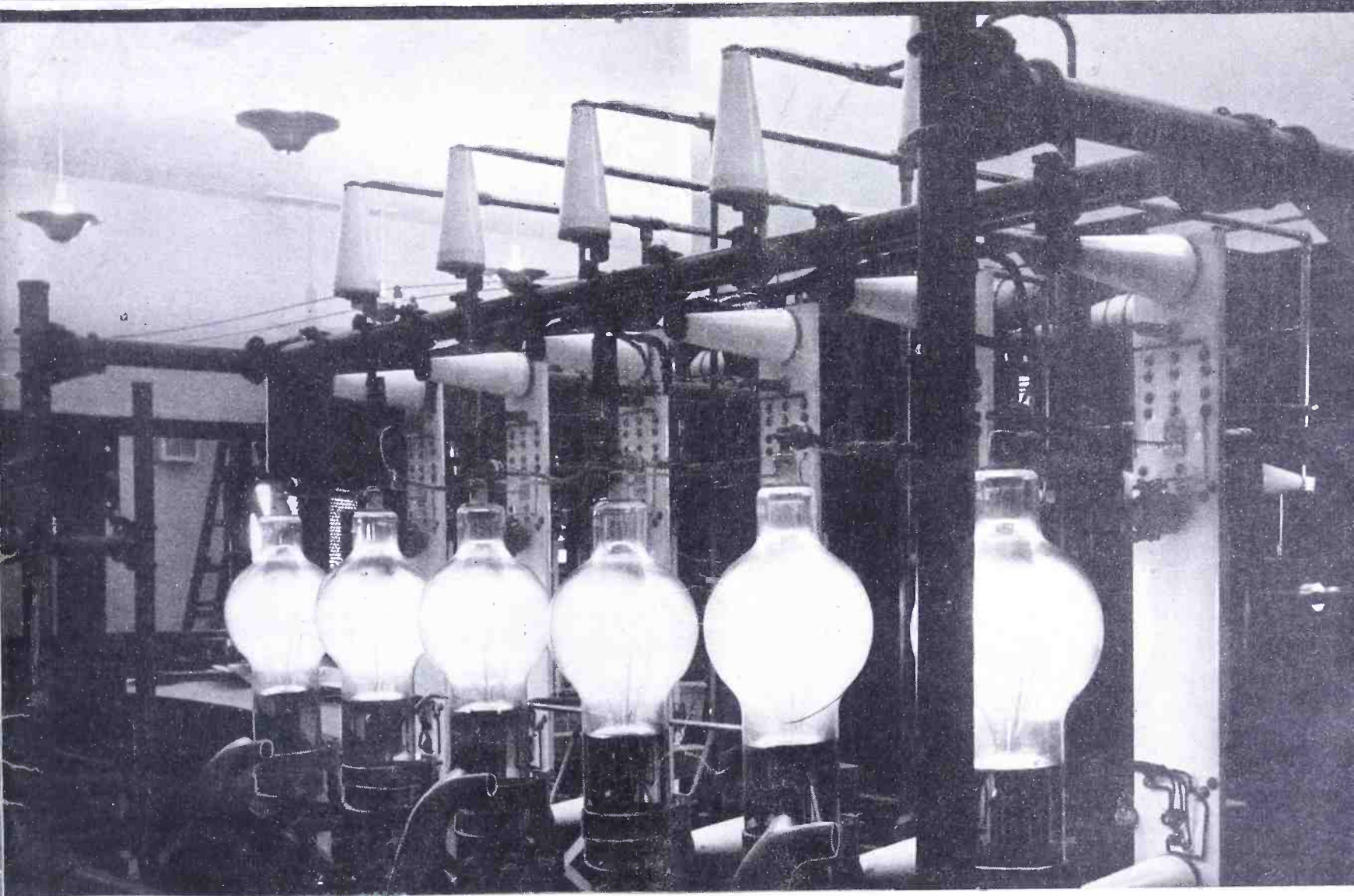


COMMUNICATIONS



AUGUST

- ★ RADIO ENGINEERING
- ★ PRE-FLIGHT COMPASS TESTS
- ★ A-N MICA CAPACITOR STANDARDS

- ★ NAB WAR CONFERENCE
- ★ BROADCAST ANTENNAS AND ARRAYS
- ★ RESISTIVE NETWORKS

1944

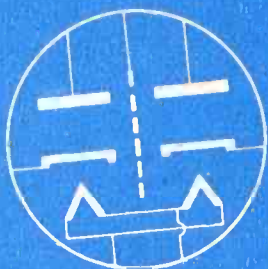
NO SUBSTITUTE NEEDED!

USE
HYTRON 6AL5

VERY-HIGH-FREQUENCY TWIN DIODE

TYPE 6AL5

(Developmental
Hytron D27)

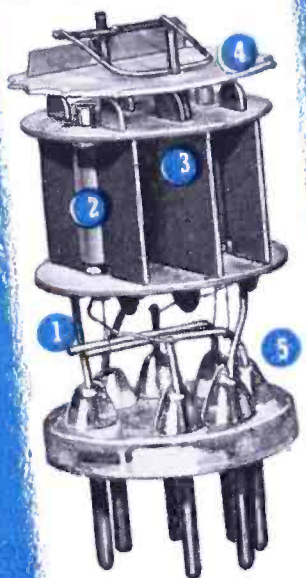


BASING

- Pin 1 — Cathode 1
- Pin 2 — Plate 2
- Pin 3 — Heater
- Pin 4 — Heater
- Pin 5 — Cathode 2
- Pin 6 — Shield
- Pin 7 — Plate 1

CONSTRUCTIONAL FEATURES

- 1 Rugged mount is supported by short, heavy stem leads as well as by top mica.
- 2 Close cathode-to-plate spacing gives high perveance. (Note plate cooling fins.)
- 3 Electrostatic shield connects to pin 6.
- 4 Baffle mica shields the elements from getter spray.
- 5 Miniature stem permits negligible lead inductance and minimum interelectrode capacitances.



The 6AL5 fills the need for a high perveance twin diode with the low voltage drop required for many special r.f. circuit applications. WPB and the Services consider diode connection of the 6J6 twin triode (and other triodes) to be a wasteful misuse. With minor changes of socket wiring, the 6AL5 easily replaces the diode-connected 6J6.

Specifically manufactured and rated as a diode, the 6AL5 is tested as a diode. Close production control keeps within a narrow range the cutoff characteristic in the contact potential region. Designed throughout for efficiency on high and very-high radio frequencies, the 6AL5 has a separately connected shield which may be grounded to isolate the two diodes and their associated circuits. A midget miniature bulb permits extra space savings.

Possible uses include: Detector and AVC, clipper, limiter, FM frequency discriminator, special high-frequency diode, power rectifier.

HYTRON TYPE 6AL5

Very-High-Frequency Twin Diode

ELECTRICAL CHARACTERISTICS

Heater potential (AC or DC)	6.3 volts
Heater current	0.3 amperes
Peak inverse potential†	460 max. volts
Heater-cathode potential†	350 max. volts
Peak plate current per plate†	60 max. ma.
Average plate current per plate†	10 max. DC ma.

INTERELECTRODE CAPACITANCES

Plate 1 to plate 2	0.015 mmf.
Plate to cathode*	2.8 mmf.
Cathode to all*	3.8 mmf.

Capacitances are averages with close-fitting shield.

PHYSICAL CHARACTERISTICS

Bulb	T-5½ midget
Base	Miniature button 7-pin
Height overall	1.82 inches max.
Diameter	0.75 inch max.

† Maximum ratings shown are absolute; design maximums should be approximately 10% lower to allow for line voltage variations.
* Value is for one of the two twin diode sections.

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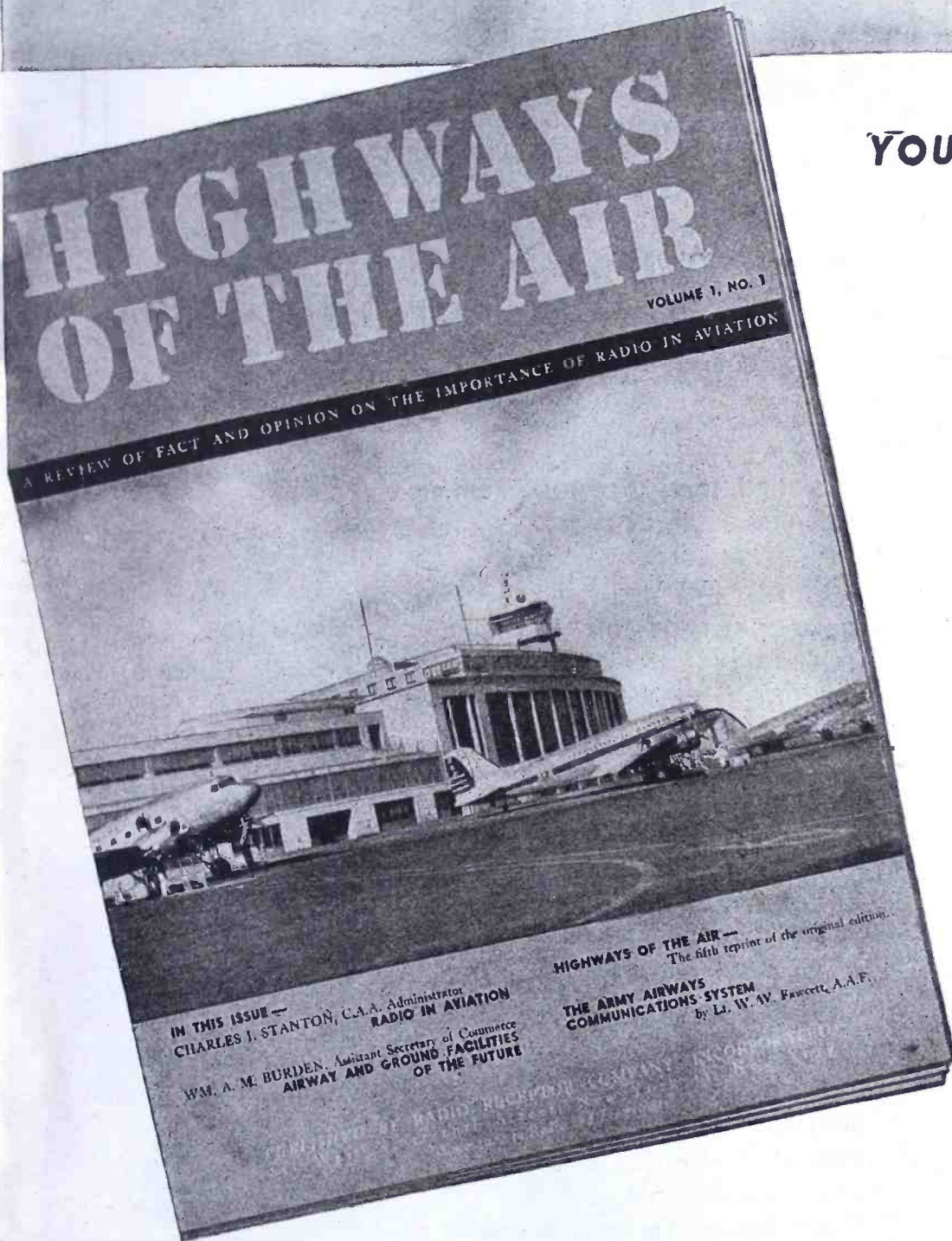
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BUY ANOTHER WAR BOND

“HIGHWAYS OF THE AIR”

Important to everyone interested in airports and aviation



YOU SHOULD KNOW - - -

What is the "bottle-neck" in post-war expansion of civil aviation See page 8

Why CAA is installing Ultra High Frequency radio ranges.

See page 8

What anti-collision devices are being developed . . See page 9

What electronic aircraft detectors are See page 9

What can civil aviation learn from the A.A.C.S. . . See page 2

What goes into an instrument landing system . . See page 11

What is approach control. See page 11



These questions and dozens of others of vital import to all those interested in the development of radio in aviation for increased safety of human life and property are discussed in the pages of "HIGHWAYS OF THE AIR"



This issue is No. 1, Volume 1—others will follow if you request them. Contents are authoritative—but non-technical—designed to inform the layman on a subject which is becoming of increasing importance.

Send for your copy on your letterhead—we are glad to send it as our contribution to a greater Air-America.

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S I N C E 1 9 2 2 I N R A D I O A N D E L E C T R O N I C S

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

We See...

A SIGNIFICANT CONCLUSION, stressing the importance of broadcasting, appeared in the postwar allocation proposal of IRAC (Interdepartment Radio Advisory Committee) presented in Washington recently at a State Department conference. An assignment of about 61% of the spectrum between 42 and 1,000 mc for f-m, television and relays is proposed. The proposal also calls for the extension of the standard broadcast band downward by adding the 540 kc band, a move that will provide improved service. For f-m, the 42-to 54-mc band is proposed. And for television, nine 6-mc channels between 54 and 108 mc, and three 12-mc or six 6-mc channels between 158 and 218 mc are suggested. Television may also receive the use of thirty 16-mc bands between 460 and 956 mc and an additional 16-mc channel between 508 and 524 mc, when these channels are no longer required for navigational aids.

Aeronautical communications also receives a substantial proportion of the spectrum in the allocation plan, with a host of channels between 200 kc and 3900 mc.

In commenting on this strident program that will eventually be placed before a postwar international communications conference, Francis C. deWolf, chief of the State Department Telecommunications Division, said that the American public has become communications wise. The tremendous increase of radio demands an international organization, he said. The radio industry, he pointed out, has set a pattern for the world. And this time U. S. radio will be there to receive its just rewards, he emphasized.

IN LONDON, A BROADCAST-TECHNIQUE engineering conference plan is now under consideration. The British IRE have advised us that they intend to hold an international convention of radio engineers about one year after cessation of hostilities. And they ask that the readers of COMMUNICATIONS comment on this proposed conference. Address all letters to G. D. Clifford, British Institution of Radio Engineers, 9 Bedford Square, London W.C. 1. We, too, would appreciate receiving your comments on the foregoing and other postwar projects under consideration.—L. W.

COMMUNICATIONS

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

AUGUST, 1944

VOLUME 24 NUMBER 8

COVER ILLUSTRATION

Closeup of 17,000-volt mercury-vapor rectifier-tube section of a 50,000 watt transmitter.
 (Courtesy Western Electric)

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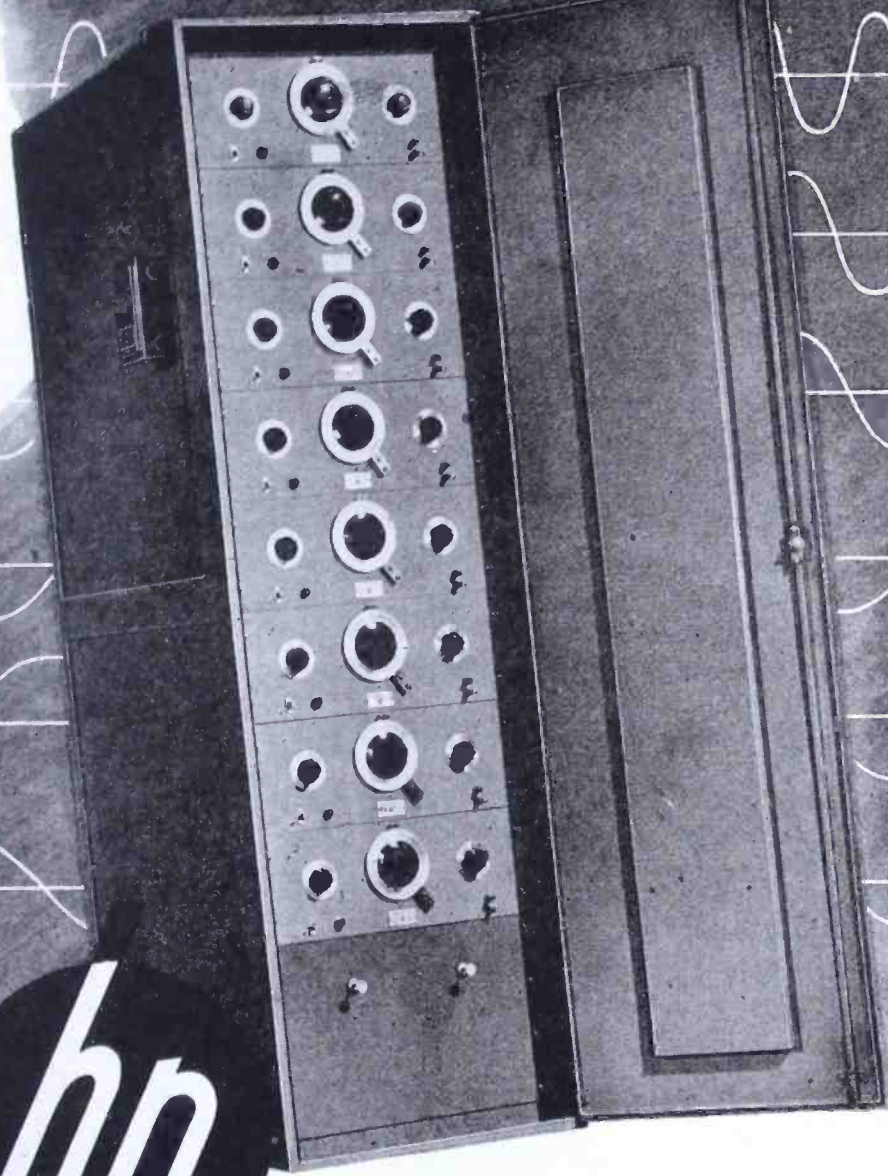
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Advertising and Editorial offices, 19 East 47th St., New York 17, N. Y. Telephone PLaza 3-0483. Cleveland 6, Ohio; James C. Munn, 10515 Wilbur Avenue. Pacific Coast Representative: Brand & Brand, 816 W. Fifth St., Los Angeles 13, Calif.; Telephone, Michigan 1732. Wellington, New Zealand: Te Aro Book Depot. Melbourne, Australia: McGill's Agency. Entire Contents Copyright 1944, Bryan Davis Publishing Co., Inc. Entered as second-class matter October 1, 1937, at the Post Office at New York, N. Y., under the act of March 3, 1879. Yearly subscription rate: \$2.00 in the United States and Canada; \$3.00 in foreign countries. Single copies, twenty-five cents in United States and Canada; thirty-five cents in foreign countries.

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COMMUNICATIONS FOR AUGUST 1944 • 3

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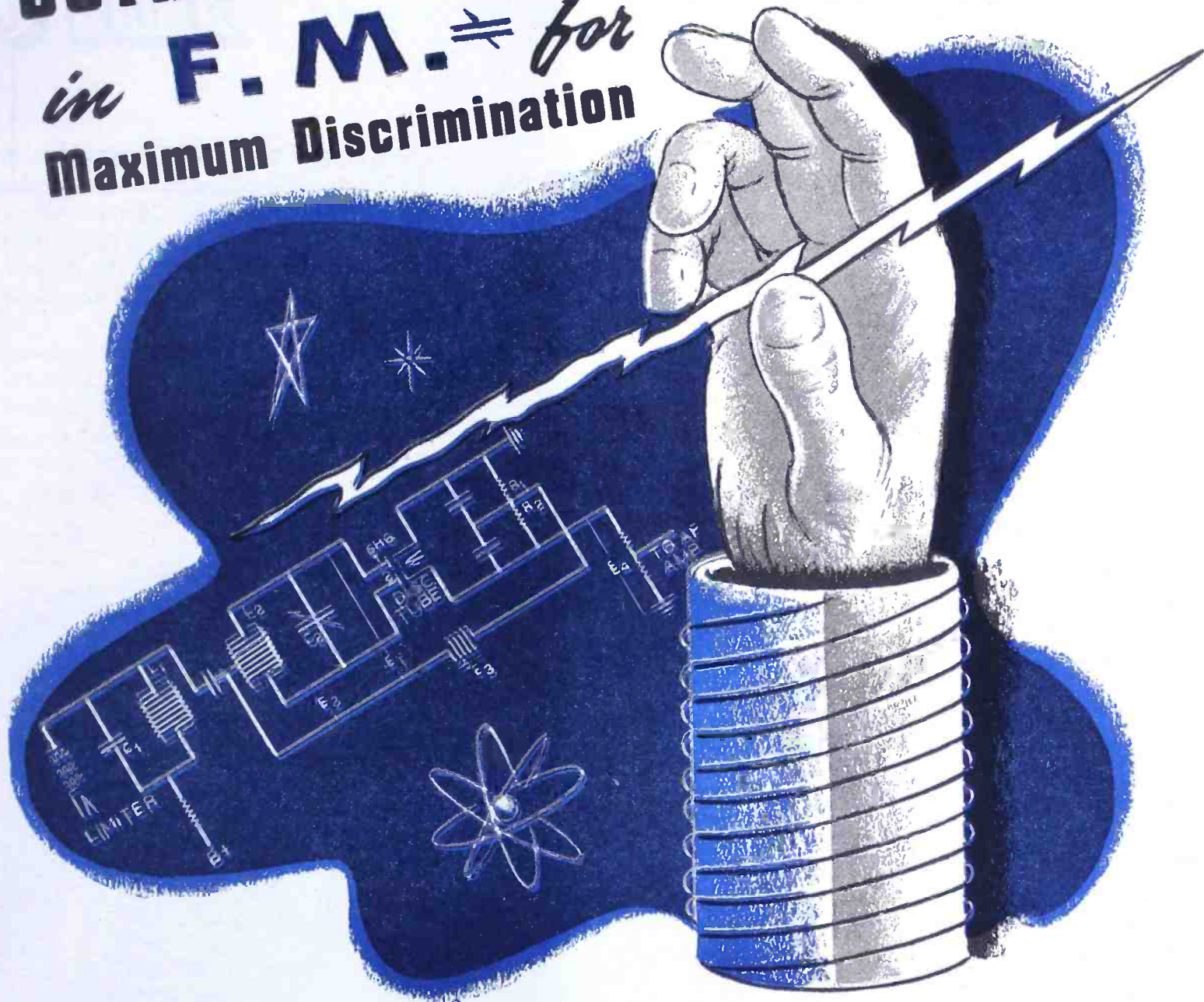
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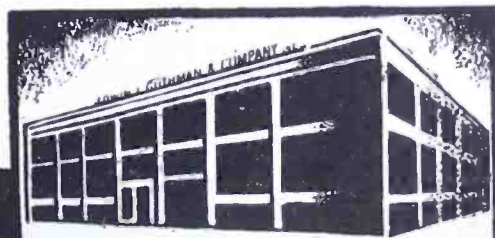
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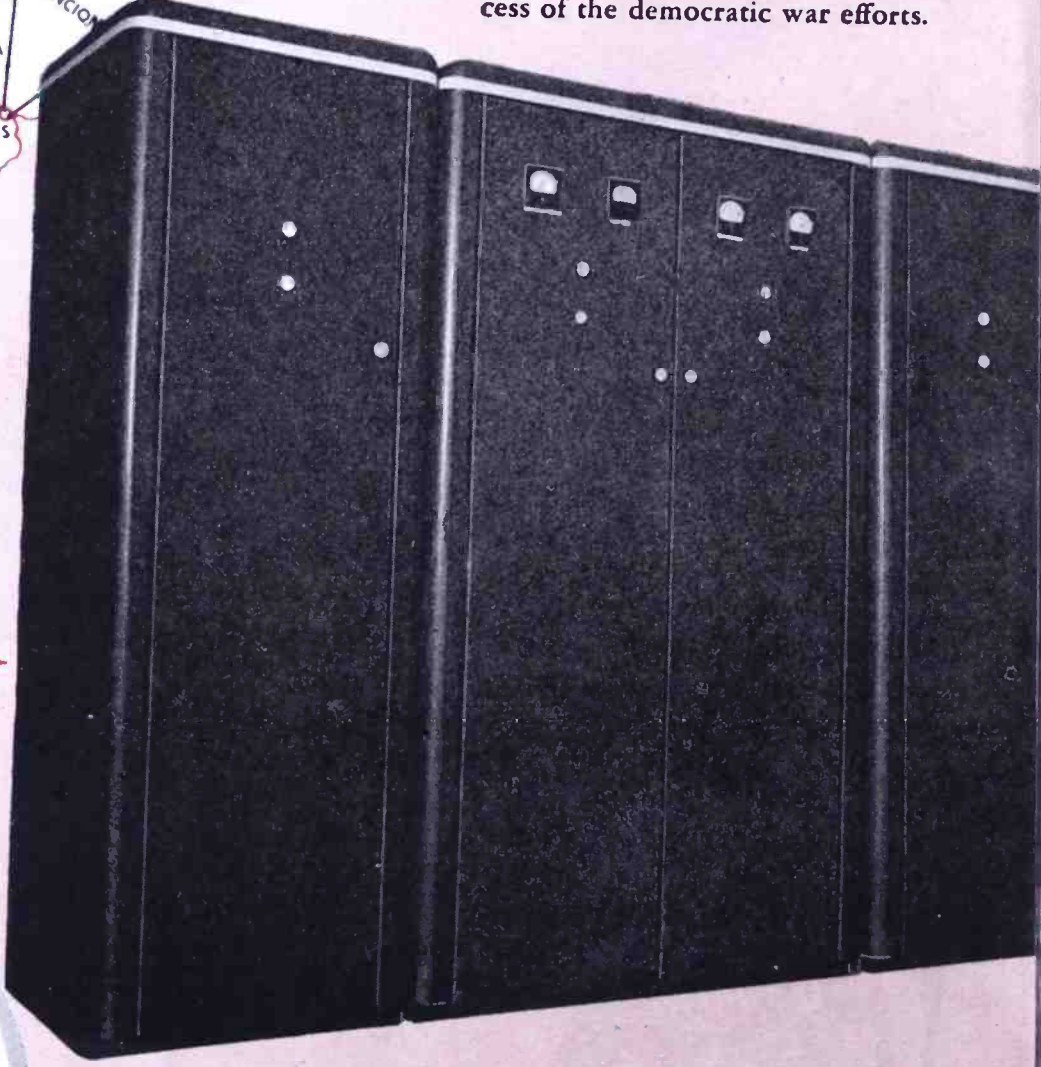


★ **ALONG THE PANAGRA ROUTE** is located AAC transmitting equipment at approximately 30 different points in Colombia, Ecuador, Peru, Chile, Bolivia and Argentina—forming the nucleus of the radio navigation and communications system.

