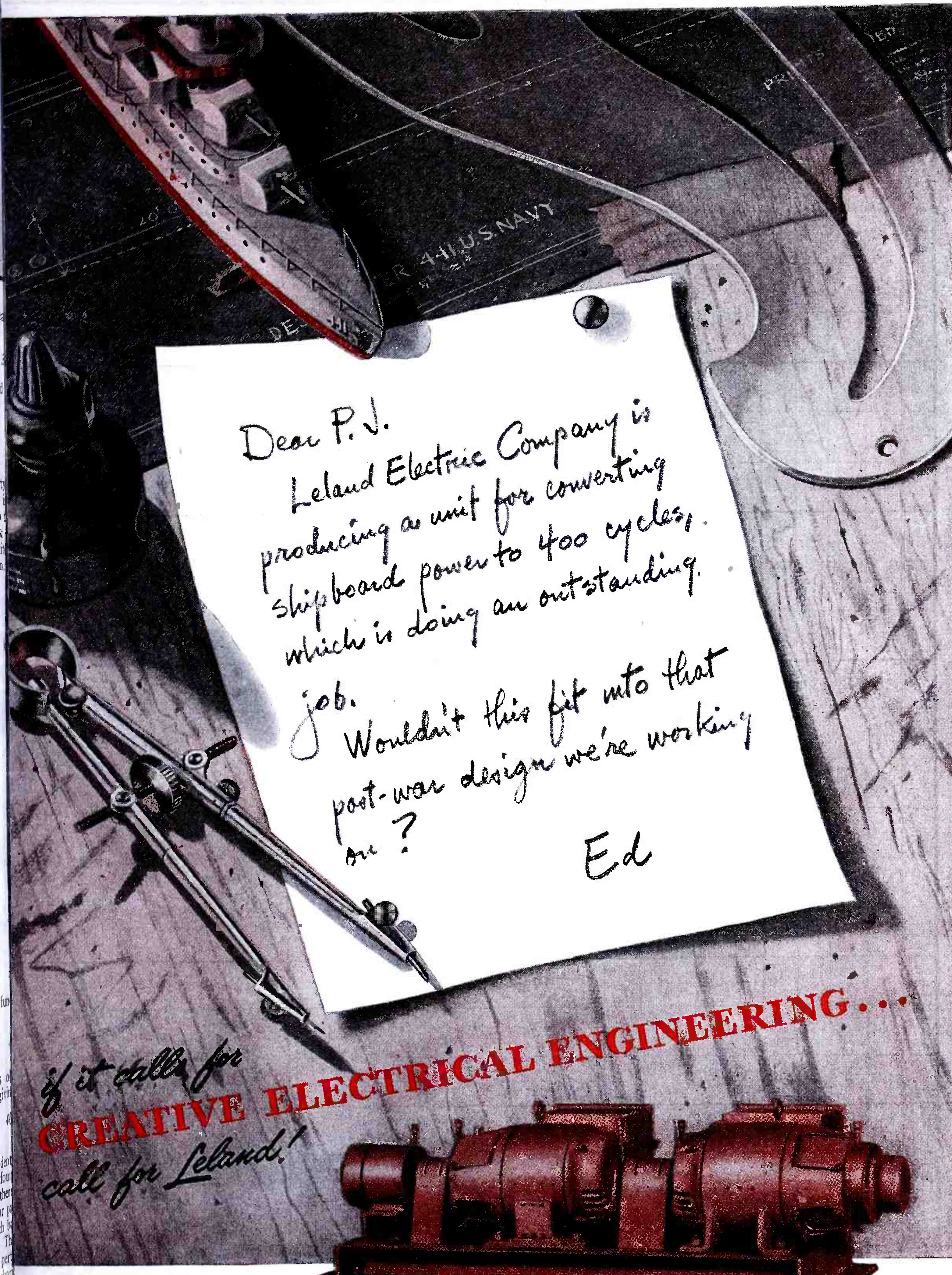

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LATTICE TO T-NETWORK EQUIVALENCES

$\psi = t+u+v+w = x_1+y_1 = x_2+y_2 = x_3+y_3$

$\psi_1 = uv - tw$

$x_1 = t+u \quad y_1 = v+w$

$x_2 = t+v \quad y_2 = u+w$

$x_3 = t+w \quad y_3 = u+v$

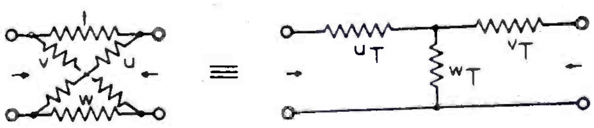
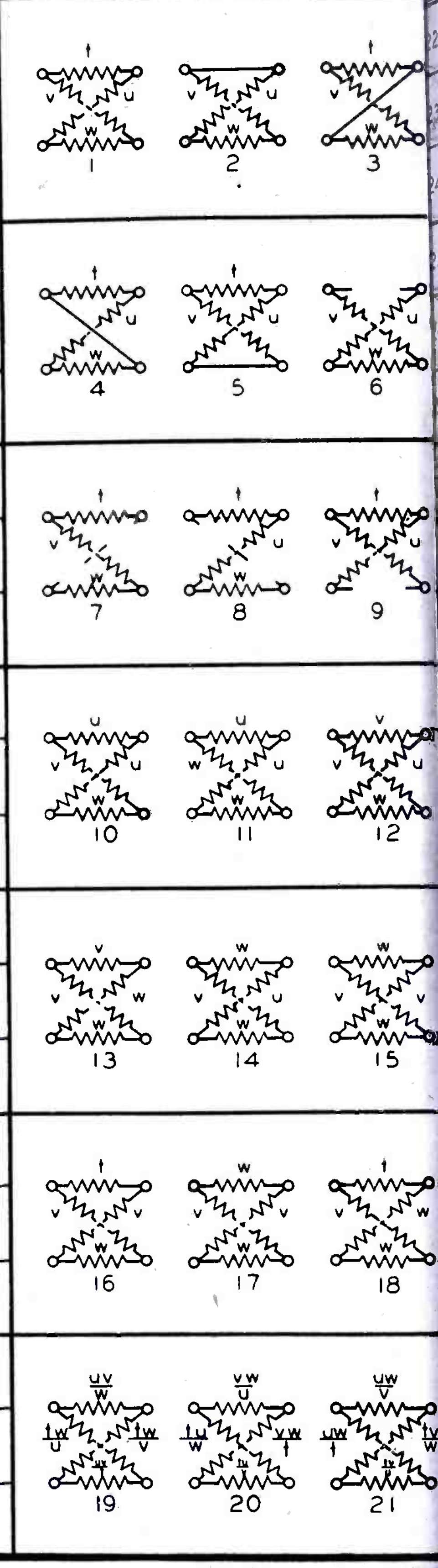


FIG	LATTICE				T-NETWORK PARAMETERS		
	t	u	v	w	u_T	v_T	w_T
1	t	u	v	w	$\frac{x_1 y_1 - \psi_1}{\psi}$	$\frac{x_2 y_2 - \psi_1}{\psi}$	$\frac{\psi_1}{\psi}$
2	o	u	v	w	$\frac{uw}{\psi - t}$	$\frac{vw}{\psi - t}$	$\frac{uv}{\psi - t}$
3	t	o	v	w	$\frac{t(v+2w)}{\psi - u}$	$\frac{w(v+2t)}{\psi - u}$	$-\frac{tw}{\psi - u}$
4	t	u	o	w	$\frac{w(u+2t)}{\psi - v}$	$\frac{t(u+2w)}{\psi - v}$	$-\frac{tw}{\psi - v}$
5	t	u	v	o	$\frac{tv}{\psi - w}$	$\frac{tu}{\psi - w}$	$\frac{uv}{\psi - w}$
6	∞	u	v	w	$v+2w$	$u+2w$	$-w$
7	t	∞	v	w	w	t	v
8	t	u	∞	w	t	w	u
9	t	u	v	∞	$u+2t$	$v+2t$	$-t$
10	u	u	v	w	$\frac{u(v+3w)}{y_1+2u}$	$\frac{uy_2+wy_3}{y_1+2u}$	$\frac{u(v-w)}{y_1+2u}$
11	u	u	w	w	$\frac{2uw}{y_2}$	$\frac{y_2}{2}$	ZERO
12	v	u	v	w	$\frac{vy_1+wy_3}{y_2+2v}$	$\frac{vy_2+wy_3}{y_2+2v}$	$\frac{v(u-w)}{y_2+2v}$
13	v	w	v	w	$\frac{y_1}{2}$	$\frac{2vw}{y_1}$	ZERO
14	w	u	v	w	w	w	$\frac{uv-w^2}{y_1+y_2}$
15	w	v	v	w	w	w	$\frac{v-w}{2}$
16	t	v	v	w	$\frac{ty_1+wx_2}{y_1+x_2}$	$\frac{ty_1+wx_2}{y_1+x_2}$	$\frac{v^2-tw}{y_1+x_2}$
17	w	v	v	w	w	w	$\frac{v-w}{2}$
18	t	w	v	w	$\frac{ty_1+wx_3}{y_1+x_3}$	$\frac{w(v+3t)}{y_1+x_3}$	$\frac{w(v-t)}{y_1+x_3}$
19	$\frac{uv}{w}$	$\frac{tw}{v}$	$\frac{tw}{u}$	$\frac{uv}{t}$	$u\frac{y_1}{y_2} = t\frac{y_1}{x_2} = w\frac{x_1}{y_2} = v\frac{x_1}{x_2}$	$u\frac{x_2}{x_1} = t\frac{y_2}{x_1} = w\frac{x_2}{y_1} = v\frac{y_2}{y_1}$	ZERO
20	$\frac{vw}{u}$	$\frac{vw}{t}$	$\frac{tu}{w}$	$\frac{tu}{v}$	$(w(u^2+v^2)+2vw^2)/y_2y_3$ $=(v(t^2+w^2)+2wt^2)/x_2x_3$ $=(u(t^2+w^2)+2tw^2)/y_2x_3$ $=(t(u^2+v^2)+2ut^2)/x_2y_3$	$\frac{2vw}{y_3} = \frac{2tw}{x_3} = \frac{2tw}{x_3} = \frac{2tu}{y_3}$	$v(u-w)/y_3 = w(v-t)/x_3$ $t(u-w)/x_3 = u(v-t)/y_3$
21	$\frac{uw}{v}$	$\frac{tv}{w}$	$\frac{uw}{t}$	$\frac{tv}{u}$	$\frac{2uw}{y_3} = \frac{2tw}{x_3} = \frac{2tw}{x_3} = \frac{2tv}{y_3}$	$(w(u^2+v^2)+2uw^2)/y_1y_3$ $(v(t^2+w^2)+2tw^2)/y_1x_3$ $(u(t^2+w^2)+2tw^2)/x_1x_3$ $(t(u^2+v^2)+2vt^2)/x_1y_3$	$u(v-w)/y_3 = t(v-w)/y_1 =$ $w(u-t)/x_1 = v(u-t)/y_3$

LATTICE-NETWORK CONFIGURATIONS



basis can be found directly from the *Table of Hyperbolic Functions* under the heading E or $\cosh^2 \Theta$.

π Network Image Impedances

The image impedances of the π network are found from the usual considerations of the open and short cir-

Figures 1 to 21

The generalized *lattice to T-network* equivalance is given by the equations and diagram of figure 1. All other cases are degenerative or special conditions obtained by imposing various restrictions upon the equations of figure 1. From these considerations, all of the standard forms of networks are found to be but specialized cases of the generalized *lattice network* form.

Text continued on page 7
Key Chart appears on page 6

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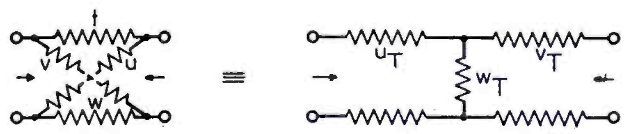
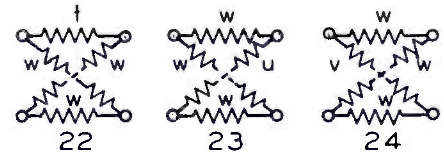
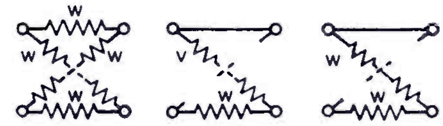
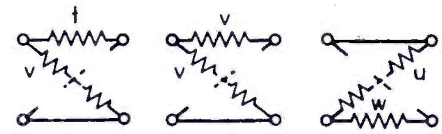
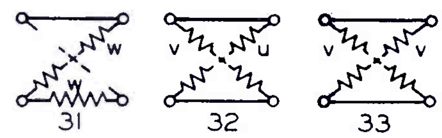
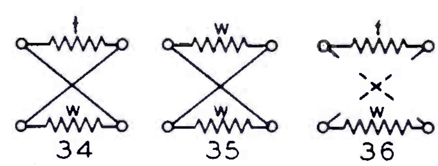
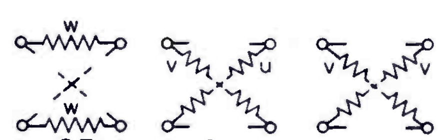
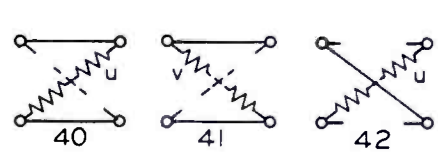
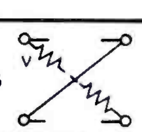
LATTICE TO T-NETWORK EQUIVALENCES

$\psi = t + u + v + w = x_1 + y_1$
$= x_2 + y_2 = x_3 + y_3$
$\psi_1 = uv - tw$
$x_1 = t + u \qquad y_1 = v + w$
$x_2 = t + v \qquad y_2 = u + w$
$x_3 = t + w \qquad y_3 = u + v$



IG.	LATTICE t	u	v	w	T-NETWORK PARAMETERS u_T	v_T	w_T	LATTICE-NETWORK CONFIGURATIONS
2	t	w	w	w	$\frac{w(w+3t)}{t+3w}$	$\frac{w(w+3t)}{t+3w}$	$\frac{w(w-t)}{t+3w}$	 22 23 24
3	w	u	w	w	w	w	$\frac{w(u-w)}{u+3w}$	
4	w	w	v	w	$\frac{w(v+w)}{v+3w}$	$\frac{w(v+w)}{v+3w}$	$\frac{w(v-w)}{v+3w}$	
5	w	w	w	w	w	w	ZERO	 25 26 27
6	0	∞	v	w	w	ZERO	v	
7	0	∞	w	w	w	ZERO	w	
8	t	∞	v	0	ZERO	t	v	 28 29 30
9	v	∞	v	0	ZERO	v	v	
0	0	u	∞	w	ZERO	w	u	
1	0	w	∞	w	ZERO	w	w	 31 32 33
2	0	u	v	0	ZERO	ZERO	$\frac{uv}{y_3}$	
3	0	v	v	0	ZERO	ZERO	$\frac{v}{2}$	
4	t	0	0	w	$\frac{2tw}{x_3}$	$\frac{2tw}{x_3}$	$\frac{-tw}{x_3}$	 34 35 36
5	w	0	0	w	w	w	$\frac{-w}{2}$	
6	t	∞	∞	w	ZERO, t,w, or (t+w)	(t+w),w,t, or ZERO	INFINITE	
7	w	∞	∞	w	ZERO, w, or 2w	2w,w, or ZERO	INFINITE	 37 38 39
3	∞	u	v	∞	ZERO, u,v, or (u+v)	(u+v),u,v, or ZERO	INFINITE	
3	∞	v	v	∞	ZERO, v, or 2v	2v, v, or ZERO	INFINITE	
4	0	u	∞	0	ZERO	ZERO	u	 40 41 42
4	0	∞	v	0	ZERO	ZERO	v	
[illegible]	∞	u	0	∞	ZERO or u	u or ZERO	INFINITE	
4	∞	0	v	∞	v or ZERO	ZERO or v	INFINITE	43 

Figures 22 to 43

generalized *lattice to T-network* equivalence given by figure 1 has been degenerated into the forms shown above by placing the restrictions shown e left upon the general equations of figure 1. From these and figures 1 to 21, the *lattice* network may be seen to be a general type of network from which the *series, shunt, series and shunt, L taper, T* and *π* networks may be derived as special cases.

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	No(db)	$\log_\varepsilon(\frac{1}{r})$	$\frac{1}{2}\log_\varepsilon(\frac{1}{r})$	$2\log_\varepsilon(\frac{1}{r})$	$\frac{1}{r}$	r	$\frac{1}{r^2}$	r^2	N	$2N$	N^2	n	$\frac{n}{2}$	No(db)
1	$20\log_{10}\varepsilon^\theta$	θ	$\frac{\theta}{2}$	2θ	ε^θ	$\varepsilon^{-\theta}$	$\varepsilon^{2\theta}$	$\varepsilon^{-2\theta}$	$(\varepsilon^\theta-1)$	$2(\varepsilon^\theta-1)$	$(\varepsilon^\theta-1)^2$	$\frac{1}{(\varepsilon^\theta-1)}$	$\frac{1}{2(\varepsilon^\theta-1)}$	$20\log_{10}\varepsilon^\theta$
	$20\log_{10}k$	$\log_\varepsilon k$	$\frac{1}{2}\log_\varepsilon k$	$2\log_\varepsilon k$	k	$\frac{1}{k}$	k^2	$\frac{1}{k^2}$	$(k-1)$	$2(k-1)$	$(k-1)^2$	$\frac{1}{(k-1)}$	$\frac{1}{2(k-1)}$	$20\log_{10}k$
	$20\log_{10}(\frac{1}{r})$	$\log_\varepsilon(\frac{1}{r})$	$\frac{1}{2}\log_\varepsilon(\frac{1}{r})$	$2\log_\varepsilon(\frac{1}{r})$	$\frac{1}{r}$	r	$\frac{1}{r^2}$	r^2	$\frac{(1-r)}{r}$	$2\frac{(1-r)}{r}$	$\frac{(1-r)^2}{r^2}$	$\frac{r}{(1-r)}$	$\frac{1}{2(1-r)}$	$20\log_{10}(\frac{1}{r})$
	No(db)	A	B	C	D	E	F	a	b	c	d	e	f	No(db)
2	$20\log_{10}\varepsilon^\theta$	$\sinh\theta$	$\cosh\theta$	$\tanh\theta$	$\tanh\frac{\theta}{2}$	$\cosh^2\theta$	$\sinh^2\frac{\theta}{2}$	$\operatorname{csch}\theta$	$\operatorname{sech}\theta$	$\coth\theta$	$\coth\frac{\theta}{2}$	$\operatorname{sech}^2\theta$	$\operatorname{csch}^2\frac{\theta}{2}$	$20\log_{10}\varepsilon^\theta$
	$20\log_{10}k$	$\frac{(k^2-1)}{2k}$	$\frac{(k^2+1)}{2k}$	$\frac{(k^2-1)}{(k^2+1)}$	$\frac{(k-1)}{(k+1)}$	$\frac{(k^2+1)^2}{4k^2}$	$\frac{(k-1)^2}{4k}$	$\frac{2k}{(k^2-1)}$	$\frac{2k}{(k^2+1)}$	$\frac{(k^2+1)}{(k^2-1)}$	$\frac{(k+1)}{(k-1)}$	$\frac{4k^2}{(k^2+1)^2}$	$\frac{4k}{(k-1)^2}$	$20\log_{10}k$
	$20\log(\frac{1}{r})$	$\frac{(1-r^2)}{2r}$	$\frac{(1+r^2)}{2r}$	$\frac{(1-r^2)}{(1+r^2)}$	$\frac{(1-r)}{(1+r)}$	$\frac{(1+r^2)^2}{4r^2}$	$\frac{(1-r)^2}{4r}$	$\frac{2r}{(1-r^2)}$	$\frac{2r}{(1+r^2)}$	$\frac{(1+r^2)}{(1-r^2)}$	$\frac{(1+r)}{(1-r)}$	$\frac{4r^2}{(1+r^2)^2}$	$\frac{4r}{(1-r)^2}$	$20\log(\frac{1}{r})$
	No(db)	G	H	M	P	Q	T	g	h	m	p	q	t	No(db)
3	$20\log_{10}\varepsilon^\theta$	$\sinh 2\theta$	$\tanh^2\theta$	$(1-\varepsilon^{-\theta})$	$\sinh^2\theta$	$\cosh 2\theta$	$\tanh^2\frac{\theta}{2}$	$\operatorname{csch}2\theta$	$\coth^2\theta$	$\frac{1}{(1-\varepsilon^{-\theta})}$	$\operatorname{csch}^2\theta$	$\operatorname{sech}2\theta$	$\coth^2\frac{\theta}{2}$	$20\log_{10}\varepsilon^\theta$
	$20\log_{10}k$	$\frac{(k^4-1)}{2k^2}$	$\frac{(k^2-1)^2}{(k^2+1)^2}$	$\frac{(k-1)}{k}$	$\frac{(k^2-1)^2}{4k^2}$	$\frac{(k^2+1)}{2k^2}$	$\frac{(k-1)^2}{(k+1)^2}$	$\frac{2k^2}{(k^4-1)}$	$\frac{(k^2+1)^2}{(k^2-1)^2}$	$\frac{k}{(k-1)}$	$\frac{4k^2}{(k^2-1)^2}$	$\frac{2k^2}{(k^2+1)}$	$\frac{(k+1)^2}{(k-1)^2}$	$20\log_{10}k$
	$20\log_{10}(\frac{1}{r})$	$\frac{(1-r^4)}{2r^2}$	$\frac{(1-r^2)^2}{(1+r^2)^2}$	$(1-r)$	$\frac{(1-r^2)^2}{4r^2}$	$\frac{(1+r^2)}{2}$	$\frac{(1-r)^2}{(1+r)^2}$	$\frac{2r^2}{(1-r^4)}$	$\frac{(1+r^2)^2}{(1-r^2)^2}$	$\frac{1}{1-r}$	$\frac{4r^2}{(1-r^2)^2}$	$\frac{2}{(1+r^2)}$	$\frac{(1+r)^2}{(1-r)^2}$	$20\log_{10}(\frac{1}{r})$

ε = 2.71828, THE MATHEMATICAL BASE.
θ, THE IMAGE PROPAGATION FUNCTION = 0.115129 X No (db)
$k^2 = P_Z/P_z \geq 1$, THE RATIO OF THE POWER INPUT TO A NETWORK AND THE POWER DELIVERED TO ITS LOAD.

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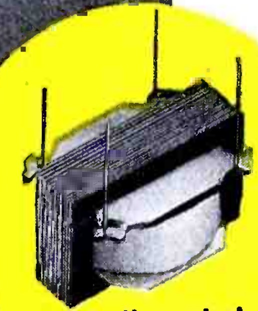

Larger than actual

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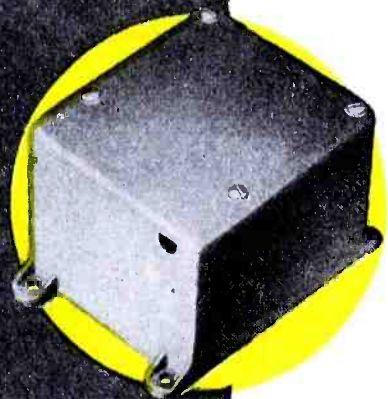

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(*Continued from page 66*)

cuited impedances as described in *Part I*[2]. They may therefore be written by inspection of Figure *1a*. For the unit network shown, this gives

$$s^2 = u'\left[\frac{v'}{u'+v'+w'}\cdot\frac{v'+w'}{u'+v'}\right]^{1/2} \qquad 41$$

$$= u'(\sigma'\rho')^{1/2} \qquad 42$$

and

$$1 = w'\left[\frac{v'}{u'+v'+w'}\cdot\frac{u'+v'}{u'+v'}\right]^{1/2} \qquad 43$$

$$= w'(\sigma'/\rho')^{1/2} \qquad 44$$

where: $\sigma' = v'/(u'+v'+w')$ 45

and $\rho' = (v'+w')/(u'+v')$ 46

When the terminations of the network are both unity, $s = 1$. These equations may then be written as

$$1 = \frac{u'v'}{(v'^2+2u'v')^{1/2}} = \frac{v'w'}{(v'^2+2v'w')^{1/2}} \qquad 47$$

In terms of the full impedance values, for $Z \geqq z$,

$$Z = u\left[\frac{v}{u+v+w}\cdot\frac{v+w}{u+v}\right]^{1/2} = u(\sigma\rho)^{1/2} \qquad 48$$

and

$$z = w\left[\frac{v}{u+v+w}\cdot\frac{u+v}{v+w}\right]^{1/2} = w(\sigma/\rho)^{1/2} \qquad 49$$

where: $\sigma = v/(u+v+w)$

and $\rho = (v+w)/(u+v)$

When $Z = z$, *47*, for the full image impedance, becomes,

$$Z = z = \frac{uv}{[v(2u+v)]^{1/2}} = \frac{vw}{[v(2w+v)]^{1/2}} \qquad 50$$

All of the design information for the π network was tabulated in chart form and presented in Figure 3 and 4 of *Part III*.[1]

Multiple Bridging Networks

A complete treatment of the types of *multiple-bridging* networks which permit the connection of any number of lines, loops or units of equipment so that they may be fed from a commn distributing source or output, such as that from the output of an amplifier, was presented in a previous paper by the author in COMMUNICATIONS, September 1943. Tables offered were designed to permit the engineer to obtain the element values of the network by simply multiplying the constants given by their associated terminating impedances. In addition tables giving losses which would be obtained for wide ranges of the ratios of the source and load or branch impedances were shown. These were supplemented by charts giving minimum loss pads, mismatching losses as well as all intermediate losses not tabulated explicitly and directly for the bridging network itself.

Therefore, in this paper, only a brief outline of the previous theory will be given, with however a difference in approach. That is, the design formulae will be related to the symbolical and hyperbolical functions given in *The Tables of Hyperbolic Functions of a Real Variable* which appeared with the first three parts of this series of papers.

As in the work preceding this, use will be made of the equivalent transformations to the *T* structure shown in Figure *2a, a, b* and *c*. This method simplifies the derivations and enables more compact expressions to be had in the final forms.

From the unit dissymetrical *T*-network equations *5, 6* and *7* and Figure *2a*, the relationship between the elements may be written at once as,

$$2R' = cs^2 - as, \quad \text{or} \quad R' = (cs^2 - as)/2 \qquad 51$$

$$2r' = c - as, \quad \text{or} \quad r' = (c - as)/2 \qquad 52$$

and

$$\frac{2r'+1}{n_m - 1} = as, \text{ or } r' = (as(n_m - 1) - 1)/2 \qquad 53$$

where: n_m = the number of outlets or branches being fed from the common source or supply. In case one or more branches do not have the desired impedance for proper matching of the network output terminals, either a matching pad or a transformer having the correct ratio of transformation of impedances should be used. The matching pad would be either a *T*-pad of dissymmetrical type, or a limiting case of it, better known as an *L*-taper pad having minimum loss. This minimum loss *L*-taper pad was shown in Figures 11 and 12 of *Part II*,[3] while the derivation of the design formulae was given in *Appendix 3* of *Part III*.[1]

When the source and load impedances are equal, as they most frequently are in practice, the element values for the network take a very simple form, since then $s^2 = 1$, and equations *51* and *52* give for the unit network, the values

$$R' = r' = D/2 = \frac{1}{2}\,\text{Tanh}\,\frac{\theta}{2} \qquad 54$$

which makes all resistances of the network equal in value. If the network is considered on an unbalanced basis, the unit resistances, $2R'$, are given directly by reading the value from column *D*.