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(Right) Type 500 Transmitter as designed by AAC for Panagra. Consists of multi-channel transmitting equipment, 1,000 watts each channel. Two channels may be operated simultaneously. Telephone and telegraph transmission. Frequency range 250-550 KC and 1500-12000 KC.



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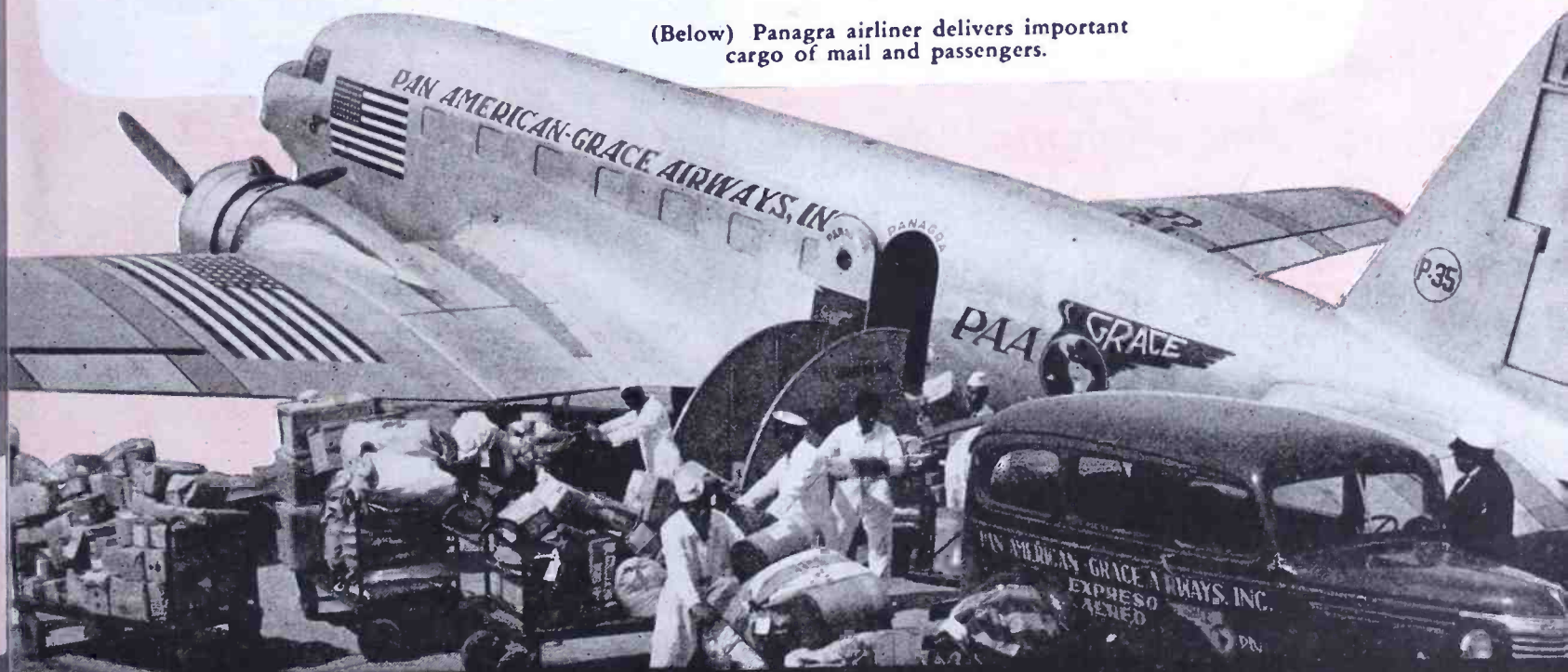
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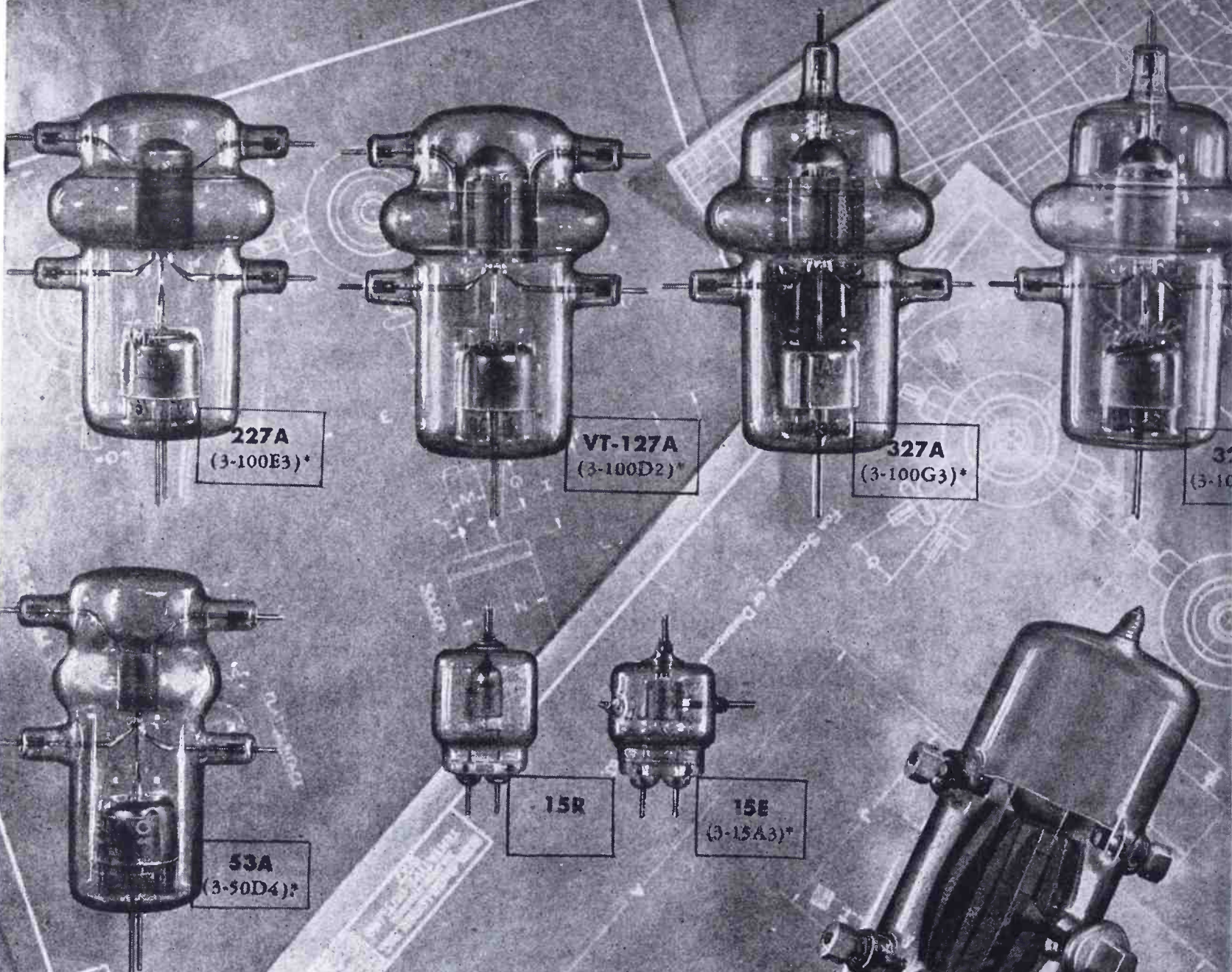
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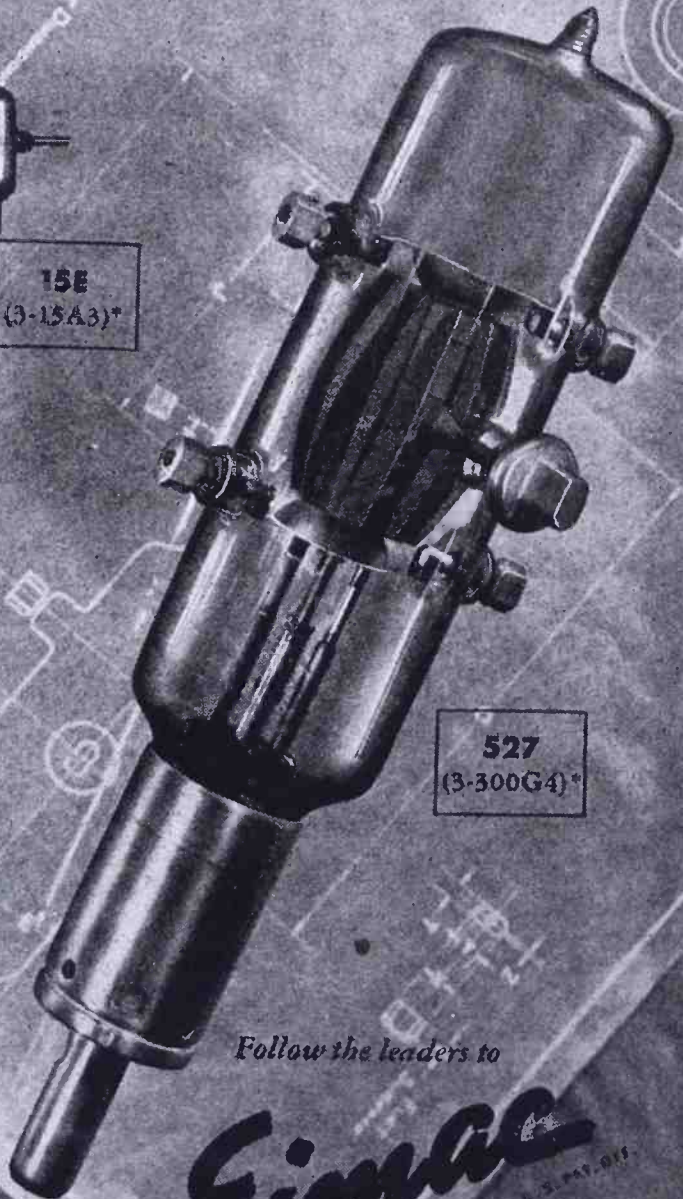
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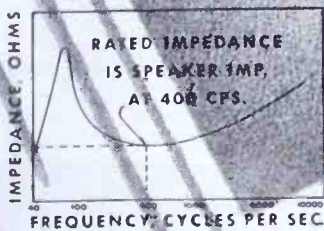
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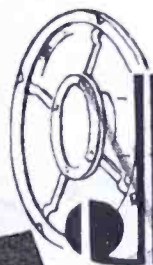
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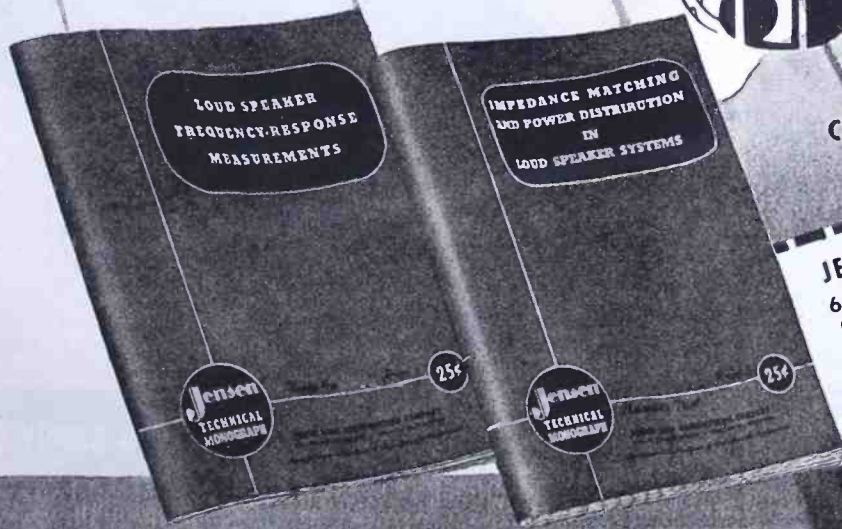
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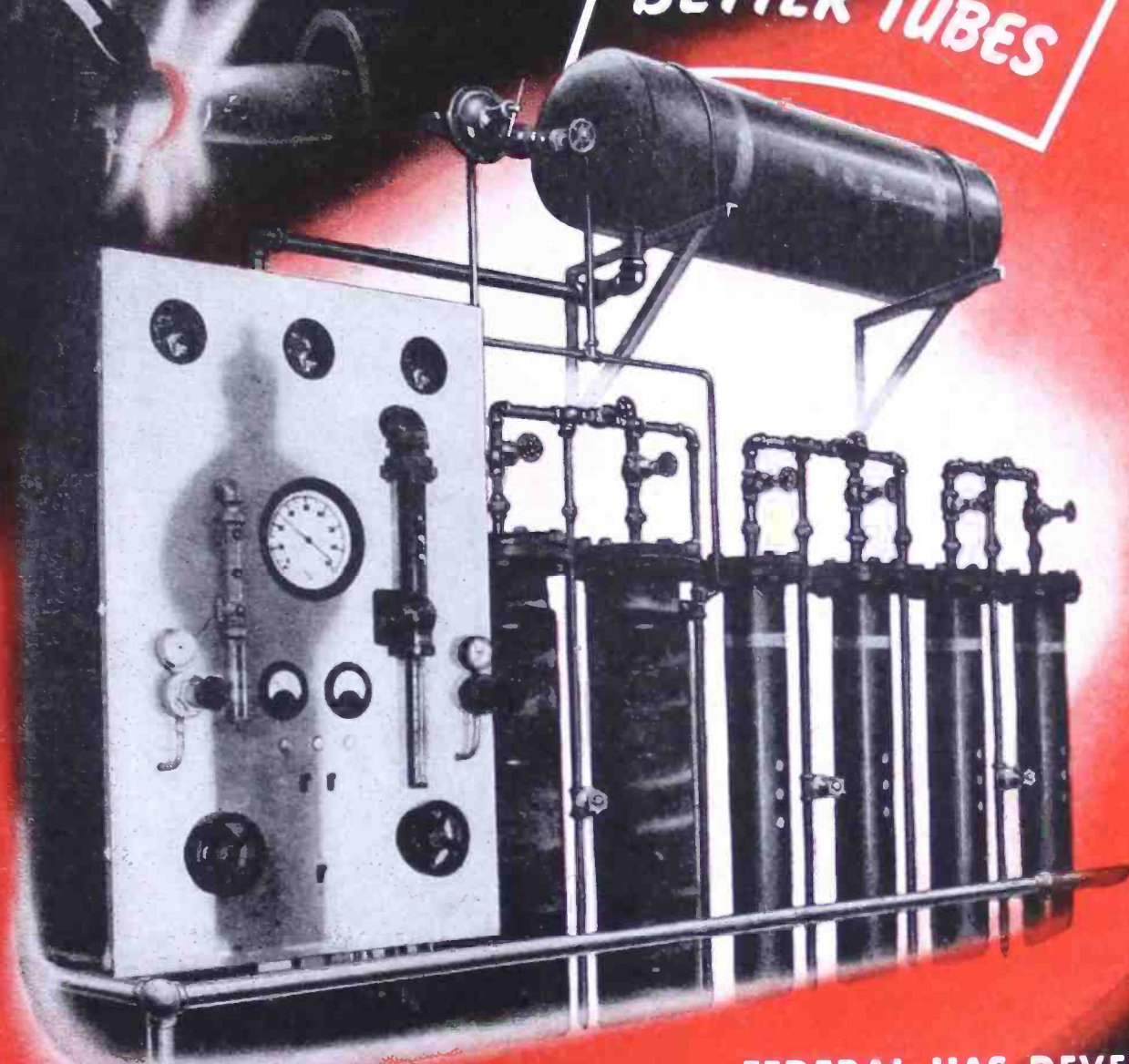


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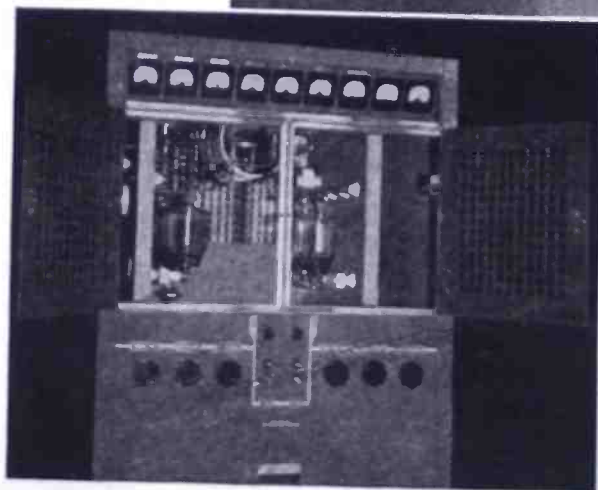
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*Model 1D — 1000
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Full front view
and close-up of
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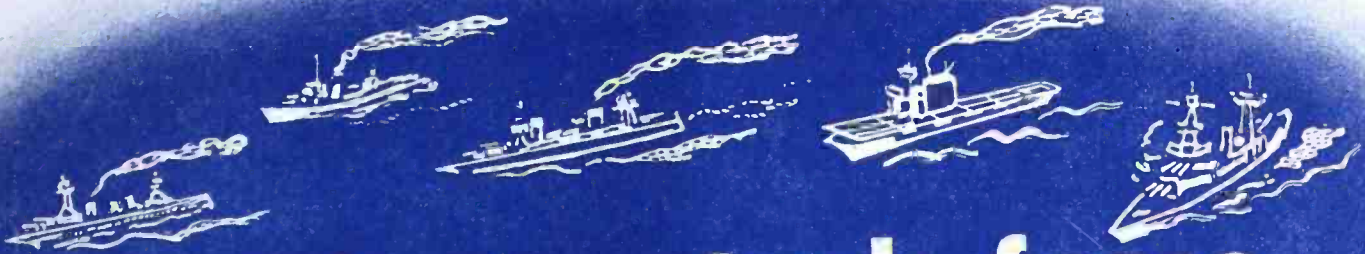
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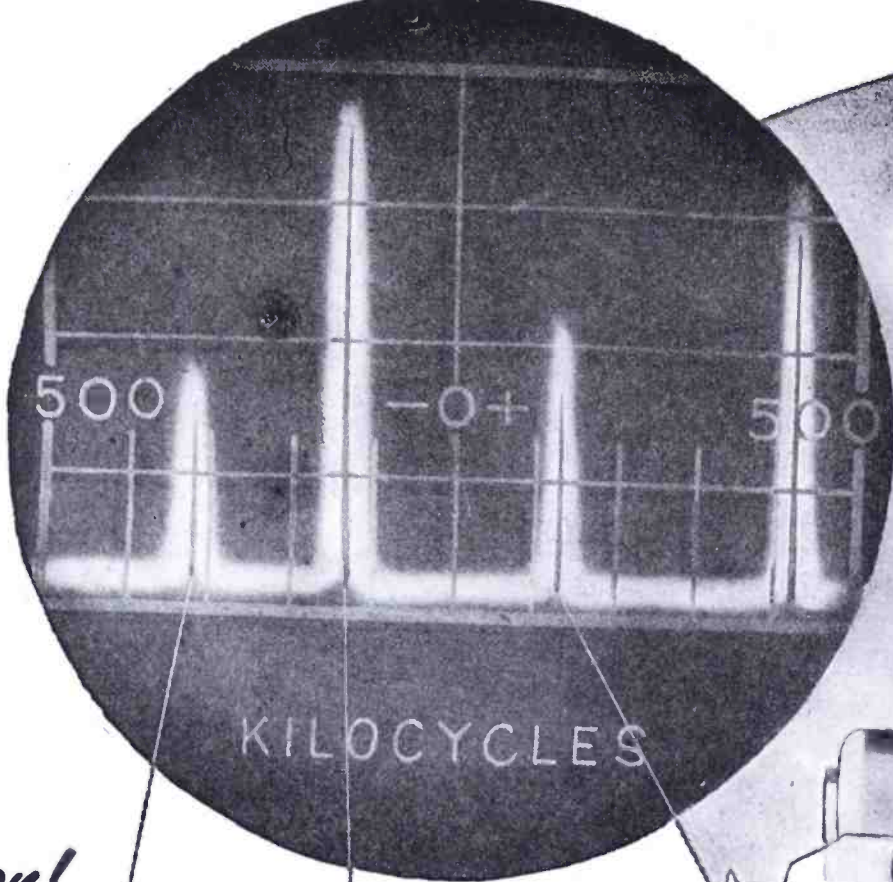
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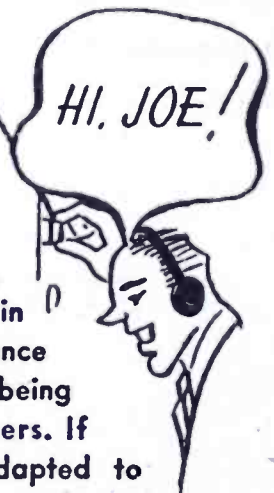
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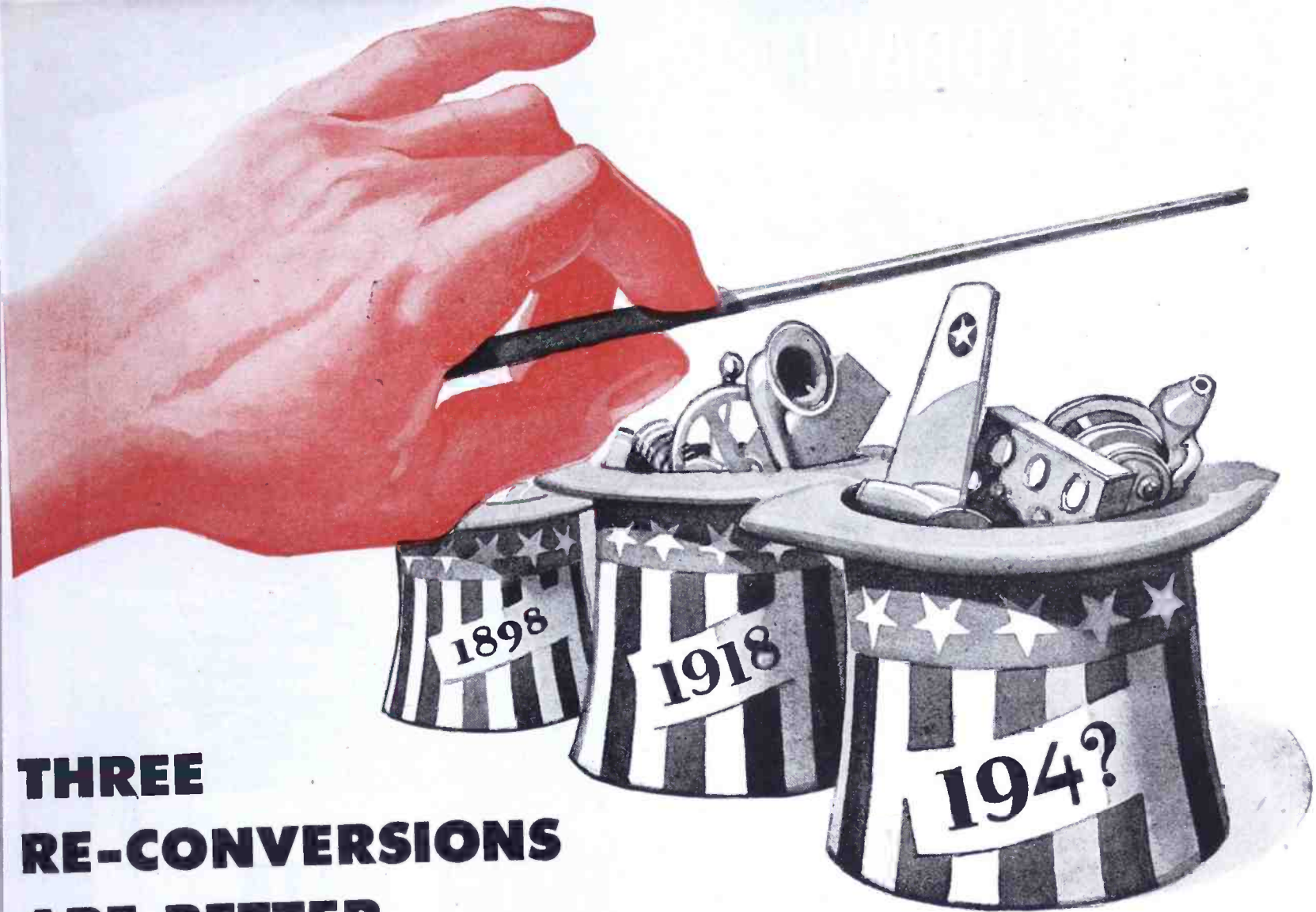
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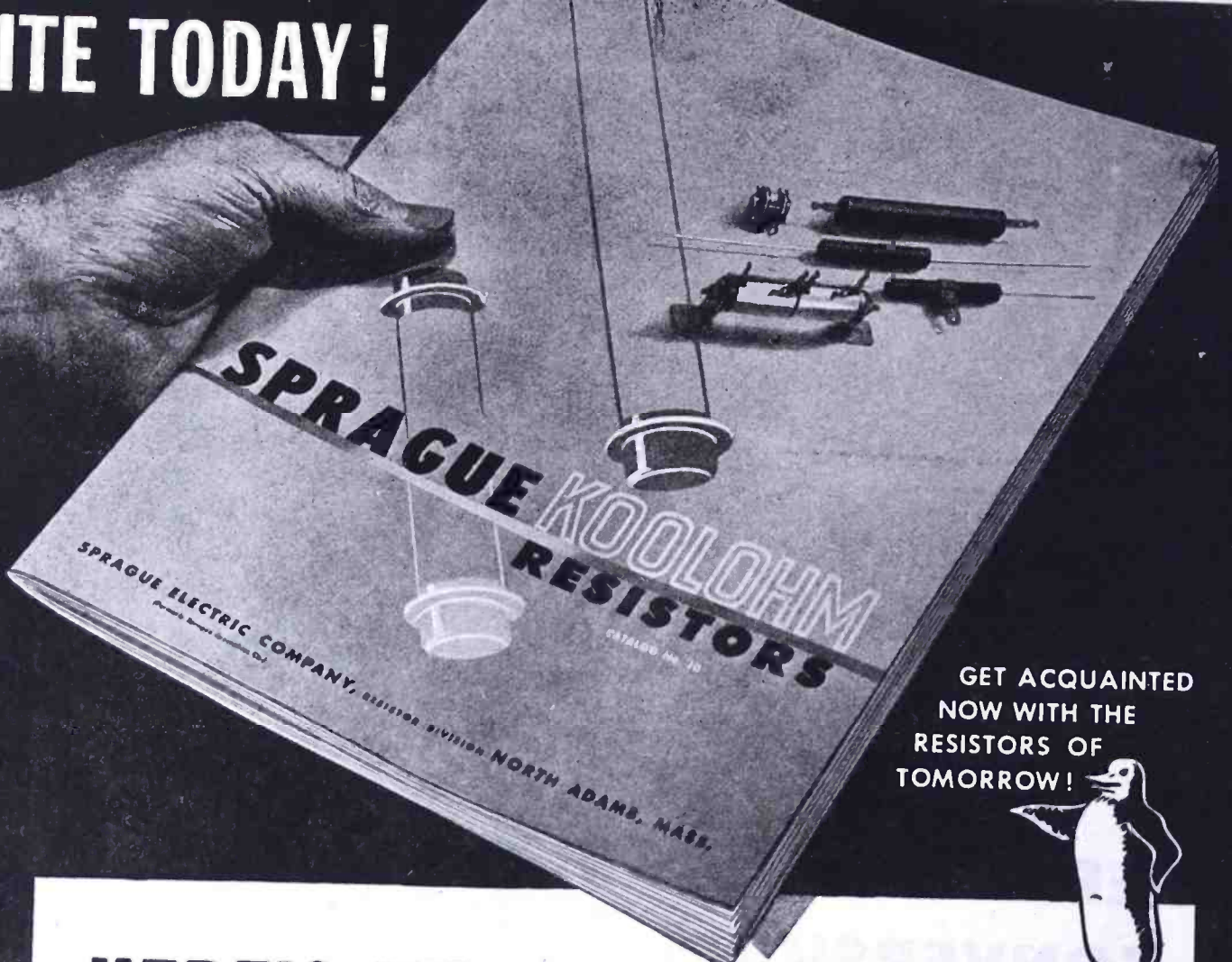
War-born companies of the 1940's have had no experience with peacetime invasions on competitive-cost strongholds. When "C-Day," comes the Conversion Casualty List will be high among sub-contractors brought up in the "Cost-Plus School" of production.

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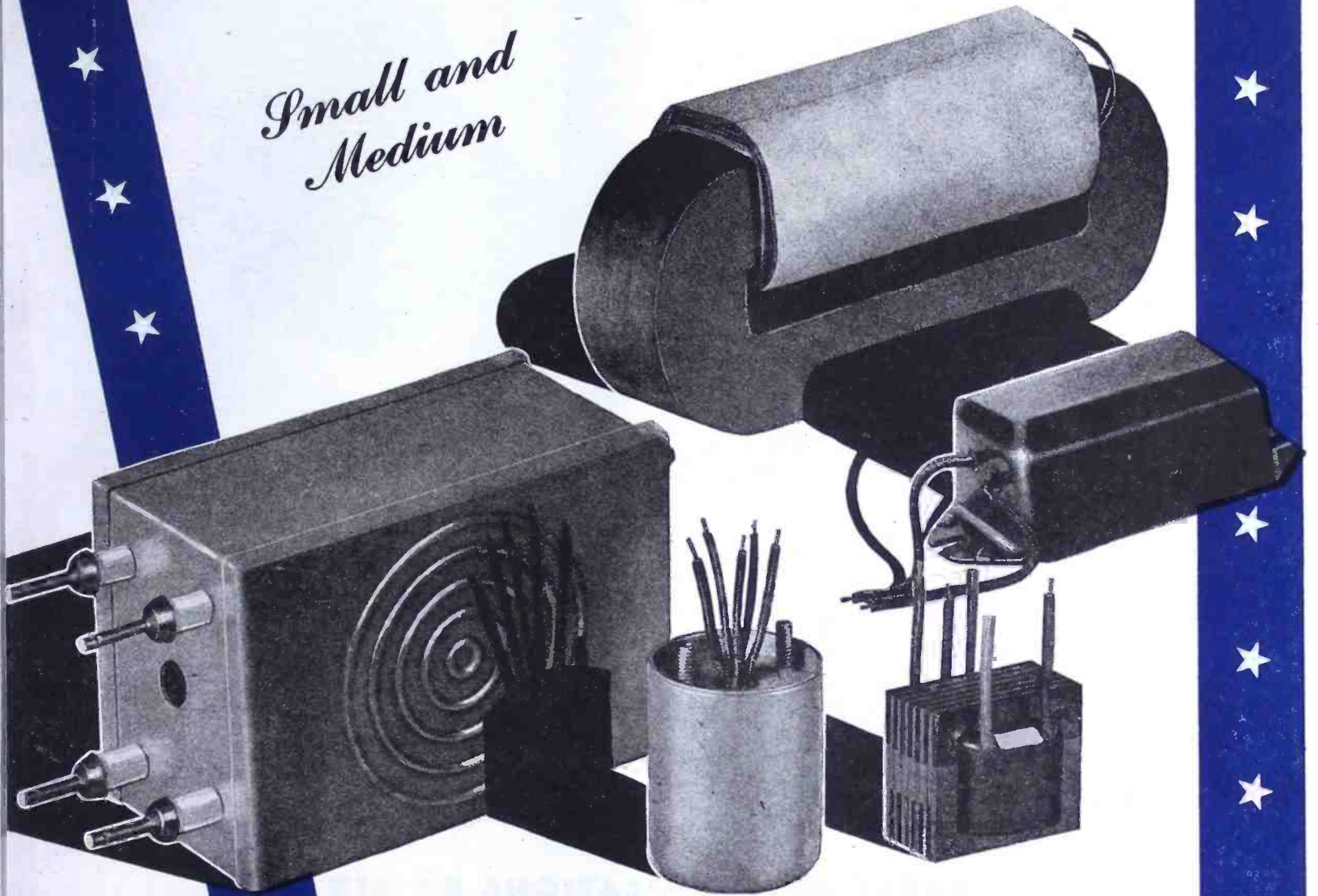


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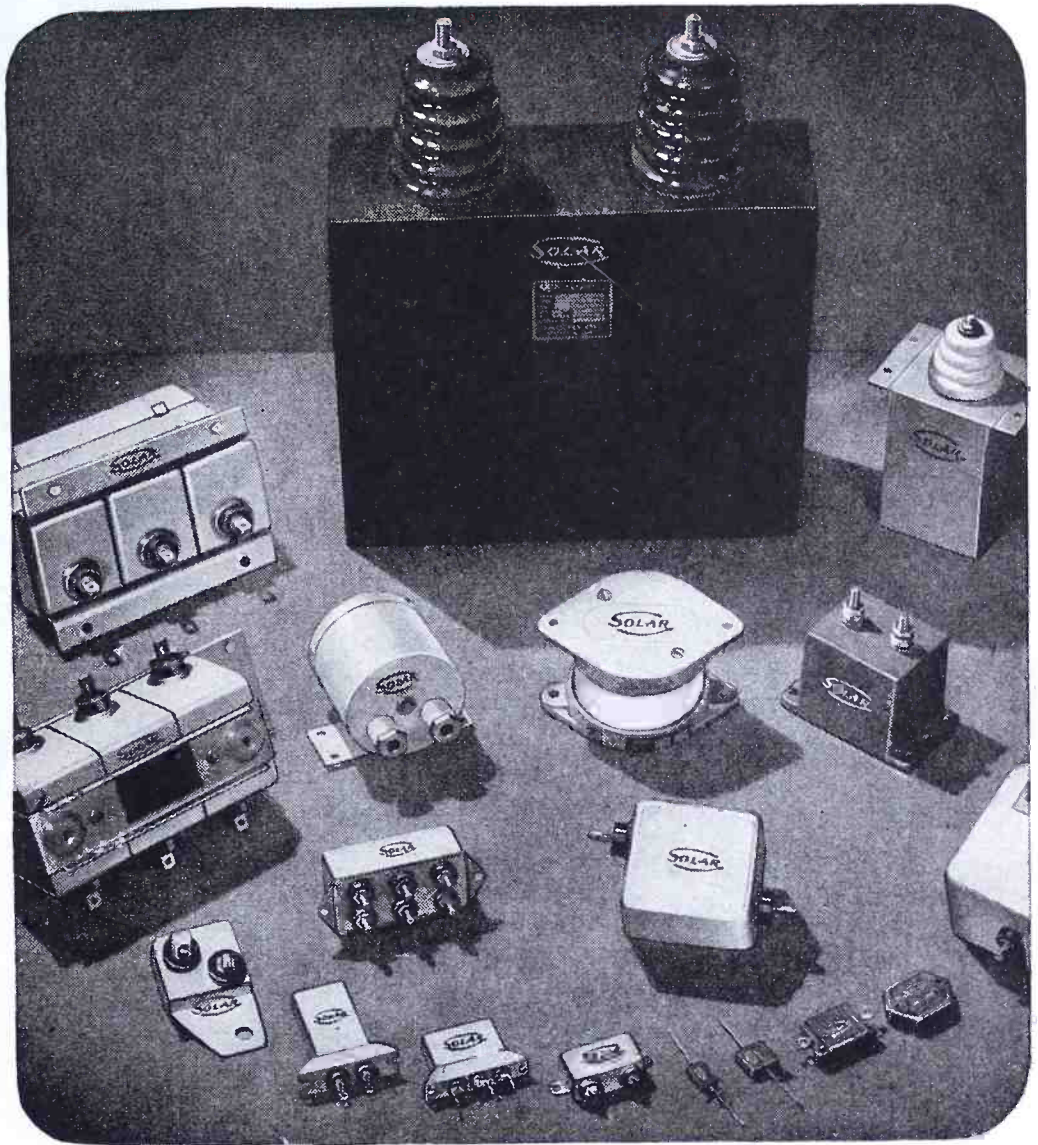


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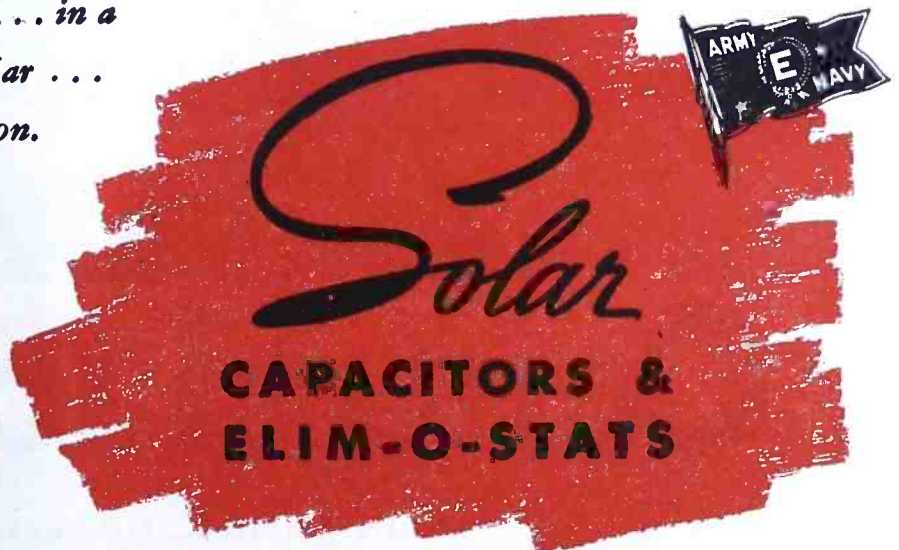
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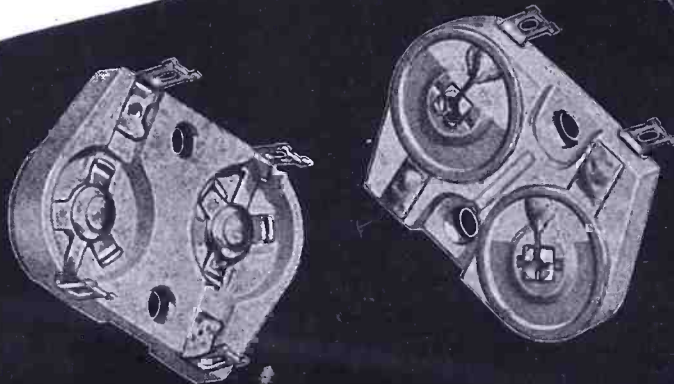
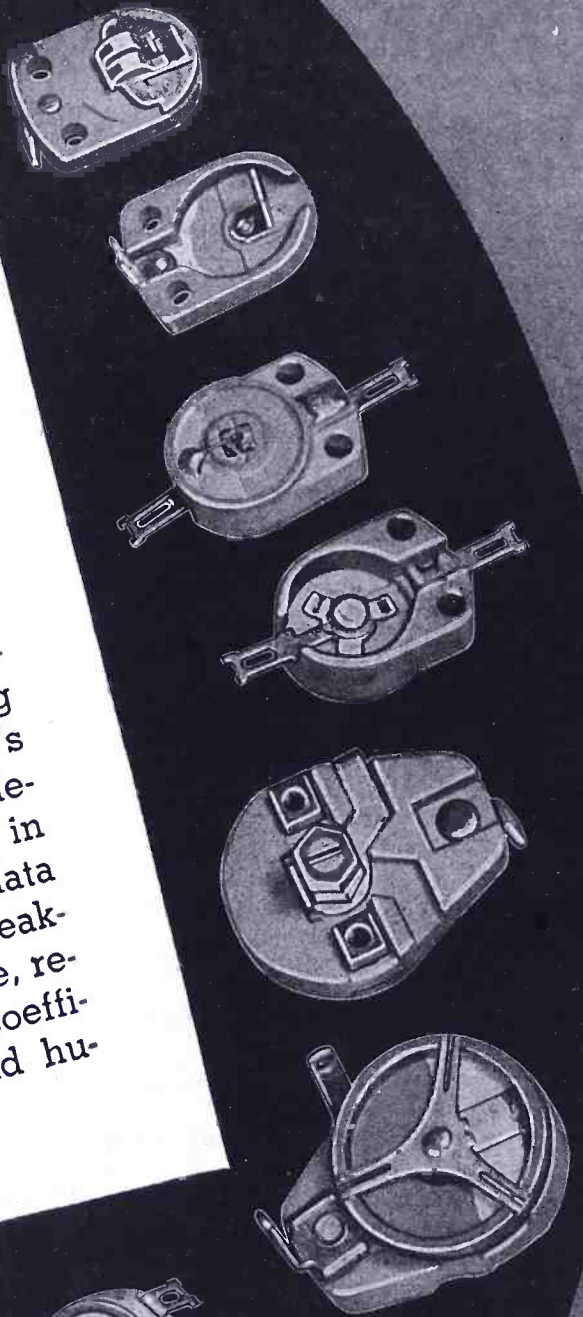
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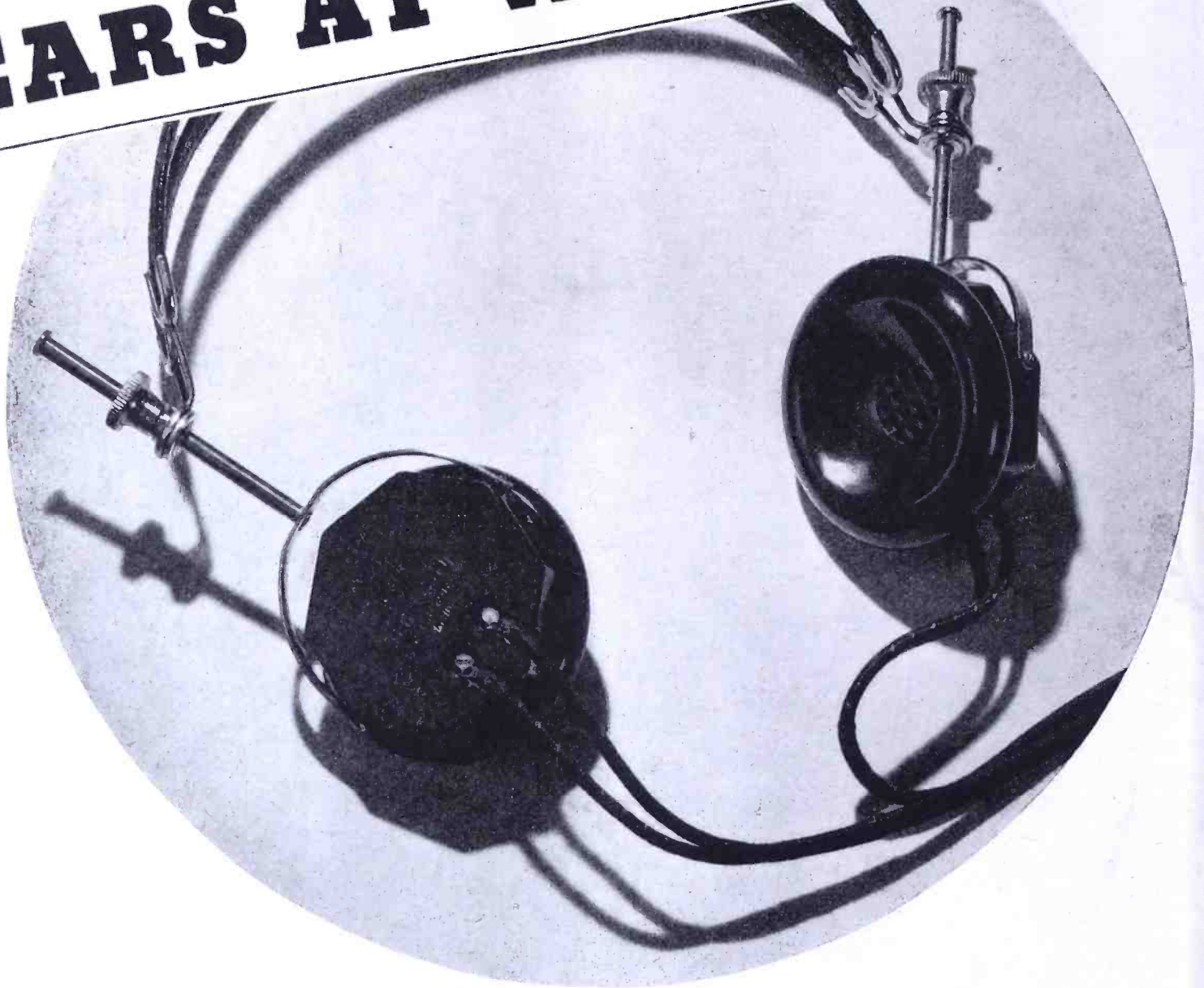
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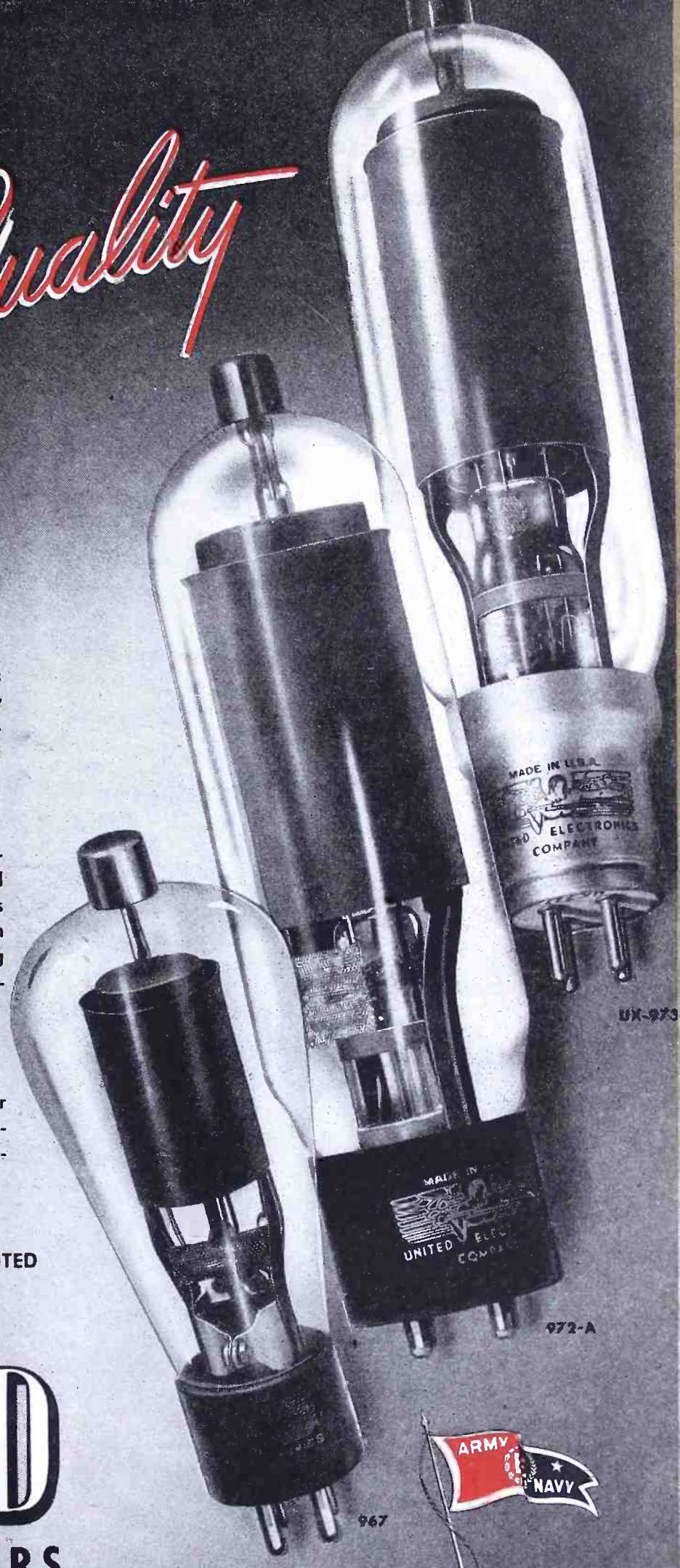
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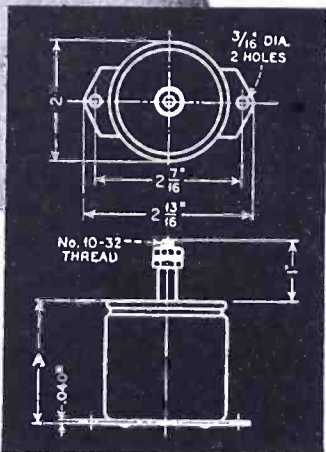
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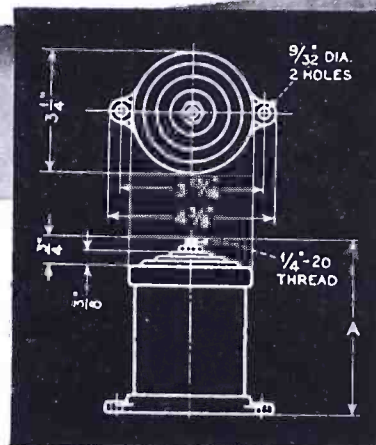
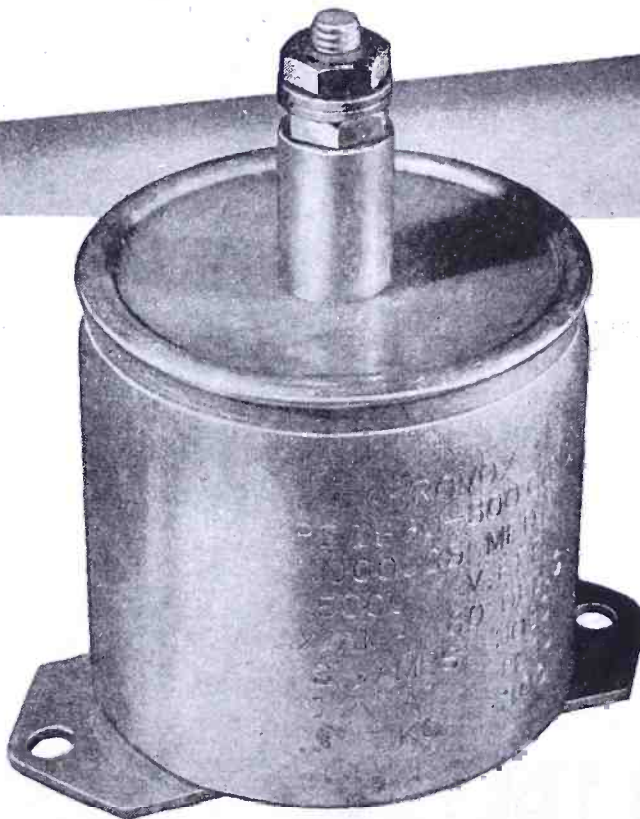
• WRITE FOR LITERATURE