The full values of the elements are obtained by multiplying each side of equations *51, 52* and *54* by *z*, the magnitube of the branch impedances. For $Z \geqq z$, we obtain the equations

$$R = (cs^2 - as)z/2 = (cZ - ay)/2 \qquad 55$$

$$r = (c - as)z/2 = (cz - ay)/2 \qquad 56$$

where $y = (Zz)^{1/2}$

When $Z = z$, there results the identity

$$R = r = Dz/2 \qquad 57$$

Transmission Loss of the Multiple-Bridging Network

From the previously developed theory of the *T* network, the loss may be written immediately by making use of the equivalence shown in Figure *2a*, as

$$k = s\,(1 + (v_T + 1)/w_T)$$

$$= s\left(1 + \frac{2r'+1}{(2r'+1)/(n_m - 1)}\right) = n_m s$$

The power transmission loss from the input or source side of the network to any one of the n_m branches is, therefore

$$db = 10\,\text{Log}_{10}\,k^2 = 20\,\text{Log}_{10}\,(n_m\,s)$$

When both the source and load impedances are equal, *59* gives,

$$db = 20\,\text{Log}_{10}\,n_m \qquad 6$$

Minimum Loss of the Multiple-Bridging Network

Since the number of branches is always an integer and can never be fractional, equation *59* shows that for any given impedance ratio of source to branches, the loss is completely dependent upon the number of branches being supplied by the output terminals of the network. Thus if the number of branches and the impedance ratio is specified in advance, there is no possibility of getting less loss than that given by *59*. It is therefore not only the minimum loss, but the only loss which will at the same time permit the impedances to be properly matched without adding additional pads to the network. However, in that event, the loss will be somewhat higher than the minimum obtainable by *59*.

Image Impedances of the Multiple-Bridging Network

The so-called multiple-bridge type of network is actually a system of resistances arranged to build out each termination to a sufficiently high value so that when the remaining branches are connected, no mismatching of impedance will take place. Inherently, the network itself has no shunt arm, and therefore strictly according to definition, the image impedance is equal to infinity. For passive types of networks, the image impedance is given by the square root of the product of open and short-circuited conditions of the network. The open condition gives infinity, while the shorted condition gives $2((R + (r/n_m))$ ohms a finite quantity. The positive square root of the product equals infinity, hence the concept of the image impedance, although correct, has but little value for this network.

Lattice Network

This is a four-terminal four-element network and is shown in Figure in the chart on page 66. By solving for the mesh currents through the use of Kirchoff's laws, the current through each of the terminations and the elements may be written

$$i_t = \frac{E}{\Phi}\,[z\,(v + w) + v\,(u + w)]$$

$$= \frac{E}{\Phi}\,[y_1\,z + v\,y_2] \qquad 6$$

(*Continued on page 86*)

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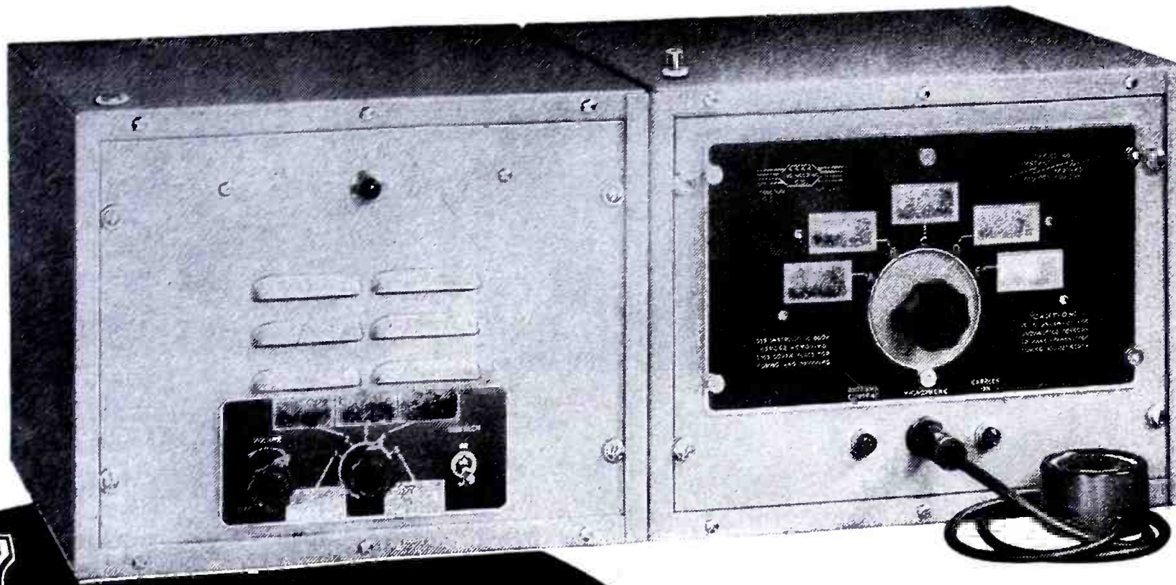

KAAR Series 46

KAAR INSTANT HEATING RADIOTELEPHONES

ABOVE: Series 46 KAAR radiotelephone, showing 5 channel transmitter and crystal-controlled receiver mounted side by side.

BELOW: Same units mounted in a different manner, and showing how transmitter slides out for servicing.

This new KAAR 50-watt series offers lower battery drain

Low battery drain, obtained through the use of instant-heating tubes, is one of the many special features in the new KAAR Series 46 radiotelephone which make this equipment so popular for police, fire, sheriff, utility, and other emergency use.

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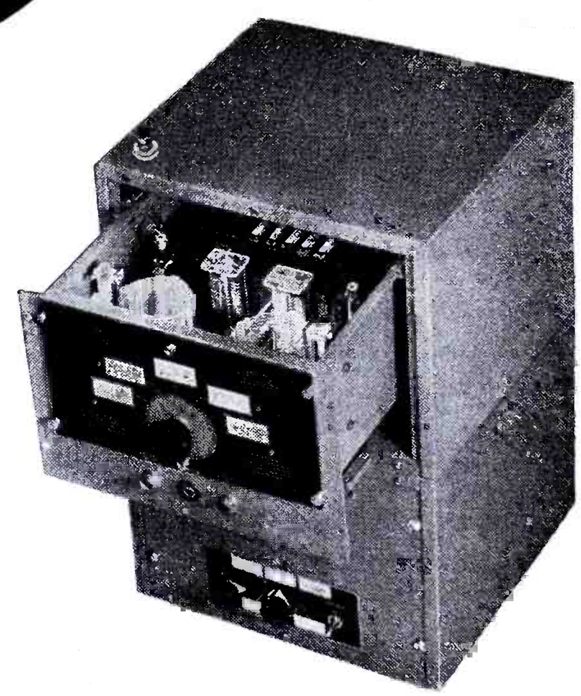

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DENVER AND RIO GRANDE WESTERN

by A. B. CAVENDISH

Figure 1
Installing the two one-half-waves in-phase antenna array on the caboose of a Denver and Rio Grande Western freight train.

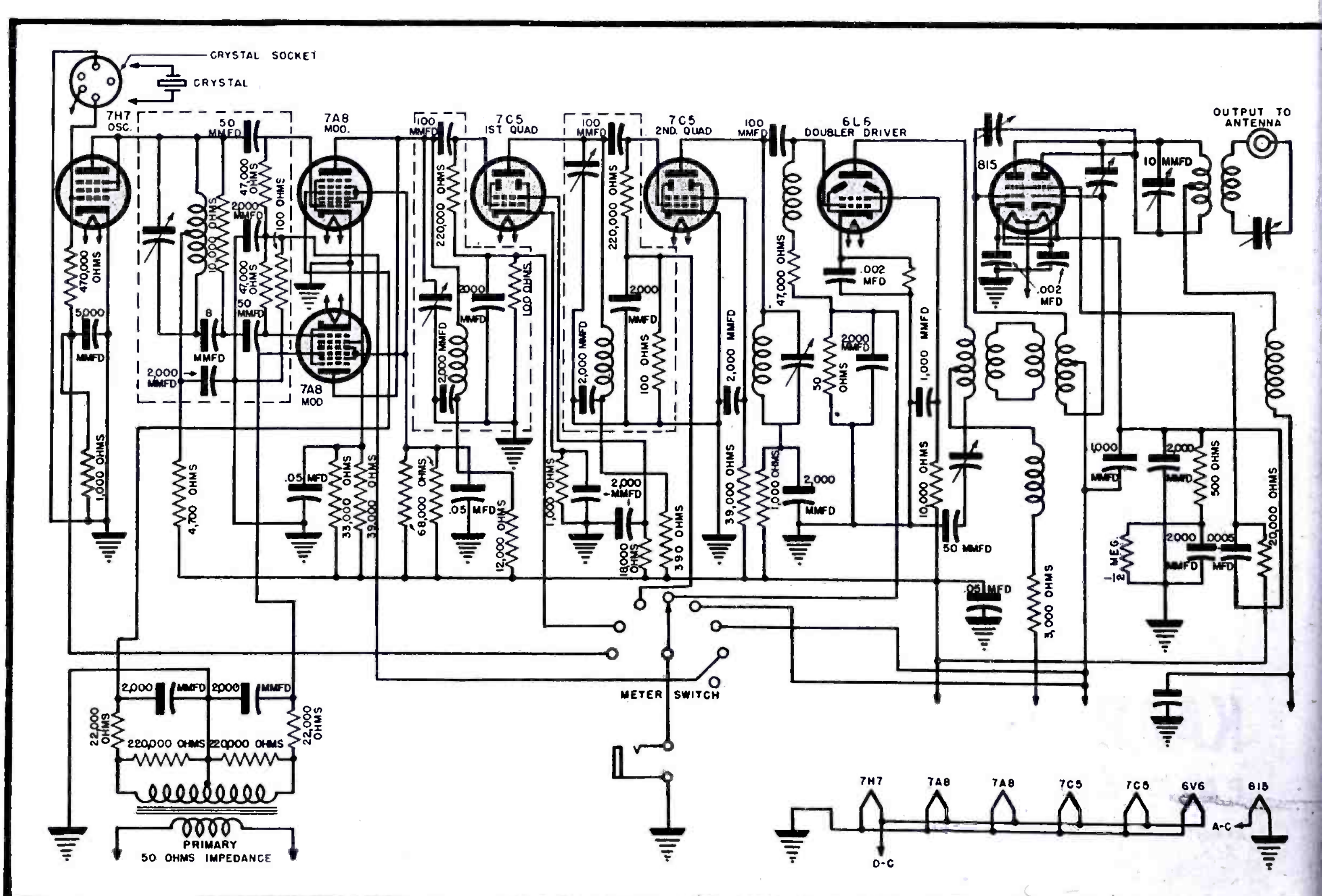
MANY railroads have become keen friends of radio communications during the past year. Railroad men have found that radio is extremely effective in expediting traffic, particularly on long freight hauls and on lengthy trains of cars.

One of the major problems in freight-traffic control has been the cab-to-caboose communications link. Without radio the hand method is necessary, a method that has obvious defects. Radio has facilitated this end-to-end contact.

Installation Problems

Installations have not been without their problems, especially where the routes are over mountainous areas. Such a route was encountered during work on the Denver & Rio Grande Western R.R. The radio system was to be installed on their diesel *Flying Ute*, pulling fast freight via the 570-mile Moffat tunnel route between

Figure 2
Circuit of the 118-mc 15-watt f-m transmitter used in the railroad system installation.



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118-MC F-M SYSTEM

Denver, Colorado and Salt Lake City, Utah.

A trial run over the route, which aided in judging the problems faced, indicated that the train run passed through about ten tunnels.

In the middle of the Moffat tunnel, which is 6.5 miles long, the train, which in this case had 65 cars, rides over a road bed that passes over the Rocky Mountain Continental Divide at an elevation of 9,239 feet above sea level.

Between Bond, Colorado, and Westwater, Utah, the railroad follows along the Colorado river, then across open rolling country to Helper, Utah; and between Helper and Salt Lake, the route goes over the Wasatch Mountains.

Surveys indicated that an extremely strong ground wave was required if communications were to be continuous over this route. The *skip* which might be more pronounced at 118 mc, the frequency used in this installation, was definitely not desired. Nor was *line-of-sight* transmission and reception to be considered, since the intervening mountains and tunnels between the front and the rear of the train would often make this impossible.

It was believed that a two one-half waves in-phase antenna array, which, if properly fed with the maximum amount of energy from an f-m transmitter, would radiate a heavy ground wave and solve the terrain difficulties. A test substantiated that decision.

The antennas adopted were of vertical doublet design, using ⅝″ copper tubing. Each half-wave section, 44″ long and fed at the center with a quarter-wave matching stub 22″ long, was tuned by a shorting bar to provide maximum energy transfer and match the impedance of a 70-ohm coaxial cable connecting the antenna to the equipment.

The equipment selected for the installation consisted of a 118-megacycle 15-watt f-m transmitter (Motorola P-8161) and a 30-40 mc f-m

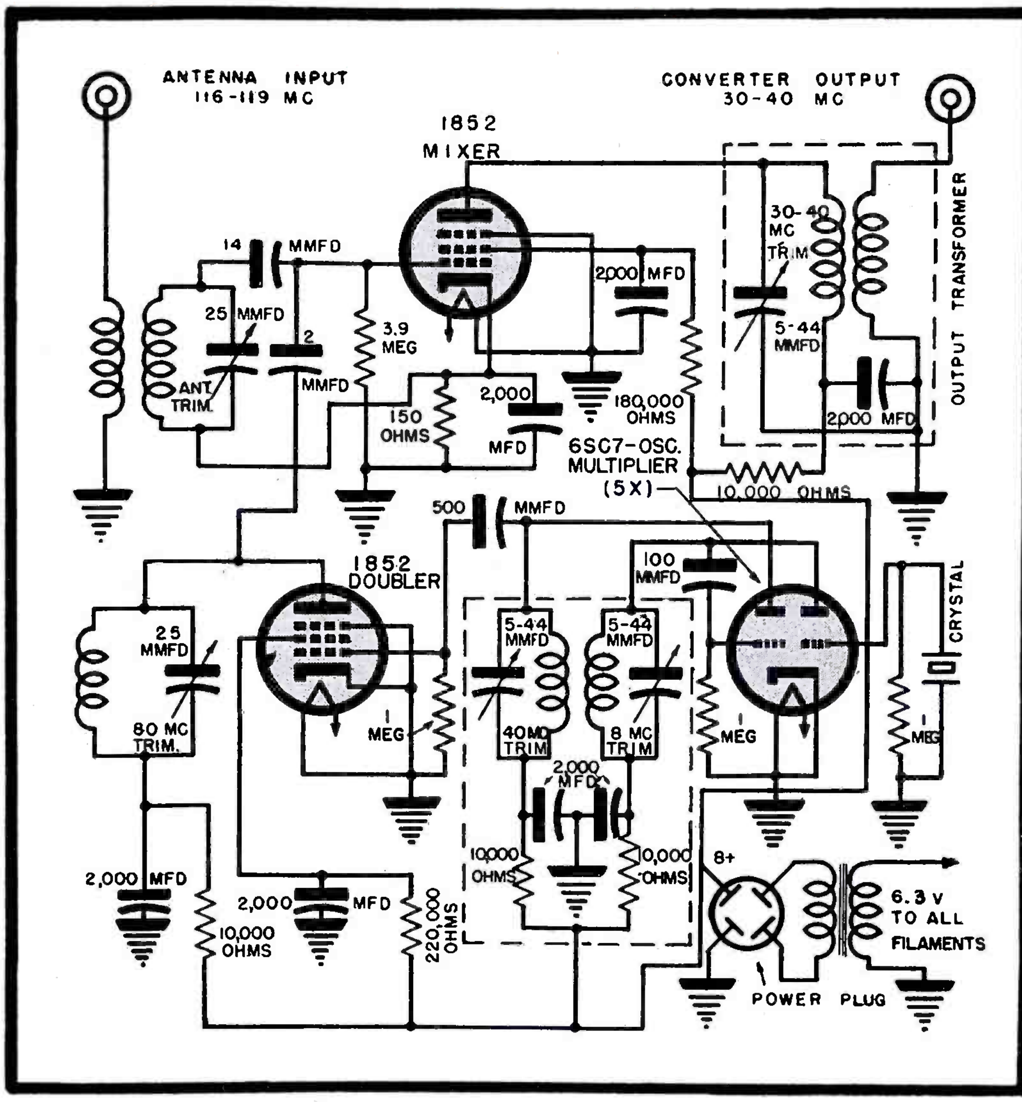


Figure 4
Circuit of the 118 to 30-mc converter.

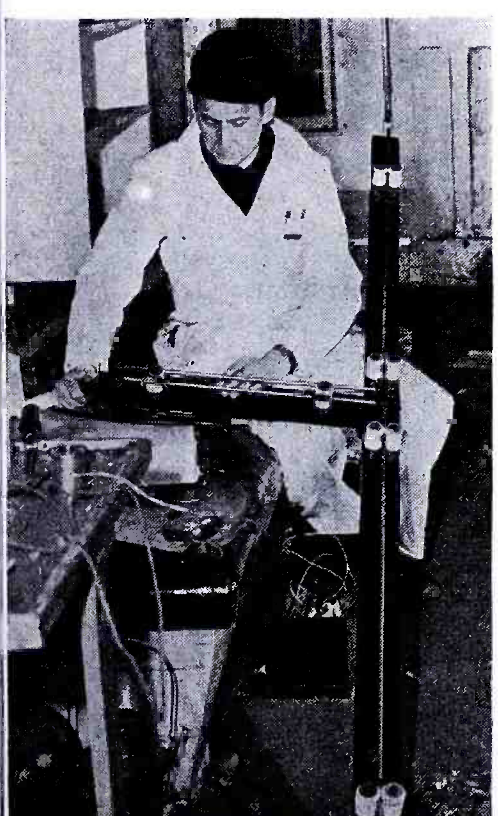
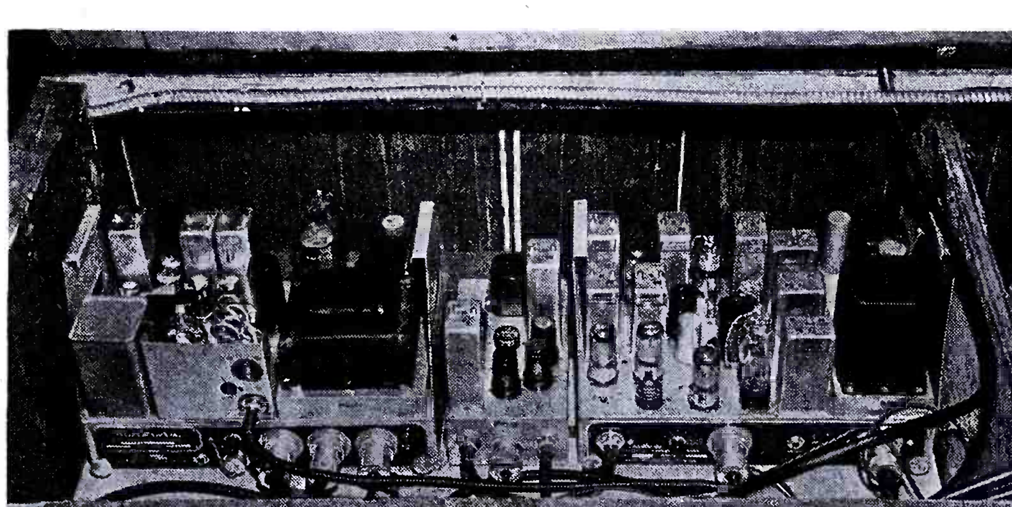


Figure 3
Checking the two one-half-waves in-phase antenna system.

Figure 5
Installation in caboose under a bunk. Left to right: transmitter, converter, and standard 30 to 40-mc f-m receiver.



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(*Continued from page 73*)

receiver (Motorola P-8160) with a converter (Motorola P-8162) for use on 118 megacycles.

In the transmitter are a 7H7 crystal controlled oscillator; two 7A8 modulators; two 7C5 quadruplers; a 6L6 doubler driver; and an 815 neutralized class *C* power amplifier.

The converter is crystal controlled, with a 6SC7 oscillator multiplier on the fifth harmonic of the crystal, followed by an 1852 doubler and an 1852 mixer. The 30-40 megacycle receiver is of standard design, with 14 tubes, including two limiters, a noise amplifier, two squelch tubes and a control tube. Output to the speaker is via a 3-ohm voice coil.

Close-Talking Microphone

To exclude local noises in the locomotive and the caboose, *close-talking* microphones, designed so that they do not respond to most of the usual noises in the locomotive cab or the caboose while the train is under way, were installed.

Carrier Call Device

Many interesting operational methods were included in the installation. For instance, when the conductor wants to talk to the engineer, he removes his microphone from its hook and pushes a *push-to-talk* button on the handle. This disengages his own loudspeaker and places his transmitter on the air. When the conductor microphone button is depressed the engineman is notified by a warning light, a red lamp, on the small panel at the receiving location in the locomotive. A green light in the caboose indicates when equipment is in operation.

In the caboose, the radio equipment is located under one of the long seats. In the locomotive the apparatus is inside the cab. Equipment consists of separate transmitting and receiving sets, operating on the same antenna.

Power Supply

On the locomotive, a-c is furnished at 115 volts from a converter, which is powered by a battery already in service for starting the engines. On the caboose, power is furnished by a small gasoline engine-driven generator delivering 115 volts a-c at 400 watts. This is mounted in a case under the car. The generator operates continuously.

The tests covered a dozen or more trips between Denver and Salt Lake.

Several incidents which would have seriously delayed the freight, had hand-methods of communications prevailed were recorded during the tests.

During one run, a fire of unknown origin started toward the rear of the train. It was discovered and the train promptly halted thanks to a report recorded by radio. The damage might have been substantial, for the cargo was explosives!

Figure 6
Running a test in the caboose of the freight train. Speaker and remote control panel are at left.

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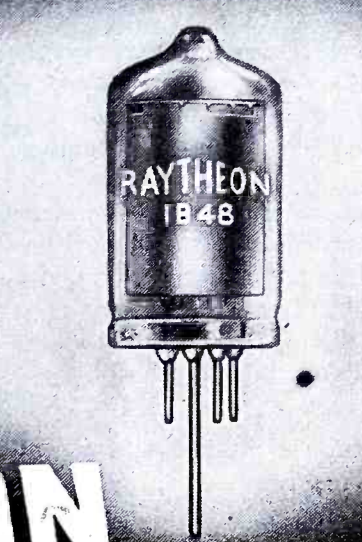


RAYTHEON
TYPE 1B48
A HIGH VOLTAGE COLD CATHODE MINIATURE GAS RECTIFIER

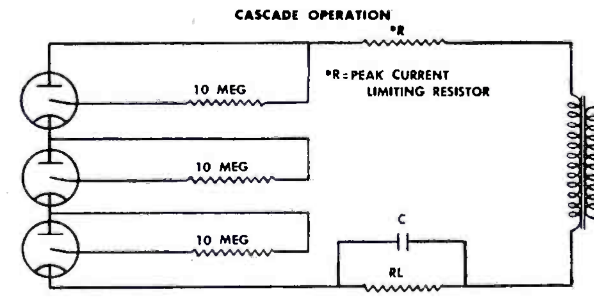
● There are many applications in which a high DC voltage, at a relatively low current, must be obtained in a minimum space and with maximum power efficiency.

If tubes necessitating a heater voltage supply are used, the space and weight requirements of a filament transformer insulated to withstand high potentials—and the additional power consumption—are often detrimental factors. Numerous oscilloscope applications are in this category.

Thus there is often a real need for a small modified miniature type cold cathode gas rectifier like the 1B48—which can easily deliver 1000 volts DC at 6 milliamperes average current. Furthermore, several tubes may be operated in series to obtain even higher voltages.

Shown below are the physical and electrical features of the 1B48. The schematic diagram indicates cascade operation in a half wave circuit. Full wave rectification may be accomplished in the conventional manner.

This Raytheon tube represents just one more entry in Raytheon's record of tube development . . . a continuing engineering program that is making possible still finer tubes for *your* postwar products.



SPECIFICATIONS OF 1B48

PHYSICAL:		
Maximum Over-all Length	2-1/4	inches
Maximum Seated Height	1-9/16	inches
Maximum Diameter	3/4	inches
ELECTRICAL:		
Maximum Peak Inverse Voltage	2700	volts
Maximum Peak Plate Current	50	ma
Average DC Voltage Drop at 6 ma	100	volts
Maximum DC Output Current	6	ma
Minimum Peak AC Starting Voltage	800	volts
Maximum Starter Anode Current	100	μa

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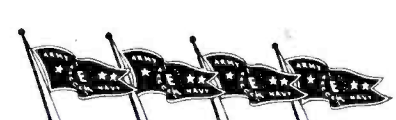

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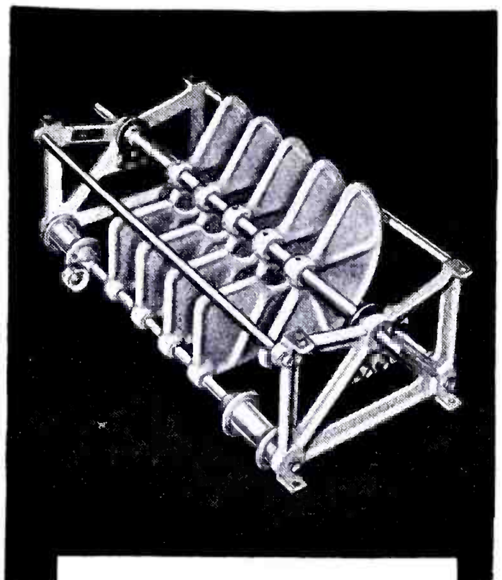


TRANSMITTER VARIABLE CONDENSER

Plate design in this JOHNSON condenser allows a 75% greater voltage breakdown rating than former models having the same spacing. Without increasing the overall size of the condenser JOHNSON engineers have raised the voltage rating by more evenly distributing the electric field, decreasing the tendency to flash over. A substantial saving in weight of plates has been achieved through the use of mechanical design ideas in placing ribs and rounded edges on the plates.

Losses in the insulation have been reduced too, first by using a good low loss material and second by judicious placement of corona shields to distribute the electric field evenly through the insulation. The rotor may be counter-weighted so the shaft will not change its position after an adjustment has been made. Multi-fingered contact brushes bear on a circular rotor contact to provide low resistance, positive contact, to the rotor. A shield is arranged on the stator terminal to nearly enclose the lead wire, resulting in less danger of sparkover at this point.

Definitely a commercial job, this condenser is worthy of consideration in the design of transmitters.

JOHNSON
a famous name in Radio

E. F. Johnson Co. Waseca, Minn.

FIELD-CIRCUIT THEORY

(*Continued from page 46*)

so that a possible solution is

$$\mathbf{E} = -j\,\omega\,\mu\,\mu_o\,\mathbf{A} \qquad 5$$

However, since the curl of the gradient of a scalar is always zero, equation *5* may have a gradient of a scalar Φ introduced so that the complete solution is given by *3*.

The scalar potential Φ is determined by the magnitudes and positions of all the charges in the system and is expressed as

$$\Phi = \iiint \frac{\rho\, d\tau}{4\pi k_e \epsilon_o r} \qquad 6$$

where τ is volume and r is distance from charge element ρ to the point under consideration.