Type 1860 (see photo and above drawing) has suitably plated brass terminal mounted in mica insulating plate. Dimension A is from 2 to 3 1/2"

10,000 test volts eff. .00001, .000025 and .00005 mfd.; 5000 v., .00005 mfd.

Catalog lists maximum current in amperes at operating frequencies from 1000 KC. to 75 MC. max., for both types.



Type 1865 (no photo, but see drawing above) differs in the use of cast-aluminum case and steatite insulator to support terminal and withstand higher voltages. Dimension A is from 2-11/16 to 6-11/16"

Tolerance for both types, plus/minus 10% standard. Available in closer tolerances. Minimum tolerance, plus/minus 2 mmf.



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SO — HERE WE GO AGAIN!

Get in on this NEW letter contest —

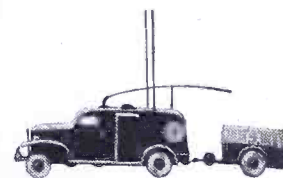
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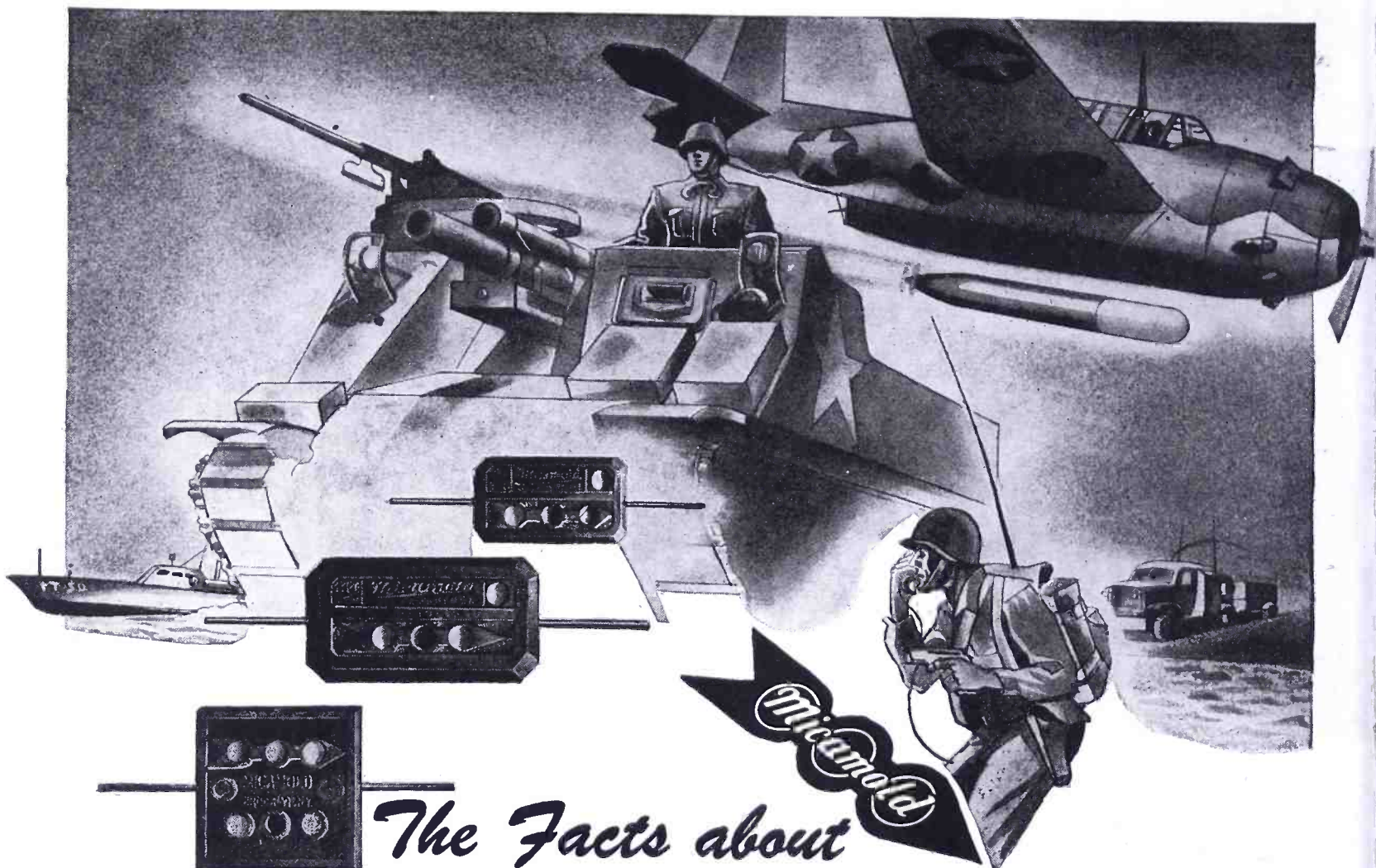


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we design and build molded paper and mica, oil and electrolytic capacitors for all radionic and electrical applications. We will be glad to cooperate with you on any project . . . for war or postwar assignments.

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Before they can earn their right to go to work in your broadcast transmitter, RCA tubes must pass a cleanliness test that would make a small boy squirm!

For example:

When the many small parts that go into such a tube are being formed and assembled, they are bound to pick up a certain amount of "factory" grease and oil.

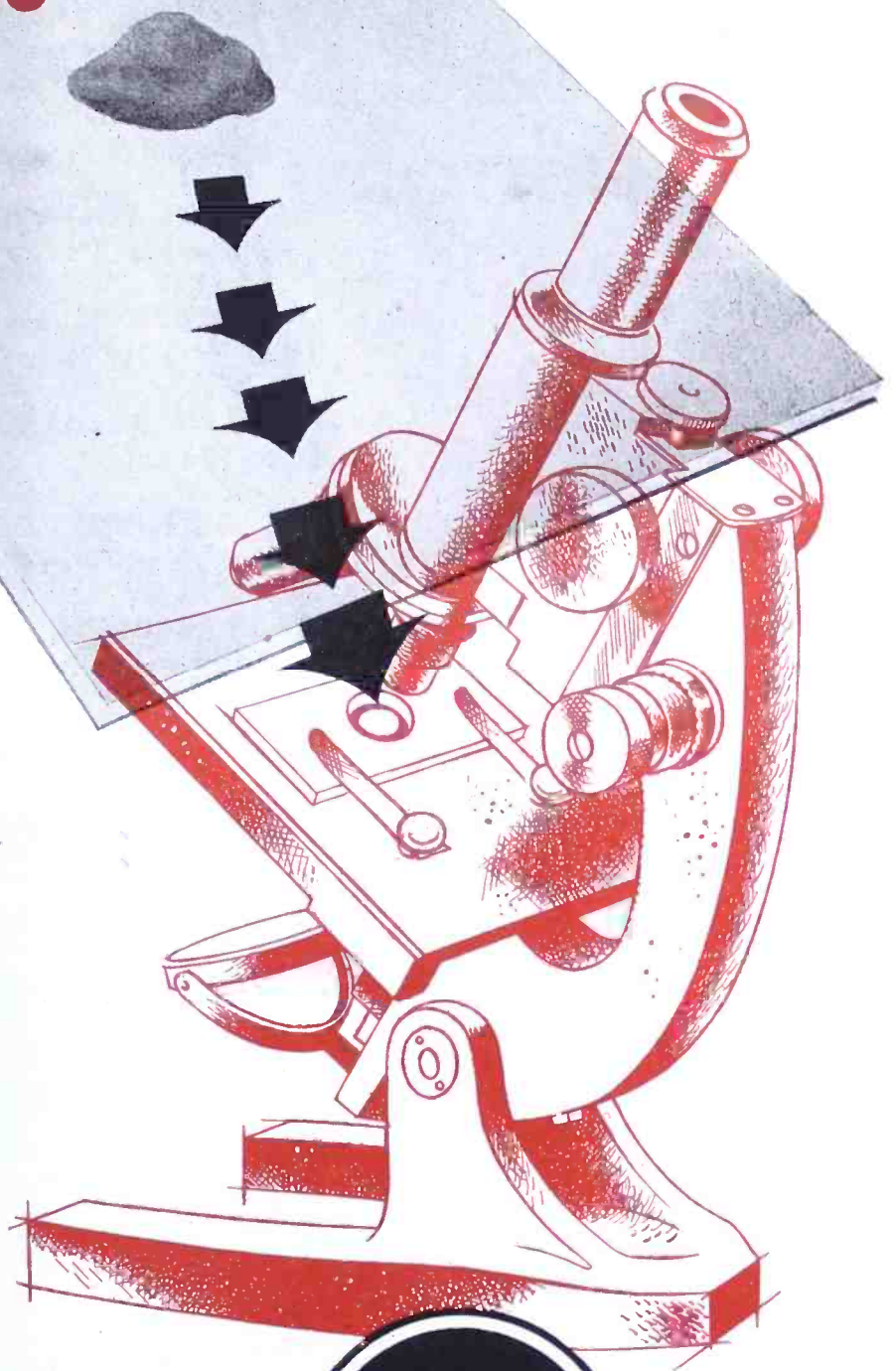
But even after we have removed all visible traces of such foreign matter from them physically and chemically, we clean them again by *vacuum firing* to drive off any gases which may have been absorbed by their metal surfaces . . . gases which might otherwise be released while the tube is actually operating and so cause it to fail prematurely.

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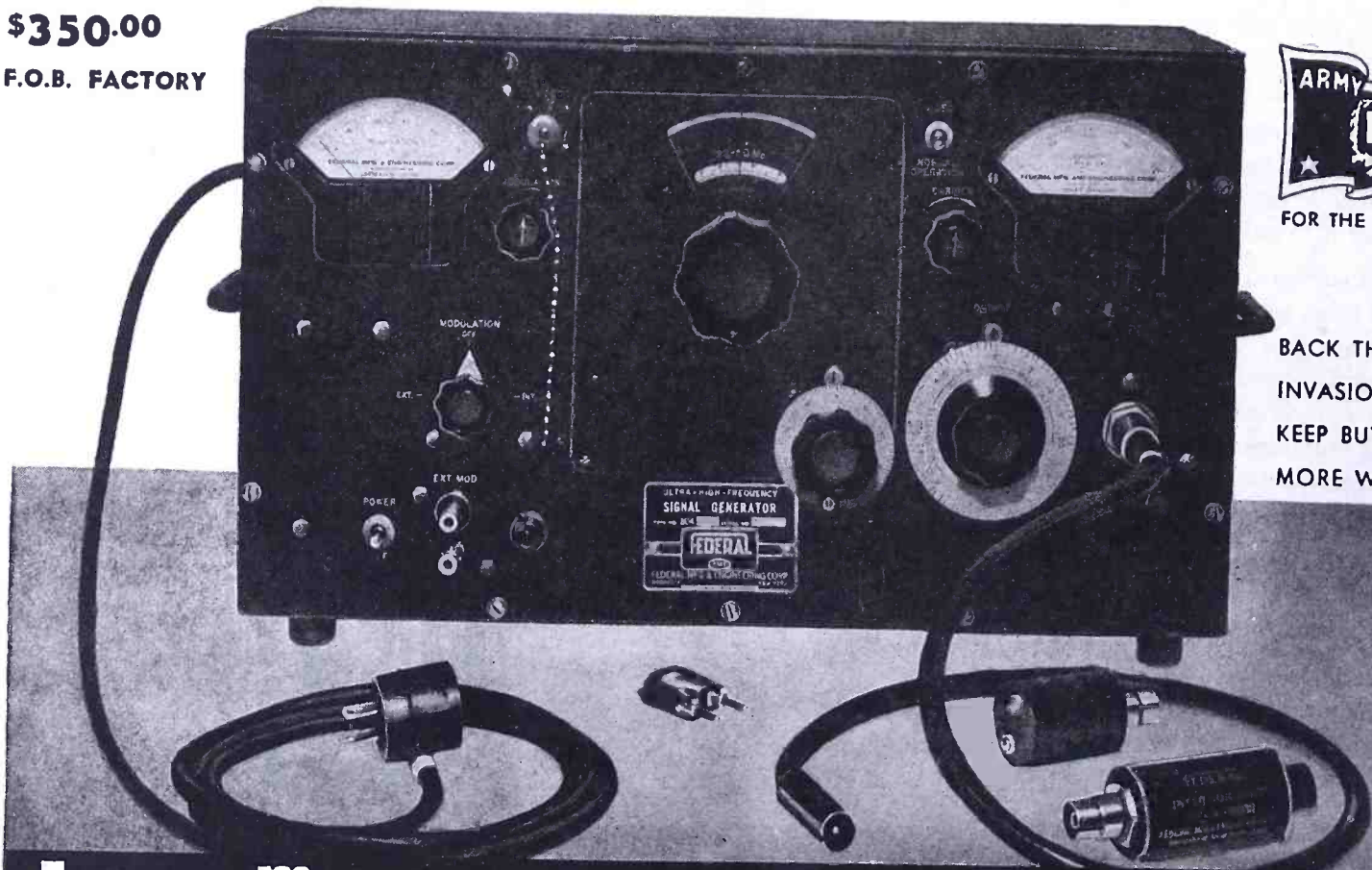
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That's doing it the hard way but it's worth it. For now we have a tool and die manufacturing plant second to none in precision, accuracy and general excellence of product.

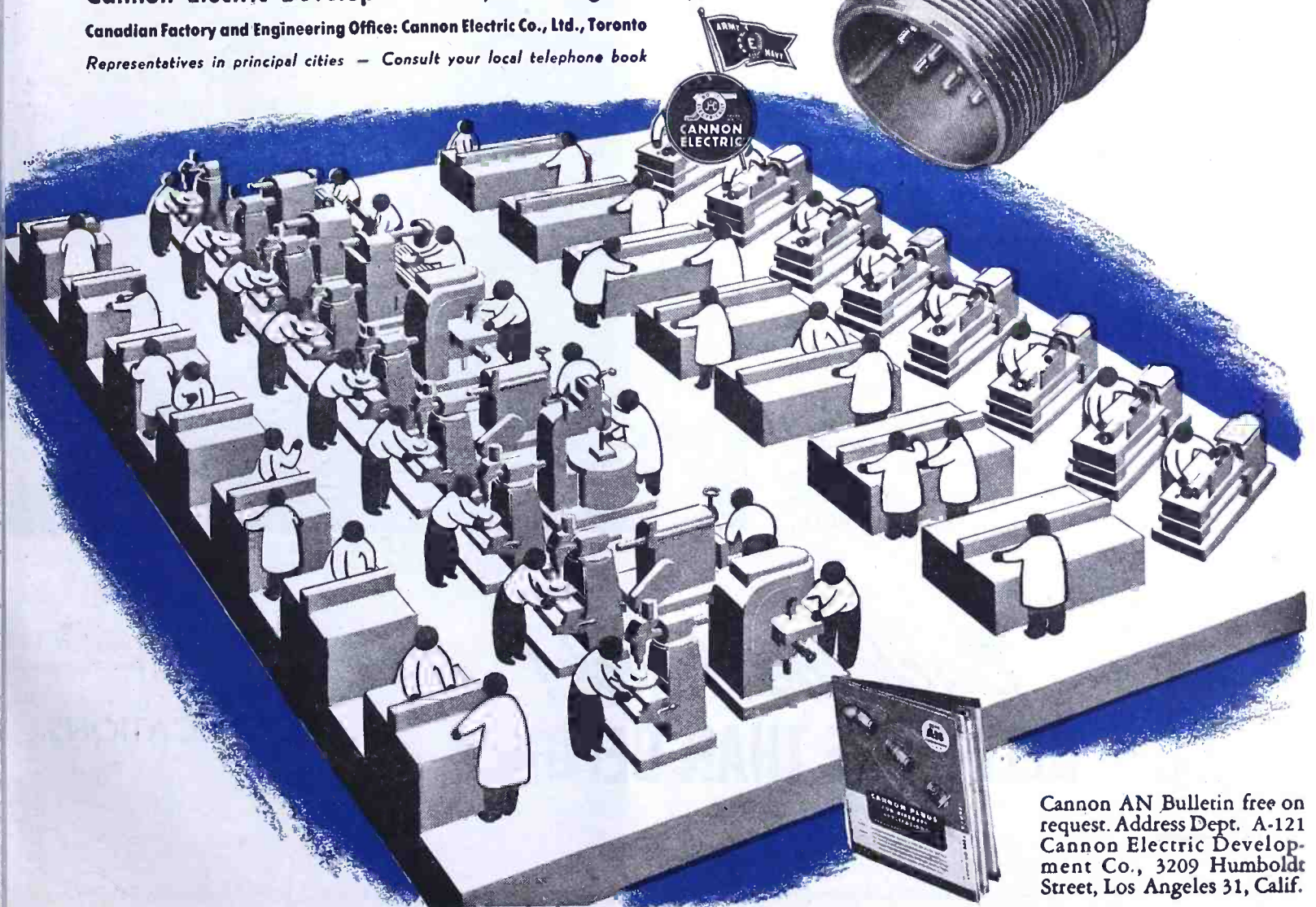
It's an organization of skilled tool makers, none with less than seven years experience. These expert craftsmen work with the best equipment and the finest materials. It is a big plant with a capacity many times our ordinary needs. But this production margin means better tools, more efficient machines, replacements long before exhaustion and thus, of course, connectors we're proud to identify with the Cannon trade mark.

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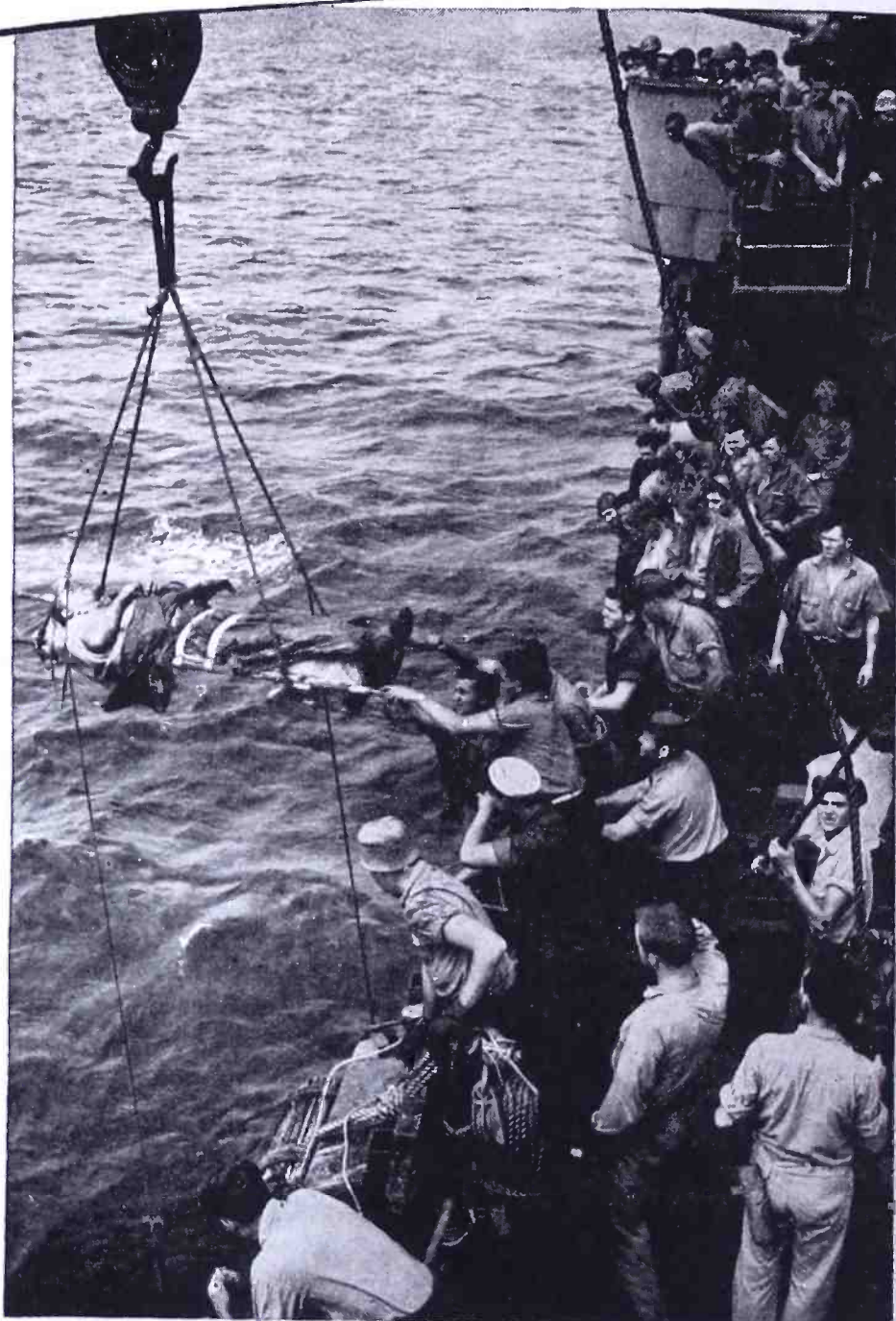
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Cannon AN Bulletin free on request. Address Dept. A-121 Cannon Electric Development Co., 3209 Humboldt Street, Los Angeles 31, Calif.

Just in case you've eased up...
ON YOUR PAY ROLL PLAN



Official U. S. Coast Guard Photo: The elevator to a Coast Guard-operated transport hospital

Pause one brief moment. Compare your lot—and that of the men and women in your employ—with the lot of the infantrymen who meet the enemy face to face, who do the hardest fighting, who suffer the most casualties.

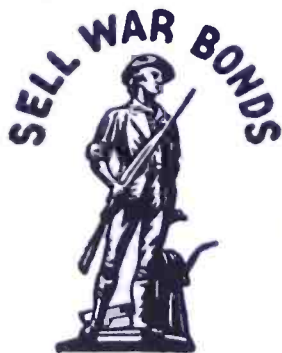
Let the full impact of war's unending grimness swiftly convert any tendency toward complacency into revitalized urgency. Remember—the war is not yet won.

As top management and labor, you've been entrusted with two major responsibilities—steadily maintained production, and steadily maintained War Bond Sales *through your Pay Roll Savings Plan.*

Decide now to revitalize your plant's Pay Roll Plan. Have your Bond Committee recheck all employee lists for percentages of participation and individual deductions. Have Team Captains personally contact each old and new employee. Raise all percentage figures wherever possible.

Don't underestimate the importance of this task. This marginal group represents a *potential sales increase of 25% to 30% on all Pay Roll Plans!*

Your success will be twofold: A new high in War Bond Sales; and a new high in production. Because a worker with a systematic savings plan has his mind on his work—not on post-war financial worries. He's taking care of the future now. His own. And his Country's future. *Help him! REVITALIZE YOUR WAR BOND PAY ROLL SAVINGS PLAN.*



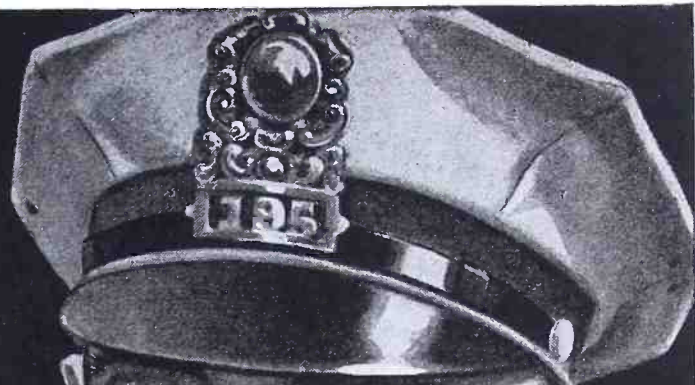
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SELL MORE THAN BEFORE!

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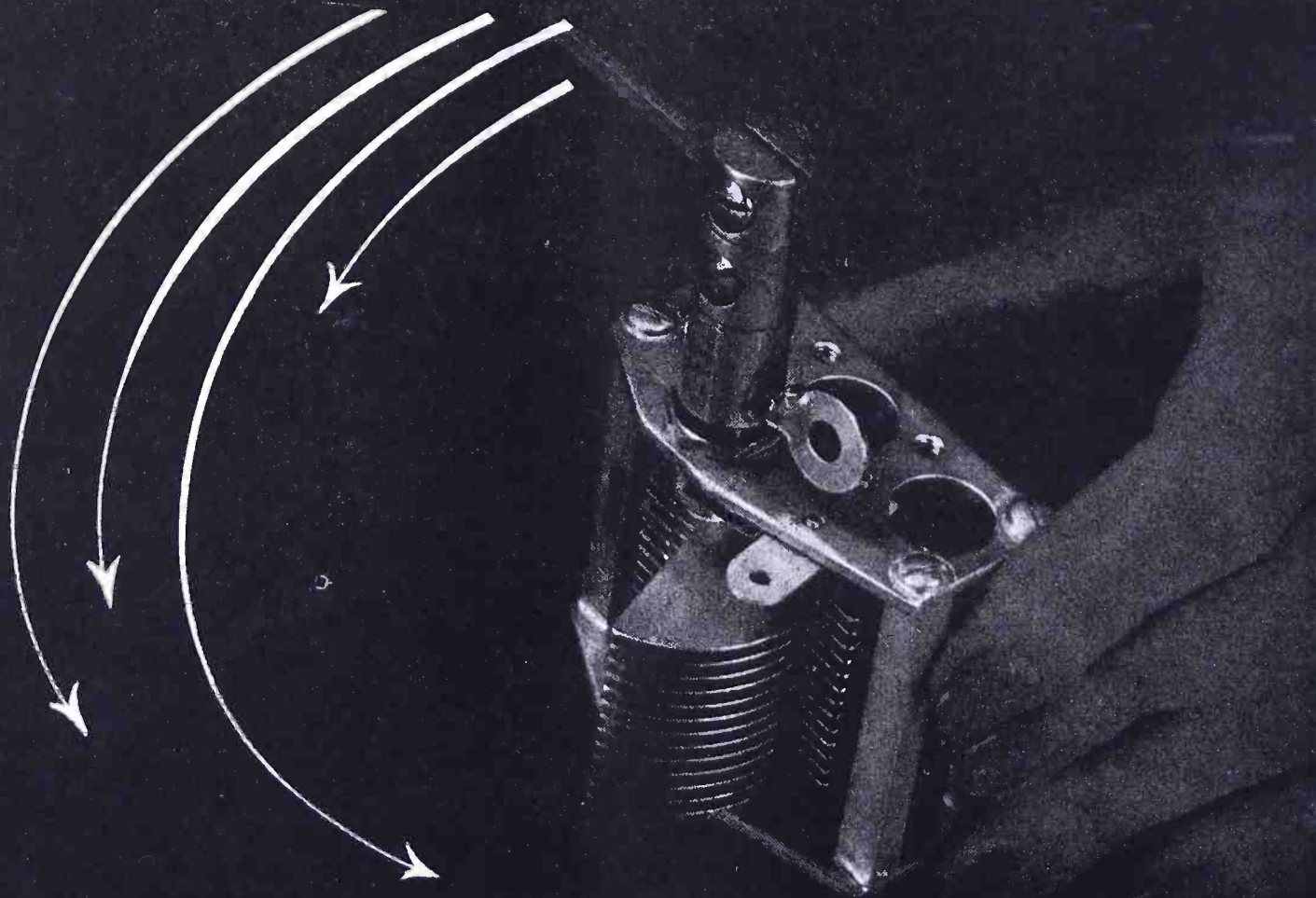
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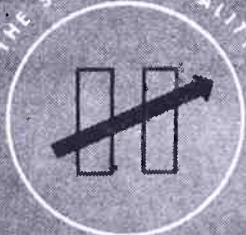


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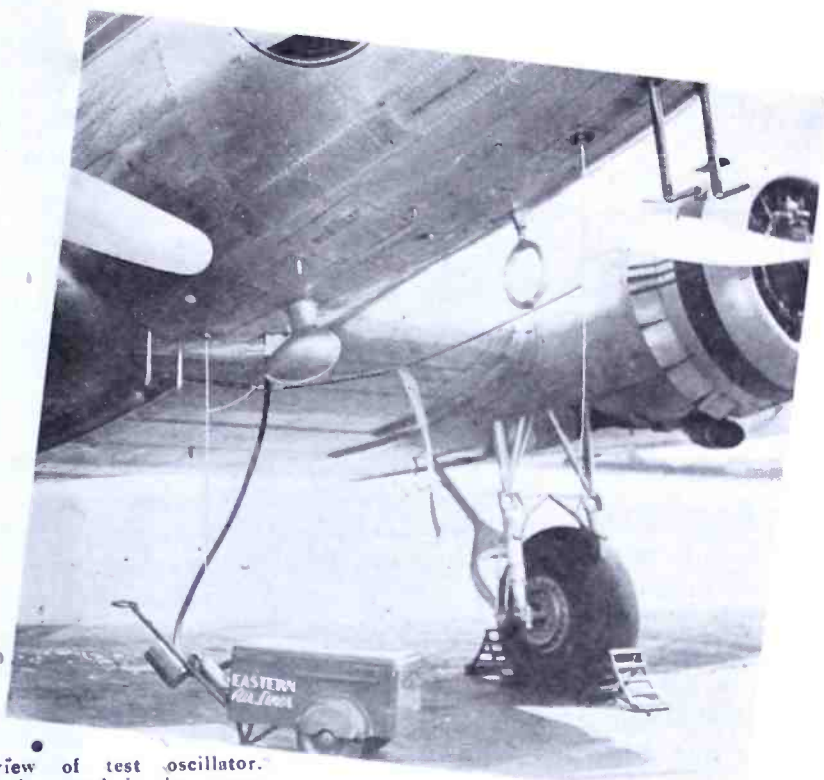
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COMMUNICATIONS

LEWIS WINNER, Editor

AUGUST, 1944

right, a ground test installation (see Figure 2). The whip antenna located aft of the automatic radio compass streamlined loop is the sense antenna. The forward whip antenna during flight is used with the range receiver. During the ground radio compass test, it is used to connect the test oscillator to an external point where the "line" may be attached. The red flag attached to transmission line is a warning that precludes oversight of removing the "line" before departure. The external battery located in the cart shown beneath the plane is used for ground operation of radio equipment and its purpose is to conserve the plane's batteries.



External view of test oscillator. Located on the panel is the power "on-off" switch and r-f output jack. Clip shown at top left of case is used to attach oscillator unit to a bulb angle channel during test. Over-all case dimensions, excluding the clip, are $6\frac{1}{2}$ " x 5" x $2\frac{1}{4}$ ".

PRE-FLIGHT INSTALLATION TESTS OF Automatic Radio Compasses

by **CHARLES W. McKEE**
Supervisor of Aircraft Radio
Eastern Air Lines, Inc.

This paper describes procedures used to make an overall check of an automatic radio compass installation aboard a plane. A test oscillator and the use of a left/right indicator meter to afford a means of comparison for calibrating oscillator output to the transmission line for a given $\mu\text{v}/\text{m}$ field strength is described. A brief analysis of ground-effect symptoms that parallel those exhibited by malfunction of equipment is also presented. The purpose of the check procedure is to obviate these ground-effect conditions and to simulate *in-flight conditions*.

subjected to certain factors that introduce bearing errors. Such errors are

caused by various loop current effects. Their phase and magnitude are dependent upon shape and relation of metal aircraft structure.² For a normal radio compass installation on a given aircraft these bearing errors possess a constant characteristic; therefore, compensation can be applied for the necessary correction.³ This is not always true when aircraft is on the service ramp or in the hangar. Under these conditions, radio bearings will usually present an error which may be plus or minus, a negative angle,* and it may possess 180° ambiguity. The errors may be quite vari-

Figure 1, below
 One method of installing the oscillator and transmission line for a pre-flight check of the automatic radio compass installed on aircraft. The oscillator is clamped to the metal pitot tube. The line is suspended on a center line with the loop antenna and connected to the aircraft metal structure which completes the test loop circuit. Because the action is that of a transmission line, it is imperative that a good electrical ground connection (to airplane structure) be made at points marked G.

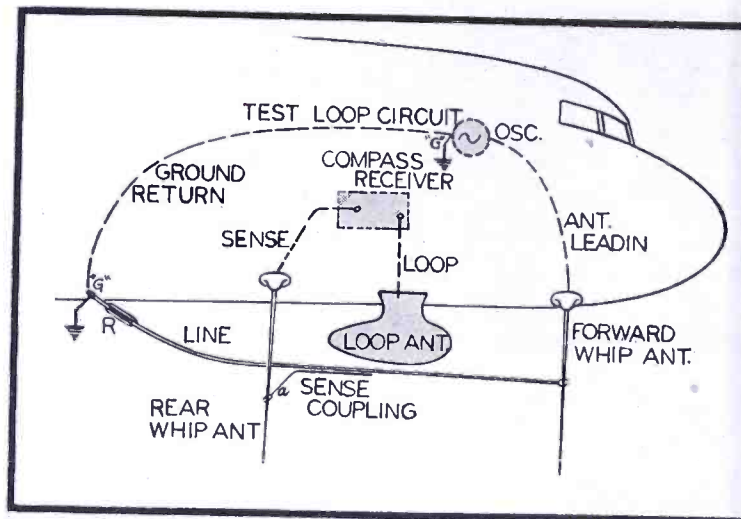
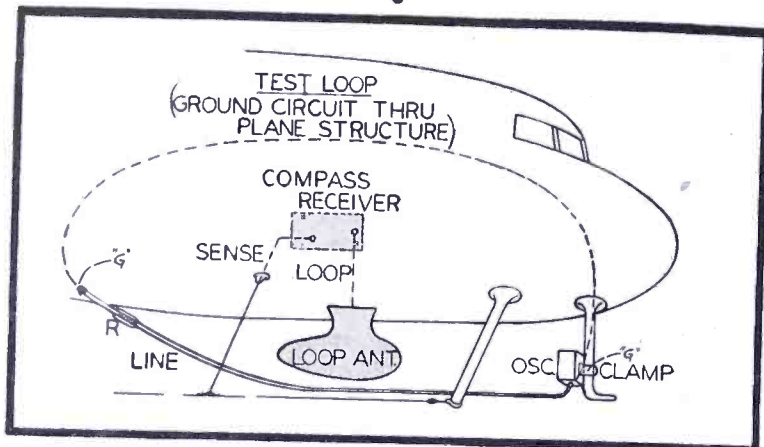


Figure 2
 Another method of forming a test loop circuit. Here the oscillator can be located within the aircraft during the ground check. This is feasible when another antenna is available so that the oscillator output can be connected through the antenna lead in. Sense antenna voltage may be varied by adjusting capacity of sense coupling lead *a* to transmission line.

able due to metal objects in the immediate vicinity of the aircraft, such as work platforms, racks, ladders, carts and hangar structure. In addition, a grounding wire³ attached to the wing or landing gear will in some cases result in giving bearings of 180° ambiguity or other erroneous bearings. (No test was made to determine the effects in this respect of graphite impregnated landing gear tires.) Bearing ambiguity may also be caused by an external battery cart cable placed adjacent to the sense antenna. A loop antenna located on top of the aircraft is not as susceptible to ground effect errors. An exception is when the plane is in a hangar and the metal structure ceiling is near the top loop antenna. Location of the aircraft in the clear of metal objects will reduce these ground errors to a negligible degree (except when taking a bearing on a station located directly on or nearly so of the aft line of the aircraft, for tail-down condition). Time economy during the servicing period of the aircraft does not always permit the *in-the-clear* location.

One method devised to make the overall-radio compass operational check without the aforementioned adverse ground conditions effects is to use a test transmission line scheme.⁵ The basic arrangement of such a plan is shown in Figure 1. The test oscillator consists of an r-f source that is fed to a transmission line or a so-called test loop circuit. The latter is formed by a line preferably placed longitudinally and spaced outward from the radio compass loop antenna.

⁵The term *negative angle* is applied to describe the condition where the normal angle of indication is displaced by an angle of equal amount on the opposite side of the center line of the aircraft.

The line is not shielded and can be across any two fixed terminal points that will place the loop antenna center directly between line and the shield (ground). Its corresponding azimuth angle is used as a reference. Should we find the amount of sense voltage incorrect, it is only necessary to change the coupling between the *line* and the sense antenna. Thus an excessive value of sense voltage will be avoided.

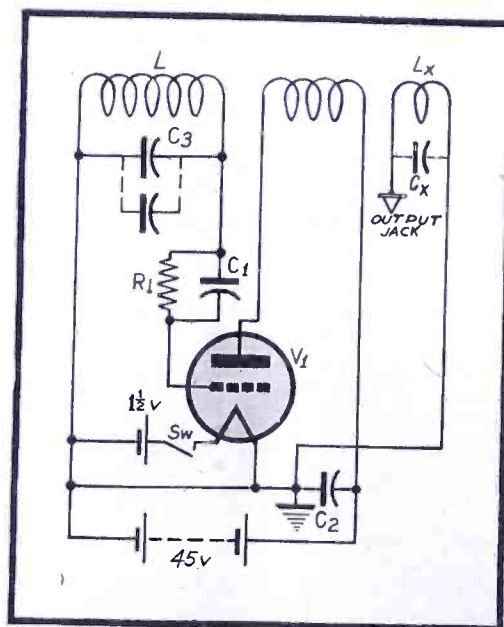
It is important to have good electrical ground contact at the oscillator and the *line* terminating point to obtain normal transmission line function. When other than a *line* is used, the

reception of the oscillator radiation presents a possibility that bearing will be subjected to ground-effect errors.

Certain antenna installations readily lend themselves to a more convenient arrangement for a setup of the transmission line. One such arrangement is illustrated in Figure 2. The test circuit *line* is formed by connecting the test oscillator output to the forward beacon-antenna lead-in. The voltage will appear on the forward whip type antenna when the antenna switch is in the *beacon-antenna* position. The loop circuit is completed by use of a *line* attached to the forward whip antenna. The other end of the line is connected to ground (at a point on the aircraft structure) through a 400-ohm resistor. This is located at the end of the line at the grounded point. The radio compass loop antenna is located within the test oscillator loop circuit. The lead designated *a* serves to introduce sense voltage from the test loop to the sense antenna.

The oscillator, operating within the 200-400-kc band, is used as a source of r-f. After the output calibration is completed and the second harmonic output is found to be of sufficient value, we have a check on the number *two* band of the receiver. It is not essential that both bands be checked because the compass loop, sense antenna and autosyn circuits are common for both bands. However, in case of interference on the fundamental, the available use of the second harmonic is an advantage. The oscillator, for obvious reasons, was designed to be compact, light weight and to include the power supply. For sake of simplicity, no

Figure 3
 Conventional oscillator circuit operating at 300 kc to provide the r-f signal for ground test. V_1 is 1E4G tube or equivalent; C_1 and C_2 , .0001 mfd; C_3 , .002 mfd; and R_1 , 0.1 megohm. Inductance L is 3 mh, L_x is one to two turns, coupling to the load, C_x value is to be determined and depends upon the desired attenuation of r-f output.



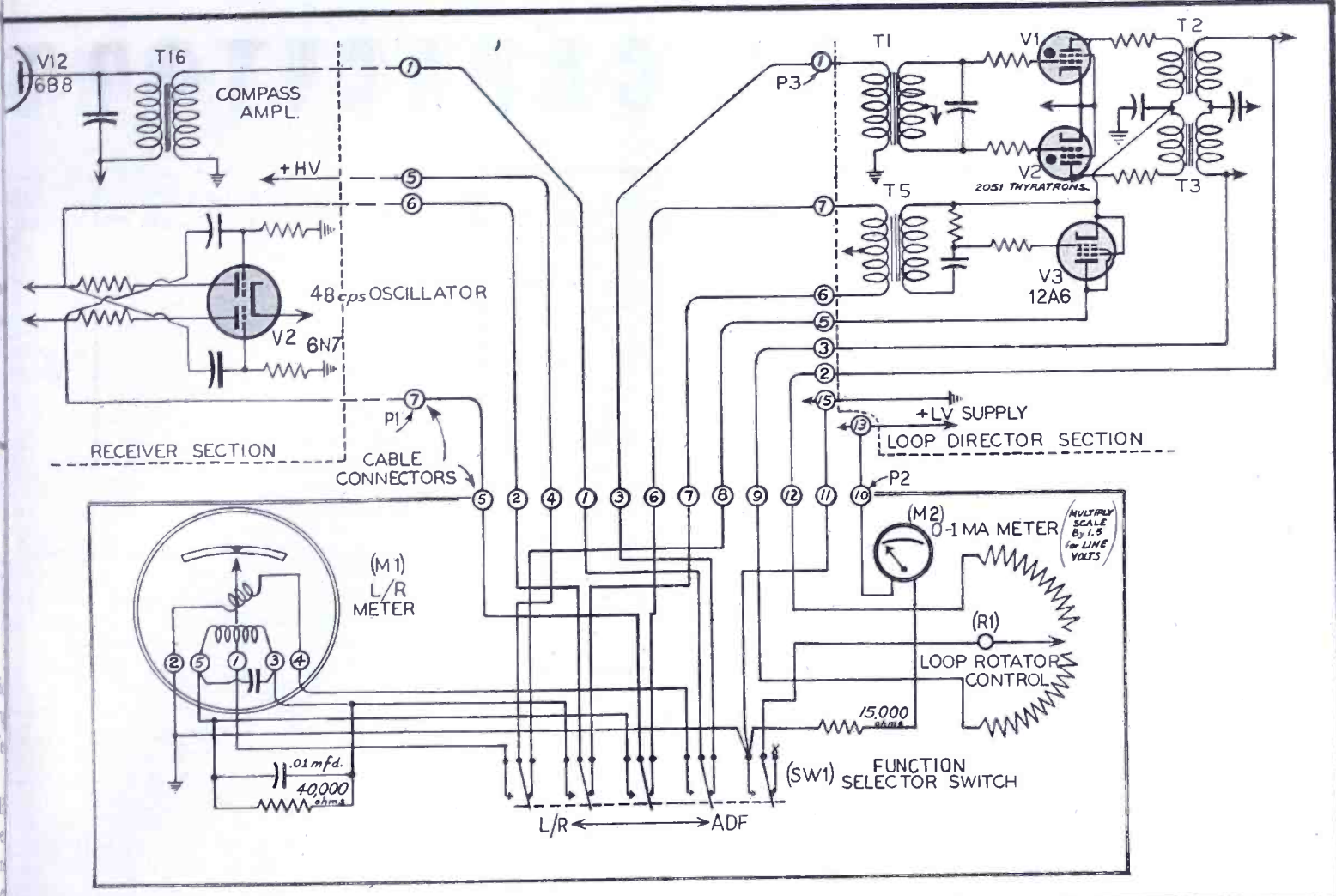


Figure 4
 Circuit of *l/r* test instrument and a section of the MN31 compass relating to the test device. Plug pins of P1 and P3, one through nineteen, not diagrammed, are not intercepted in adaptor cable. They are connected direct, in accordance with MN31 circuit. Exceptions are the tapped circuits; 13 and 15 pins.

modulation is provided. This is permissible when a beat frequency oscillator is included in the compass receiver.