The vector potential **A** is determined by the magnitudes, directions, and positions of all of the conduction currents in the system and is expressed as

$$\mathbf{A} = \iiint \frac{\mathbf{i}\, d\tau}{4\pi r} \qquad 7$$

Substituting *2* into *3* the solution is

$$\frac{\mathbf{i}}{\sigma} = -\text{grad}\,\Phi - j\,\omega\,\mu\,\mu_o\,\mathbf{A} \qquad 8$$

or

$$0 = \frac{\mathbf{i}}{\sigma} + j\,\omega\,\mu\,\mu_o\,\mathbf{A} + \text{grad}\,\Phi \qquad 9$$

Equation *9* is the solution by means of Maxwell's equations for the equilibrium conditions of electric field at any point in space in terms of the conduction current at the point and the effects of the charges and currents distributed throughout the surrounding space.

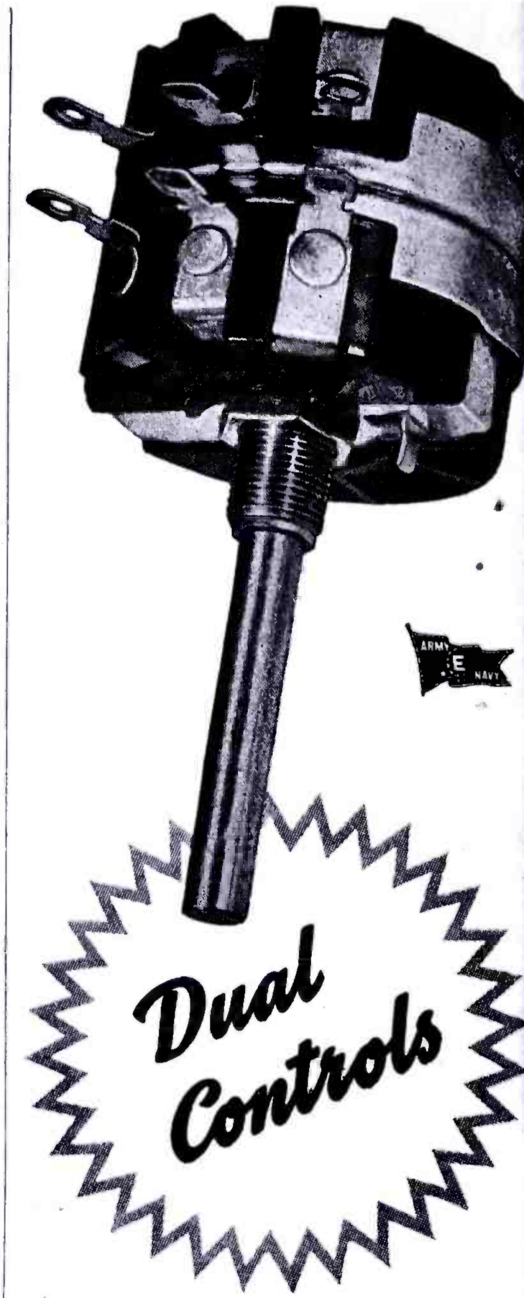
Circuit Theory Restrictions

In order to convert equation *9* into a useful circuit equation it is desirable to make certain assumptions. It is understood, of course, that any assumptions that are made will necessarily limit the applicability of the resultant equations. These assumptions are:

(1)—The circuit dimensions are small enough so that no retardation effects need be considered.

(2)—The effects of σ, **A** and Φ may be represented by separate impedance elements connected by leads of zero impedance.

Let us consider the circuit shown in Figure 1 wherein three elements consisting of pure resistance *R*, pure inductance *L* and pure capacitance *C* are employed, connected by leads of zero impedance. This circuit can be considered everywhere continuous for the conduction current except at the capacitance *C*, and at the voltage



★ The improved, tougher Type 58 Clarostat wire-wound control provides, among other notable advantages, a neat, more rugged, still more effective tandem dual assembly as here shown. Also with or without power switch.

The metal locating pin on front unit will not break or tear off. The bushing, keyed into the bakelite case, cannot slip or turn when locking nut is tightly drawn up. 1500 v. breakdown insulation between windings and shaft. Each center rail is in one piece with its terminal. Direct connection between winding and "L" and "R" terminals. Thus a real good dual control is made still better with these improved Type 58 units.

★ Submit your problems . . .

CLAROSTAT *Controls and Resistors*

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ource V. Taking the line integral of quation *9* around the closed circuit

$$\oint \mathbf{E}\cdot ds = 0 = \oint \frac{\mathbf{i}}{\sigma}\cdot ds$$

$$+ \oint j\,\omega\,\mu\,\mu_o\,\mathbf{A}\cdot ds + \oint \text{grad}\,\Phi\cdot ds \qquad 10$$

t should be noted that between b and only the term σ is effective, since a pure resistance there is no voltage rop generated by the *fields* associated ith current and charge.

Between d and e only the term involving **A** is effective since in a pure nductance the voltage drop generated s purely a function of the *field* due to onduction current flow and does not nvolve the effects of charge distribuion or electrical conductivity. Beween f and g only the term involving Φ is effective, since in a pure capaciance the voltage drop generated is urely a function of the field due to lectric charge distribution. Between and a, i.e., the voltage source V, gain only the term involving Φ is ffective, since any potential source is ssentially a device which acts to build p a charge difference at its terminals, his action occurring either mechanially, chemically or electrically.

Rewriting equation *10*

$$0 = \int_b^c \frac{\mathbf{i}}{\sigma}\cdot ds + \int_d^e j\,\omega\,\mu\,\mu_o\,\mathbf{A}\cdot ds +$$

$$\int_f^g \text{grad}\,\Phi\cdot ds + \int_h^a \text{grad}\,\Phi\cdot ds \qquad 11$$

Impositions of Boundary Conditions

Now, letting α equal the cross-sectional area of the resistance element

$$\int_b^c \frac{\mathbf{i}}{\sigma}\cdot ds = \int_b^c \frac{\mathbf{i}\alpha}{\sigma\alpha}\cdot ds \qquad 12$$

but

$$\mathbf{i}\alpha = I \qquad 13$$

where I denotes the total current and

$$\int_b^c \frac{1}{\sigma\alpha}\cdot ds = R \qquad 14$$

so that

$$\int_b^c \frac{\mathbf{i}}{\sigma}\cdot ds = IR \qquad 15$$

Now consider the term involving **A**. By definition let a coefficient L be determined by

$$L = \frac{1}{I}\int_d^e \mu\,\mu_o\,\mathbf{A}\cdot ds \qquad 16$$

so that the second term of *11* becomes

(*Continued on page* 80)

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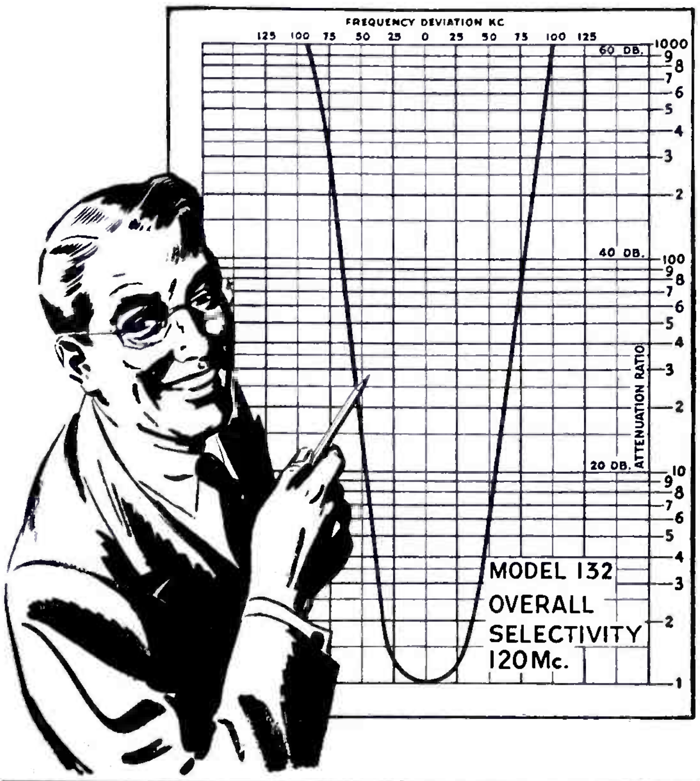

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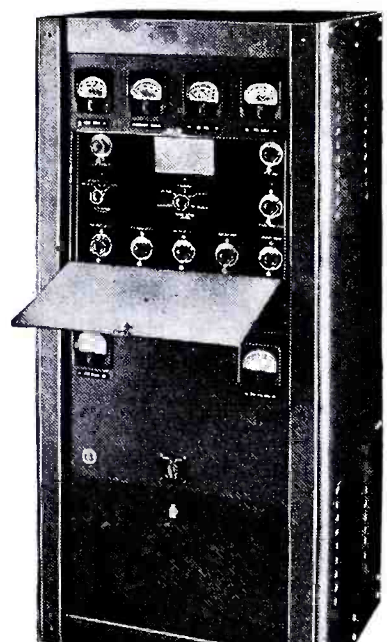

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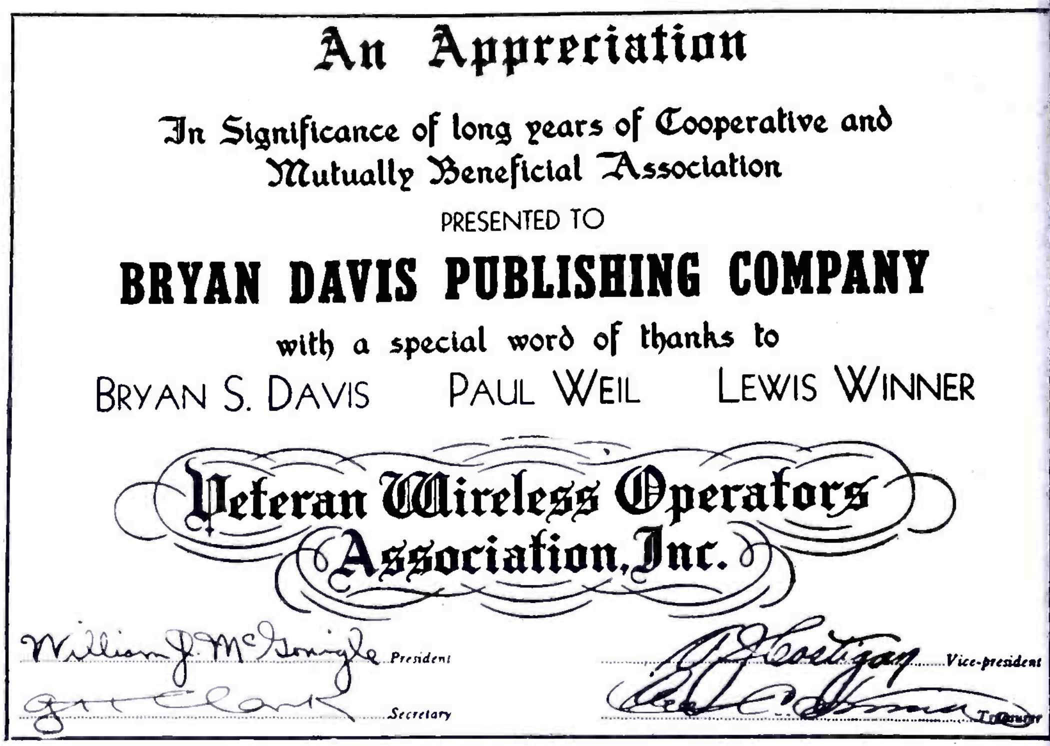
VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

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

Personals

SINCERE congratulations to Rear Admiral Carl F. Holden upon his recent promotion. Admiral Holden, while Director of Naval Communications was a guest of honor at the 1943 cruise of our association. A grand person, a fighting Admiral. . . . Dr. Allen B. Du Mont, president of the Allen B. Du Mont Laboratories has sent in a note, which said in part: "I wish you would express my appreciation to the officers, directors and members of VWOA for the Marconi Memorial Medal of Achievement presented to me at the 20th anniversary dinner-cruise, which I value greatly." . . . Frank Melville, president of the Melville Radio School, has joined our ranks. He has been a commercial radio operator since 1931, having seen service on a freighter and many airlines. . . . Other new VWOA members include P. H. Sohar and L. E. Grant. Sohar, in radio since 1919, has seen service aboard Luckenbach ships, Panama Railroad, and the Ship Owners Radio Service. L. E. Grant has had twelve years' broadcast experience. . . . Lt. John F. Hill, of the Army Signal Battalion in San Francisco has also become a VWOA member. . . . Some interesting facts about Charles M. Hodge were revealed recently. Hodge enlisted in the Navy as an Apprentice Seaman (Radio Branch) in 1925. In 1933 he became a Warrant Officer (Radio Electrician) at Ichang, China. In 1939 Hodge retired. Hodge returned to active service soon after though, and today he is in Arabia as a radio electrician with the Arabian American Oil Company. . . . Arthur Isbell, a former VWOA director, is now in San Francisco serving as a board member of OPA. . . . He continues his active VWOA interests. . . . A new VWOA member, Kenneth Richardson, is now vice president and general manager of World Wide Electronics, Inc. . . . Serving in the United States Marine Corps for two years as a Warrant Officer, Raymond W. Rodgers, Jr., has returned to his engineering position with WFIL in Philadelphia. He has requested reinstatement in VWOA, having been too busy with the War to keep up with us.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VWOA *Appreciation* scroll awarded to COMMUNICATIONS during the recent annual dinner cruise.

April Meeting

MANY attended our interesting get-together during the latter part of April. Among those present were: George Clark, secretary; Bill Simon, treasurer and executive secretary; ye prexy; "Steve" Wallis, director, now with the Allen D. Cardwell Manufacturing Company as a special expediter; Arthur H. Lynch, director, New York Manager for the National Company; Lee Smith, manager of the Seaboard branch of the New York Life Insurance Company; Peter Podell, one of our founders with Colonel Lamb, former Bronx County Commander of the Veterans of Foreign Wars; George Higgins and Peter de Angelo of the Clarostat Company; Ed Tyler, sales manager of Micamold; E. H. Price, marine superintendent of the Mackey Radio Telegraph Company; C. D. Guthrie, VWOA director and radio supervisor of the War Shipping Administration; Jack Bossen of Mackay, a charter member of VWOA; E. K. Jones, a new member; George Duvall, formerly with the Army Signal Corps, now back at the old stand as a radio and television consultant; Bill Marshall of the radio department of A. T. & T.; Sam Schneider, charter member of VWOA; Herman H. Parker, who did such a grand job as secretary for some years; Frank Orth, another charter member and a supervisor in the engineering division of CBS; George Davis, inspector with Tropical Radio; John Lohman, supervising inspector for Mackay Radio; V. P. Villandre, war services manager for Radiomarine; Henry Hayden and Mr. Wunderlich of the engineering department of Ward Leonard.

Tribute

FROM the president of a leading advertising agency we've received a note praising our Year Book. He said: "I want to congratulate you on the excellence of the 1945 Year Book of the VWOA. . . . I have never seen a more enlightening and interesting presentation of leading personalities and their work. . . . Of special note was the praise offered to wireless by generals, admirals and others of our fighting forces, stressing the contributions made toward the winning of the war."

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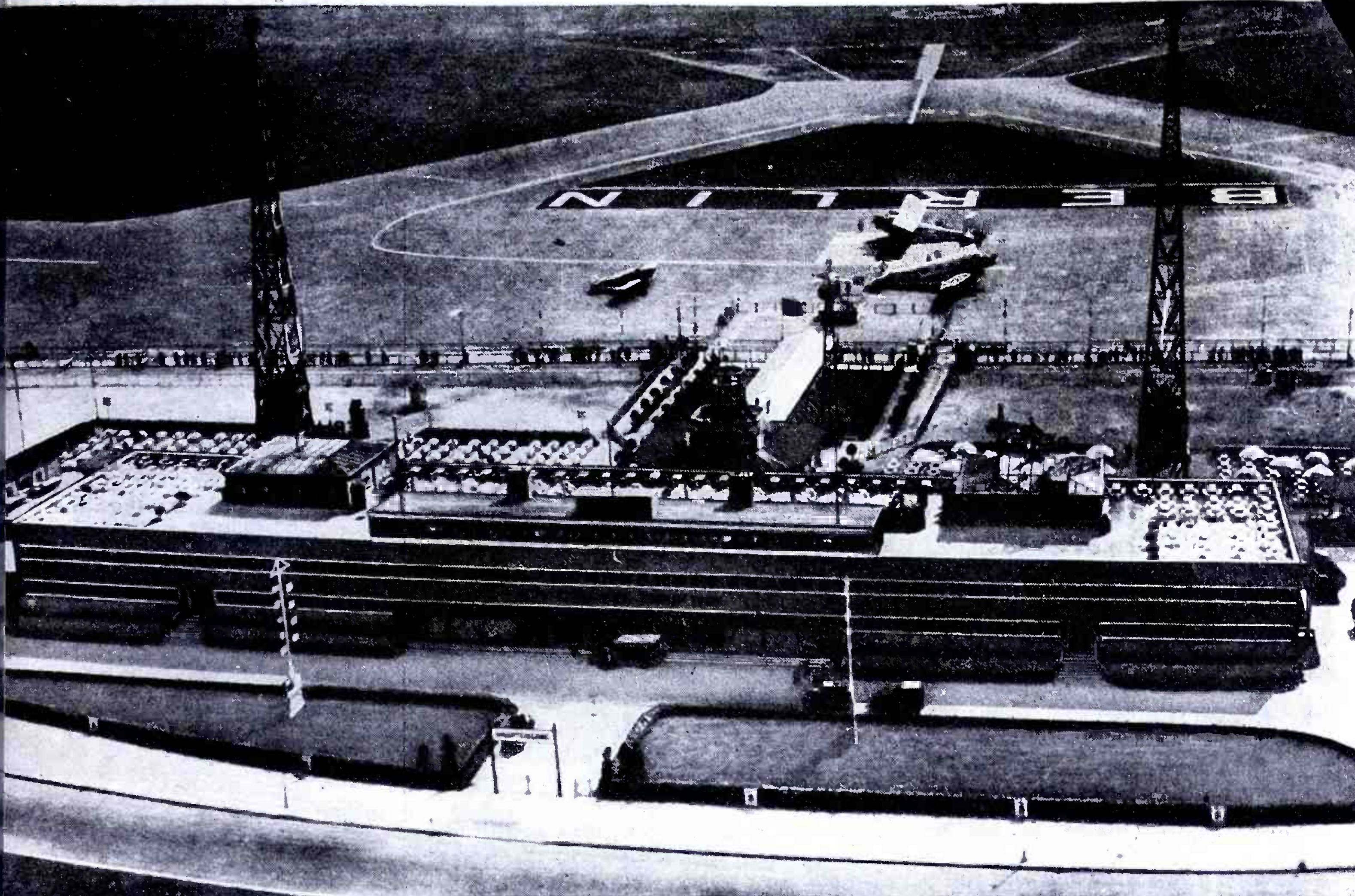

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AP PHOTO

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MPLEHOF AIRPORT, just outside rlin, and one of the major airports of world, came under new management late in April, due to circumstances beyond the control of the own-. Under its new management, it will undoubtedly serve its purpose with a greatly enlightened vision. The outlook for the immediate future is for continued military patronage, although it will lose its former principal military user. Upon the completion of certain operations now in progress in Germany, the airport will probably be reopened to civilian aviation, limited perhaps to foreign planes, owing to a serious dislocation of the airplane manufacturing industry in the Reich.

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New management brings new policies; new policies often include new equipment—which is where *RADIO RECEPTOR* comes in. *RADIO RECEPTOR* is v planning with leading airlines and airports, here and abroad, for their vigation, airport traffic control and communication ground radio requirements.

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Now is the time to plan—purchase can be deferred until later, if necessary. e predicted large demand on manufacturing facilities incident on the enor-us expansion of our domestic program strongly suggests immediate action.

Another issue of *"HIGHWAYS OF THE AIR"* — a non-technical review and digest of fact and opinion on the importance of radio in aviation — is now in course of preparation. Date of publication depends upon the paper situation and other factors. Meanwhile, those interested in airport development are invited to write for a copy on their business letterhead. No obligation is entailed.

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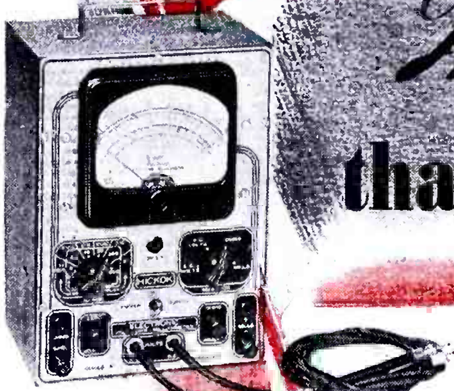
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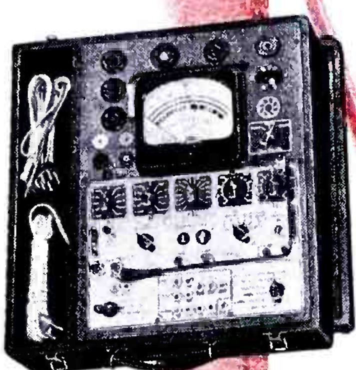
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FIELD-CIRCUIT THEO[RY]

(*Continued from page 77*)

$$\int_d^e j\,\omega\,\mu\,\mu_0\,\mathbf{A}\cdot ds = j\,\omega\,L\,I$$

It can be shown from *16* that the co-efficient L is what is commonly kno[wn] as the inductance.

Since the third term of *11* conce[rns] the integral of a gradient of Φ, it [is] equal to the difference between values of Φ at points g and f. Th[us]

$$\int_f^g \text{grad}\,\Phi\cdot ds = \Phi_g - \Phi_f$$

For a lumped element such as [a capacitor,] integrating *6* shows that the volta[ge] drop is proportional to the total char[ge] q at any instant. Letting $1/C$ be t[he] constant of proportionality

$$\Phi_g - \Phi_f = \frac{q}{C}$$

but

$$q = \frac{I}{j\,\omega}$$

so that

$$\int_f^g \text{grad}\,\Phi\cdot ds = \frac{I}{j\,\omega\,C}$$

C in *21* is what is commonly know[n] as capacitance.

The final term of *11* is determin[ed] directly by the emf of the source, [so] that

$$\int_h^a \text{grad}\,\Phi\cdot ds = V_{ha} = -V_{ah}$$

where V_{ah} is the source voltage.

This treatment differs from th[at] presented by Ramo and Whinnery [in] their book, *Fields and Waves in Mo[d]ern Radio,* in that it eliminates th[e] weak assumption that the impresse[d] voltage must be separated out fro[m] the solution of Maxwell's equations.

Equation *11* thus becomes

$$0 = I\,R + j\omega L I + \frac{I}{j\,\omega\,C} - V_{ah}$$

Equation *23* is Kirchoff's wel[l] known law for the equilibrium [of] voltages around a circuit.

Discussion

Equation *23* shows that Kirchoff['s] laws may be derived directly fro[m] Maxwell's equations with certain sim[-]plifying assumptions. The first as[-]sumption made was that the circu[it] dimensions be small enough so that n[o] retardation effects need be considere[d.] This does not mean that the circu[it] element dimensions must be so sma[ll] that no wave propagation takes plac[e]

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within them. What is really meant is that at the two terminals of the impedance element an equivalent *lumped* impedance can be considered to exist. Thus, if a lossless cavity fed by a small dipole were considered to be one of the elements, it can be replaced by an equivalent value of C or L at the specific frequency involved.

The assumptions made also rule out the possibility of using a transmission line or wave guide section which is not negligible in electrical length as a connecting element between two points in a circuit. It still allows the use, however, of transmission lines and wave guides for two terminal impedance circuit elements. The second assumption, wherein the effects of σ, Φ and $\mathbf{A}$ have to be represented by separate impedances, is necessary in order to substitute in Kirchoff's law. This does not mean that each element has to be either pure resistive or pure reactive, but rather that it may be represented by impedances made up of resistive and reactive elements. Thus, a cavity element may be represented by a reactive element determined by its tuning and a resistive element determined by its loss. In many cases the resistive component is dropped for simplification, but it may always be included for rigorous solutions.

UTILITY COMMUNICATIONS

(*Continued from page* 45)

ment but not supplant the established voice transmissions. Consequently, the basic system may be installed and engineered primarily for voice coverage of the desired area without fear of obsolescence upon the availability of new services. Due consideration must be given to general developments in communication equipment during the war. New designs now being planned for release as soon as war conditions permit will be far superior to prewar models. General postwar planning now under way by all electric utilities should include a comprehensive radio communications system for installation when new equipment can be obtained.

Utility Communications Future

Extended radio communication systems will enable the electric utilities to operate even more efficiently, expand service to areas hitherto not supplied, and render the maximum service to the greatest number of consumers at the lowest possible cost, thus truly serving in the public *interest, convenience and necessity.*

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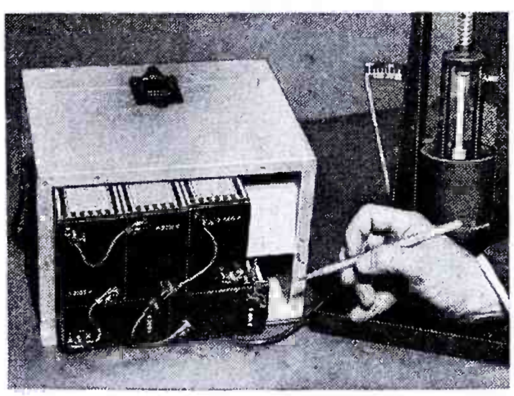

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FREQUENCY CONVERSION

(*Continued from page* 58)

mixers differs from the mixing action in circuit-coupled mixers, as described by equation *1*. The action is simply understood if we look at a mixer as a device of variable conductance, the value of the conductance being periodically controlled by the local-oscillator voltage. Thus in case of a circuit-coupled device the oscillator voltage acts to move the *Q*-point back and forth along the i-e characteristic for the mixer, the change in slope indicating the change in conductance or transconductance, Figure 4*a*. Such a converter may be referred to as a *sliding-Q-point converter*, or, as the path of operation remains essentially the same during operation, as a *fixed-path-of-operation* (fpo) *converter*.[3] The applied signal wave, when passing through the non-linear device, is periodically expanded and contracted, i-e becomes modulated, and all the various components given by the classical modulation theory appear in the output. There is one component of applied frequency $A/2\pi$, and two side frequencies $(A \pm B)/2\pi$, where $B/2\pi$ is the frequency of the local oscillator. If all these components are picked up we have the typical case of a modulator (the square-law or Van der Bijl modulator); but if all other components except $(A - B)/2\pi$ are rejected in the output we have the typical case of a frequency converter.

In case of an electron-coupled device the conductance variation is performed not by sliding the *Q*-point on the curved i-e characteristic for the signal electrode, but by shifting the *Q*-point along an ordinate from one signal electrode characteristic to another, the instantaneous value of the voltage on the oscillator-grid determining the signal electrode characteristic on which the *Q*-point is located. These conditions are illustrated by Figure 4*b*. For simplicity the signal-electrode characteristic has been assumed to be straight, which proves that rectification on the input electrode is not a necessary condition for frequency conversion. When the signal wave is applied to the signal electrode the *Q*-point moves within a region *abcd*, and changes its path continuously until a complete sequence of movements is completed. This type of converter may, therefore, be referred to as a *shifting-Q-point converter* or *changing-path-of-operation* (*cpo*) *converter*.

The action of the oscillator grid may as well be viewed as being the action of a valve or a gate, sometimes open-

[3]Harry Stockman, *Superheterodyne Converter Terminology, Electronics*; Nov. 1943.

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ɡ up in phase with the signal grid d sometimes opening up out of phase th the signal grid. Regardless of ether the oscillator grid precedes or lows the signal grid, it changes the e coefficients of that grid, and the ion may be expressed as a variation the transconductance of the signal d. This effect may be referred to the *gate-effect*, and is explained re in detail in one of the references.[1]

Generally, for both circuit-coupled d electron-coupled devices the action y be explained as follows, in terms transconductance variation. Let us ume the transconductance of the nal grid with a constant polarizan potential on the oscillator grid to g_m. Then when a variational oscilor voltage of assumed amplitude $= kE_{B\,max}$ is superimposed

$$(g_m)_{inst} = g_m + k E_{B\,max} \cos Bt, \qquad 2$$

ere k is a proportionality constant. r an input voltage $e_A = E_{A\,max}$ cos the variational output current of erest is

$$(k E_{B\,max} \cos Bt)\,(E_{A\,max} \cos At)$$
$$= k E_{A\,max} E_{B\,max} \cos At \cos Bt, \qquad 3$$

after further developments

$$------ + \tfrac{1}{2} k E_{A\,max} E_{B\,max} \cos (A - B)\, t \qquad 4$$

When electron-coupling was tried in practice the tube and set manuturers soon became aware of the t that although circuit coupling was uced to a negligible amount, aner type of undesirable coupling own as *indirect interaction* or (*unirable*) *space-charge coupling* apred. This coupling is obtained via space charge (or virtual cathode) ich in most tubes of this kind deops in the neighborhood of the sig grid. When the intensity of such pace-charge is varied at the oscilr frequency and electrons move to from the signal grid, correspond charges move through the grid imance, setting up voltages of oscilr frequency across the tuned signal-l circuit. The amplitude and phase these voltages depend upon tuning impedance conditions, but the ef is more or less the same as if such ages had been set up by direct inction, or via undesirable circuit pling. Various means of reducing effect of space-charge coupling are cribed in the literature.[5]

comparison of circuit- and elec-n-coupled converters with reference automatic-volume regulation favors

(*Continued on page* 84)

arry Stockman, *A Treatment of Nonar Devices based upon the Theory of Re Linear Functions*, Journal of Applied hics; December 1943

W. Herold, *The Operation of Frequency erters and Mixers for Superheterodyne Reon*, Proceedings IRE; February, 1942

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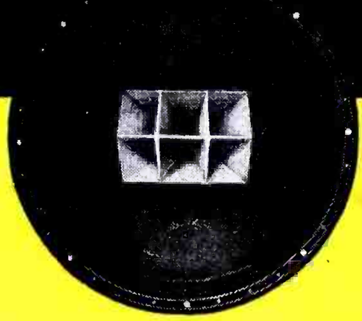
KEEP OFF THE *Beam*



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FREQUENCY CONVERSION

(*Continued from page* 83)

the latter type of converters at broadcast frequencies. This is mainly because avc voltage disturbs the rectification action in circuit-coupled single-input devices, but is not necessarily harmful to the mixing operation of electron-coupled double-input devices. This is, however, only true if the frequency is sufficiently low, and on the short-wave bands the avc action is considerably impaired. This is partly because the variations in space-charge intensity and tube gain alters the equivalent input admittance and thus provides for detuning of the signal grid circuit. In case of converter tubes the effect is primarily less satisfactory oscillator operation, and at u-h-f the oscillator may cease to operate altogether. It is therefore common to find receivers so designed that the converter stage operates with avc on broadcast and short-wave bands but without avc on u-h-f bands. There are a complexity of phenomena governing avc-action which have been described in technical papers.

H-F- Problems

The general tendency of mixer and converter tubes to give poorer performance at high frequencies became of great importance around 1935-1938, when television and other services pressed down the lower wavelength limit from 15 or 20 meters to 6 or 7 meters. Especially in converter tubes, poor oscillator action together with undesirable space-charge coupling and transit-time effects limited the use to wavelengths above 10 meters or so, even if good frequency converter action was possible at television wavelengths. In general, mixer tubes are useable at higher frequencies than converter tubes, as a mixer may be used with an oscillator suitable for short-wave operation. Triode-hexodes and triode-heptodes may be used to about the same frequency limit as mixer tubes. Modern television and f-m receivers use triode-hexodes, triode-heptodes or mixer tubes. With a mixer tube of pentagrid type, operation at a wavelength of a few meters is possible.

Non-Linear Effects

Around 1940 a new type of converter became appreciated for the region of frequencies where multielectrode types of mixer tubes cease to operate. This new type of converter employed a diode or crystal as non-linear element, in some cases a triode,

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later became of the greatest interest as centimeter-wave converters.

...her Converter Applications

The foregoing discussion has been ...oted to the development of fre...ncy converters used in receivers. ...e use in measurement technique and ...quency modulation will now be con...ered.

The method of determining an un...own frequency by means of hetero...ing was probably known and used ...eady by Fessenden. The possibili...s of the method became more and ...re appreciated as the art proceeded ...l the technique of utilizing har...nics for frequency determination ...s adopted. With a heterodyne ...vemeter the frequency of a source ...ld be determined with very high ...uracy and without appreciable load... of the source. The main difficulty ...olved is the uncertainty of how a ...rticular sum or difference frequency ...produced; if by the two fundamentals ...ncerned or by any particular pair of ...rmonics. There are, however, re...ble ways of determining the fre...ency, and when properly used the ...thod is of the greatest importance, ...t the least in work at ultrahigh fre...encies.

...M Uses

Frequency-modulation receivers em...y frequency conversion in the same ...y as amplitude modulation receivers. ...e converters differ in design with ...spect to bandwidths, whistle genera...on, etc. On the transmitting side, the ...ocess of frequency conversion is ...re unique. Direct crystal-controlled ...nsmitters for meter and centimeter ...ves do not require frequency con...rters. Direct crystal-controlled ...ansmitters for broadcast purposes ...erating around five to ten meters, ...nerally require frequency converters. ... his early design, prior to 1935, ...rmstrong employed considerable fre...ency multiplication, necessitated for ...taining a large frequency swing in ...e output. This multiplication re...lted in a carrier frequency above ...e desired value. To prevent this he ...serted a frequency converter some...here between the modulator and the ...tenna.

In the indirect crystal-controlled sys...m frequency conversion is needed as ...ell to provide for the frequency con...olling action.

...dditional References

A. W. Hull, N. H. Williams, *Charac...ristics of Shielded-Grid Pliotrons*, Phys. ...ev., p. 432; Apr., 1926.

A. W. Hull, *Measurement of High-...requency Amplification With Shielded-...rid Pliotrons*, Phys. Rev., p. 439; Apr. 1926.

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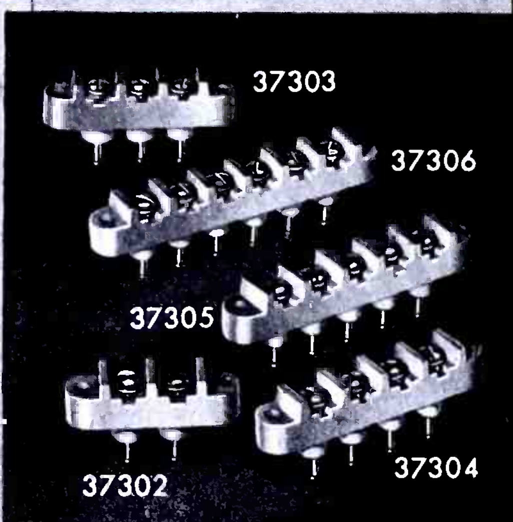

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RESISTIVE NETWORKS

(*Continued from page 70*)

$$i_u = \frac{E}{\Phi}\left[z(v+w) + w(t+v)\right]$$

$$= \frac{E}{\Phi}\left[y_1 z + w x_2\right] \qquad 62$$

$$i_v = \frac{E}{\Phi}\left[z(t+u) + t(u+w)\right]$$

$$= \frac{E}{\Phi}\left[x_1 z + t y_2\right] \qquad 63$$

$$i_w = \frac{E}{\Phi}\left[z(t+u) + u(t+v)\right]$$

$$= \frac{E}{\Phi}\left[x_1 z + u x_2\right] \qquad 64$$

$$i_Z = \frac{E}{\Phi}\left[z(t+v) + (u+w)(t+v+z)\right]$$

$$= \frac{E}{\Phi}\left[z(x_2 + y_2) + x_2 y_2\right] \qquad 65$$

$$i_z = \frac{E}{\Phi}\left[(uv - tw)\right] = \frac{E}{\Phi}\left[uv - tw\right] \qquad 66$$

where:

$$\text{letting}\begin{cases} x_1 = t+u, & y_1 = v+w \\ x_2 = t+v, & y_2 = u+w \end{cases} \qquad 67$$

$$\Phi = Zz(t+u+v+w) + (Z+z)(uv+tw) + Z(vw+tu) + z(tv+uw) + tu(v+w) + vw(t+u) \qquad 68$$

or

$$\Phi = Zz(x_1+y_1) + (Z+z)(uv+tw) + Z(vw+tu) + z(tv+uw) + vw\,x_1 + tu\,y_1 \qquad 69$$

Transmission Loss of the Lattice Network

On an image impedance basis, the transmission loss is

$$db = 10\,\text{Log}_{10}(P_Z/P_z) = 10\,\text{Log}_{10}\,k^2 = 20\,\text{Log}_{10}\,k \qquad 70$$

where P_Z = power delivered to the network input terminals, and

P_z = power delivered to the load.

Hence the power transmission loss is,

$$db = 10\,\text{Log}_{10}\frac{i'^2_Z Z}{i'^2_z z} = 20\,\text{Log}_{10}\left[\frac{i_Z}{i_z} s\right] \qquad 71$$

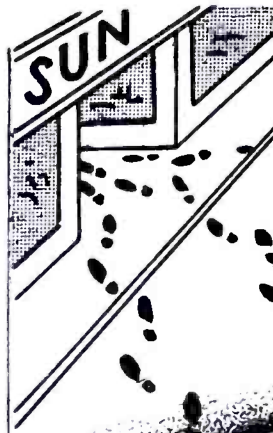
resulting in

$$db = 20\,\text{Log}_{10}\left[s\left[\frac{z(x_2+y_2) + x_2 y_2}{uv - tw}\right]\right]$$

$$= 20\,\text{Log}_{10}\left[s\,\frac{z\Psi + x_2 y_2}{uv - tw}\right] \qquad 72$$

Therefore, from *70* and *72*,

$$k = \frac{z(x_2+y_2) + x_2 y_2}{uv - tw}\,s = \frac{z\Psi + x_2 y_2}{uv - tw}\,s \qquad 73$$



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en the terminations are equal, z, u = v, and t = w. Then the tion

$$z\Psi + \frac{x_2y_2}{uv - tw} = \frac{y_1 + 2z}{v - w}$$

$$= \frac{v + w + 2z}{y - w} = 1 + \frac{2z}{v - w} \qquad 74$$

ge Impedances of the Lattice ework

hese are found by making use of open and short-circuited condi-s for the network as explained in 1^2 and shown for the *T* and π works previously. The image im-nce at the larger impedance end he network is

$$(Z_{sc}\,Z_{oc})^{1/2} = \left[\left(\frac{tv}{t+v} + \frac{uw}{u+w}\right)\left(\frac{(t+u)\,(v+w)}{t+u+v+w}\right)\right]^{1/2} \qquad 75$$

$$= \left[\frac{tv\,y_2 + uw\,x_2}{x_2\,y_2} \cdot \frac{x_1\,y_1}{x_1 + y_1}\right]^{1/2} \qquad 76$$

that at the smaller end is

$$(z_{sc}\,z_{oc})^{1/2} = \left[\left(\frac{tu}{t+u} + \frac{vw}{v+w}\right)\left(\frac{(t+v)\,(u+w)}{t+u+v+w}\right)\right]^{1/2} \qquad 77$$

$$= \left[\frac{tu\,y_1 + vw\,x_1}{x_1y_1} \cdot \frac{x_2y_2}{x_2 + y_2}\right]^{1/2} \qquad 78$$

product

$$= \left[\frac{(tv\,y_2 + uw\,x_2)\,(tu\,y_1 + vw\,x_1)}{(x_1 + y_1)^2}\right]^{1/2} \qquad 79$$

quotient

$$\frac{Z}{z} = s^2 = \left[\frac{tv\,y_2 + uw\,x_2}{vw\,x_1 + tu\,y_1} \cdot \frac{x_1\,y_1}{x_2\,y_2}\right]^{1/2} \qquad 80$$

imposing a special condition or re-onship between the elements, these ations are reduced to much simpler ns. Let

$$= tu \qquad 81$$

$$Zz = (vw) = (tu) \qquad 82$$

$$\frac{Z}{z} = s^2 = \frac{(t+u)\,(v+w)}{(t+v)\,(u+w)} = \frac{x_1y_1}{x_2y_2} \qquad 83$$

he equivalent *T* for this case is n by Figure 20 in the chart.

y solving equations *73, 79* and *80*

(*Continued on page* 88)

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1025- 4	12	9	9	1025-16	24	15	15
1025- 5	18	9	6	1025-17	24	18	12
1025- 6	18	9	9	1025-18	24	18	15
1025- 7	18	12	9	1025-19	24	18	18
1025- 8	18	6	6	1025-20	24	12	9
1025- 9	18	15	9	1025-21	42	9	9
1025-10	18	12	6	1025-22	36	12	9
1025-11	18	15	12	1025-23	30	15	9
1025-12	18	12	12	1025-24	42	12	9

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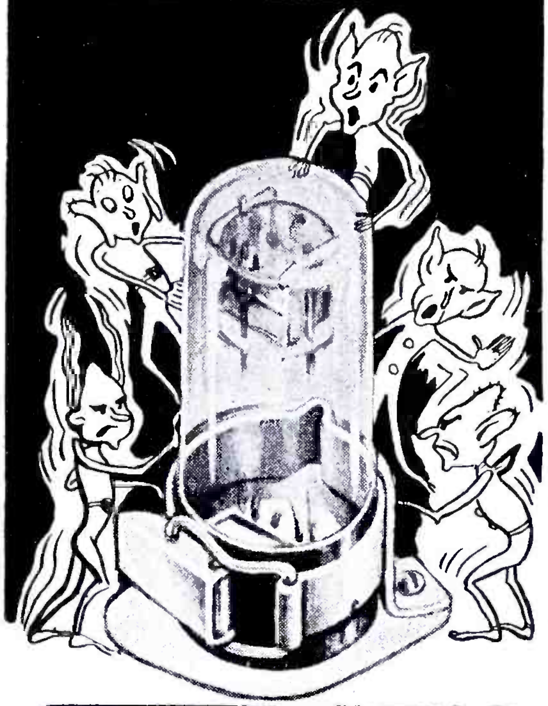

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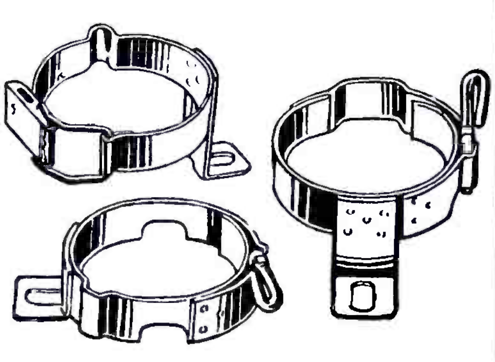

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(Continued from page 87)

explicitly for the element values in terms of the function k and the terminations, the network elements are found to be given by symmetrical appearing equations* which differ only in their algebraic signs, but are of the same form.

These algebraic forms with suitable change in notation to conform to the nomenclature of this paper for $Z/z \geqq 1$, are

$$t = \frac{(k^2-1)s+(k^2+1)\sqrt{s^2-1}}{(k^2+1)+2ks}\sqrt{Zz} \qquad 84$$

$$u = \frac{(k^2-1)s-(k^2+1)\sqrt{s^2-1}}{(k^2+1)-2ks}\sqrt{Zz} \qquad 85$$

$$v = \frac{(k^2-1)s+(k^2+1)\sqrt{s^2-1}}{(k^2+1)-2ks}\sqrt{Zz} \qquad 86$$

$$w = \frac{(k^2-1)s-(k^2+1)\sqrt{s^2-1}}{(k^2+1)+2ks}\sqrt{Zz} \qquad 87$$

Exponential Function

By making the substitution of $k^2 = \varepsilon^{2\theta}$, these may be written in the hyperbolic form, from the definitions of the hyperbolic functions, in terms of the exponential function. These then become for $Z/z \geqq 1$

$$t = Z\frac{y \tanh\theta + (y^2-z^2)^{1/2}}{y + Z \operatorname{sech}\theta}$$

$$= Z\frac{y \sinh\theta + (y^2-z^2)^{1/2}\cosh\theta}{y\cosh\theta + Z} \qquad 88$$

$$u = Z\frac{y \tanh\theta - (y^2-z^2)^{1/2}}{y - Z \operatorname{sech}\theta}$$

$$= Z\frac{y \sinh\theta - (y^2-z^2)^{1/2}\cosh\theta}{y\cosh\theta - Z} \qquad 89$$

$$v = Z\frac{y \tanh\theta + (y^2-z^2)^{1/2}}{y - Z \operatorname{sech}\theta}$$

$$= Z\frac{y \sinh\theta + (y^2-z^2)^{1/2}\cosh\theta}{y\cosh\theta - Z} \qquad 90$$

$$w = Z\frac{y \tanh\theta - (y^2-z^2)^{1/2}}{y + Z \operatorname{sech}\theta}$$

$$= Z\frac{y \sinh\theta - (y^2-z^2)^{1/2}\cosh\theta}{y\cosh\theta + Z} \qquad 91$$

where $y^2 = Zz$ and $\theta = 0.115129 \times$ No. (db) loss of the network.

Network Parameters

By making the substitutions for the algebraic and the hyperbolic forms as defined by the *Tables of Hyperbolic Functions Key Form,* in terms of the symbolical notation adopted for compactness, the parameters of the network become

*Guy C. Omer, Jr., *Lattice Attenuating Networks,* Proc. IRE; May 1937.

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$$= y\,\frac{s+cx}{c+as} \qquad 92$$

$$\frac{Cs-\sqrt{s^2-1}}{1-bs} = y\,\frac{s-c\sqrt{s^2-1}}{c-as}$$

$$= y\,\frac{s-cx}{c-as} \qquad 93$$

$$\frac{Cs+\sqrt{s^2-1}}{1-bs} = y\,\frac{s+c\sqrt{s^2-1}}{c-as}$$

$$= y\,\frac{s+cx}{c-as} \qquad 94$$

$$y\,\frac{Cs-\sqrt{s^2-1}}{1+bs} = y\,\frac{s-c\sqrt{s^2-1}}{c+as}$$

$$= y\,\frac{s-cx}{c+as} \qquad 95$$

...ere $s^2 \geq 1$; $x = (s^2-1)^{1/2}$, $a =$ ...θ; $c = \coth\theta$; $b = \text{sech}\,\theta$; and ... $(Zz)y^2$.

...hen the terminating impedances ... equal, $Z = z$, the forms for the ...ameters become quite simple since ..., $u = v$ and $t = w$, or

$$w = z\,\frac{k-1}{k+1} = z\tanh\frac{\theta}{2} = Dz \qquad 96$$

...ch is the same value as that for the ...es arm of an unbalanced-to-ground ...mmetrical *T* pad having equal atten-...on.

$$v = z\,\frac{k+1}{k-1} = z\coth\frac{\theta}{2} = dz \qquad 97$$

...ch is the same value for a given ... as the shunt arm for an unbal-...ed-to-ground symmetrical π pad.

...tice Network Unit Impedance

...o place the lattice network on a ...t basis, it is only necessary to di-...e all parameters and terminations ..., the smaller impedance. This will ...e the network on a conditionally ...t basis with a one-ohm termination ...one end and s^2 ohms at the other. ...it is desired to place the network ...n an absolute unit basis, an ideal ...nsformer having an impedance ...nsformation ratio of s^2 to 1 may be ...d. Suitable primes may be used ... shown by Figure 8 in the charts ... *Part III.*[1]

...ll of the design information pre-...ted here for the lattice network ...h $tu = vw$ and Z/z 1 was pre-...ted in chart form in *Part III*,[1] Fig-...s 7 and 8. As may be noted, this ...work is only one of many special ...es of the general lattice shown in ...ure 1 of the chart on equivalent

(*Continued on page* 90)

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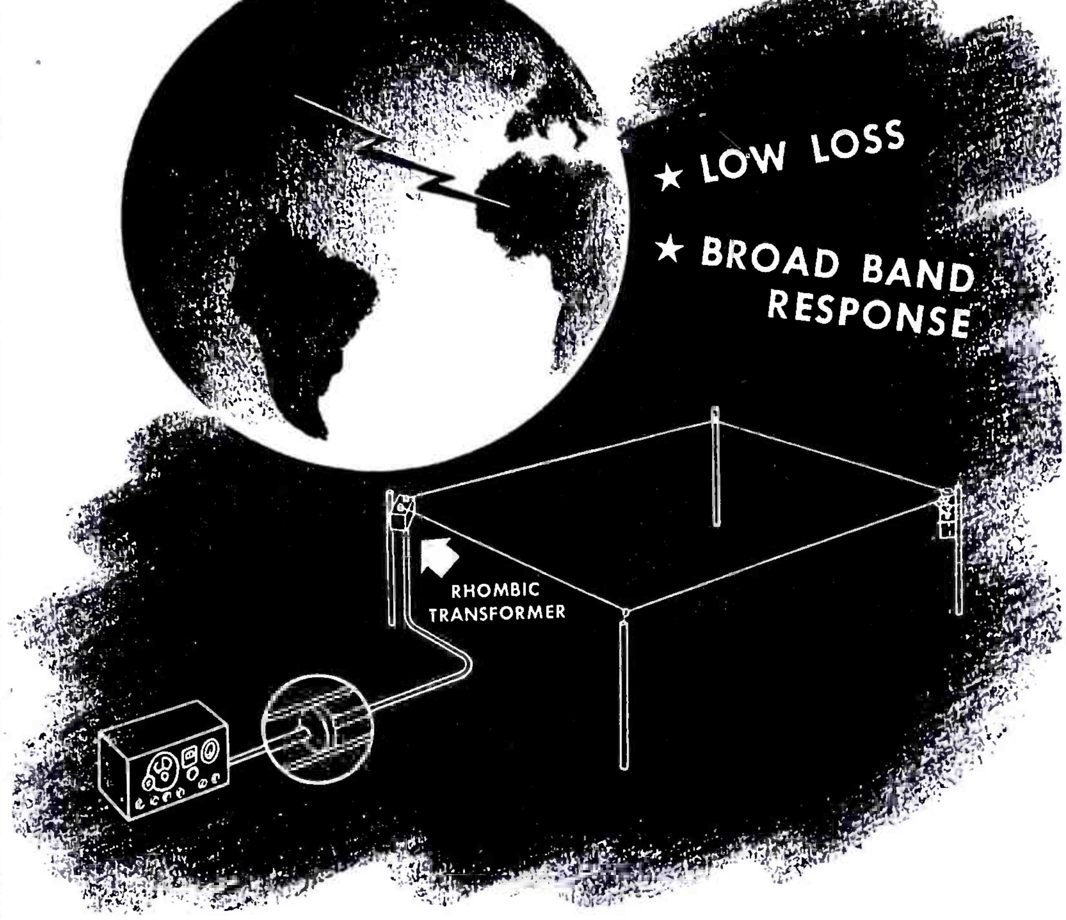

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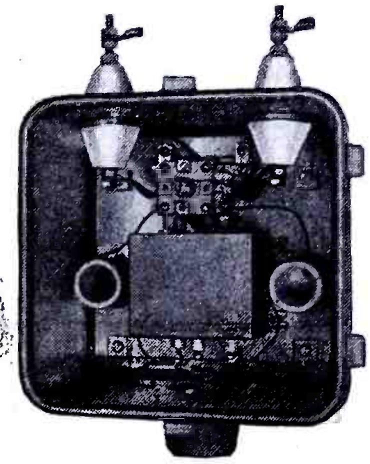

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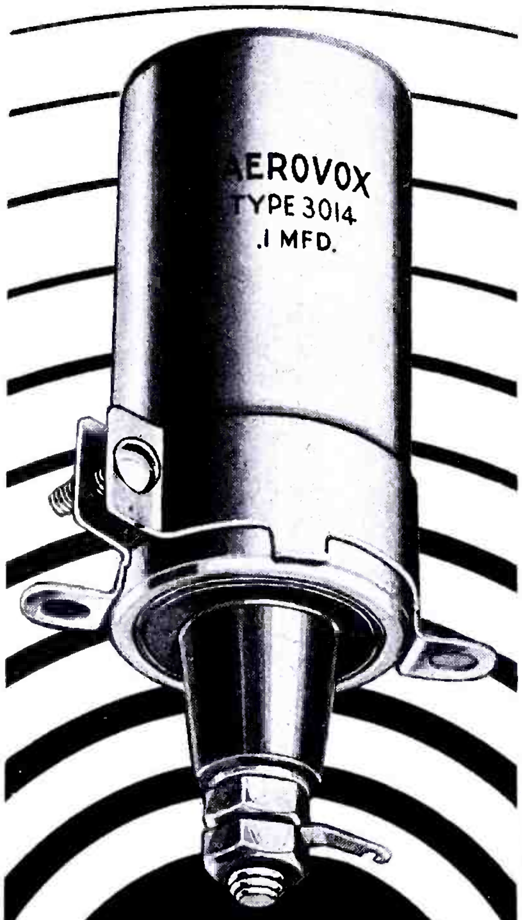

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(Continued from page 89)

T-network forms. The equivalent *T* network for this particular condition appears in Figure 20 of the chart in this paper, which shows a number of other combinations of the elements and the resulting equivalence forms which they take. Some of these are used for fixed pads, while others give the equivalences for the series, shunt, series-shunt, *L* types, *T* and π networks. It may thus be seen that the lattice network is a much more general one than any of the commonly known standard types, since all of them may be derived from the lattice merely as special cases.

Appendix I

THE mathematical treatment of the generalized lattice network is not particularly difficult, but in the cases which involve complex impedances in each arm of the network, the work may prove to be quite laborious because of the number of operations necessary to convert from rectangular to polar forms, and from polar to rectangular. This work may be greatly reduced by means of the vector and other special type slide rules.

The suggestion of *Maxwell* that circulating currents which traverse complete circuits are more convenient to use than branch currents was placed on a systematic basis by *Kirchoff* who enunciated two rules of procedure to follow in the solution of the currents in any network. These rules of procedure are known as *Kirchoff's* laws. The *first law* is the statement that . . . "the algebraic sum of the currents entering a junction is zero." This is actually a statement of continuity, since for this condition to hold true there must be as much current flowing away from a point or junction as there is flowing to it. Were this not so, the potential at the junction would build up with accumulated charge until the potent[ial] between that point and some other po[r]tion or point in the circuit or to grou[nd] would cause a flashover to occur. T[he] *second law* states in effect . . . "t[he] algebraic sum of the potential diffe[r]ences taken around any closed circ[uit] equals the impressed voltage or pote[n]tial." If the sum of the potential diffe[r]ences were less than the impress[ed] voltage this might indicate that i[n]finite time would be necessary for t[he] current to reach a steady state, wh[ile] if the sum of the potential differenc[es] were greater than the impressed vol[t]age, we would have the absurdity of [a] passive network generating pow[er] within itself and supplying voltage [at] a higher potential than that of the im[]pressed voltage. In applying these law[s] to a-c circuits, it is necessary to tak[e] into account the magnitude and pha[se] of currents or voltages in combinin[g] them, or very erroneous results may b[e] obtained. Since a vector is a symbolic[al] means of representing anything whic[h] has magnitude as well as direction, an[d] since current and voltage both hav[e] magnitude and direction with respec[t] to some arbitrary reference, they ma[y] be treated as vector quantities.