Shown in Figure 3 is a conventional oscillator circuit used for the test model. For sake of compactness and simplicity, a fix-tuned type oscillator was used for the model to conduct the test to check this procedure. To avoid radio interference, a clear channel within the band was selected for the ground location involved. To select frequency suitable for the test location, we made provision for padding, a 10-mmfd padding condenser. This provides a decrease in frequency of approximately 10 kc. An adjustable on-core inductor could be used instead of the condenser padding to affect frequency change, and it would not necessarily add to space requirements. A wide tuning range would affect the r-f output of the test oscillator. Should this frequency change be great enough, it would cause a corresponding change in the oscillator output level which would affect the calibration. The oscillator metal case construction provides access to batteries for check and replacement. This is important because accuracy is affected when battery voltages are below permissible limits. (The model described was found by actual performance test to operate normally with

battery limits of *B* voltages, 45 to 35, and *A* voltages, 1.5 to 0.8.) These values were those measured under load. In connection with this subject, there is a point well known, but merits mentioning; that is, the variations of the r-f oscillator output that can be tolerated are dependent upon the receivers overall automatic gain control characteristics. A larger variation is permissible without detrimental effects when operation is at the threshold (or knee) of the signal input versus 48 cps modulated output curve. Conversely the limits are very narrow when the oscillator signal level is of such value that it operates below the knee of the curve.

An analysis of the involved circuit function of the *l/r* compass and automatic compass differences, will show that for a quantitative comparison check in the field the oscillator output and transmission line coupling must not be excessive. This is because the gain of the loop amplifier stage of the automatic radio compass is controlled by

avc rectified from the compass amplifier stage. It is factual that the linear relation between the *l/r* meter deflection and signal input will flatten out at the point when the overall avc characteristics limits the 48 cps side-band modulation in the receiver. However, for general qualitative checks and fault isolation purposes the oscillator output and sense r-f coupling need not be accurately calibrated and a wider battery voltage can be tolerated.

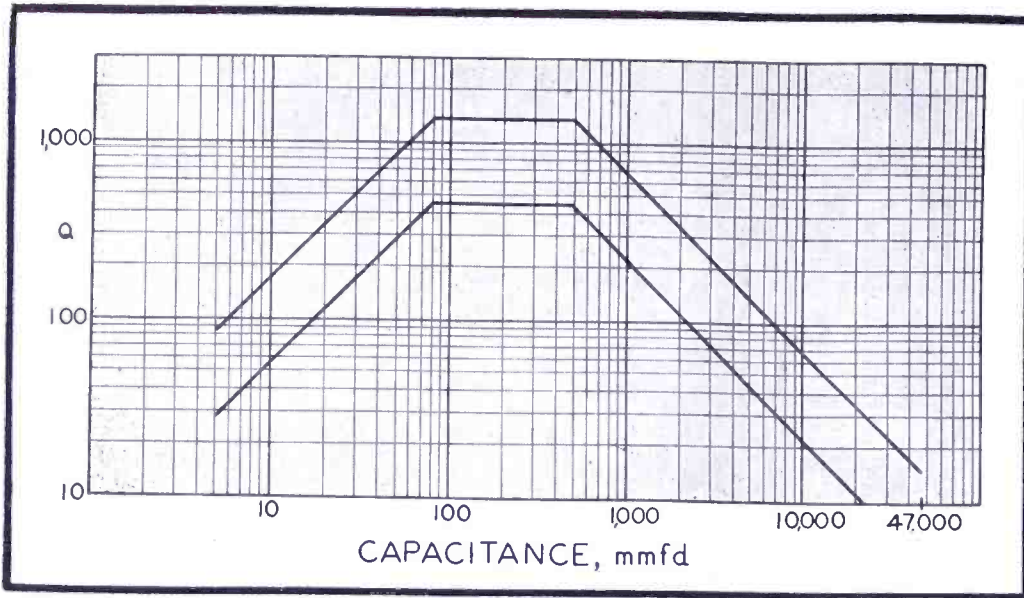
Compliance with simplicity requirements require the omission of an adjusted type of r-f output attenuator. This of course eliminates attention that would be required for such an adjustment. Oscillator r-f output power is calibrated to a pre-set value within the required limits to give the approximate $\mu\text{v/m}$ field strength at the loop antenna as used in the screen room.

The value used is that which is comparable to a minimum signal encountered in service.

The value of sense voltage introduced from the transmission line (of the test loop) is a function of the degree of coupling, referred to in Figure 2. Relation of sense antenna voltage to the loop antenna voltage determines the degree of 48 cps modulation. A reference base for their relation is given as a field strength of 1,000 $\mu\text{v/m}$ at the loop antenna and a vertical an-

(Continued on page 64)

FIXED MICA CAPACITORS



•
Figure 1
Capacitance and Q at 1 megacycle.
•

STANDARDIZATION of fixed mica-dielectric capacitors under Joint Army-Navy Specification JAN-C-5 has brought about a changing supply situation in which *standard* mica capacitors can now be procured more easily than the *non-standard* units they replace.

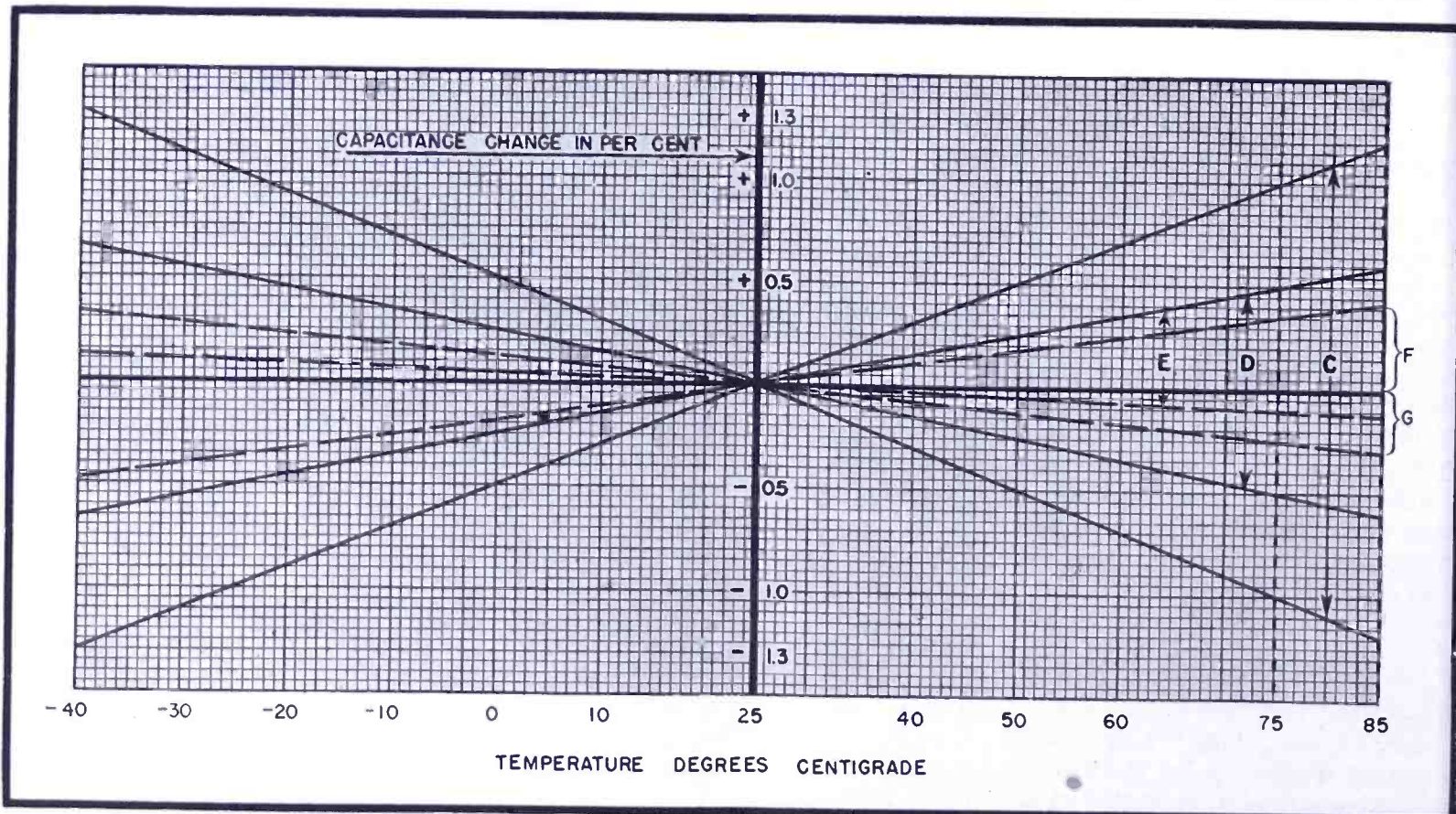
Anticipating the time when the majority of orders will call for *standards*, capacitor manufacturers have geared to *standard* types and are urging that all orders, wherever possible, be converted to *standards* so that production facilities, made available through *standardization*, may be utilized.

Demonstrating the manufacturer's capability of meeting the requirements of the mica capacitor *standard*, approximately 75% of the industry's output is now backed by Qualification Approval. Additional approvals are expected to raise this

percentage as *qualification testing* proceeds.

JAN Specification C-5, in addition to specifying general requirements, is actually a comprehensive catalog of *standard* capacitors. The various physical and electrical sizes, each with its own *standard* type designation, are designed to meet practically all applications. The *standard*

•
Figure 2
Limiting curves of temperature coefficients listed in table 1 of pro JAN C-5 specification.
•



is not intended to cover the few cases where special values and tolerances are essential to the performance requirements of critical circuits.

Case Sizes

Standardization of physical sizes has been achieved by establishing maximum dimensions for several case sizes: *CM20*, *CM25*, *CM30*, etc. (See voltage table for complete listing of *CM* numbers.) The dimensions for each are given in the detailed drawings of Specification JAN-C-5.

Characteristics

Requirements of the present war dictate that military equipment must be capable of maximum performance at all times regardless of variations in climatic conditions. The war in the air, at ever increasing altitudes, has brought about even more severe conditions.

To meet the requirements for various grades of mica capacitors, letters have been assigned corresponding to the characteristics necessary for proper application.

Characteristic *A* is usually satisfactory for most applications where temperature coefficient and Q are not critical. The lower curve of Figure 1 shows the minimum values of Q for *A* characteristic mica capacitors.

Characteristic *B* is also satisfactory where a definite temperature coefficient is not essential but where a higher value of Q is desired. The upper curve of Figure 1 shows the minimum value of Q for characteristics *B*, *C*, *D*, *E*, *F* and *G*. Figure 1 does not apply, however, to those capacitors listed in the *Standard* having specific r-f current ratings.

Characteristics *C*, *D*, *E*, *F* and *G* are used in applications requiring definite

SIN THE ARMY-NAVY ELECTRONICS

Standardization Program

by **GEORGE A. OSMUNDSEN**

First Lieutenant, U. S. Signal Corps
Assistant Chief Standards Application Staff

limits of capacitance-change with temperature. The temperature coefficient in parts per million for each of the characteristics C, D, E, F and G are as follows:

Characteristic	Temperature Coefficient parts/million/degree C
C	± 200
D	± 100
E	- 20 to + 100
F	0 to + 70
G	0 to - 50

(parts per million per degree Centigrade may also be thought of as micromicro-

farads per microfarad per degree Centigrade)

Silvered Micas

Capacitor manufacturers are able to meet these higher requirements through the use of silvered mica, together with suitable aging processes to stabilize the capacitor at the desired characteristic. In general, mica capacitors have a positive temperature coefficient; that is, the capacitance increases with increase of

temperature. The negative characteristic G is available only in the larger transmitting types and is obtained through the use of ceramic dielectric sections in combination with mica sections.

The mica capacitor temperature coefficient chart (Figure 2) is a graphical representation of the temperature characteristics C, D, E, F and G. Parts per million per degree Centigrade have been converted to percentages corresponding to temperatures over the range -40° C to + 85° C. 25° C is the normal or reference temperature from which all temperature changes are calculated. Thus

(Continued on page 90)

Table 1

Voltage Ratings of Jan. Specifications C-5 Fixed Mica-Dielectric Capacitors

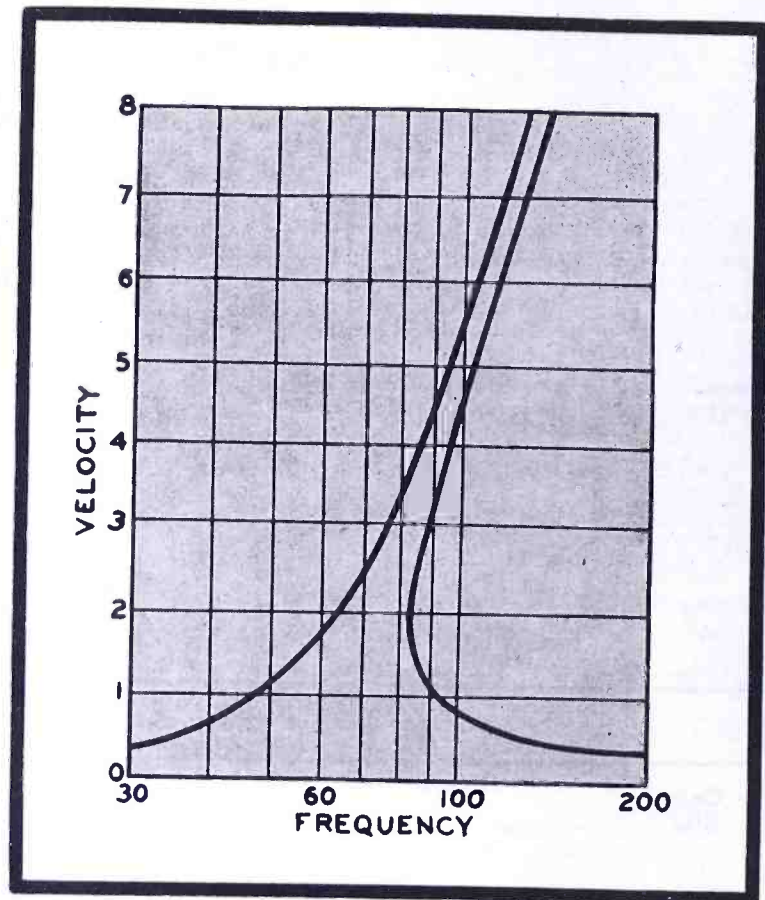
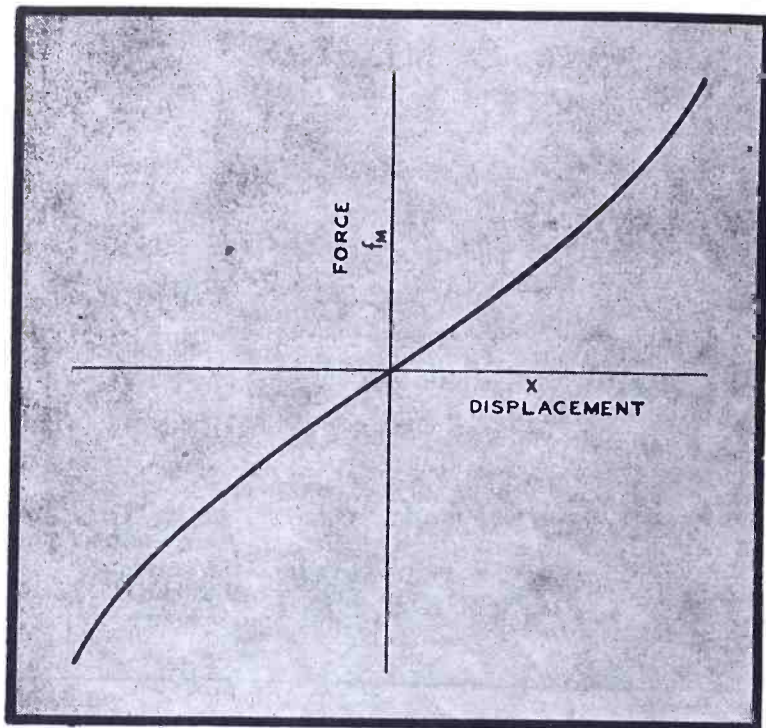
Case Size	Capacitance mmfd			DCWV	Case Size	Capacitance mmfd			DCWV
	From	Above	Up To†			From	Above	Up To†	
CM20	510	500	CM80	.....	.....	2000	10000
CM25	1000	500	.....	.....	2000	4300	8000
CM30	3300	500	.....	.....	4300	5100	6000
CM35	6200	500	.....	.....	5100	11000	5000
CM40	3300	.....	8200	300	.....	.....	11000	16000	4000
CM45	8200	10000	300	.....	.....	16000	27000	3000
CM50	2000	.....	1800	2500	.....	.....	27000	68000	2000
CM55	3600	1200	CM85	.....	68000	100000	1500
and	10000	600	.....	.....	1100	1100	20000
CM56	5100	2500	.....	.....	1100	2000	15000
CM60	11000	1200	.....	.....	2000	4300	12000
and	27000	600	.....	.....	4300	8200	10000
CM61	4300	2500	.....	.....	8200	11000	8000
CM65*	13000	1200	.....	.....	11000	24000	5000
.....	33000	600	.....	.....	24000	68000	3000
.....	16000	2500	CM90	.....	68000	100000	2000
.....	33000	600	.....	.....	1000	1000	30000
.....	47000	3000	.....	.....	1000	1800	25000
.....	2400	2000	.....	.....	1800	3900	20000
.....	7500	1500	.....	.....	3900	7500	15000
.....	9100	1000	.....	.....	7500	9100	12000
.....	24000	500	.....	.....	9100	11000	10000
.....	43000	250	.....	.....	11000	16000	8000
CM70*	2400	5000	.....	.....	16000	30000	6000
.....	7500	3000	.....	.....	30000	62000	5000
.....	7500	2000	.....	.....	62000	75000	4000
.....	22000	1500	.....	.....	75000	100000	3000
.....	51000	1000	CM95	.....	.....	1800	35000
.....	75000	500	.....	.....	1800	3300	30000
CM75	4700	6000	.....	.....	3300	5100	25000
.....	4700	4000	.....	.....	5100	6200	20000
.....	11000	3000	.....	.....	6200	10000	15000
.....	16000	2000	.....	.....	.....	.....	.....
.....	27000	1500	.....	.....	.....	.....	.....
.....	68000	1000	.....	.....	.....	.....	.....
.....	100000	1000	.....	.....	.....	.....	.....

*Characteristic G in Case Sizes CM65 and CM70 are derated 50% in voltage and current ratings.

†Including.

HIGHLIGHTS OF OLSON AND LEONARD PAPERS

Presented At N. Y. Meeting of Acoustical Society of America



Figures 1 (above) and 2 (right)

Figure 1, the force displacement characteristic of the suspension system of the cone of a direct radiator loudspeaker, discussed by Dr. Olson. Figure 2, theoretical undamped response frequency characteristic of a direct radiator loudspeaker with a nonlinear suspension system having a force displacement characteristic depicted in Figure 1.

Action of a Direct Radiator Loudspeaker with Nonlinear Cone Suspension System. Harry F. Olson, RCA Laboratories, Princeton, New Jersey.

DURING the past few years a number of mathematical investigators have directed their efforts toward the solution of differential equations with variable coefficients. These analyses, ex-

plained Dr. Olson, are useful in explaining some of the phenomena which occur in electroacoustic vibrating systems with nonlinear elements. In particular, this mathematics may be used to explain the various phenomena exhibited by a direct radiator loudspeaker with a nonlinear cone suspension system. One of the effects is a jump phenomenon in the response frequency characteristic. Another effect is the production of harmonics and subharmonics.