The conclusion of this lattice network discussion will appear in the June COMMUNICATIONS.

●

RESONANT LINE OSCILLATORS

(Continued from page 56)

ing in the plate circuit. By writing the equations for potential drops around the closed loops in the equivalent circuit for assumed steady state conditions, an equation was developed which gives the relation between the frequency of the oscillator, circuit and tube parameters[4]. The development of this equation is not difficult, but it is quite tedious, so it will not be given here. We will restate the equation in the following form

$$j\omega(Z_s B + r_p F) - \omega^2 Z_s r_p A + (1 - \mu) = 0 \quad (12)$$

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ere $A = (C_{gp} C_{gf} + C_{gf} C_{pf} + C_{gp} C_{pf})$
$B = C_{gf} + C_{gp}(1 - \mu)$
$F = C_{gf} + C_{pf}$
r_p = a-c plate resistance of tube
$\omega = 2\pi \times$ frequency, f
Z_s = impedance of a section of transmission line connected to grid and plate $= R_s + j X_s$
μ = amplification factor of tube.

The real terms or the imaginary ms of equation *12* may be equated zero and a simpler equation can be ickly obtained. Equating the imagi- ry terms to zero, we have

$$\omega X_s = \frac{1}{A}\left(\frac{R_s B}{r_p} + F\right) \qquad 13$$

troducing the values of R_s and X_s om equations *4* and *5* gives an equa- on involving ω, $\tan \frac{\omega l}{v}$ and $\cos \frac{2 \omega l}{v}$, t not directly solvable for ω and rther difficult to handle in any ap- oximate or graphical manner. In uation *13* the ratio R_s/r_p occurs, is the series effective resistance of e inductive branch of the oscillator ansmission line *tank* circuit. This tio appears in frequency formulas r many conventional oscillator cir- its, and if it is small it can be as- med to be zero, resulting in simpli- ation. Figure *7* shows the variation resistance and reactance of a trans- ission line with receiving end orted, assuming low ohmic conduc- r resistance and negligible radiation, ith length. At a quarter wavelength may be greater than one megohm r a coaxial design, but for such a w-loss (high *Q*) line, R_s quickly be- omes low as *l* is made less (or eater) than a quarter wavelength $\lambda/4$). Since for oscillation the line ust have an inductive reactance, the equency is such that the length *l* is ss than a quarter wavelength. And perience shows that it is sufficiently ss than $\lambda/4$ so that R_s is found upon lculation to be low compared to r_p, calculations given later will show. herefore we can neglect the first rm in the parenthesis in equation *13* d obtain

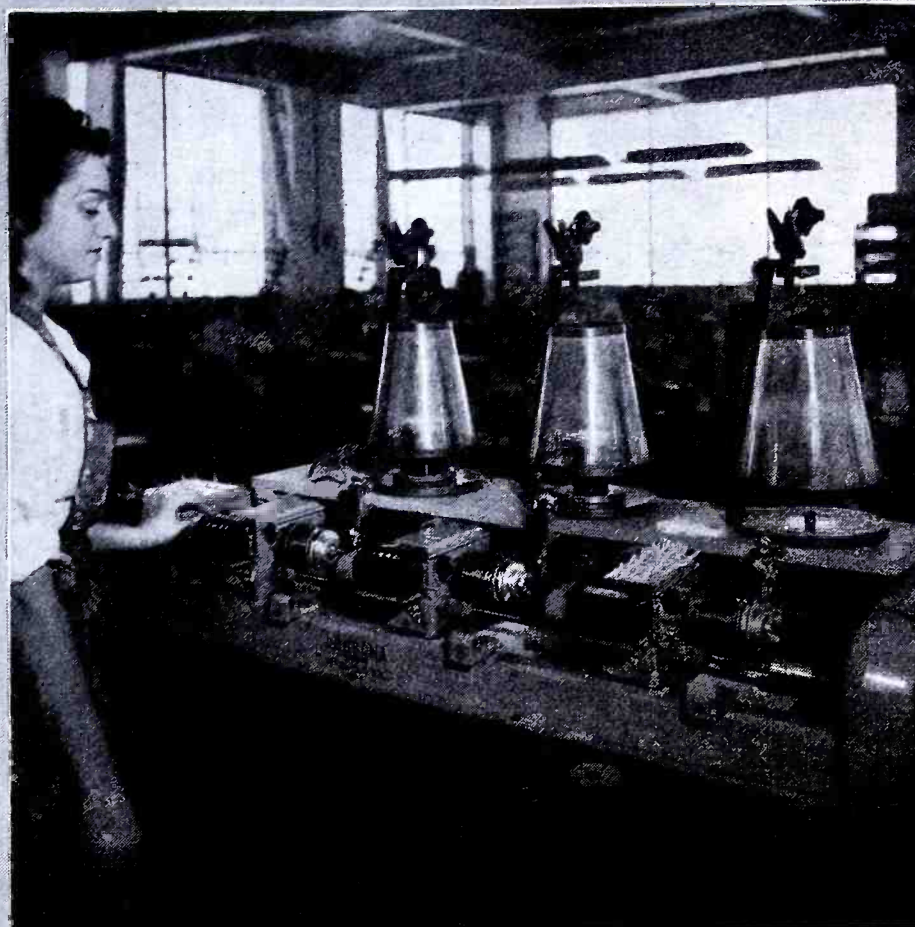
$$Z_0 \tan \frac{\omega l}{v} = \frac{1}{C_t} \qquad 14$$

here

$$= \frac{A}{F} = \frac{C_{gp} C_{gf} + C_{gf} C_{pf} + C_{gp} C_{pf}}{C_{gf} + C_{pf}}$$

$$= C_{gp} + \frac{C_{gf} C_{pf}}{C_{gf} + C_{pf}}$$

Ronald King, Proc. IRE, pp. 1368-1373; Aug. 32.



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(*Continued from page 91*)

It will be noted that C_t is actually the total geometrical tube electrode capacitance of the tube between grid and plate terminals, and equation *14* is exactly like equation *6*. It is admittedly a roughly approximate formula, but it is useful for the calculation of the approximate frequency range when either l or C_t are varied between desired or specified limits. The equivalent circuit in (*b*) of Figure 6 is also approximate because the grid-filament input conductance, appreciable at u-h-f, has been neglected. Since equation *14* has the same form as equation *6* we can determine approximately the frequency of the type of oscillator shown in Figure 6, by the use of Figure 4 or by the use of equations *10* or *11*, providing that the value of $\frac{l}{\sqrt{Z_o C_t}}$ falls below the specified limits.

Experimental Check

Let us find the frequency of such an oscillator using a Western Electric 316-A tube. The electrode capacitances are

$$\left.\begin{aligned} C_{gf} &= 1.2 \text{ mmfd} \\ C_{pf} &= 0.8 \text{ mmfd} \\ C_{gp} &= 1.6 \text{ mmfd} \end{aligned}\right\} C_t = 2.08 \text{ mmfd}$$

The transmission line rods are 0.640 cm in diameter, and spaced 1.10 cm, the same as the grid and plate terminals of the tube. However, careful measurement of the *floating* capacitance between the grid and plate terminals with an r-f bridge indicates 2.25 mmfd. Using this latter value for C_t, measurements and calculations of frequency were made for 2 values of line length. Table I shows the results obtained.

The per cent differences are too large for good accuracy. This is of course disappointing, but we should remember that at such frequencies as

Length l of grid-plate line, centimeters	$\frac{l}{\sqrt{Z_o C_t}}$	Oscillator Frequency-Megacycles: Calculated from from equation *11*	Obtained from Figure 4	Measured by wavemeter	Per cent Difference
13.7	*1.52*	*354*	*344*	*334*	3.0
8.3	*0.88*	*470*	*469*	*436*	7.3

Table 1

Empirical results obtained by measurement of a resonant-line oscillator versus the calculated and graphical methods.

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Table 1 many factors contribute to [u]reliability of calculation of fre[q]uency or other performance from [the]ory. When the tube is connected [t]o the circuit there are probably [ext]raneous shunting capacities which [ma]ke the actual C_t even greater than [the] given measured value for the tube [ale]d. Then too, the input impedance [of] the parallel wire line may contain [a] resistive component that is not [ne]gligible, so that a frequency formula [mu]st be developed from equation *12* [wh]ich contained the term R_s. This [re]sistance could be calculated from the [lin]e dimensions, but the mathematical [or] graphical solution for frequency [wo]uld be involved, and hardly justifi[ab]le. To see how important the line [re]sistance is, we will calculate the in[pu]t reactance X_s and resistance R_s at [th]e wavelength of 90 cm, from *Table* [1] using equation *4*, a wavelength λ [of] 90 cm, line length of 13.6 cm and [ch]aracteristic impedance Z_o of 137 [oh]ms. To find R_s it is necessary to [ca]lculate the attenuation constant α [an]d hence the effective resistance of [th]e line per-unit-length (per cm) R_1. [A]n approximate formula for this is[5]

$$R_1 = \frac{84\sqrt{f}\ 10^{-9}}{r\sqrt{1-\left(\frac{2r}{D}\right)^2}} \text{ ohms per cm}$$

[w]here *D* is the line conductor, *r* is the [co]nductor radius. Calculating α as [g]iven in equation *1*, and putting the [p]roper values in the resistance term [o]f equation *4* gives a value of R_s of [.0]61 ohm which is quite negligible [c]ompared to X_s, even at such a short [w]avelength, as shown at *a*, Figure 7. [T]herefore we were justified in neglect[i]ng R_s compared to X_s in solving [e]quation *12* for oscillator frequency at [9]0 cm wavelength. It may be noted [t]hat the *Q* of the inductive branch of [t]he oscillator tank circuit is 95/.061 = [1]550, a quite desirable value to in[s]ure good oscillation or frequency sta[b]ility. The third influencing factor is [t]he input conductance of the tube, an [u]ncertain but important quantity at [u]-h-f. It also would greatly compli[c]ate the derivation of a frequency [f]ormula, by adding another current [p]ath to the network of Figure 6. In [s]pite of these obstacles, Figure 4 and [e]quations *10* and *11* do give us a con[v]enient means of finding roughly the [f]requency range of a grid-plate reso[n]ant line oscillator of a specified or [g]iven variation of line length.

[5]L. E. Reukema, Electrical Engineering, p. 1006; Aug. 1937.

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FIELDS AND WAVES IN MODERN RADIO

By *Simon Ramo*, Electronics Laboratory, General Electric, and Union College, and *John R. Whinnery*, Electronics Laboratory, General Electric . . . 502 pp. . . . New York: John Wiley & Sons, Inc. . . . $5.00

Prepared for the General Electric advanced engineering program series covering electromagnetic waves and microwave transmission, this volume is basically a text for student engineers. However it may also serve as a source of information for specific design calculations in the field of microwaves.

Eleven chapters and an appendix provide an effective analysis of many topics. Some of these are: Oscillation and wave fundamentals; equations for stationary electric and magnetic fields; solutions to static field problems (several methods are shown); Maxwell's equations and high-frequency potential concepts, covering time variable electrical phenomena; circuit concepts and their validity at high frequency; skin effect and circuit impedance elements; propagation and reflection of electromagnetic waves (a discussion of waves in unbounded regions and the effects of conductors and dielectrics on wave shapes); guided electromagnetic waves, including examples and their analysis; characteristics of common wave guides and transmission lines; resonant cavities (a discussion of various forms of cavity resonators); and radiation, covering wave concepts, Poynting calculations, radiator combinations and antenna characteristics.

One appendix contains a comprehensive listing of reference books for associate study, while another provides a complete list of the nomenclature used in the text together with their definitions and page references.

Mathematical treatments applied require only a knowledge of calculus and other usual engineering concepts. A clear concept of the electromagnetic field may be obtained without too complete a study of the mathematics projected.

•

RADIO DIRECTION FINDERS

By *Donald S. Bond*, Radio Corporation of America . . . 287 pp. . . . New York: McGraw-Hill Book Co., Inc. . . . $3.00

Radio direction finding, though almost as old as radio itself, did not become an exceptionally active art, until about ten years ago. Much of this interest was prompted by air transportation expansion. Although the literature on the subject is extensive, few complete treatises have been available until recently. This volume is quite thorough, serving as a textbook and reference for advanced engineering

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CONTACT IN ITALY

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Col. Frank E. Kidwell, 5th Army Assistant Signal Officer, and Col. Duvivier, a British Chief Officer in Italy with f-m portables during the Italian campaign. (*Courtesy U. S. Signal Corps*)

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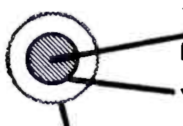

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Four appendixes offer data on the erivation of formulas used in the text; adiation due to an infinitesimal dipole, eld strength calculation for propagation ver plane earth of finite conductivity, alculations for the directive pattern of a ong-wire antenna and effective height of vertical antenna, and phase relations n coupled circuits.

Three complete schematics of automatic irection finders RCA-Sperry Mark 1, Bendix MN 31, and the RCA AVR 8F ight-left finder are included in a chapter n visual direction finders.

Extensive mathematical analyses are rovided in discussing such subjects as leviation errors, loop characteristics, shot nd tube noise effects, etc.

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ELECTRICAL ESSENTIALS OF RADIO

By Morris Slurzberg, B.S., M.A., and William Osterheld, B.S., M.A., Instructors in Radio at the W. L. Dickinson High School and Evening Technical and Industrial High School, Jersey City, N. J. . . . 529 pp. . . . New York: McGraw-Hill Book Co., Inc., $4.00

This book has been written for basic radio students and is ideal for classroom use. Twelve chapters trace the history of communications, its basic theory, batteries, electric circuits, magnets, meters, generators, inductance, capacitance and a-c, resonant and basic radio circuits. An appendix contains many standard charts and formulas. Simplified mathematics are used. Some exemplary questions and references are included with each chapter.

The volume is profusely illustrated. Pictures, diagrams and sketches are included to clarify component study.

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By Headquarters Staff, American Radio Relay League . . . 728 pp. . . . West Hartford, Conn.: ARRL, Inc. . . . $1.00

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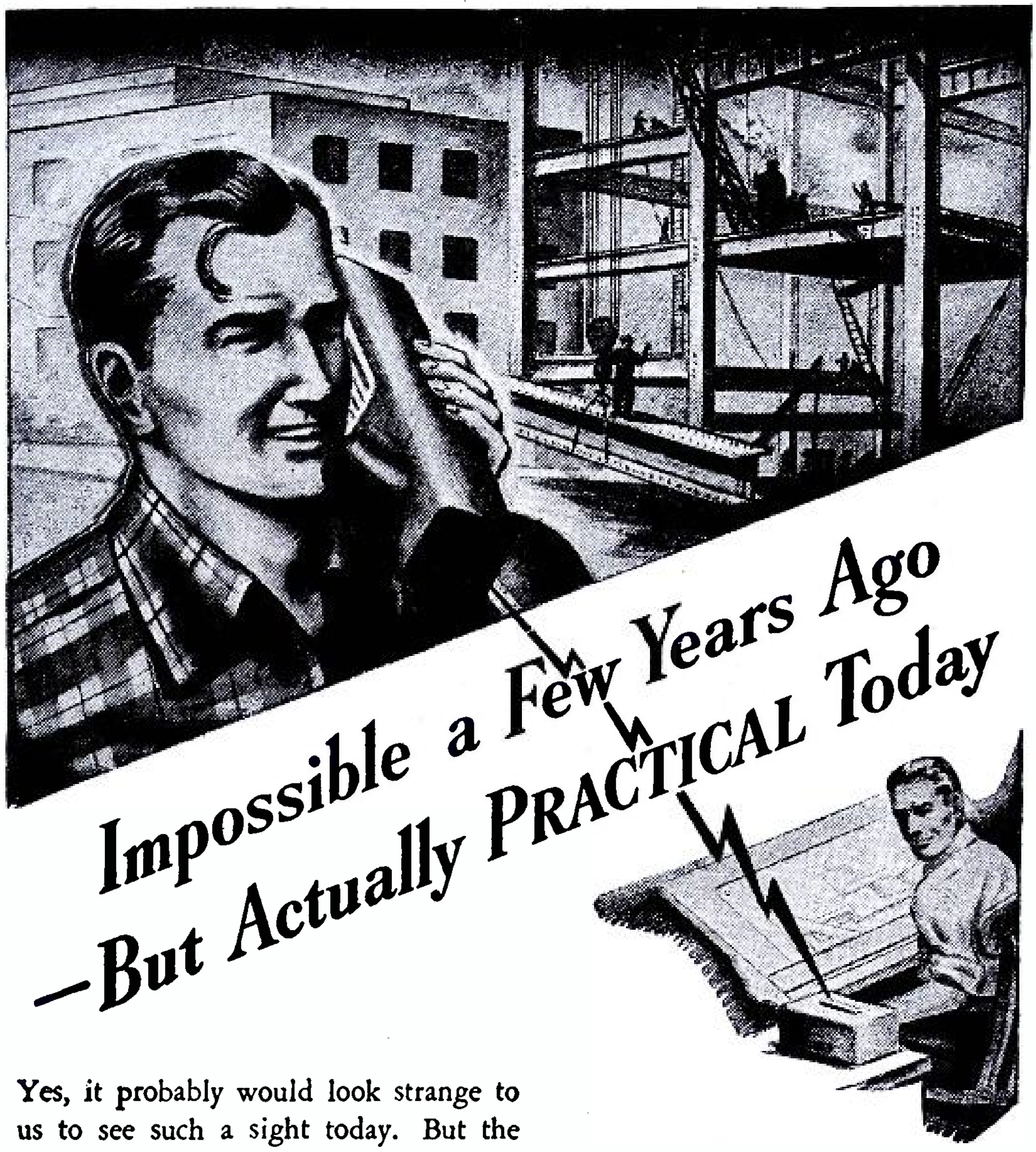

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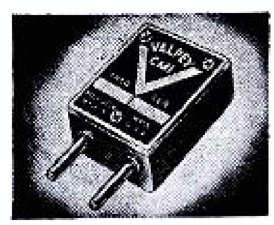

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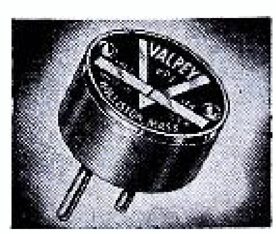

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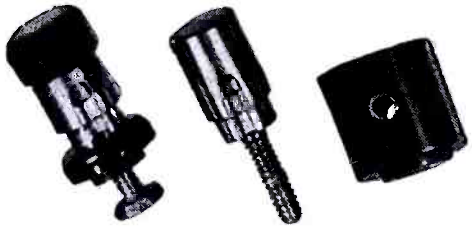

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NEWS BRIEFS

CLEAR-CHANNEL HEARINGS IN SEPT.

The clear-channel hearings scheduled to begin on May 9, have been postponed until Wednesday, September 5, 1945.

Substantial preparatory work has already begun. Three engineering committees have been established to prepare comprehensive reports on the basic underlying data necessary for the hearings. These committees composed of FCC representatives and members of industry will study:

(1) What constitutes a satisfactory signal.
(2) What constitutes objectionable interference.
(3) Distances to which and areas over which various signal strengths are delivered.

It is expected that these committees will be ready to report well in advance of September 5th. These reports will probably be made available to interested persons in advance of the hearings.

A fourth committee concerned with the problem of conducting a survey of listeners has also been established. It is hoped the results of this survey will also be ready for the opening of the hearings.

In addition to the foregoing committees, the FCC has also set up staff committees to prepare material on all the issues covered by the proceeding. The staff is available at all times for conferences or assistance. Arrangements for such conferences should be made through the Commission's general counsel or chief engineer.

* * *

RADIO - RADAR DELIVERIES INCREASE

Deliveries of radio and radar equipment on prime contracts during March totaled $218,364,000, an increase of 7.3 per cent over February deliveries, which totalled $203,446,000, according to WPB. The average monthly delivery in 1944 was $225,344,000.

These costs cover radio and radar end equipment only, and exclude such items as power equipment, tubes, test equipment, and miscellaneous equipment, unless incorporated in the end equipment.

Deliveries to the Army during March were $112,425,000, an increase of 14 per cent, while deliveries to the Navy, which amounted to $103,253,000, represented an increase of one per cent over February. Deliveries to others, totaling $2,686,000, represented an increase of 7 per cent.

The undelivered balance on outstanding prime contracts as of April 1 was $2,571,920,000, of which $1,444,783,000 was specified for delivery in the next six months. In order to meet this, an average monthly delivery of $240,797,000 will be required, or an increase of 7.8 per cent over the 1944 average delivery rate.

The total undelivered balance on prime contracts has increased $35,027,000 since last month.

* * *

IRE BUILDING FUND NEARS 50% OF $500,000 GOAL

The $500,000 building fund program of The Institute of Radio Engineers is nearing the half-way mark, according to IRE officials.

Dr. W. R. G. Baker of G. E. is chairman of the Initial Gifts Committee consisting of 47 members.

Dr. Austin Bailey, of the American Telephone & Telegraph Company, heads the IRE Section Solicitation Committee which includes membership and other local solicitation in 33 U. S. and Canadian IRE sections.

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e first television broadcast from Washing-n was recently transmitted over a relay twork to Philadelphia by Philco.

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HILIPS TO OFFER PATENTS IRECTLY TO U. S. INDUSTRY

e Hartford National Bank and Trust Com-ny as trustee under an August 25, 1939 denture with N. V. Philips' Gloeilampen-brieken (Philips Incandescent Lamp Works mpany) Eindhoven, Holland, has announced at effective July 1, all licenses issued by A under the United States patents of Philips ll terminate.

The trustee is taking steps to make the tent rights available to the Government and dustry under appropriate terms after the esent licenses expire.

These patent rights have been assigned to merican industry for the last twenty years rough license agreements (now terminated) th RCA, G. E. and Westinghouse. Licenses der these patents were also included in the ense granted by RCA to the Government war purposes. RCA, G. E. and Westing-use will continue to hold non-exclusive enses after July 1 under existing patents. t is also planned that future U. S. patents Philips' inventions will be made available industry.

* * *

S.-CANADIAN RMA EET AT MONTREAL

ecutives of the U. S. RMA were guests the Canadian RMA in Montreal recently.

The joint meeting was attended by thirty-e American and an equal number of Ca-dian industry leaders. President R. C. Cos-ove, on behalf of the U. S. RMA, extended invitation to the Canadians to hold another nt meeting next September. This meeting tentatively scheduled at the Westchester untry Club, Rye, N. Y.

Highlights of the Montreal meetings were the record talks by Major General William Harrison, Chief of Procurement and Dis-bution Service, U. S. Signal Corps; Captain nnings B. Dow, Director of Electronics Di-sion, Bureau of Ships, Navy Department; rector Louis J. Chatten, WPB Radio & dar Division, and Ray C. Ellis, special WPB nsultant with the Johns Hopkins University d former Radio & Radar Division director. her speakers included J. A. Beckingham, nadian Director General, Signals Production

(*Continued on page* 98)

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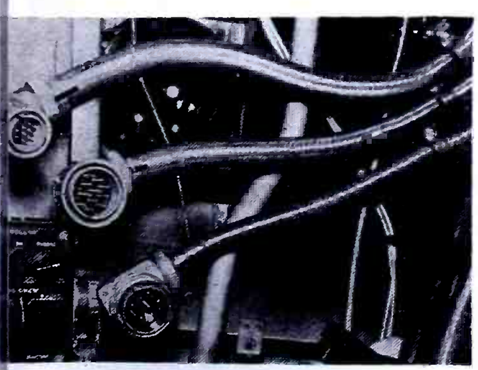
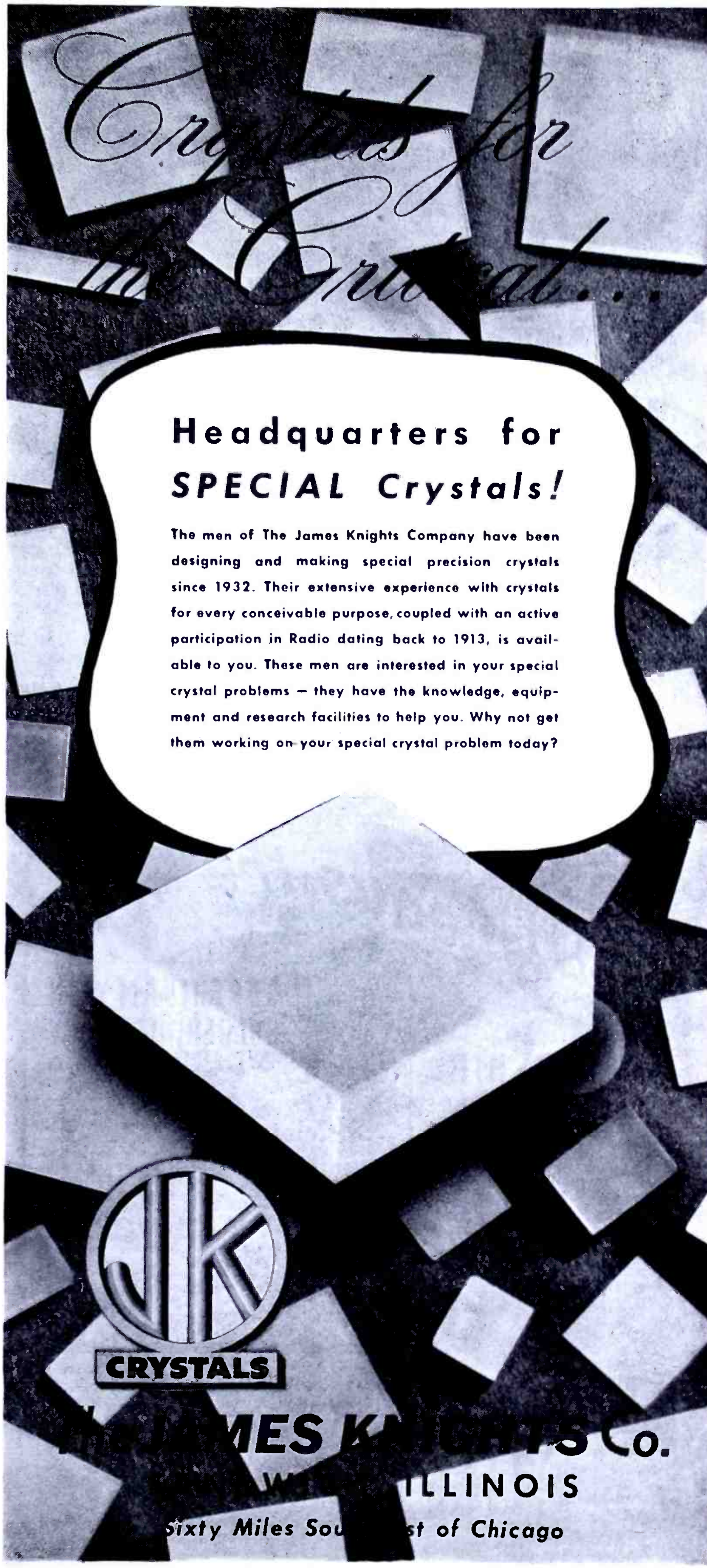
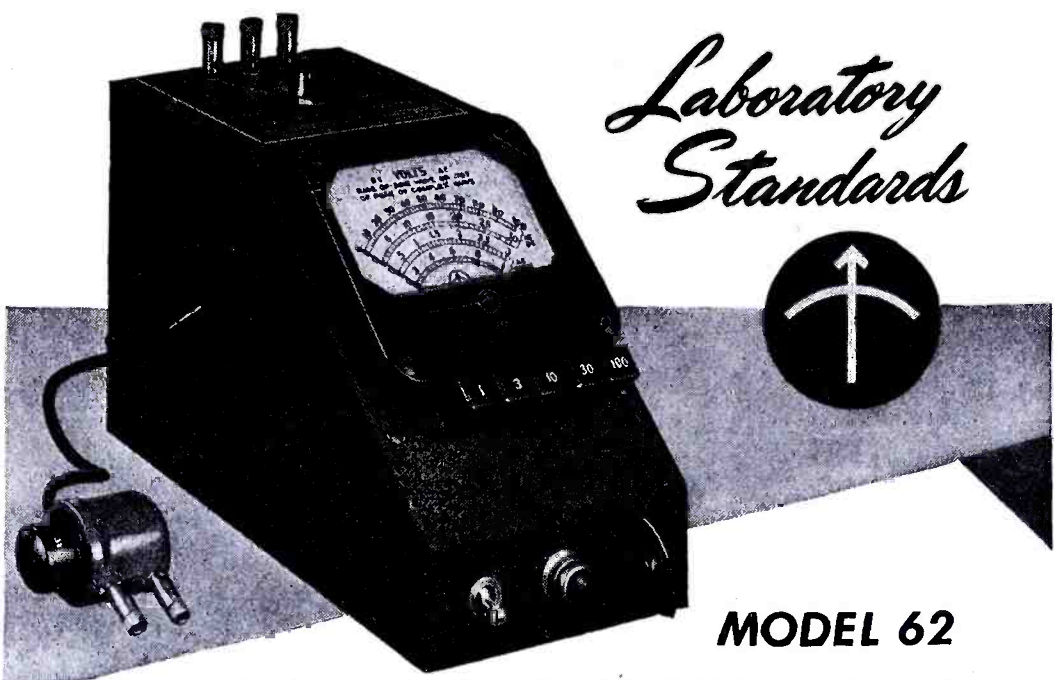
CABLE POSITIONING



accurately position electronic equipment in-connecting cables, engineers of the tool divi-n of the Glenn L. Martin Company, Balti-re, Md., paint two indicating marks on each le which locate the cable with respect to the rest structural clamp. Twisting and possible e breaking is eliminated. Indicating marks are plied prior to the installation of any wires with a special jig.





Laboratory Standards

MODEL 62

VACUUM TUBE VOLTMETER

SPECIFICATIONS:

RANGE: Push button selection of five ranges—1, 3, 10, 30 and 100 volts a. c. or d. c.
ACCURACY: 2% of full scale. Useable from 50 cycles to 150 megacycles.
INDICATION: Linear for d. c. and calibrated to indicate r.m.s. values of a sine-wave or 71% of the peak value of a complex wave on a. c.
POWER SUPPLY: 115 volts, 40-60 cycles—no batteries.
DIMENSIONS: 4¾" wide, 6" high, and 8½" deep. **WEIGHT:** Approximately 6 lbs.
PRICE: $135.00 f.o.b. Boonton, N. J. Immediate Delivery

MEASUREMENTS CORPORATION
BOONTON, NEW JERSEY

INSULINE CORP. OF AMERICA ICA TRADE MARK

Leads the way

LEADERSHIP

IN DESIGN AND MANUFACTURE OF RADIO-ELECTRONIC PRODUCTS

The outstanding production records of Insuline have twice been commended by the Army and Navy. New designs, new products, new manufacturing methods are constantly being devised, so that after V-Day it will still be true that, in the Radio-Electronics field, "ICA Leads the Way."

SUPERIORITY IN SOLDERING IRONS

ICA Irons embody these important construction features:—

Heating elements wound on high heat-resisting bobbin of machined and threaded Insulex. Winding utilizes special resistance wire. Complete bobbin is impregnated in non-hygroscopic ceramic compound. ICA Irons heat up to operating temperature in three minutes, and in one additional minute surpass the heat peak of ordinary irons. Special air chamber reduces heat losses. Thoroughly insulated. Rubber tube protects cord from excessive wearing and short-circuiting . . . Write for full details now.

Write for 48-page Catalogue describing the extensive line of ICA Radio-Electronic Products . . . Also 8-page brochure presenting the ICA Manufacturing facilities.

HEADQUARTERS FOR RADIO-ELECTRONIC PRODUCTS

INSULINE
CORPORATION OF AMERICA
INSULINE BUILDING · LONG ISLAND CITY, N.Y.

ARMY NAVY

NEWS BRIEFS

(*Continued from page 97*)

Branch, Department of Munitions and Supply, and M. C. Lowe, Administrator of Capital Equipment and Electrical Products, Wartime Prices & Trade Board.

Discussing WPB's gradual contract cutback and future reconversion plans, Mr. Chatter expressed the opinion that military production would drop only about 10 per cent in the next few months. He predicted that the resumption of home receiver manufacturing probably would not be possible before the first quarter of 1946.

The present plan of the WPB calls for a partial lifting of controls permitting the manufacture of radio equipment for essential commercial services, such as aircraft, police, point-to-point communications. L-265 will not be completely rescinded until the scheduled military requirements recedes below 75 per cent of the delivery date, for the first quarter of 1945.

Even then uninterrupted military production would be assured by top priority control of materials.

* * *

A. T. & T. TO BUILD SEVEN RELAY STATIONS

A. T. & T. has filed application with the FCC for authority to construct seven relay stations between the terminals of the New York-Boston radio relay project. FCC approval on the two terminals was granted last year.

Purpose of the trial is to determine in practical operation the relative efficiency and economy of radio relays for transmission of long distance telephone messages and of sound and television programs, compared with transmission over wires, cables and coaxial cables.

The coaxial cable program will not be curtailed, A. T. & T. officials announced. They reported that by the end of this year the Bell System expects to have 2,000 miles of its coaxial cable network manufactured and at least three-fourths of this mileage in the ground.

The all-cable route to the West Coast is expected to be in the vicinity of Fort Worth and Dallas, half way across the continent, before the year is over. The aim is to reach Los Angeles in the spring of 1947.

The radio relay sites selected include:

Jackie Jones Mountain, 35 miles up the Hudson from the New York terminal in lower Manhattan. The mountain is 5 miles west of Stony Point, N. Y.

Birch Hill, 5 miles southeast of Pawling, N. Y.

Spindle Hill, 4 miles southwest of Bristol, Conn.

John Tom Hill, 7 miles east of Glastonbury, Conn.

Bald Hill, 3 miles east of Staffordville, Conn.

Asnebumskit Mountain, in Paxton Township, 5 miles northwest of Worcester, Mass.

Bear Hill, one mile northwest of Waltham, Mass., and 11 miles west of Boston.

The New York terminal will be atop the A. T. & T.'s Long Lines building at 32 Sixth Avenue, while the Boston station will be on the Bowdoin Square Building of the New England Telephone and Telegraph Company.

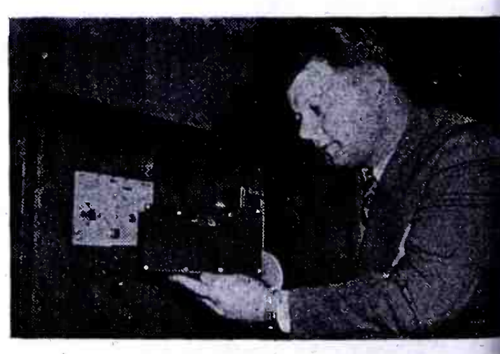
The New York-Boston experiments are scheduled to use 2,000, 4,000 and 12,000 megacycles. Eight channel assignments, each 20 megacycles wide, in each of these bands, have been requested.

The existing links in the coaxial network plus the sections to be installed or in process this year are:

In Service—New York-Philadelphia, 2-coaxial cable, 90 miles long; installed in 1936 for

•

HOME RADIO WIRE RECORDER



William P. Lear, president of Lear, Incorporated, with the magnetized wire magazine of the Lear home radio and wire recorder combination. Magazines, which are plugged into amplifier, can provide one-hour of recording.

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experimental purposes; now in service for telephone purposes.

Stevens Point, Wis.-Minneapolis, Minn. 4-coaxial cable, 200 miles; installed in 1940; now in service for telephone purposes.

In the Ground—Not Yet Equipped—Baltimore-Washington. 4-coaxial cable, 43 miles. Philadelphia-Baltimore. 6-coaxial cable, 100 miles. Terre Haute-St. Louis. 6-coaxial cable, 175 miles.

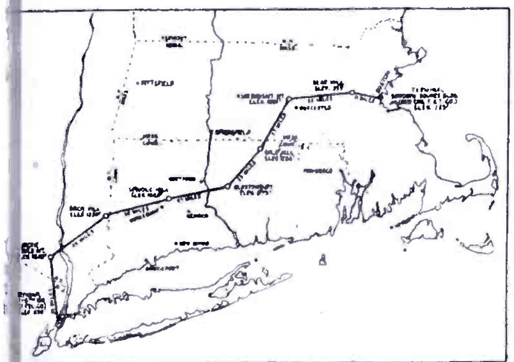
Atlanta, Ga.-Jacksonville, Fla. 4-coaxial cable, 295 miles.

1945 Program—Atlanta, Ga.-Meridian, Miss. 6-coaxial cable, 310 miles.

Shreveport, La.-Dallas, Tex. 8-coaxial cable, 200 miles.

Washington-Charlotte, N. C. 8-coaxial cable, 400 miles.

Meridian-Shreveport—315 miles section, with 6-coaxial cable from Meridian to Jackson, Miss., and 8-coaxial cable from Jackson to Shreveport.



* * *

PASCHKES BECOMES SOLAR BOARD CHAIRMAN

Otto Paschkes has relinquished the presidency of the Solar Manufacturing Corp. to assume the newly created post of board chairman. Paul Hetenyi, formerly executive vice president, succeeds Mr. Paschkes as president.

In his new position, Mr. Paschkes will continue actively as chief administrative officer.

Wickham C. Harter has been named to the dual post of vice president and secretary, and James I. Cornell, chief engineer, has also been elected vice president.

* * *

WHITMORE NEW W. E. AD MAN

Will Whitmore, advertising supervisor of Western Electric, has been named advertising manager to succeed H. W. Forster, who died recently.

* * *

AERO NEEDLE REPS MEET

Burton Browne, president, and Mrs. Dorothy Stevens, vice-president of Aero Needle Company, Chicago, discussed sales problems with their representatives from Cleveland, San Francisco, Oregon and Texas, recently. Among those present were Earl Dietrich and R. L. Meyer of Cleveland; Don Burcham and Bill Earl of

(*Continued on page* 100)

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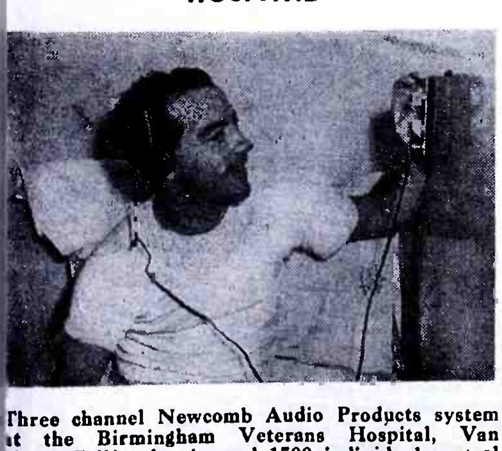
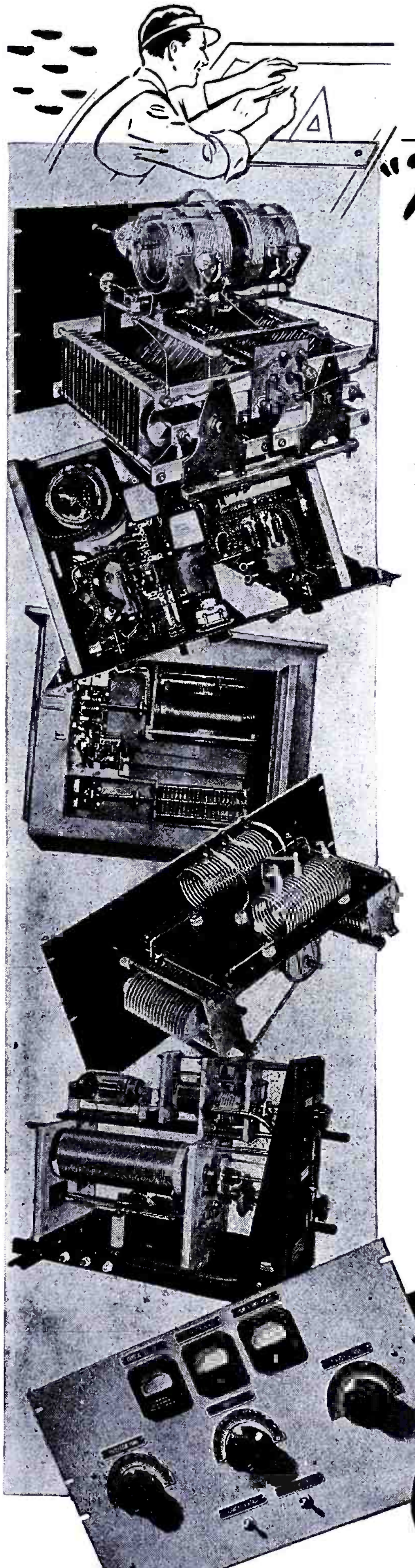
RADIO SYSTEM AT VETERANS HOSPITAL



Three channel Newcomb Audio Products system at the Birmingham Veterans Hospital, Van Nuys, California. Around 1500 individual control boxes are in the hospital.



"Tailor-made"

ELECTRONIC EQUIPMENT ASSEMBLIES

Designed and produced from stem to stern by recognized experts to match your needs *exactly*.

DIELECTRIC & INDUCTION HEATING EQUIPMENT

•

TUNING UNITS

•

TEST EQUIPMENT

•

RADIO TRANSMITTERS

•

HIGH AND ULTRA-HIGH FREQUENCY EQUIPMENT

B&W is neither too large for the smallest job nor too small for the largest. Write for details, outlining your requirements.

ARMY E NAVY

B&W

BARKER & WILLIAMSON

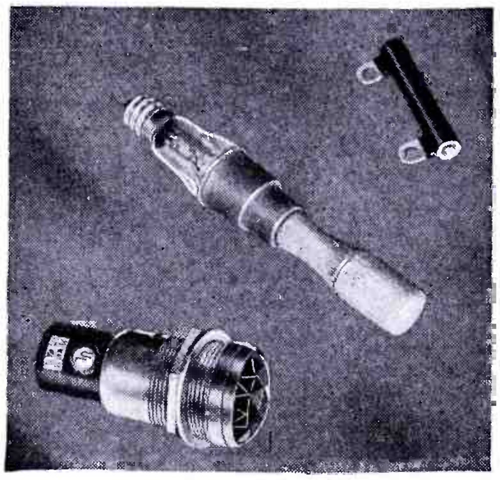
AIR INDUCTORS • VARIABLE CONDENSERS • ELECTRONIC EQUIPMENT ASSEMBLIES

DEPT. C-55 235 FAIRFIELD AVENUE • UPPER DARBY, PA.

Export: LINDETEVES, INC., 10 Rockefeller Plaza, New York, N. Y., U. S. A.

CONSIDER THE NEW DRAKE No. 75 AP

Underwriters Approved!



TRADE demand has caused Drake to produce this new totally enclosed candelabra screw base 1" pilot light assembly. The unit is approved by the underwriter's laboratories for 75 watt, 125 volt service. Designed to house the Mazda S6, 110 volt, 6 watt candelabra screw base lamp. Can be supplied with lamp installed. The unit mounts in a 1" hole and is regularly furnished with a 1" diameter faceted colored glass jewel. It is also supplied with a steel lock washer which holds the unit firmly to the panel. Mounts on any thickness panel up to ½".

Although designed to operate on 110 volt circuits, this assembly can readily be used on 220 volt circuits by connecting our #116 wire wound resistor in series with the pilot light.

Lamps are easily removed with our S6 lamp remover. Anyone who has to maintain, or install in production, large numbers of S6 lamps, will find the S6 lamp remover a great convenience.

DRAKE

SOCKET AND JEWEL LIGHT ASSEMBLIES

DRAKE MANUFACTURING CO.

1713 WEST HUBBARD ST., CHICAGO 22, U. S. A.

TOUGH!

Cinaudagraph Speakers are made to take the tough raps. This is the built-in result of better manufacturing experience. Look at the record of achievement and you'll put Cinaudagraph Speakers at the top of your list.

Watch Cinaudagraph Speakers After Victory!

CINAUDAGRAPH SPEAKERS

Cinaudagraph Speakers, Inc.

3911 S. Michigan Ave., Chicago
Export Div., 13 E. 40th St., New York 16, N. Y.

"No Finer Speaker in all the World"

NEWS BRIEFS

(Continued from page 99)

Portland, Oregon; Jim Hermans of San Francisco and Bob Campion of Texas.

* * *

MARSHANK SALES MOVES

Marshank Sales Company have moved from 2022 West 11th Street to 672 South Lafayette Park Place, Los Angeles, Calif.

* * *

SURPLUS CONTRACT TO HALLICRAFTERS

The Hallicrafters Company, Chicago, Illinois, has signed a contract with the Defense Surplus Corporation for the disposal of electronic equipment declared surplus by the armed forces.

The plants handling the DSC work are at 1339 West 51st Street and 5114-22 South Racine Avenue.

* * *

UNITED ELECTRONICS NAMES F. B. RUSSELL REP

Frank B. Russell has been appointed direct factory sales representative for United Electronics Company, Newark, New Jersey.

Mr. Russell will cover Eastern Pennsylvania, Delaware, Maryland and Virginia.

* * *

G.E. DEMONSTRATES RADIOTYPE AND F-M EMERGENCY EQUIPMENT TO POLICE OFFICERS

Radiotype and f-m emergency communications demonstrations by G. E. were given during the recent meeting of the New York State chapter of the Associated Police Communication Officers at Schenectady, N. Y.

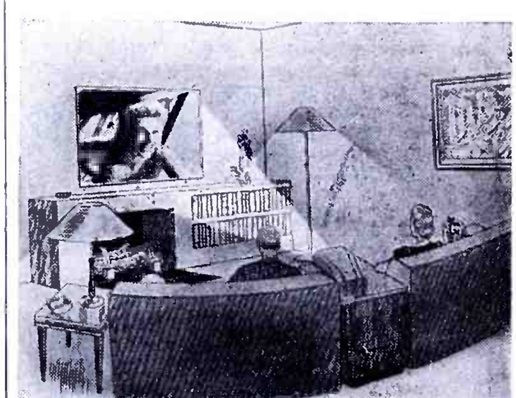
The radiotype demonstrations were conducted on 35.46 megacycles. Experimental 4-watt mobile f-m equipment operating on 161.775 mc was also shown.

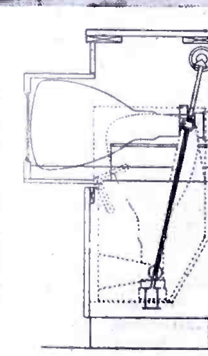
The Radiotype equipment uses a standard electromatic typewriter. In full automatic operation, copy is typed on a typewriter which perforates a tape. This tape is *read* by an automatic transmitting head which keys the transmitter sending out a tone. This tone is sent over a circuit and at the receiving end the tone is fed into a unit which selects the proper keys on the receiving typewriter, which prints the message.

According to A. C. Holt, assistant to the general manager of the Radiotype division of I. B. M., the Radiotype equipment can trans-

●

DU MONT TELEVISION PROJECTION SET





Above, Du Mont projection teleset, providing 3' x 4' picture (7" tube used). At right, interior of 20" c-r tube set with space-saving device, permitting use of cabinets only 24" deep. A mechanism activated by pushbutton which starts motor, brings tube to viewing position.

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mit at 100 words a minute. The equipment used was an improved type of that shown at the last World's Fair.

* * *

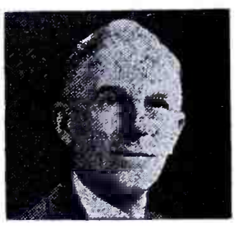
T. F. JOYCE JOINS RAYMOND ROSEN

Thomas F. Joyce has acquired an interest in Raymond Rosen & Company, Philadelphia, Pa. He will act as general manager. Mr. Joyce was formerly general manager of the radio, phonograph and television department of the RCA Victor Division of RCA.

* * *

R. H. MANSON BECOMES STROMBERG-CARLSON PRES.

Dr. Ray H. Manson has been named president of Stromberg-Carlson Company. He was formerly executive vice president and general manager. Wesley M. Angle, whom Dr. Manson succeeds, has become chairman of the board. Lee McCanne succeeds Dr. Manson as vice president and general manager.



Left, Lee McCanne; above, Dr. R. H. Manson.

* * *

C. H. THORDARSON DEAD

Chester H. Thordarson, former owner of Thordarson Electric Manufacturing Company, died recently. He was 78 years.

* * *

PACKARD-BELL EXPANDS

Packard-Bell Company has moved to 3443 Wilshire Boulevard, Los Angeles 15, Calif.

A. R. Ellsworth has been named the director of research. Mr. Ellsworth has been chief engineer for the past 12 years.

* * *

JEFFERSON-TRAVIS AND FONDA MERGE

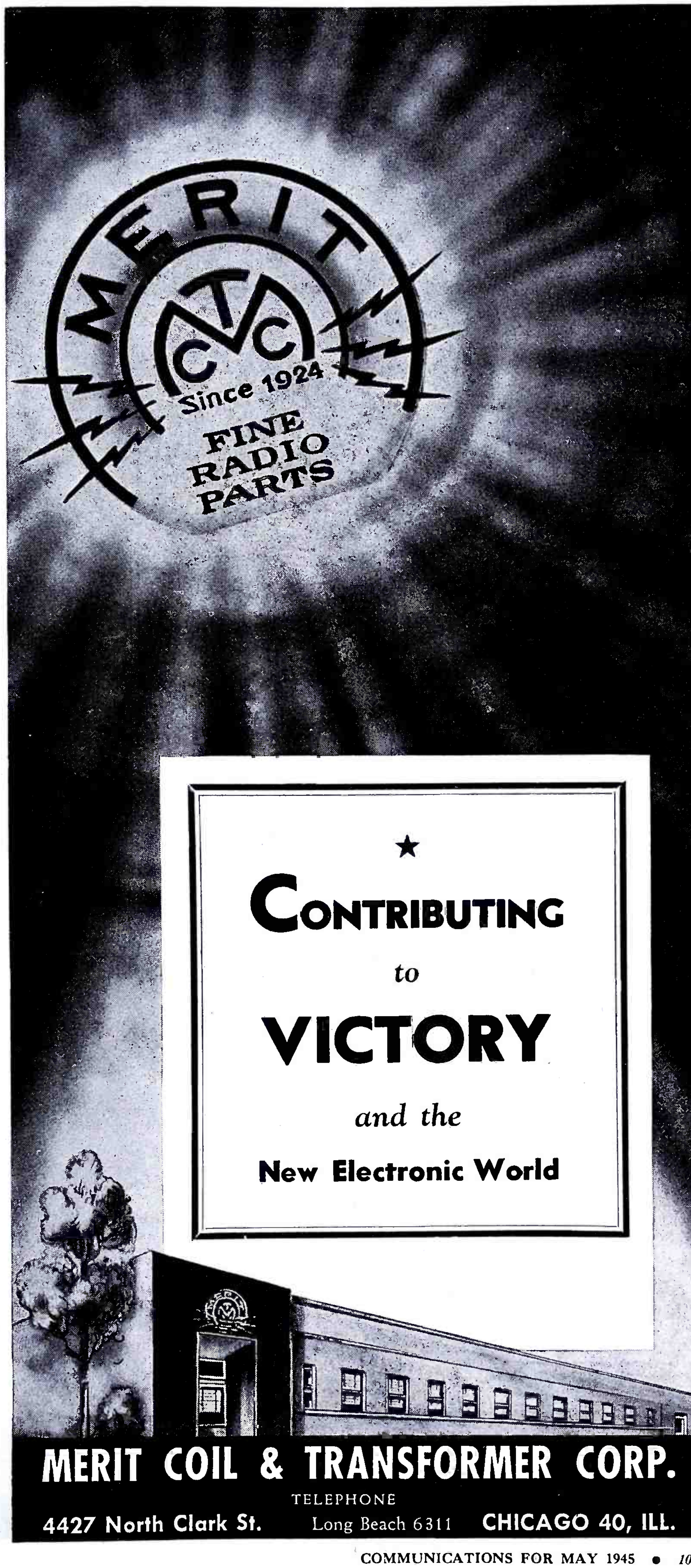
The Jefferson-Travis Radio Mfg. Corp. and Fonda Corporation have been consolidated. The

(*Continued on page* 102)

•

NOVICK HONORED

At dinner in Chicago, honoring S. J. Novick, president of ECA, for his contribution to better labor-management relations during war. Left to right: Brig. Gen. Joseph Barzynski, Commanding Officer, Quartermaster Corps, Chicago; Mr. Novick; E. De Maio, UERMW vice president, James MacLeish, general vice president of union; Mayor Edward J. Kelly of Chicago; Commander R. J. Twyman, personnel director of 9th Naval District.



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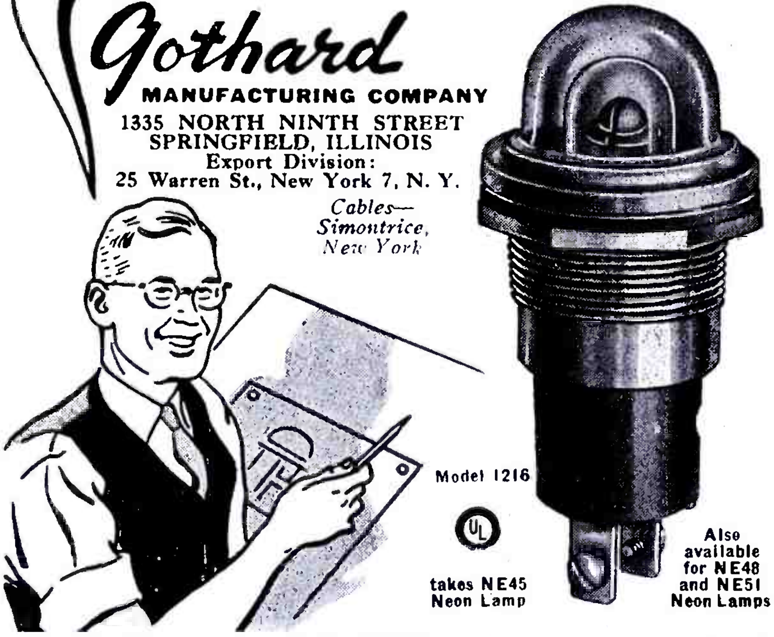
Silent operation of postwar appliances and electrical equipment will require Pilot Light assurance of "ON" and the added advantage of the animated eye appeal of light. Gothard's broad line of Pilot Light Assemblies —developed thru both war and peacetime research—will provide the solution to that need. Beyond the scope of this broad line—Gothard engineers offer you a wealth of Pilot Light experience to satisfy special requirements. Consult Gothard on your present and postwar plans.