Precision Method for Determination of Velocity of Sound in Air. R. W. Leonard, University of California, Los Angeles

A METHOD has been developed and refined in the laboratory at UCLA for the measurement of the velocity of free progressive sound waves in air. The method involves wavelength measurements in a free sound field of known frequency. A directional source radiating spherical waves is placed at one end of the free field room. Measurements of positions of equal phase along the axis of the source are made with a movable microphone. The phase measurements are made on the screen of an oscilloscope. The amplified voltage developed by the microphone is applied to the vertical plates of the oscilloscope and a voltage derived from the source oscillator is applied to the horizontal plates. Closure of the ellipse on the oscilloscope screen is used to determine position of equal phase. The microphone is moved away from the

(Continued on page 88)

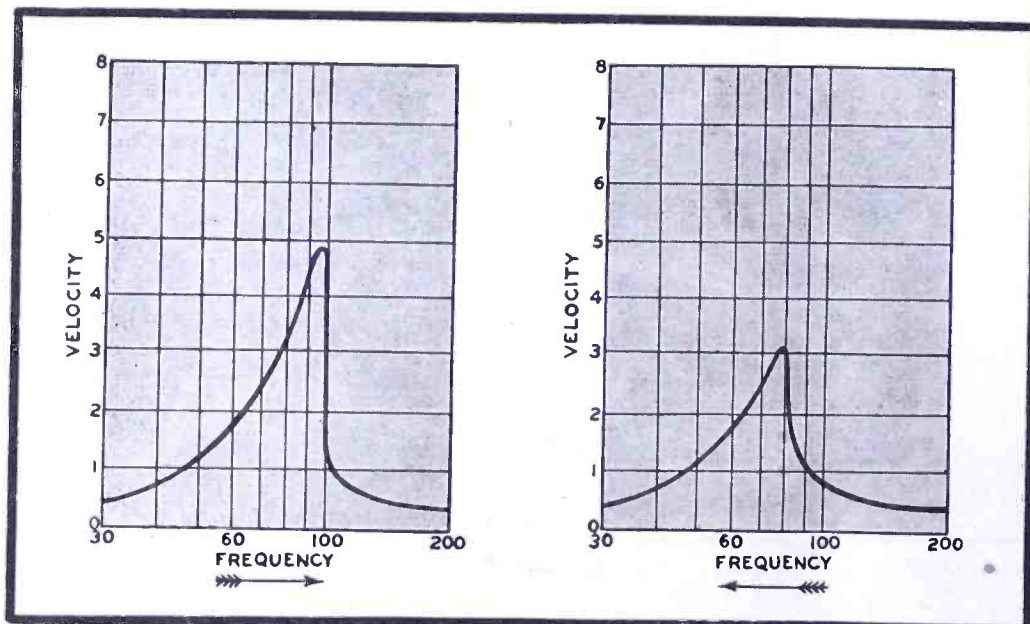
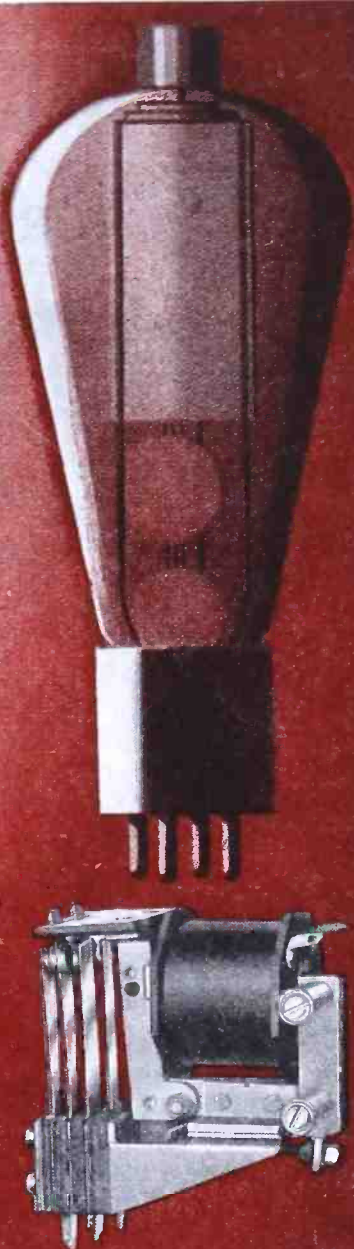
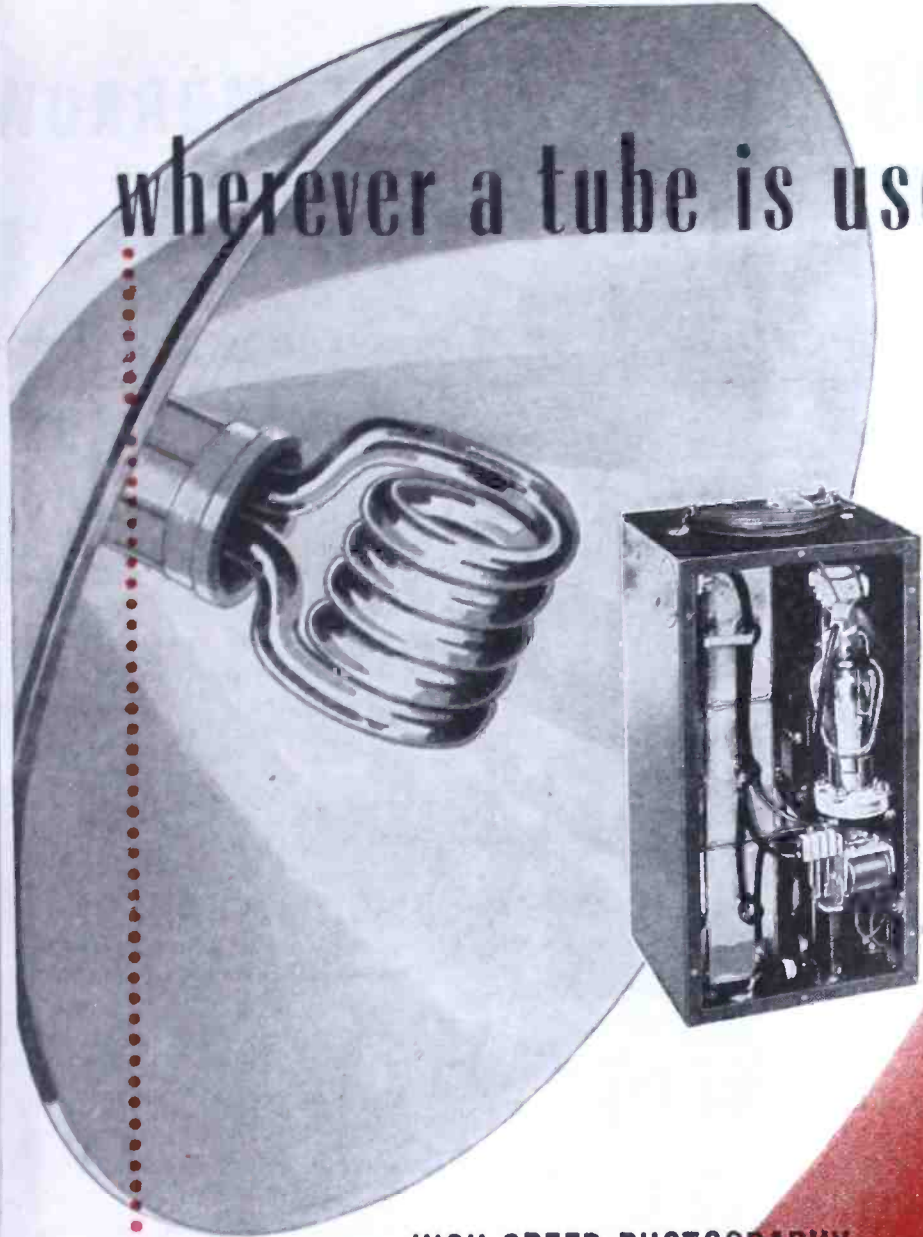


Figure 3

Experimental response frequency characteristics of a direct radiator loudspeaker with a non-linear suspension system having a force displacement characteristic shown in Figure 1. *A*: The response for an applied alternating voltage which continuously increases in frequency. *B*: The response for an applied alternating voltage which continuously decreases in frequency.

wherever a tube is used...



...for example: **HIGH-SPEED PHOTOGRAPHY**

The Lee Stobo-Speed lamp stops action of rapid movement with a flash of about one thirty-thousandth of a second. One flash exceeds in light intensity the illumination of 2,000 kilowatts of ordinary tungsten lamps. Operates on 115 volts, 60 cycles, A.C.

THERE'S A JOB FOR

Relays BY GUARDIAN

In the Lee Stobo-Speed lamp a rectifier tube is employed to build up a high charge on a bank of condensers. These are discharged through the flash lamps when the Guardian Series 15 relay is energized. This special application illustrates the flexibility of design incorporated into Guardian relays. The Guardian standard Series 15 was selected for the job and engineered to meet the high voltage requirements and other special conditions.

Another Lee Stobo-Speed unit with three flash tubes operating from three banks of condensers also employs the Series 15 relay. In this application the relay is equipped with additional switches to handle three circuits instead of one. Contact switches in both units are specially insulated to withstand the high voltages.

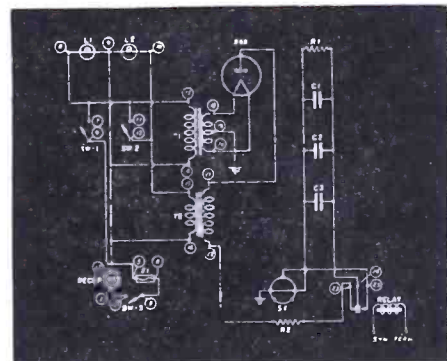
The Series 15 is a compact unit having a maximum switch capacity of 10 pole, single throw with 1½ amp. contacts; 6 pole single throw with 8 amp. contacts; 4 pole double throw with 12½ amp. contacts. Coils for standard voltages range up to 220 volts and may be equipped with copper slug time delay on release or attract.

For D. C.—write for Series 15 bulletin.

For A. C.—write for Series 30 bulletin.

GUARDIAN  **ELECTRIC**
1623-J W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY



Single Flash Tube, Single Circuit Diagram.

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

COMMUNICATIONS TODAY AND TOMORROW

As Viewed By Engineer-Executives

A COMMUNICATIONS NAB Executives War Conference Feature

by **HOWARD S. FRAZIER**

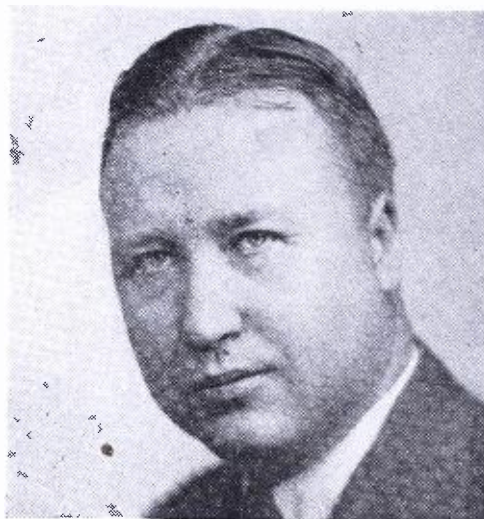
Director of Engineering
National Association of Broadcasters

AS this issue of COMMUNICATIONS goes to press, broadcasters are preparing for the NAB Executives War Conference in Chicago on August 28 to 31, and our industry approaches the fourth year of wartime operation. Those charged with responsibility for the technical operation of broadcast stations have, to a large extent, now established stable operating conditions. In other words, wartime operation has now become what we might call the normal practice instead of the new and untried. Problems of equipment maintenance and the training of replacement personnel have been met with little, if any, deterioration in service to the American public.

Broadcasting has always been an industry of growth, expansion and technical improvement. What is more natural then, at this time, than to turn our thoughts toward the future. The work of the *Radio Technical Planning Board* is well underway and already the panels on television and f-m have submitted reports which outline the technical standards recommended for these broadcast services in the post-war period. Panel 4 on *Standard Broadcasting* has completed work on many of the agenda items and a preliminary report from that group can be expected early in the fall of this year.

Aural broadcasting began soon after the first world war and continued to expand and develop rapidly through the years which preceded Pearl Harbor. Shortly after December 7, 1941, the plant expansion and development in this field, for the first time, came to almost a standstill. The industry devoted its efforts to rendering even greater service to the American public and to the winning of the war with the then existing facilities.

The time has now come to look forward into the future and to the resumption of the industry's plant ex-



Howard S. Frazier

pansion. Many of us feel very keenly the lack of the reliable crystal ball. We can be reasonably sure that many more aural broadcast stations will come on the air. But who *knows* what method of modulation these stations will use in 1950?

Will it be economically practical to provide local aural station service in communities of 5,000 to 10,000 people?

Will the problem of providing adequate rural coverage throughout the United States be solved?

Will the public buy television receivers in sufficient quantities to permit the rapid development of television service to small cities and national television networks?

Who will be the television broadcasters of the future? Will they be the present broadcasters, the movie interests, publishers or others who will

Technical Session NAB Executives War Conference

Thursday, August 31, Palmer House,
Chicago

2:15 P.M.: Symposium on postwar future of broadcasting, Commander T. A. M. Craven presiding. Speakers will include Paul Chamberlain, G.E.; Niles Trammel, NBC; William Lodge, CBS; Thomas Joyce, RCA; Dr. E. H. Armstrong, who will cover f-m; Paul Godley, who will discuss a-m; and J. V. L. Hogan on facsimile.

dominate the new medium of mass communication?

I don't know the answers to these and many more questions heard frequently. But I do know the years ahead offer great opportunities, for service and achievement to those who are privileged to be part of radio.

by **O. B. HANSON**

Vice President and Chief Engineer
National Broadcasting Co.

WAR, particularly modern war, gives an impetus to engineering progress that far exceeds normal developments in peace time. Yet, because of the single vital objective of this research and refinement—ultimate victory—little of the engineers' accomplishments can be reported for public consumption. When the war is brought to a successful finish or when national security permits, the communications industry will have a story to tell that will excite the imagination of those who have not been intimately concerned with laboratory and manufacturing activities.

In the broadcasting field the main problem has been maintenance. Yet with manufacturing facilities devoted almost entirely to the war effort it has not been possible to carry out many of the normal replacements for obsolete units that good engineering practice ordinarily dictates. This has made it necessary for stations to improvise numerous components and, in many instances, to construct replacements from available parts. That American broadcasters have been able to continue their high standard of service with few interruptions is a tribute to the ingenuity of engineering staffs.

Possibly the outstanding accomplishments in the past year have been the construction of the two short-wave station groups at Bound Brook, N. J., and Dixon, California. The six transmitters at Bound Brook were installed

(Continued on page 50)

ENGINEERING CONFERENCE

"WHY THAT'S JOCK!"



Right on the field of battle is the CBC truck with its Presto recorder taking down the sounds of battle, the words of Canadian men doing the fighting . . .

Yes! It actually happens. Canadian families are now hearing the voices of their own loved ones on the battlefronts, thanks to a program service originated by the Overseas News Service of CBC. This enterprising and much appreciated service consists of recordings made right on the scene of battle, the actual sounds of battle forming a terrible background. The recordings are rushed to Algiers, short-waved either via London or direct to Ottawa, where they are re-recorded, and sent out over the CBC leased lines. All this is made possible by the use of PRESTO Recording Equipment, which is used throughout the Canadian Broadcasting Corporation.



. . . Transmitted by short wave to BBC in London, the broadcast is re-recorded on one of the fifty complete Presto recording installations in the British Isles . . .



Presto Recording Corporation, New York 19, N. Y., U. S. A.

World's Largest Manufacturers of Instantaneous Sound Recording Equipment and Discs



. . . Short-waved again, this time to CBC in Ottawa, the battle-recorded broadcast is then sent over wire lines to the stations on the CBC networks across the Dominion.

BROADCAST ANTENNAS AND ARRAYS

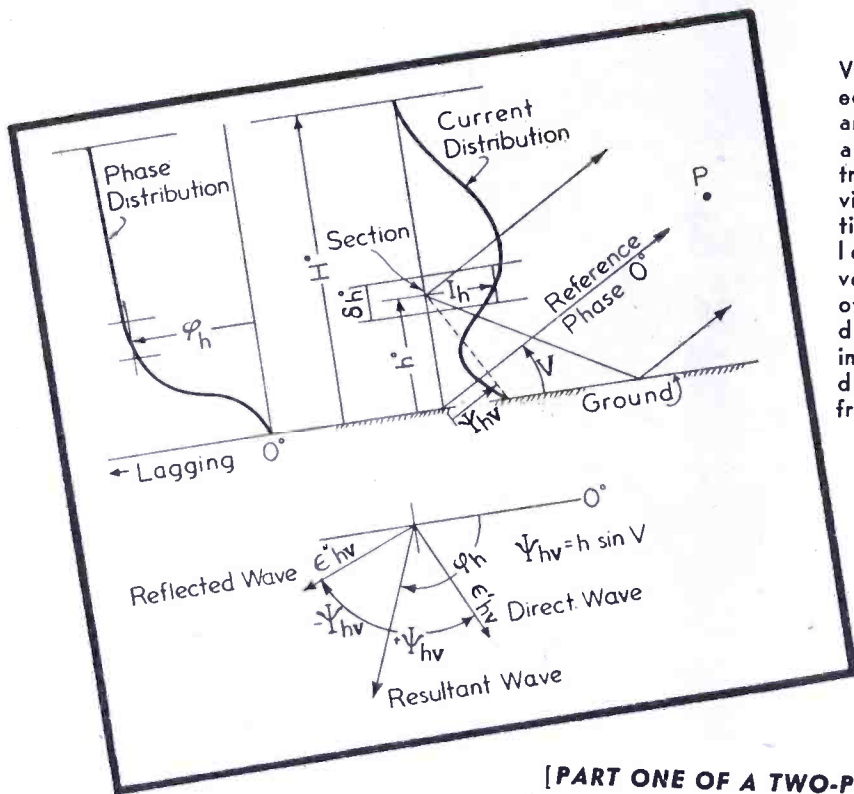


Figure 1
Vertical ground antenna with arbitrary current and phase distribution, and divided into sections of equal length with vector diagram of fields at P due to current I_h in section h . All dimensions in free-space degrees.

[PART ONE OF A TWO-PART PAPER]

THE non-sinusoidal current distribution in practical broadcast antennas yields patterns that differ from the ideal usually assumed. The discrepancy is more pronounced in the case of arrays than in single antennas. The computation method

outlined in this paper is independent of current distribution and phase-shift along the antenna.

Methods for measuring relative current and phase in antenna systems have been described.^{1,2,3,4} It is therefore assumed that the relative current

Table 1
Values for the function $f(h, V) = \cos(h \sin V) \cos V$; (for slide rule use)

h Degrees	Values of the function: $\cos(h \sin V) \cos V$							
	V = 10°	V = 20°	V = 30°	V = 40°	V = 50°	V = 60°	V = 70°	V = 80°
5.....	0.985	0.940	0.865	0.764	0.642	0.499	0.342	0.173
15.....	0.984	0.936	0.858	0.756	0.630	0.487	0.332	0.168
25.....	0.982	0.930	0.845	0.736	0.608	0.465	0.314	0.158
35.....	0.979	0.919	0.826	0.708	0.574	0.432	0.287	0.143
45.....	0.976	0.906	0.800	0.670	0.530	0.389	0.253	0.124
55.....	0.971	0.890	0.768	0.624	0.477	0.337	0.212	0.102
65.....	0.966	0.872	0.730	0.571	0.418	0.278	0.165	0.076
75.....	0.959	0.847	0.687	0.511	0.347	0.212	0.114	0.048
85.....	0.952	0.822	0.638	0.444	0.271	0.144	0.061	0.019
95.....	0.944	0.793	0.585	0.371	0.190	0.067	0.004	-0.011
105.....	0.936	0.761	0.527	0.293	0.107	-0.009	-0.051	-0.040
115.....	0.926	0.726	0.465	0.212	0.022	-0.084	-0.106	-0.068
125.....	0.915	0.691	0.400	0.128	-0.063	-0.156	-0.157	-0.095
135.....	0.903	0.651	0.332	0.043	-0.147	-0.227	-0.205	-0.118
145.....	0.891	0.609	0.261	-0.041	-0.230	-0.291	-0.246	-0.138
155.....	0.878	0.566	0.187	-0.128	-0.310	-0.347	-0.282	-0.154
165.....	0.865	0.520	0.113	-0.211	-0.380	-0.399	-0.310	-0.166
175.....	0.850	0.472	0.038	-0.294	-0.447	-0.440	-0.330	-0.172
185.....	0.836	0.423	-0.038	-0.371	-0.505	-0.471	-0.340	-0.174
195.....	0.818	0.373	-0.113	-0.443	-0.553	-0.491	-0.342	-0.170
205.....	0.801	0.320	-0.187	-0.511	-0.592	-0.499	-0.334	-0.161
215.....	0.783	0.270	-0.261	-0.570	-0.620	-0.497	-0.317	-0.147
225.....	0.765	0.211	-0.332	-0.625	-0.637	-0.483	-0.292	-0.128

Calculation of Radiation Patterns

by WILSON PRITCHETT

Radio Engineer
E. F. Johnson Company

and phase distribution on each antenna is known or can be measured. Since practical broadcast antennas usually employ extensive ground systems that approach the ideal,¹ a perfect earth has been assumed in computing the patterns.

Absolute and Relative Patterns of Single Antennas

Let us consider the antenna of Figure 1, with its current and phase distribution as shown. The vector diagram gives the magnitude and phase at the remote point, P , of the direct and reflected increments of the field produced by the current, I_h , flowing in a section. The resultant is

$$\epsilon_{hv} | \phi_h = 2 \left[\frac{60\pi \delta_h}{d \cdot 360^\circ} I_h | \phi_h (\cos(h \sin V) \cos V) \right] \text{ volts per unit } d \quad (1)$$

For the section, δ_h , 10° long and the distance, d , to point, P , 1 mile,

$$\epsilon_{hv} | \phi_h = 0.00651 I_h | \phi_h f(h, V) \text{ volts per meter} \quad (2)$$

Certain values of the function $f(h, V)$, useful in the study of broadcast antennas, are given in Table 1.

Finally it is necessary to combine the contributions from all sections vectorially to find the total resultant field ($\epsilon_v | \phi_v$) at point, P , for a given elevation angle V .

$$\epsilon_v | \phi_v = \sum_{h=H^\circ}^{\delta h^\circ} \frac{\epsilon_{hv} | \phi_h}{2} \text{ volts per unit } d \quad (3)$$

Determination of patterns for arrays requires, first the determination of the individual relative patterns. All antennas are divided into equal sections, δ_h , and the relative current and phase distribution expressed with respect to unity current ratio and zero



War Gem Today

WHAT WILL THE QUARTZ CRYSTAL DO TOMORROW?

The fabled princes of Hindustan or the wealthy Nizam of Hyderabad never owned a gem more valuable.

The quartz crystal is doing more than rubies or emeralds to protect our way of life against the aggressor.

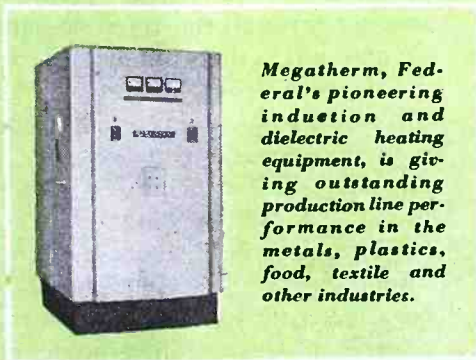
Cut into tiny wafers the quartz crystal is performing with merit wherever fixed radio frequencies are a "must".

Federal is mass producing frequency control crystals for military use. How many difficult jobs they are doing is a war secret. But their versatility is unlimited.

Even now—in the great FTR research laboratories—men are finding new uses for

quartz crystals—pointing the way to widespread industrial and civilian use after the war is won.

Not alone in communications—but in such widespread applications as precision timing and measuring devices, television, supersonics, pressure gauges, filters, generators, induction heating devices and automatic control equipment, crystals will find new uses . . . a war gem will become a peacetime servant.



Megatherm, Federal's pioneering induction and dielectric heating equipment, is giving outstanding production line performance in the metals, plastics, food, textile and other industries.

To achieve mass production Federal has installed new machinery and new methods to speed crystals on their way to war—and will continue to be a leader in crystal production. Now is the time to get to know Federal.

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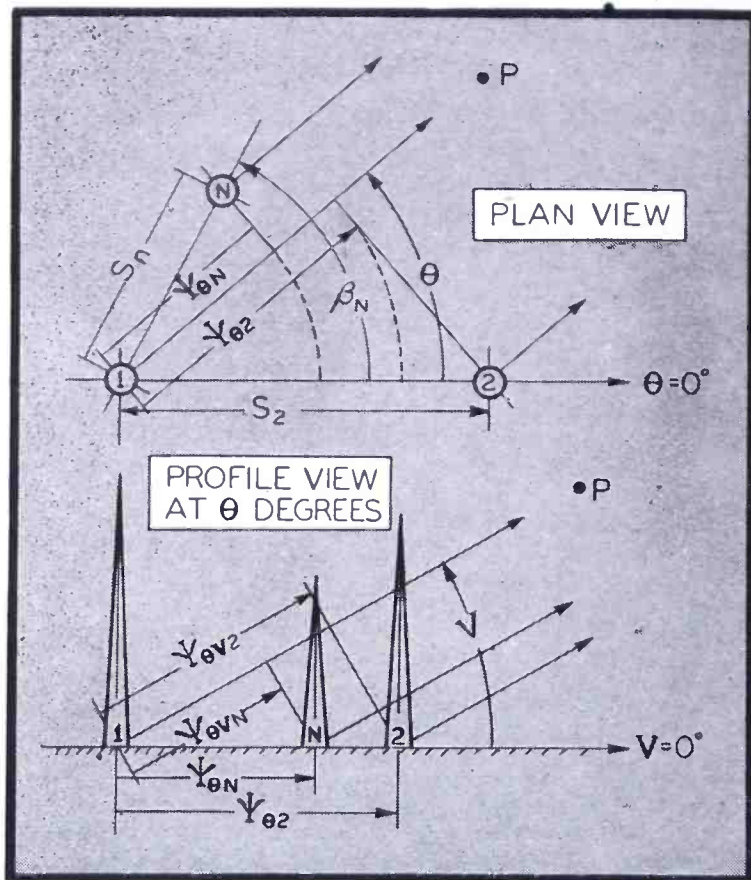


Figure 2
Plan and profile view
of multi-element
array of vertical
antennas.

tennas. It is merely necessary to combine them vectorially at the proper angles accounting for the differences in path length traveled, $\Psi_{\theta V N}$, and the actual time phase, $\phi_{V N}$, of the individual fields. Thus, the resultant relative field intensity from the array is

$$K_{\theta V} = k_{v1} |\phi_{v1} + k_{v2} |\phi_{v2} + \Psi_{\theta V 2} + \dots + k_{vN} |\phi_{vN} + \Psi_{\theta V N} \quad (6)$$

From Figure 2 it is easily seen that $\Psi_{\theta V N} = S_N \cos(\theta - \beta_N) \cos V$ (7)

The vector addition represented by equation 6 is a special feature of various antenna pattern calculators that have been described.^{6,7,8}

The protractor reproduced in Figure 3, mounted on a sheet of stiff cardboard and fitted with a transparent radial index arm, can be used advantageously in laying off the angles $(\phi_{V N} + \Psi_{\theta V N})$.