Gothard
MANUFACTURING COMPANY
1335 NORTH NINTH STREET
SPRINGFIELD, ILLINOIS
Export Division:
25 Warren St., New York 7, N. Y.
Cables—Simontrice, New York



Toroids.. by DX

Doughnut Coils for electronic and telephone purposes. High Permeability Cores are hydrogen annealed and heat treated by a special process developed by DX engineers. Send us your "specs" today—ample production facilities for immediate delivery.

DX RADIO PRODUCTS CO.
GENERAL OFFICES 1200 N. CLAREMONT AVE., CHICAGO 22, ILL., U.S.A.

DX COILS
"the heart of a good receiver"

NEWS BRIEFS

(Continued from page 101)

merged corporations will be known as the Jefferson-Travis Corporation. Irving M. Felt is president of the corporation.

Other officers include: Edgar Ellinger, Jr., executive vice president; John T. Filgate, vice president in charge of engineering and production; Justin C. Harris, treasurer; and Frank Baron, secretary.

* * *

RAYTHEON N. Y. OFFICE MOVES

The New York City offices of the radio receiving tube division of Raytheon Manufacturing Company are now located at 60 East 42nd Street.

General sales headquarters of the receiving tube division will remain indefinitely at 55 Chapel Street, Newton, Massachusetts.

* * *

HALLIGAN PRAISED BY CHICAGO BUSINESS ANALYST

William J. Halligan, president of the Hallicrafters Company, was praised recently by Phil S. Hanna in his Chicago Daily News column for . . . "his handiwork that was in large part responsible for driving Rommel out of Africa and insuring the success of numerous invasions since then."

* * *

"E" AWARDS

The Army-Navy "E" has been awarded to the home radio division of Westinghouse Electric and Manufacturing Company at Sunbury, Pa.

The Chicago, Illinois, and Richmond, Indiana, plants of the Belden Manufacturing Company, Chicago, have also won "E" pennants.

The "E" has also been awarded to the power tube division of Machlett Laboratories, Norwalk, Conn.

A fourth star has been added to Army-Navy "E" flag of the industrial electronics and x-ray divisions of Westinghouse at Baltimore.

* * *

AMPHENOL LIQUID POLYSTYRENE BULLETIN

A 6-page bulletin describing "polyweld," a pure polystyrene in solution, has been released by American Phenolic Corporation, Chicago 50, Illinois.

Data offered covers dielectric constant, power and loss factor.

Polyweld is recommended for doping, coating, impregnating or sealing for r-f, u-h-f and v-h-f applications.

* * *

PHILHARMONIC AND ATF REMOTE CONTROL UNIT MERGE

The Philharmonic Radio Corporation and the remote control division of American Type Founders, Inc., have been consolidated. Zeus Soucek is president of the new organization. Avery Fisher remains as vice president in charge of Philharmonic sales.

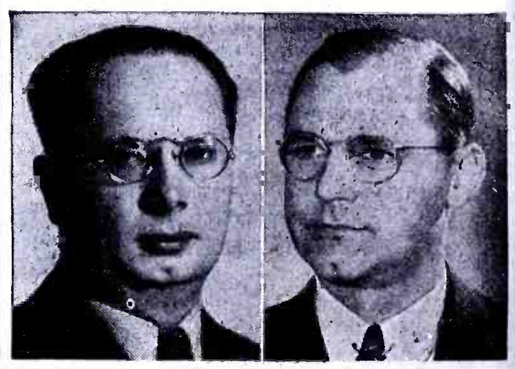
The remote control division will continue under the management of M. H. Hoepli.

* * *

R. R. SIMONS NOW GEN. MGR. OF COMMUNICATION PARTS

R. R. Simons has become general manager of Communication Parts, 1101 N. Paulina St., Chicago, Ill. Mr. Simons was formerly a partner in the S-W Inductor Co., Chicago.

Howard J. Christianson is chief engineer of the company. R. Edward Stemm will direct sales.



R. R. Simons — R. E. Stemm

* * *

RCA VICTOR RECORD NAMES REISKIND CHIEF ENGR

H. I. Reiskind has been appointed chief engineer of the record department of RCA Victor division. Mr. Reiskind was formerly record research and advance development engineer for RCA Victor in Indianapolis.

* * *

LISTER ELECTRONIC NAME CHANGE

Lister Electronic Products Co. will hereafter be known as the Electronic Research & Manufacturing Corporation, 5805 Hough Ave., Cleve-

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land 3, Ohio. The directors of the new corporation are: W. J. Brown, chairman of the board; Geo. H. Lister, president; and H. P. Hoffmeyer, treasurer. Telephone numbers are: Endicott 8151-6660.

* * *

F. R. LACK NOW ON W.E. BOARD

Frederick R. Lack, vice president and manager of the radio division of Western Electric, has been elected to the board of directors.

* * *

GOLENPAUL CELEBRATES 15TH YEAR WITH AEROVOX

Charley Golenpaul celebrated his fifteenth anniversary with the Aerovox Corporation in May.

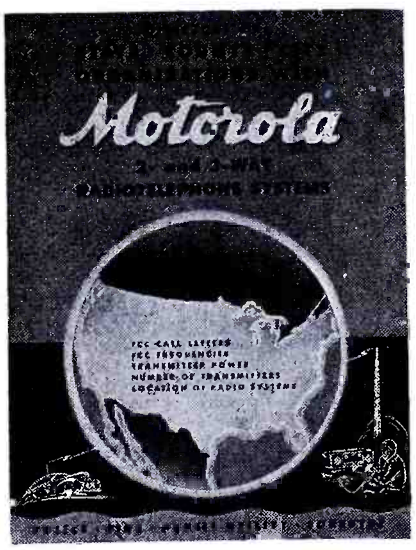
Mr. Golenpaul was formerly with Clarostat as general sales manager. He helped organize the Sales Managers Club and has served several terms as chairman of the Eastern group, which post he again occupies.

* * *

MOTOROLA EMERGENCY COMMUNICATIONS DIRECTORY

A 72-page directory listing 1050 licensees using 2- and 3-way emergency communications equipment has been published by the Galvin Manufacturing Corporation, 4545 West Augusta Boulevard, Chicago 51, Illinois.

Included are county maps of all the states showing the locations of the stations. Types of equipment, assigned call-letters, and output power of approximately 750 municipal and county police departments, 200 state police departments, and 100 special emergency, forestry and fire departments are also shown.



* * *

HABER AND DESFOR WIN RCA PROMOTIONS

Julius Haber has been appointed assistant director of the advertising and sales promotion department of RCA Victor division of RCA. Mr. Haber was formerly director of publicity.

Harold D. Desfor has been named director of publicity. He was formerly assistant to Mr. Haber.

J. Haber

H. Desfor

* * *

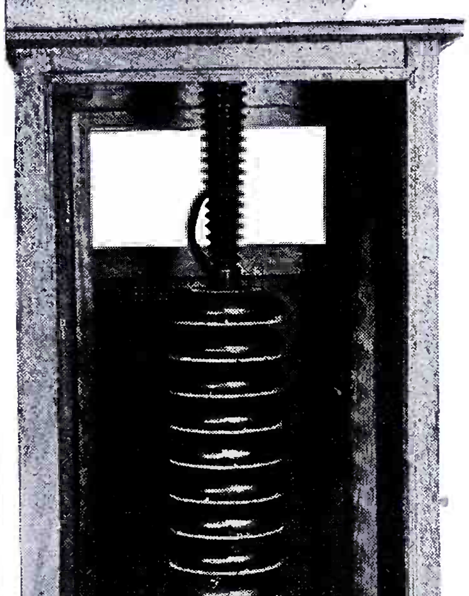
FRENCH TELEVISION TO RESUME OPERATION

The pre-war Eiffel Tower station working on 455 lines with 30-kw peak power will tem-

(*Continued on page* 104)

Typical of the larger portable Shallcross Kilovoltmeters, No. 722 is rated 2-20 KV. d-c, 1000 ohms per volt.

Interior view of Kilovoltmeter Multiplier No. 712-5-3. 12 kv., 5 ma., 2.4 megohms.



A special Shallcross Corona Protected Kilovoltmeter with front shielding wire screen removed to show interior. Meters illustrated are optional.

Shallcross HIGH VOLTAGE TEST AND MEASUREMENT EQUIPMENT

If your requirements call for standard kilovoltmeters or kilovoltmeter multipliers in any one of many sizes and voltage ranges or for specially designed high voltage equipment, Shallcross offers the services of its High Voltage Engineering Section. Backed with many years of experience in this field, Shallcross engineers welcome the opportunity to help in the solution of practically any high voltage test or measurement problem.

WRITE FOR BULLETIN

Bulletin "F", recently released, includes detailed descriptions of standard Kilovoltmeters, Kilovoltmeter Multipliers, and Corona Protected Resistors and serves as a guide to the many special types that can be produced to match particular requirements in a range of potentials from 1 to 200 kilovolts.

SHALLCROSS MFG. CO.

DEPT. C-55 COLLINGDALE, PA.

ENGINEERING • DESIGNING • MANUFACTURING

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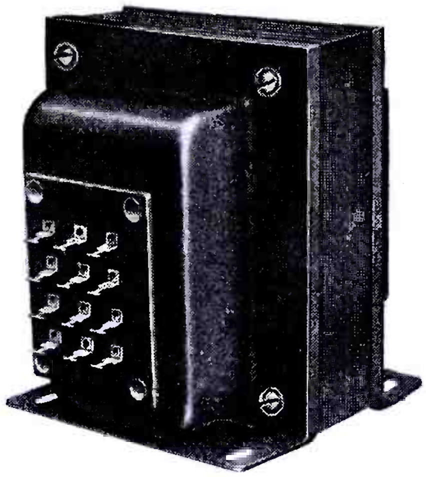
More Examples of ACME TRANSFORMER ENGINEERING



◆ The specially designed testing unit (illustrated above) has 140 terminals providing 70 individual secondary circuits of 2 volts each.

This radio power transformer is designed with a standard 115 volt, 60 cycle primary winding and provides a high voltage secondary winding and filament winding. Manufactured in quantity to high performance standards. ◆

THE ACME ELECTRIC & MFG CO.
Cuba, N. Y. Clyde, N. Y.

Acme ACME Electric
TRANSFORMERS

UTC **JUST ARRIVED—The Little Tools for Really Big Jobs** UTC

UNIVERSAL MIDGET SERVICE TOOLS

USE UNIVERSAL MIDGETS WHERE OTHER TOOLS WON'T GO

SET A	SET B	SET C
NEW UNIVERSAL OPEN END WRENCHES 4 Wrenches — 8 sizes in pocket roll............ $3.95	NEW UNIVERSAL 6 pc. Midget Punch and Chisel Set in pocket roll ONLY...... $4.95	NEW UNIVERSAL 5 pc. Set—3 Midget Pliers, Screwdriver and Screw-holder...... $6.95
DEAL 1	DEAL 2	DEAL 3
NEW UNIVERSAL Miniature Mite 1/4" Square Drive 11 pc. Socket Set — 7/32" to 7/16" $7.95 MITEY-HANDY	NEW UNIVERSAL Midget 1/4" Square Drive Socket Set—12 pc. 3/16" to 1/2"—New Socket Starter..... $12.95 A-HONEY	NEW UNIVERSAL 3/8" Cub Square Drive—12 pc. Socket Set—3/8" to 3/4" Only...... $19.95 A-DANDY

5 Sets A, B and C Plus Deals 2 and 3, Complete 39 Pc. Set, with all steel case ONLY........ $48.75

From the Heart of America— UTC
Overnight by Air to Anywhere in U. S. A.

ORDER TODAY!
EASY AS ABC—123
Send names of 3 friends needing tools now and you will receive a useful gift.

UTC

UNIVERSAL TOOL CO. O. B. Dematteis President
1527 Grand C Kansas City 8, Mo.

NEWS BRIEFS

(*Continued from page 103*)

porarily resume operation, according to Guy Rabuteau of I. T. & T.'s Le Materiel Telephonique, Paris.

Mr. Rabuteau also reported that Robert Buron, French broadcasting administrator, pointed out recently that despite German occupation, French research organizations have continued developing television technique and manufacturers are now in a position to deliver pick-up equipment, transmitters and receivers suitable for black and white high definition television and later on full color television. Experiments will be made on both 750- and 1,000-line black and white images, according to Mr. Buron, and low-power transmitters for 1,500, 600- and 150-megacycle tests will be ordered.

* * *

50TH X-RAY ANNIVERSARY

On November 8, the 50th anniversary of the discovery of X-rays by Roentgen will be celebrated. Pioneer manufacturing companies who will celebrate this event include the Machlett Laboratories.

* * *

ANDREW CABLE ACCESSORY BOOKLET

A 4-page booklet describing accessories used in installing soft and rigid coaxial cables, such as glass insulated terminals, solderless connectors, gas fittings, etc., has been published by the Andrew Company, 363 East 75th Street, Chicago 19, Illinois.

* * *

EBY STOCK INTEREST SOLD

The stock interest of Hugh H. Eby was purchased by J. L. Hawley, F. Holmstrom and T. J. Mullaney. J. L. Hawley will act as president; F. Holmstrom, vice president and treasurer; and T. J. Mullaney, secretary.

* * *

WESTMAN JOINS ELECTRICAL COMMUNICATION

Harold P. Westman has joined the staff of "Electrical Communication" as an associate editor. Mr. Westman was formerly with the ASA as a staff engineer on standardization of radio components for the Armed Forces.

* * *

GRENBY AND CARDWELL MERGE

The Grenby Manufacturing Company, Plainville, Connecticut and the Allen D. Cardwell Manufacturing Corporation, Brooklyn, New York, have consolidated. Both companies will maintain their present corporate identity and will continue their present management.

* * *

C-D REPLACEMENT CAPACITOR CATALOG

A 24-page catalog, 195, with data on electrolytic can and cardboard tube capacitors, paper capacitors, wax impregnated and Dykanol tubular capacitors, drawn metal shell units, replacement paper units, photo-flash units, auto radio units, transmitting paper types and mica capacitors has been released by Cornell-Dubilier Electric Corp., South Plainfield, N. J.

* * *

PANORAMIC BOOKLET

A 32-page booklet, entitled "From One Ham to Another," and covering panoramic reception techniques has been published by the Panoramic Radio Corporation, 242-250 West 55th Street, New York 19, New York.

Described are amateur tuning problems and proposed solutions.

To obtain free copies address requests to Harvey Pollack.

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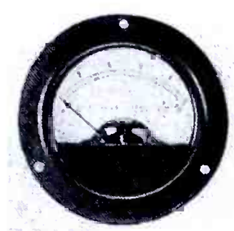
THE INDUSTRY OFFERS . . . —

HICKOK HERMETICALLY SEALED METERS

Hermetically sealed 2½", 3½" and 4" round style meters with internal pivot construction, have been announced by The Hickok Electrical Instrument Company, 10529 Dupont Ave., Cleveland 8, Ohio.

Dimensions are in accordance with American War Standards C39.2-1 and C39.2-2. The 4" round instruments are for use in radio service equipment where several scale arcs are required and have a body diameter of 3½", flange diameter of 4½" taking a mounting hole radius 1 15/16". Instruments offered are voltmeters, ammeters, milliammeters and microammeters, both a-c and d-c. Vacuum seal used in standard models. They can also be sealed with dry air at sea level pressure or inert gas. Glass window is said to withstand 25 pounds pressure psi. High strength Alnico magnets are used. Operation at 85° C said to be possible.

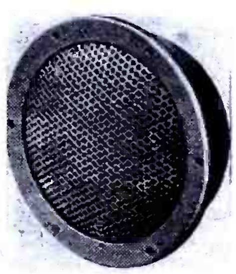


* * *

JENSEN SPEAKERS

A special purpose speaker, type NF-300, originally developed for use as a loudspeaker and microphone in ship intercommunicating systems is now available from the Jensen Radio Manufacturing Company, 6601 South Laramie Street, Chicago 38, Illinois.

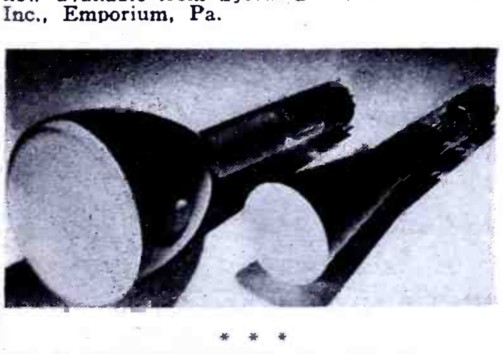
Speaker features a reflex horn. Alnico 5 permanent magnet material is used. Diaphragm is of moulded phenolic and the sound chamber is a combination of moulded bakelite and metal castings. Voice coil impedance is 12 ohms, nominal value. Maximum power-handling capacity for speech is 10 watts.



* * *

SYLVANIA CATHODE-RAY TUBES

Standard 3AP1, 3BP1, 5AP1, 5BP1, 5CP1 and 5HP1 RMA c-r tubes, and similar tubes supplied with P4 or other special phosphors, are now available from Sylvania Electric Products Inc., Emporium, Pa.



* * *

W. E. WATER-PROOF LIP MIKES

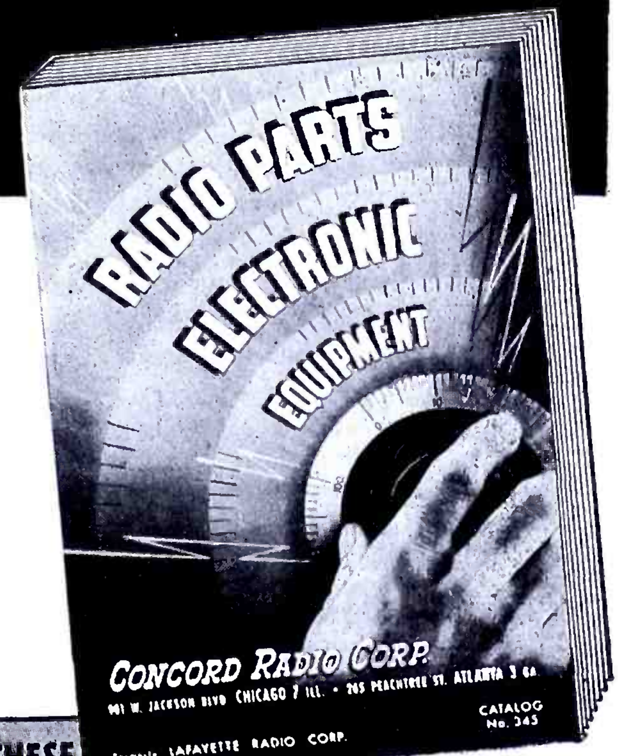
A lip microphone and headset combination that is said to be "submersion-proof" is now being manufactured by Western Electric Equipped with an especially designed gland, which will pass air but exclude water, the new microphone is said to be capable of withstanding a submersion cycle of 25 minutes under 10 inches of sea water followed by baking in an oven at 125° F repeated five consecutive times without damage to the instrument. The gland

(*Continued on page* 106)

Send For CONCORD'S New

RADIO PARTS BUYING-GUIDE

It's Free!



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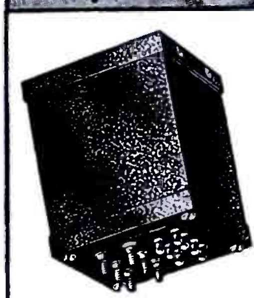

Power Transformer
Pri. 110, 200, 220, 240 Volts 50-60 cycles. Sec. 6.3 @ 1.45 A. 5V @ 2A. 376 Vct. @ .025 A. 5B5016. . . $3.95

I. F. Transformer
10 Megacycle I. F. Transformer in heavy aluminum can. Size: 3¾" H, 1 15/16" W, 1½" D. 5B5017 $2.95

Telephone Switch
Lever type switch D. P. D. T. No knob supplied. Dull black finish with chrome plated lever. 5B4026 . . 59c

Phone Jacks
Switchboard type 2 circuit normally closed. Takes standard tip and sleeve plug. 5B6927 . . . 49c

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Concord carries vast stocks. Concord ships to you at once from the nearest shipping warehouse, CHICAGO or ATLANTA. Concord invites you to consult our technical experts on special requirements. Concord can expedite any "essential" order and speed action. Concord now serves the United States Government, Institutions, Industry—and can serve YOU, whether you want one part or a hundred. Telephone, wire, or write your needs.

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Dept. R-55, Chicago 7, Ill.
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Address..
City.......................... *State*.........

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THE INDUSTRY OFFERS . . . —

(*Continued from page* 105)

permits equalization of air pressure under altitude changes which is said to allow for safe transport of this equipment to the fighting fronts via cargo plane.

Not much larger than a half-dollar and less than one-half inch thick, the microphone, a single button carbon type, employs the differential principle of operation. The average articulation is about 86% on a multi-syllable test with both talker and listener in a noise field composed of simulated airplane noise at a level of 118 db.

* * *

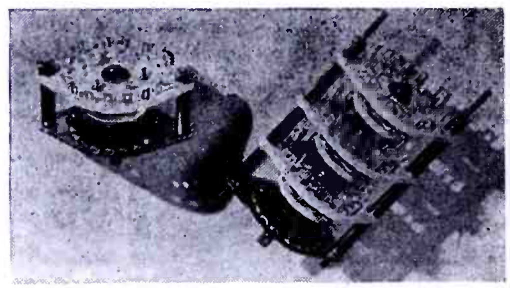
CENTRALAB MEDIUM DUTY POWER SWITCHES

A J-switch series for power applications has been announced by Centralab, Division of Globe-Union, Inc., 900 East Keefe Ave., Milwaukee 1, Wis.

Switches will be available in one to five sections, with shorting or nonshorting type contacts. In addition to the complete units, sections and indexes will be available separately for individual assembly in any desired combination. The switching combinations for the present will be one pole, 17 positions (18 positions, continuous rotation, with eighteenth position "off") and 3 poles, 5 positions (6 positions, with sixth position "off"). All units will be furnished with adjustable stops for limiting the desired number of positions.

Switches will have single hole, bushing mounting. In addition, there will be tie-rod extensions at both the front and rear of the switch to serve as locating keys and offer additional support in mounting. Locknuts, lockwashers and a 2¼" bar knob will be furnished with each unit. The bar knob has double set screws for secure mounting to the shaft.

Units will have a double-roller index with minimum life operation of 25,000 cycles. Contact buttons will be solid silver, and the terminals lug type. The rotor operating shaft will be square, fitting a staked sleeve in steatite rotors; sections will be grade L5 steatite, wax impregnated. Switches will be rated at 7½ amperes at 60 cycles, 115 volts.



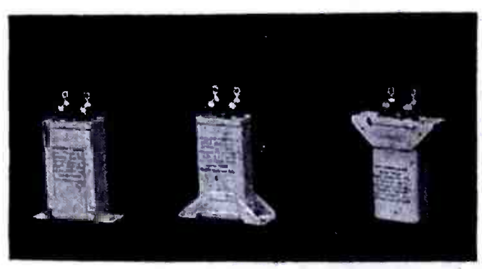
* * *

G. E., PAPER CAPACITORS WITH GLASS TERMINAL SEALS

Hermetically-sealed, fixed paper-dielectric capacitors with glass terminal insulators, CP-60, —62, and —64, characteristics E and F, have been announced by G.E.

The glass terminal seals are said to provide an unusually high degree of resistance to humidity, fungus growths, and termites.

Capacitance values range from 0.05 to 0.50 mfd, for voltages of 600, 1000, or 1500.



* * *

OHMITE RITEOHM RESISTORS

Two Riteohm type precision resistors, series 82 and 83, have been announced by the Ohmite Manufacturing Company, 4835 Flournoy Street, Chicago 44, Illinois.

Both units use enameled alloy resistance wire, non-inductively pie-wound on a non-hygroscopic ceramic bobbin which has a hole through the center for a No. 6 screw. After being wound, the units are vacuum impregnated with a varnish. The resistors can be supplied with a varnish coating containing a fungicidal agent.

Riteohm 82 is available in 2, 4 and 6-pie units. Maximum value of 2 pie is 400,000 ohms; 4-pie, 750,000 ohms; 6-pie, 1 megohm. Sizes are 1½"

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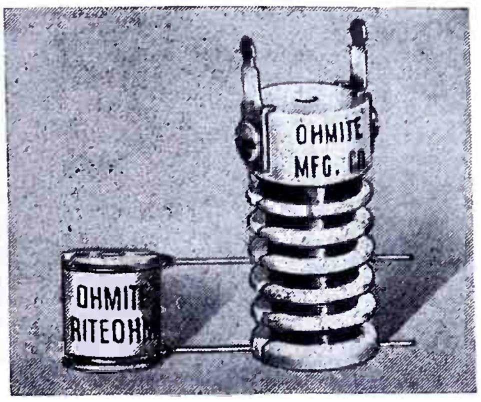
diameter by 1⅛" long, 1$\frac{7}{16}$" long or 1¾" long for 2-, 4- and 6-pie units respectively. The minimum resistance is .1 ohm for all units.

Riteohm 83 is available in small and large 2 pie, and 4 pie units. Small 2-pie max. value is 200,000 ohms; large 2-pie, 400,000 ohms; 4-pie, 800,000 ohms. Sizes are ½" diameter by $\frac{7}{16}$" long, ⅝" long or 1" long. Minimum resistance is 10 ohms for all units.



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UNIVERSITY P-M DRIVER UNITS

Permanent-magnet driver units featuring molded diaphragm flexing surfaces, heatproof voice coil suspensions, and hermetically sealed dust covers have been developed by University Laboratories, 225 Varick Street, New York 14, N. Y.

Another feature is said to be the rim centering of voice coil assembly in the magnetic gap, instead of the use of aligning pins.

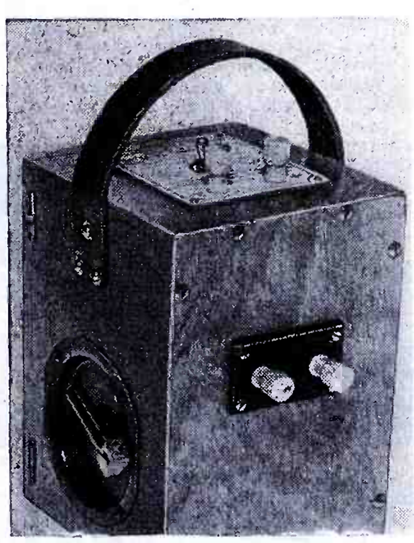
Model PAH has a rating of 25 watts; impedance, 15 ohms; frequency, 100 to 6,000 cycles; diameter 5¼"; height 5"; weight 9 pounds. Model SAH rating is 25 watts; impedance, 15 ohms; frequency, 100 to 6,000 cycles; diameter 4½"; height 5"; weight 5 pounds.

* * *

CONNECTICUT TEL CIRCUIT TESTER

A multipurpose portable circuit tester for testing insulation between wires or from wires to the ground has been developed by the Connecticut Telephone and Electric division of Great American Industries, Inc., Meriden, Conn. Audible indications at the point of test are provided. An indicator also determines the polarity of wires, visually.

Operates on a hand cranked generator which develops 500 volts d-c.



* * *

RME AUTOMATIC ANNOUNCER

An automatic announcer employing a voltage-

(*Continued on page* 108)

PLUGS and JACKS

...for every known application!

Built in accordance with latest Signal Corps and Navy specifications, Amalgamated Plugs and Jacks are tropicalized to make them fungus resistant, waterproof and moistureproof when called for. Insulators of these components are designed to wthstand extremes of temperatures for −67°F to +167°F, at humidities up to 100%. We also specialize in producing Plugs which will bear up under the high heat met in rubber molding cord sets.

NOTE: Amalgamated Engineers will gladly consult with you on the design and development of Plugs and Jacks for special applications — present or postwar.

PLUG PL-55 and N.A.F. 1136-1

Long sleeve, two-conductor plug, mate to Jack JK-34-A. Withstands minimum of 60 cycles AC, potential of 500 volts effective, applied between any two terminals for not less than two seconds. Meets minimum insulation value of 2000 megohms between conductors at 68°F at humidities up to 100%.

JACK JK-26, N.A.F. 215284-2

Two-conductor Jack, mate to PL-54. Tropicalized. Withstands 60 cycle AC potential of 500 volts effective, applied between any two terminals for not less than two seconds. Meets minimum insulation value of 2000 megohms between conductors at 68°F, at humidities up to 100%.

PLUG, STYLE "A"

Two-conductor, special type plug for use with Neoprene or Buna S molded cords. Same specifications as PL-55.

JACK JK-48

Light duty, two-conductor Jack, mate to Plug PL-291 and Plug 291-A.

PLUG PL-204

Hand set. A special plug wherein both a modified plug, PL-55 and PL-68, are held in place by a phenolic case. Same specifications as PL-55 and PL-68.

PLUG PL-54, PL-540, PL-354, N.A.F. 215285-2

Short sleeve, two-conductor plug, mate to Jack JK-26. Same specifications as PL-55.

PLUG, STYLE "D"

Two-conductor, special type plug for use with Neoprene or Buna S molded cords. Same specifications as PL-55.

AMALGAMATED RADIO TELEVISION CORP.

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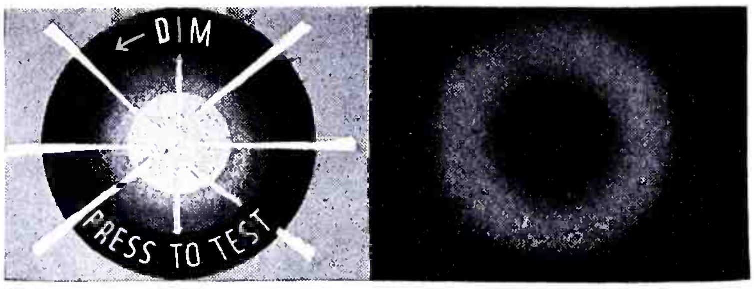
BACK THE INVASION—BUY MORE BONDS NOW!



CORRECT LIGHT... **DAY or NIGHT** ...CORRECT LIGHT

DIALCO "Vari-Dim" PILOT LIGHT #V.M.400

5 DISTINCTIVE FEATURES:—In daytime this unit emits concentrated penetrating light which is visible thru surrounding brightness . . . A turn of the knurled head produces soft diffused light which is ideal for night operation. No effect on operator's vision . . . Field of visibility is a full 150°, 60° more than required minimum . . . Press-to-test — light finger-tip pressure actuates the bulb testing circuit . . . Accommodates screw-base or bayonet base bulbs which can be quickly discharged by finger-tip pressure . . . Assemblies supplied complete with required lamps. Consult us about your problem.

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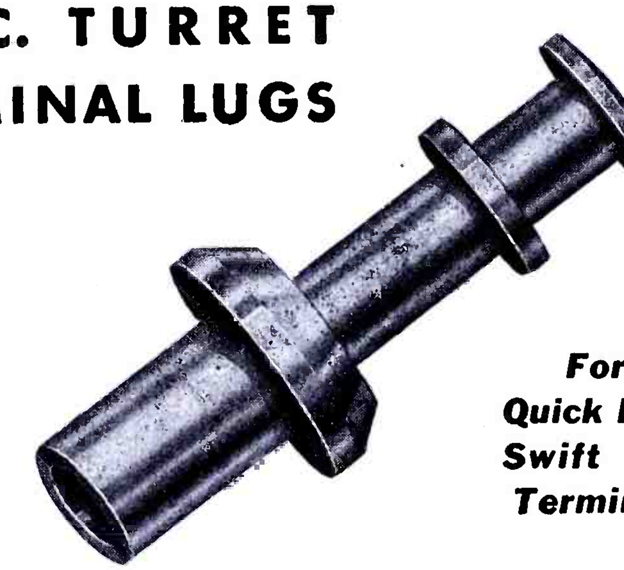
C. T. C. TURRET TERMINAL LUGS



For Firm, Quick Fastening, Swift Soldering Terminal Posts

Just swage them to the terminal board and you have strong, well anchored terminal posts. Two soldering spaces permit wiring of two or more connections without superimposing wires. Soldering is swift because sufficient metal is used in Lugs to provide strength, but there's no surplus metal which would draw heat and thus slow soldering.

Made of heavily silver plated brass, C. T. C. TURRET TERMINAL LUGS are stocked to fit 1/32", 2/32", 3/32", 4/32", 6/32" and 8/32" terminal boards.

Write for C. T. C. Catalog No. 100

CAMBRIDGE THERMIONIC CORPORATION
442 Concord Avenue • Cambridge 38, Mass.

THE INDUSTRY OFFERS . . .

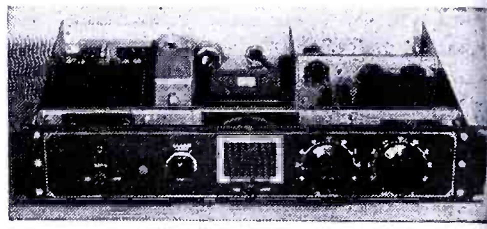
(*Continued from page* 107)

regulated power supply, a d-c amplifier, lam and alarm bell, together with associated operating relays, that can function as a radio-operated switch, has been introduced by Radio Mfg. Engineers, Inc., Peoria, Illinois.

It will operate from any d-c voltage source having an output of approximately 0.5 volt, usually developed across the diode load circuit in standard receivers tuned to either phone or cw; the incoming carrier signal is used to trigger the relay.

Sensitivity as well as time constant controls located on the front panel of the instrument are said to be variable, corresponding to actual operating conditions. Delay is said to range from 0 to over 100 milliseconds, with off-delay action constant at more than 500 milliseconds.

Operates off 115-volt a-c; power consumption, 34 watts; weight about 40 pounds. Designed for standard relay rack mounting, panel height being 3½".



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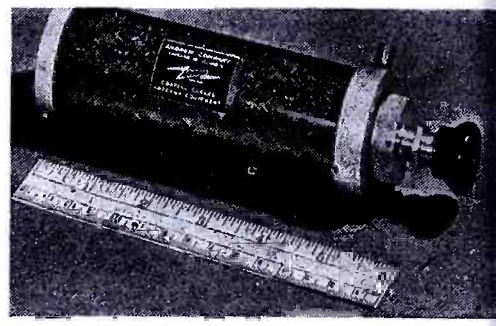
ANDREW MIDGET PANEL-MOUNTED DRY AIR PUMP

A midget dry air pump, 6" long (behind panel) and 2" in diameter, has been produced by the Andrew Company, 363 E 75th Street, Chicago 19, Illinois.

Output is said to be 3 cubic inches per stroke. Weighs 10 ounces. Has a transparent plastic cylinder which contains the drying agent. The latter is blue until its dehydrating capacity is exhausted. Then it turns pink, at which time it may be reactivated or replaced.



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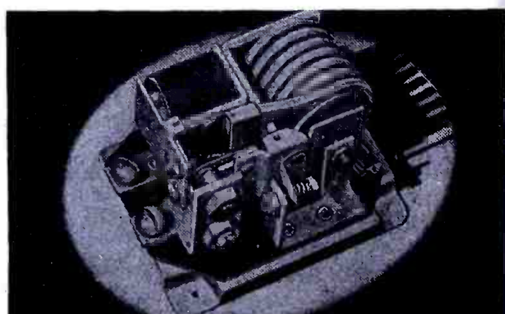
R-B-M REVERSE CURRENT RELAY

A reverse current relay, type 9100, using a magnetic latch to prevent accidental closing of armature and contacts due to vibration up to 10 G, or heavy shock, has been announced by the R-B-M Manufacturing Company, division of Essex Wire Corp., Logansport, Indiana.

Contacts rated 100 amperes at 30 volts d-c maximum. Width $4\frac{1}{16}$", depth $3\frac{7}{16}$", height $2\frac{1}{16}$". Approximate weight, 1.6 pounds.

Relay, without magnetic latch type 9000, is also available for use where severe vibration and shock are not encountered, in sizes as low as 300 watts at 6, 12, 18, and 24 volts d-c.



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TECHRAD INTERPOLATING COUNTERDIAL

An interpolating counterdial with scale graduations from 0 to 100 for each revolution of the dial has been developed by the Technical Radio Company, 275 Ninth St., San Francisco, Calif.

Each graduation has two marked divisions providing a total of 200 readable parts on the

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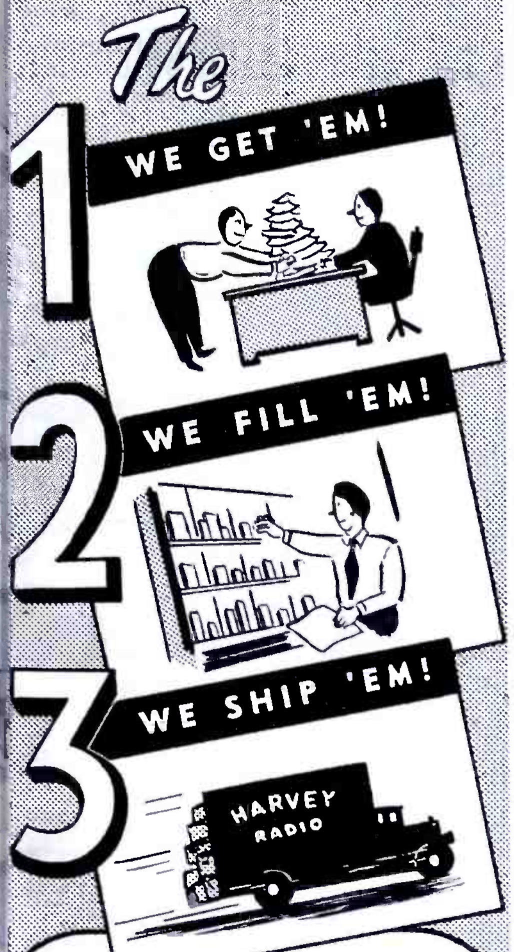

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HARVEY RADIO COMPANY

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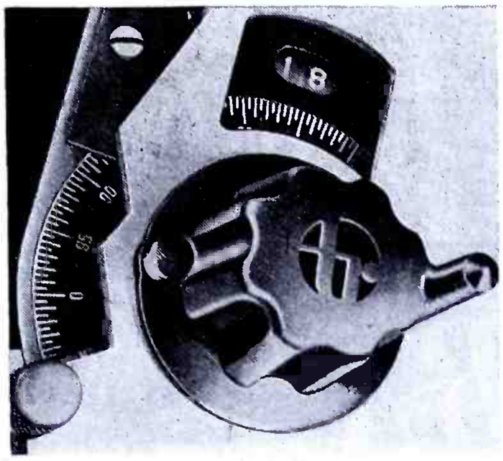
dial. An additional counting mechanism records each dial revolution, either forward or backward.

Dial can be used with a roller coil variable inductor to obtain a record of the number of turns. Other applicationsf include use with devices operating on a lead-screw principle, such as lead-screw type variable capacitors, v-h-f signal generators, gear train variable capacitors, and worm-gear driven capacitors.

All stock models have a direct drive through stem shaft without gear ratio. Standard stock counters have two digit numbers (0 to 99). Three digit numbers (000 to 999) available on special order.



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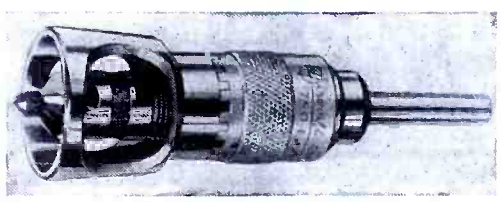
AIRCRAFT TOOL COUNTERSINK

A micro-set stop countersink, AT-400-B, with a large bell skirt has been announced by Aircraft Tools, Inc., 750 E. Gage Avenue, Los Angeles 1, California. The bell skirt is said to provide added base support.

Shaft runs in oilite radial bearing with ball-bearing thrust. Polished flutes are used.

Countersink takes up to 5/8 cutters.



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BURGESS MAGNESIUM STRIP-COILS

Thinstrip magnesium in widths from 3/4" to 5" and in gauges from .010" a sthan as .005", has been developed by Burgess Battery Company, Freeport, Illinois.

Sample strip will be sent free on request to department M-20.

* * *

U.P.P.C. COLORED PLASTIC COLLETS

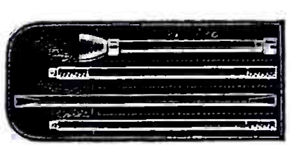
Colored plastic collets have been developed by United Precision Products Co., 3524 W. Belmont Ave., Chicago 18, Illinois.

Collets are green for the "go" plug and red for the "no go" plug. Both plugs are contained in the same handle.

* * *

GENERAL CEMENT VEST POCKET ALIGNING KIT

An all-purpose aligning kit, 5022, with alligator and hexagonal screw drivers, enclosed in a leatherette case has been produced by General Cement Manufacturing Co., 919 Taylor Avenue, Rockford, Illinois.



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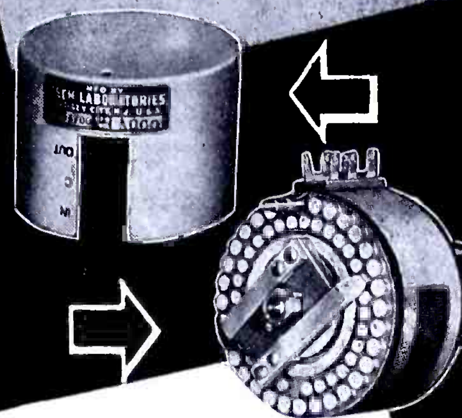
RADIOMARINE LIFEBOAT RADIO

Lifeboat radio equipment that automatically transmits SOS and radio direction finder signals has been developed by Radiomarine Corporation of America. Model has a hand-driven power generator, which replaces storage bat-

(*Continued on page* 110)

NEW IMPROVED "T"-PAD

ATTENUATORS BY TECH LAB



- Stainless Silver Alloy contacts and wiper arms.
- Rotor hub pinned to shaft prevents unauthorized tampering and keeps wiper arms in perfect adjustment.
- Can be furnished in any practical impedance and db. loss per step upon request.
- Write for our Bulletin No. 431.

TECH LAB MICROHMMETER

Direct and instantaneous resistance readings down to 5 microhms and up to 1,000,000 megohms. Write for Bulletin No. 432.

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MYCALEX K—a series of improved capacitor dielectrics, with dielectric constant selectable from 8 to 15.
MOLDED MYCALEX—low loss, high temperature injection molded insulation, in irregular shapes. Metal inserts can be molded in.
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RUBYFLUID—for Faster, Easier Soldering
Rubyfluid Flux, Paste and Stainless Steel Flux produce neat, strong joints—easily and quickly. No objectionable or harmful fumes. Meets exacting government specifications.
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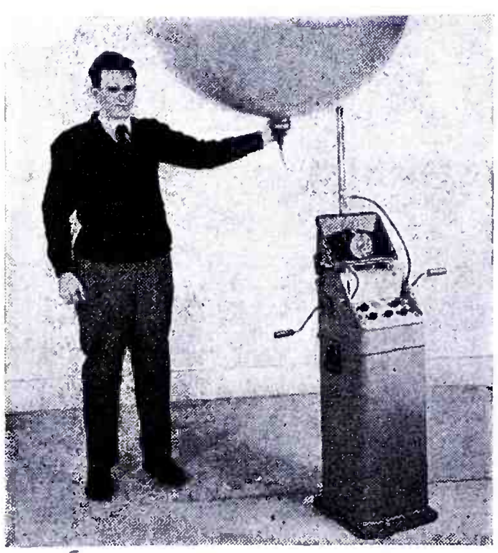
THE INDUSTRY OFFERS . . . —

Continued from page 109)

teries. Two-way radiotelegraph and radiotelephone facilities for 500 and 8,280 kc, are combined in a single binnacle-shaped waterproof housing. Operates with a 300' antenna, carried aloft by either a kite or a balloon. Kite, a collapsed balloon in a hermetically sealed container and a small canister of helium, are standard parts of the equipment. Weather and wind conditions determine the use of either the balloon or the kite. The balloon is designed to remain aloft for a week or more.

Transmitter delivers 5 watts to the antenna. Keying device provides transmission of groups of SOS signals to summon aid and "long dash" signals for radio direction finder bearings.

Receiver is pre-tuned to the 500-kc international distress frequency. It also can be tuned to sweep the short-wave band from 8,100 to 8,600 kilocycles.



* * *

WALSCO SYNTHETIC WIRE INSULATION

Synthetic wire insulation, "flexitube," has been announced by the Walter L. Schott Company, 9306 Santa Monica Boulevard, Beverly Hills, California.

Flexitube is said to be resistant to abrasion and effective over a temperature range of minus 35° C to plus 75° C.

Insulation is also said to be practically impervious to oils, grease, alcohol, hydro-carbons, alkalies and acids; it is affected by ketones and some chlorinated hydro-carbons. The average tensile strength is claimed to be 3,000 psi.

Stock colors are red, black, green, and clear; other colors can be supplied. Sizes (B-S gage) range from 2 to 18.

A sample kit containing various sizes and colors will be furnished free upon request.

* * *

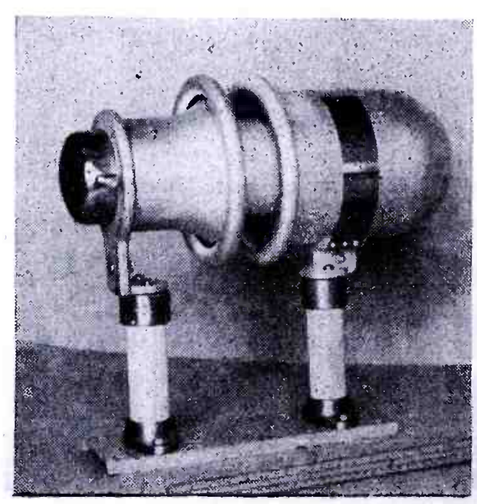
JOHNSON NEUTRALIZING CAPACITORS

Type TN neutralizing capacitors featuring cylindrical construction in a high voltage design have been announced by E. F. Johnson Company, Waseca, Minn.

Two sizes are available, rated at 45,000 volts and 35,000 volts peak breakdown, respectively. Capacity ranges are 33.1 to 12.6 mmfd for the former and 26.0 to 7.2 mmfd for the latter.

Rough adjustment of capacity is made by moving the outer cylinder under the clamp, and precision settings are made by rotation of a shaft, the location of which may be changed in steps of 45°, around the axis of the condenser.

Material is spun and cast aluminum. Connections are made direct to aluminum castings and leads may come off at any angle.



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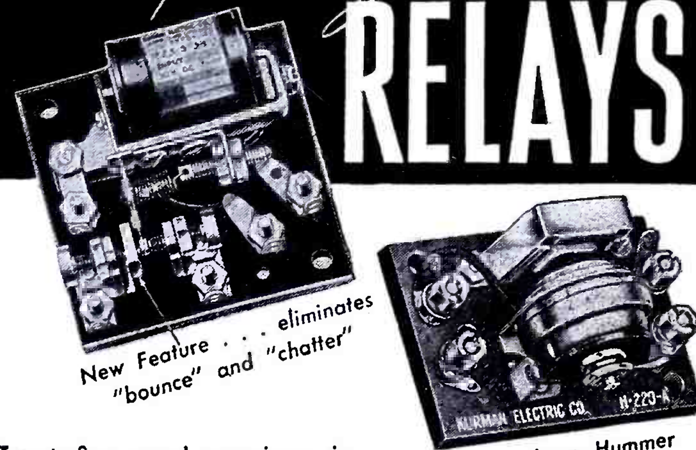

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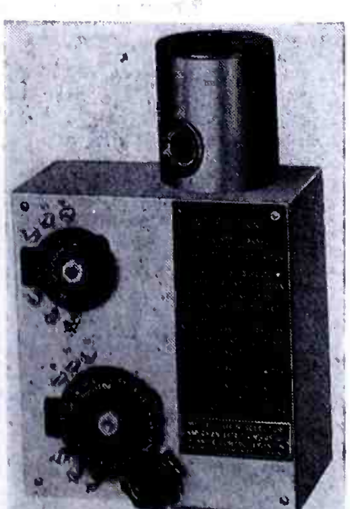
ATF REMOTE CONTROLS

Four types of remote-control systems, developed under the Yardeny patents, are now being made by the American Type Founders, Incorporated, Remote Control Division, 11. W. 42nd Street, New York 18, New York.

One type is a continuously variable control, with a non-synchronous follow-up control provided with a repeat back indicator for positioning the shaft of a reversible motor to any point of any revolution. Another is a multi-turn selector. This unit is motor-driven and its connected load may be placed in any one of several (usually six) adjustable positions over one or a number of revolutions. The third type is a dual control. This incorporates the features of both the continuously variable control and the multi-turn selector. By this combination, the operator may position the load to any one of the pre-set positions, or by turning a knob, to any point over the full range. Fourth unit is an integrating selector. This provides automatic setting of the load to many positions with a comparatively small number of push buttons.

ATF reports that normal accuracy of positioning can be as close as one one-hundredth of a degree of the output shaft.



* * *

HARVEY-WELLS DECADE UNITS

A decade unit that is said to provide almost any desired value or combination of values covering capacitance, inductance, resistance, transformer ratios, etc., has been developed by the Harvey-Wells research laboratories of Harvey-Wells Electronics, Inc., Southbridge, Massachusetts.

* * *

MAGNOGRAPH RECORDING TAPE

A multiple line steel tape magnetic recording method "Talkertape," has been announced by Magnograph Corporation, 5800 West Third Street, Los Angeles 36, California.

Licenses for the production and merchandising of Magnograph devices in the home-recording, business dictation, educational and entertainment fields, are now being granted according to M. B. Price, executive vice president.

The Magnograph method uses a steel tape, ½" wide, .002" thick. Tensile strength is said to be 365,000 psi. Tape speed can be varied from 30 feet per minute for speech to 60 to 75 per minute for music.

Multiple line recording is said to permit the use of from two to twenty channels. A 4" reel containing 400' of tape will produce one hour of music or speech.

* * *

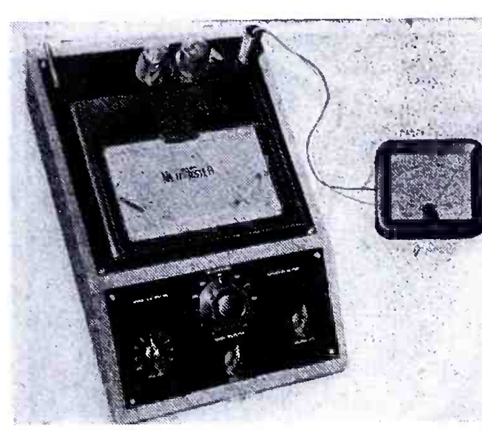
MARION MULTI-RANGE METERTESTER

A 0-25 microampere/0-10 ma/0-100-volt multi-range metertester featuring a stepless vacuum tube voltage control; 8½" mirror scale standard instrument and .1% wire-wound resistors has been announced by the Marion Electrical Instrument Co., Manchester, New Hampshire.

Type 6N7 tube is used as a grid-controlled variable resistor. Power supply uses a 6X5 full-wave rectifier with a VR150-OD3 voltage regulator.

Overall accuracy is said to be better than ½ of 1%, with tester hand-calibrated by the potentiometer standard cell method, on equipment certified by the Bureau of Standards. Instrument is said to have a basic sensitivity of 10 milliamperes.

The unit is housed in an oak carrying case. Distributed by the Electrical Instrument Distributing Co., 458 Broadway, New York, N. Y.



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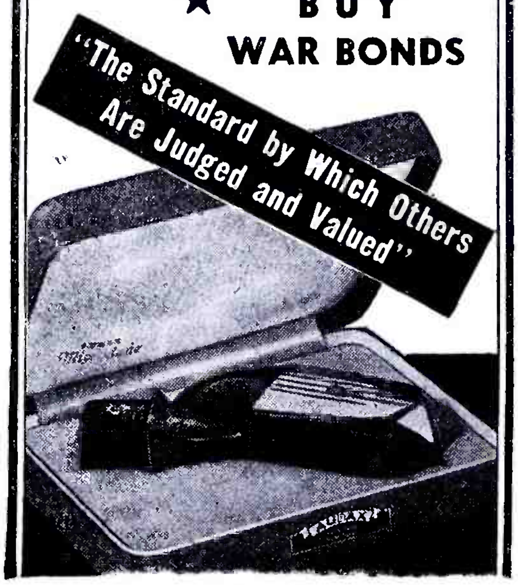

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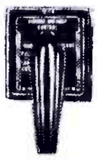
Rectangular Indicating Lamp—A low-drain lamp for extreme angular visibility and compact mounting. Of medium size, it is especially suited for installation with switches shown below.

Large Indicating Light—Provides high illumination and can be universally mounted. Has comparatively high drain but gives maximum visibility at greater distances.

These indicating lamps, for mounting on panels up to 2 inches thick, operate on a-c or d-c, from 25 to 250 volts. Lenses are available in clear or opalescent and in red, green, blue, amber. For additional information, ask for Catalog Section 37-200. For suggested panel drilling layout of switches and groups of indicating lamps, write your Westinghouse office.

CONTROL SWITCHES

Minatrol—A compact switch, with small dimensions, to save space on miniature panels. Has heavy-duty contacts which eliminate interposing relays in most circuits. Available for control, instruments, temperature indicators, etc.



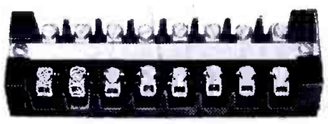
Type W Switch—A standard heavy-duty control switch available in a variety of full-hand grips—removable, keyed type; pull-out lock type, automatic-return-to-neutral type; and stay-out types. Used for control, instruments, temperature indicators, etc.

Auxiliary Switch—Similar to Type W, except it is mechanically actuated by levers. Can be actuated by doors or moving mechanisms—and is commonly used for safety interlocks, sequence or process controls. Special mounting provisions and housings, including an outdoor type, are available.

Selector Switch—Locks into each position, and can be operated by one hand—thus leaving other hand free for other operations. Handle is pushed in for release to turn. Circuit is broken by auxiliary contacts. Available in 4 to 24 single-pole, or up to 8 double-pole arrangements.

For additional information on the Minatrol switches ask your Westinghouse office for Catalog Section 37-175, for Type W and auxiliary switches ask for Descriptive Data 37-150.

TERMINAL BLOCKS



8-circuit black terminal block with high-pressure connectors.

Cover partially removed, showing clamp type terminals on 8-circuit terminal block.

These terminals are used extensively in Westinghouse products and are available in a variety of molded bases, terminal constructions and number of terminals. The three commonly used combinations are:

1. 4, 5, 8 or 12 terminals per block—with standard or captive high-pressure terminals or hardware. This is a standard type board with black molded plastic base of high impact strength and very low moisture absorption.

2. This block is specified for Navy electronic equipment. Black molded plastic base has high impact strength, low moisture absorption and high fire resistance. Hardware includes binder head screws and shakeproof washers.

3. This block is specified for Navy switchgear—has 4, 8 or 12 terminals, and standard hardware. Has black molded plastic base of high impact strength, low moisture absorption, and high fire resistance.

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