Protractor Description and Use Procedure

The circular arcs numbered from 30° to 330° indicate $\Psi_{V N}$ which is constant for any vertical angle V and equal to $S_N \cos V$. A table of values for $\Psi_{V N}$ is computed for the various elevation angles V . The angle $\Psi_{\theta V N}$ is read directly from the intersections of the spiral lines with the $\Psi_{V N}$ arc for the specific elevation angle V . The spirals are drawn for 10° increments of $(\theta - \beta_N)$, and so use of the protractor is limited to β_N taken at 10° intervals. Interpolation for intermediate values of $\Psi_{V N}$ is easy, however. Figure 4 shows the vector diagram for a specific elevation angle, V , of a simple array. Advantage is taken of the fact that k_{vN} , ϕ_{vN} and $\Psi_{V N}$ are constant. The relative field from the reference antenna k_{v1} is laid off at the angle ϕ_{v1} . Upon its ends are laid off arcs with radii k_{v2} and k_{v3} , as shown. Upon these arcs are laid off values of $\Psi_{\theta V N}$, with the aid of the protractor of Figure 3 mounted as described, and having a hole at the origin for centering it upon the ends of the vector $(k_{v1} |\phi_{v1})$. First the phase angle ϕ_{vN} is laid off as shown and the zero on the rim of the protractor laid in that direction. Successive angles $\Psi_{\theta V N}$ are then laid off from $(\theta - \beta_N) = 0^\circ$ to $(\theta - \beta_N) = 90^\circ$. These two extremities are $\Psi_{V N}$, and zero, read from the rim of the protractor. Intermediate values of $\Psi_{\theta V N}$ are plotted from successive intersections of the spirals with the arc $\Psi_{V N}$. A pair of dividers can be used to lay off these same intervals on the other side of ϕ_{vN} for $(\theta - \beta_N)$ continuing from 90° to 180°. Returning on the same points gives suc-

phase at the base of one antenna taken as a reference. Mutual impedance between antennas destroys the quantitative relationship of equation 1, and the individual relative patterns must be found first. This is done by re-writing equation 2, using relative current, $k_b |\phi_b$, in each section, δ_h , to compute the relative increment of field, $k_{hv} |\phi_h$. The constant term is dropped.

$$k_{bv} |\phi_b = k_h |\phi_h f(h, V) \quad (4)$$

The total relative field, $k_v |\phi_v$, is the vector sum of the contributions from the sections, and corresponds to equation 3:

$$k_v |\phi_v = \sum_{h=0}^{\delta_h} \frac{k_{hv} |\phi_h}{2} \quad (5)$$

The procedure for using Table 1 and equation 2 or 4, to find the pattern of an antenna, is:

- (1)—Prepare a table of the form of Table 1, inserting columns for $0.00651 I_h$ (or k_h) and ϕ_h , in which the other tabulations consist of products of $0.00651 I_h$ (or k_h), and the corresponding value of $f(h, V)$ from Table 1.
- (2)—With the aid of an engineer's scale and protractor (or drafting machine) we add vectorially each column. Since all values in each horizontal row are laid off at the same angle (ϕ_h), it is expedient to use a drafting machine and prepare a single

vector diagram for the entire table. After all vectors are drawn, the magnitude and phase of the field at each elevation angle is measured and tabulated at the end of the proper column.

In the case of short antennas, in which the phase distribution is constant, the columns are simply added algebraically.

Tall antennas have a number of the functions, $f(h, V)$, negative, and it is usually necessary to provide a fairly large sheet of detail paper to avoid passing off the edge.

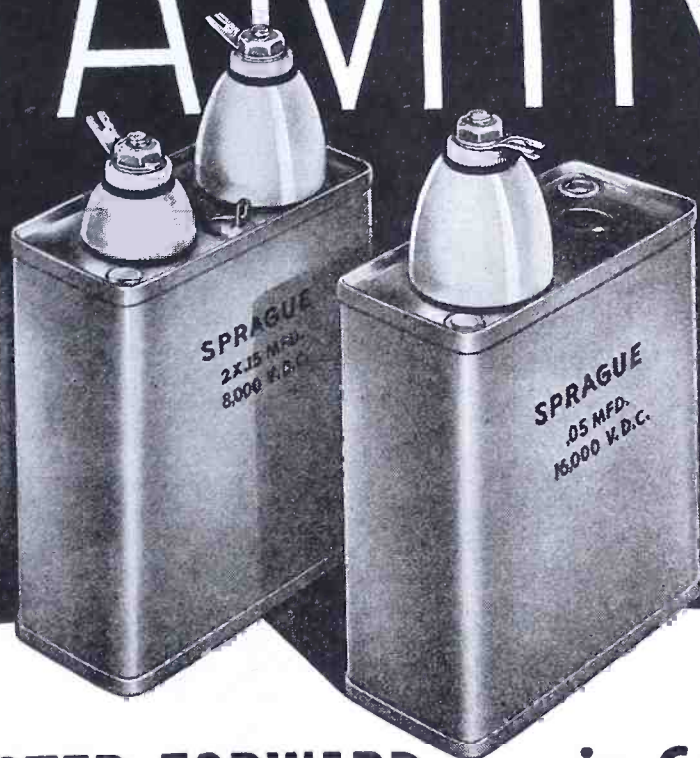
The writer has found application of the 10° schedule of Table 1 to ideal antennas up to 220° tall, to give results that check the well known formulas within a fraction of a per cent.⁹

Relative Patterns of Arrays

Figure 2 shows the plan view and one profile view of a multi-element array. The reference horizontal direction, $\theta = 0^\circ$, is in a vertical plane passing through the reference antenna 1, and any other antenna 2, spaced S_2 degrees from antenna 1, and is directed from the reference antenna 1 to the other antenna 2. The other antennas lie in arbitrary directions, β_N , at arbitrary spacings S_N .

Since the relative phase and magnitude of the individual fields have been determined with respect to the relative phase and magnitude of the base currents, and the earth assumed perfect, the fields at point P , due to the individual antennas, appear to emanate from the bases of the an-

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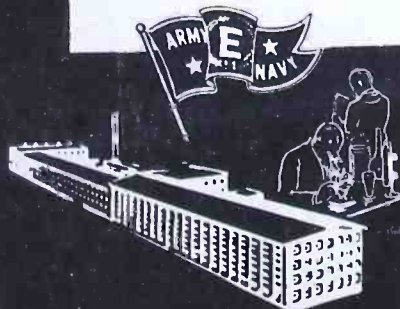
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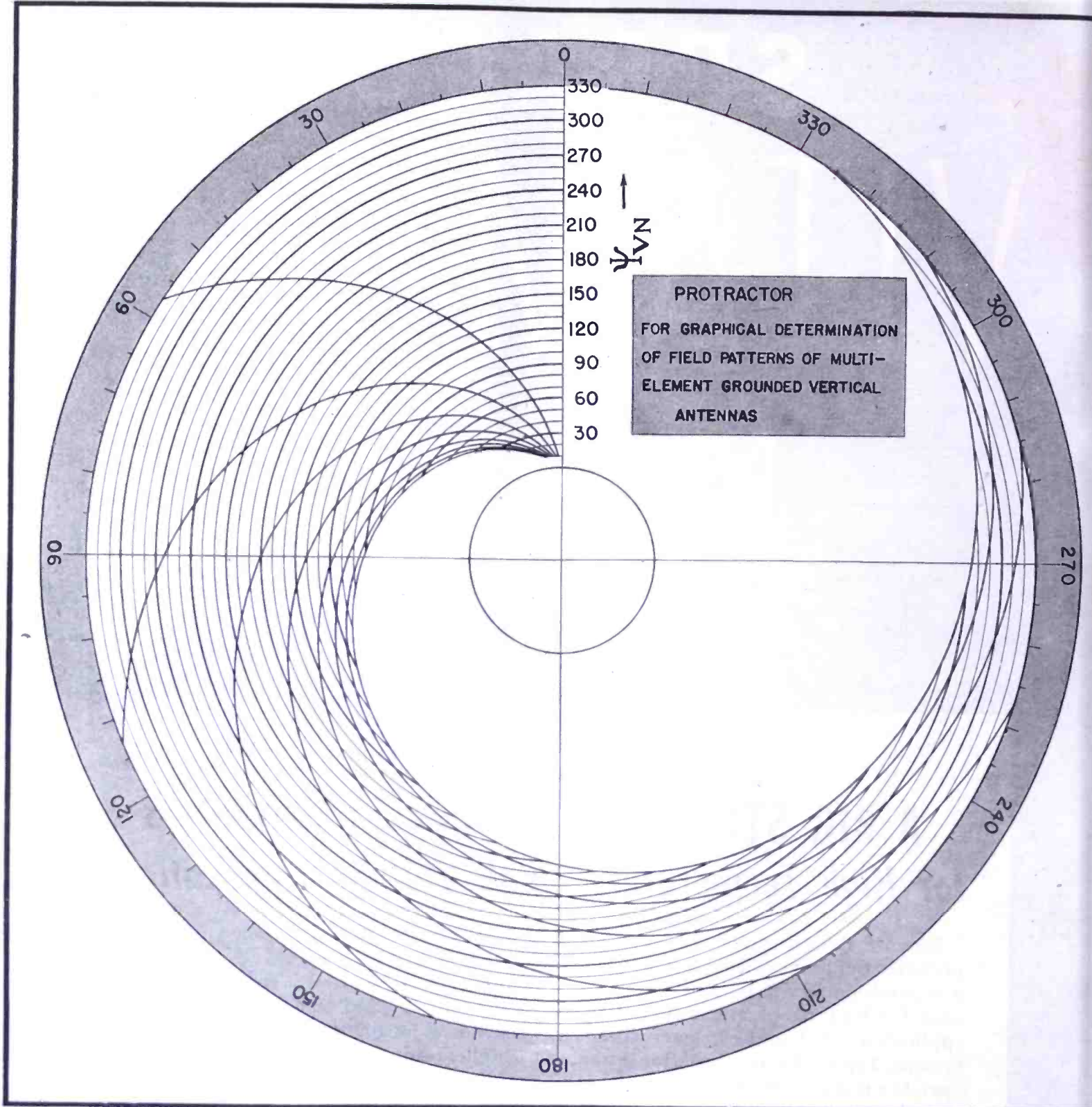


Figure 3

Protractor for mounting on cardboard and fitting with a transparent ruled radial arm. A hole is provided in center bearing for observing centering of protractor on vector diagram.

cessive values of $\Psi_{\theta VN}$ from 180° to 360° .

In the case of arrays of more than three antennas, it is necessary to lay off the proper values of $(\phi_{VN} + \Psi_{\theta VN})$ upon the end of a moving vector. The dividers are used to measure the total resultant relative field, $K_{\theta V}$, which is the displacement between the ends of the corresponding vectors. The displacements are plotted directly on polar coordinates as measured. Use was made of the proportional dividers set at 0.5 to 1.0, Figure 4.

Adjustment of Relative Patterns

The total power, P , radiated from

an antenna system is the summation of the power flowing out through the zones of an enclosing hemisphere and is

$$P = 2\pi d^2 \delta_v (0.00265) \sum_{z=1}^{z=N} \epsilon_z^2 \cos V_z \quad (8)$$

watts

where:

d = the radius of the hemisphere in meters

N = the number of zones, all having equal central angles into which the surface of the hemisphere is divided

$$\delta_v = \frac{\pi}{2N}$$

V_z = elevation angle to the center of the zone

ϵ_z = the effective field in volts per meter

in the zone. Its value is quite accurately

$$\epsilon_z^2 = \frac{\epsilon_L^2 + \epsilon_U^2}{2}$$

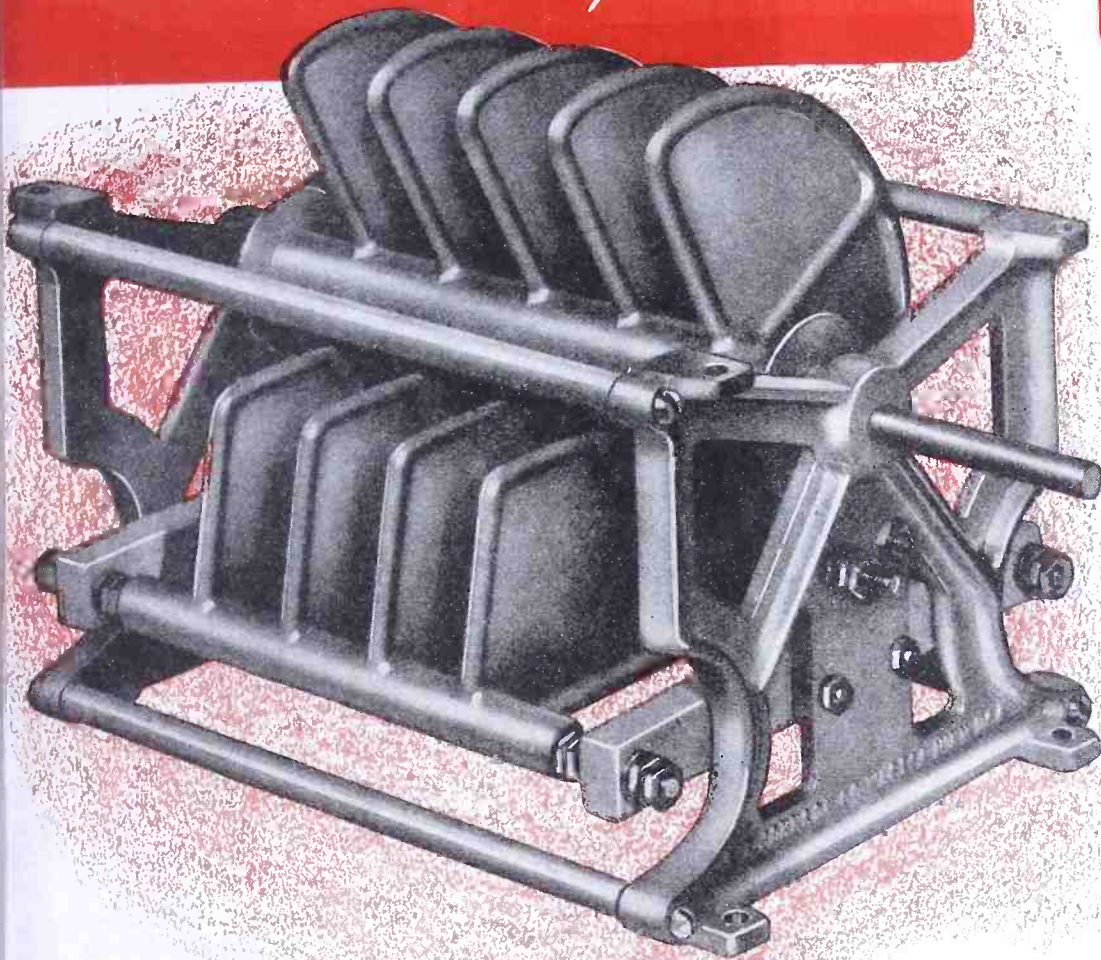
where ϵ_L is the effective field at the lower edge of the zone, and ϵ_U is the effective field at the upper edge of the zone. The effective field at the edge of a zone is equal to the radius of a circle having the same area as a polar plot of the actual field around the edge of the zone.

For the hemisphere with a mile radius and divided into 10° zones, the square-root of the summation in equation 8 becomes

$$\sqrt{\sum_{z=1}^{z=9} \epsilon_z^2 \cos V_z} = 0.3645$$

for 1000 watts radiated (9)

New Development



Again Johnson scores a first with newly designed thick plates which allow much higher voltages, particularly at high frequencies.

It has long been known that plates with rounded edges have higher breakdown voltages in variable condensers, but it remained for Johnson Engineers to work out ratios of plate thickness, design, voltage, and spacing for maximum advantage.

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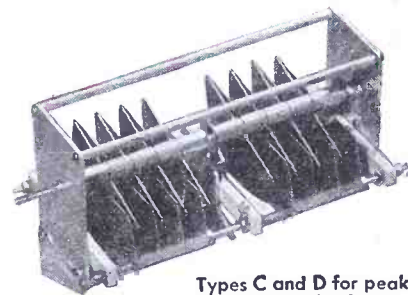
Corona is noticeably less with the new type plates and corona shields have been added where stator bars enter insulators, resulting in still further improved performance.

Despite these many improvements, in most cases prices are lower because of the saving in material.

Now available in Types A and B, both fixed and variable, this new plate shape and construction will be incorporated in other types as quickly as possible. Write Johnson today for more information and for recommendations on YOUR variable condenser application.

New Catalog 968E now ready.

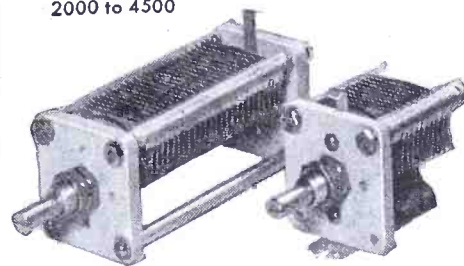
Decreased Spacing
Shorter Length
Lower Minimum
Less Inductance



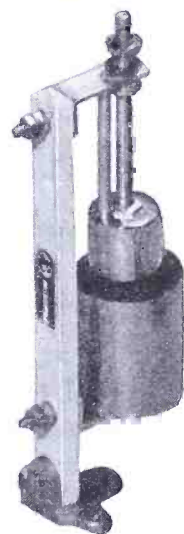
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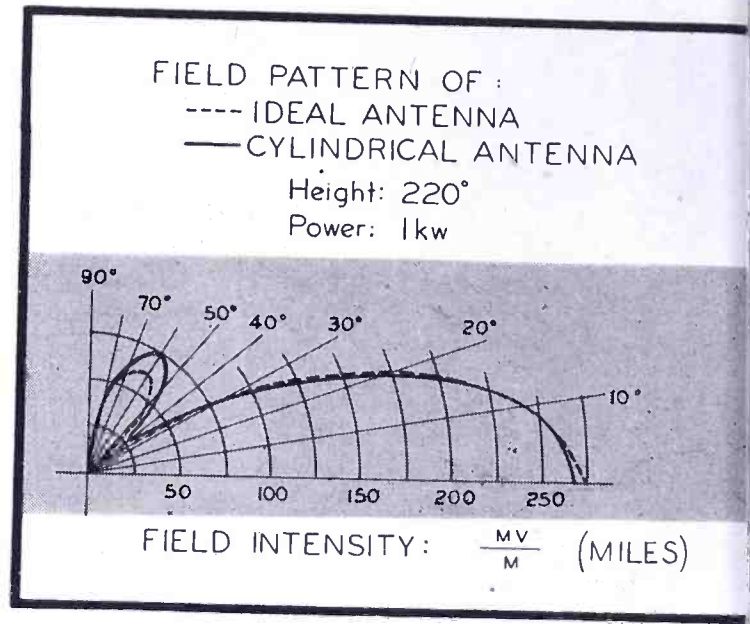
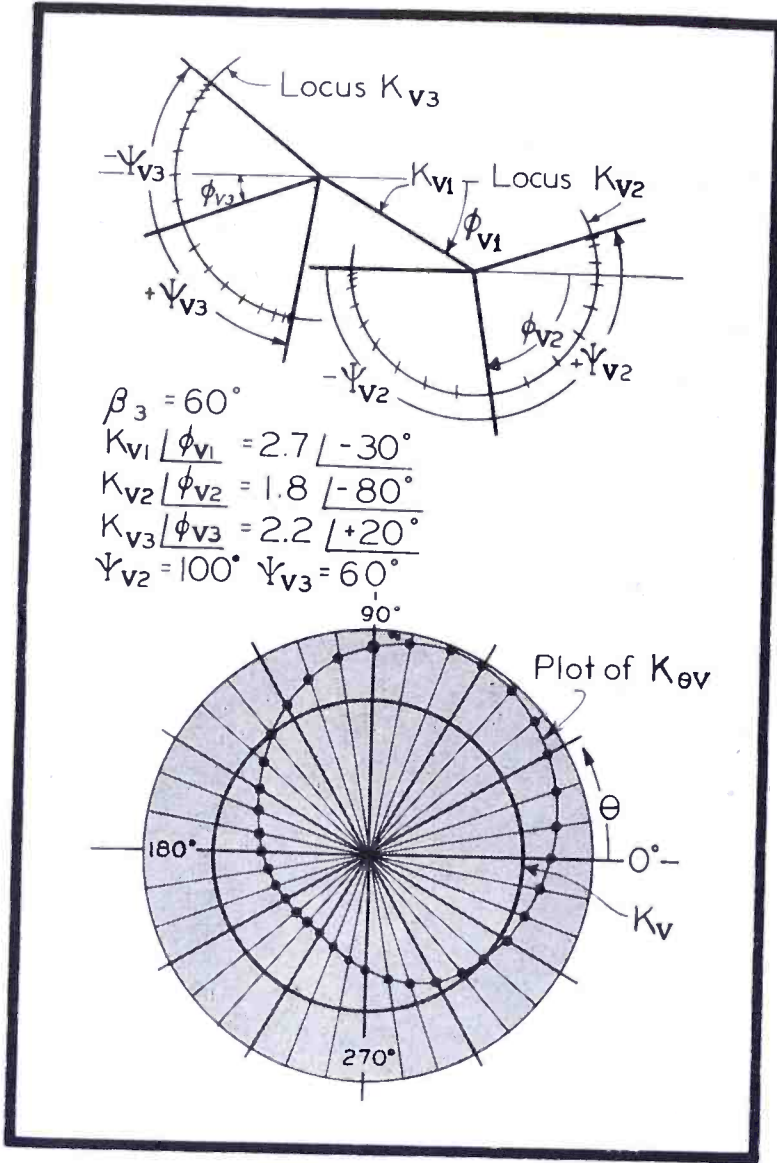


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Figures 4 (left), 5 (above), and 6 (below)

In Figure 4 we have a vector diagram of individual relative fields of a 3-element array drawn with the aid of protractor shown in Figure 3. The resulting pattern (K_v) and its rms value (K_v) is shown. Figure 5 shows a comparison of fields from ideal and practical antennas. Figure 6, a comparison of fields in the line of towers of ideal and practical 2-element arrays having horizontal patterns of identical shape.

If we consider the relative pattern of an array resulting from the summation of equation 6, and let the actual field intensity for one kilowatt radiated be related to the relative field by the factor M , we find that

$$\epsilon_{\theta v} = M K_{\theta v} \quad \text{volts per meter at a mile} \quad (10)$$

Let K_z be the relative effective field in a zone corresponding to ϵ_z for the effective field in volts per meter in the zone, and

$$M = \frac{0.3645}{\sqrt{\sum_{z=1}^9 K_z^2 \cos V_z}} \quad (11)$$

A simple procedure for evaluating M is:

- (1)—Tabulate V and V_z , 5° increments
- (2)—Tabulate K_v and K_v^2 opposite the proper even 10° increments of V . (See Figure 4 for K_v)
- (3)—Average successive values of K_v^2 and tabulate $K_z^2 = \frac{K_L^2 + K_U^2}{2}$ opposite the alternate 10° increments, V_z (5°, 15°, etc.)
- (4)—Multiply each K_z^2 by its $\cos V_z$
- (5)—Divide 0.3645 by the square root of the total of the column ($K_z^2 \cos V_z$)

Now that M is found, equation 10 adjusts the relative pattern to the absolute field intensity in volts per

meter at a mile for one kilowatt radiated. The field intensity for any other value of power is equation 10 multiplied by the square-root of the actual power in kilowatts.

Ideal and Actual Patterns

Figure 5 shows the comparison of the vertical directivity of an ideal 220° antenna with one in which the current and phase distribution more nearly approach that to be found in actual uniform cross-section antennas. The current and phase distribution used were adapted from a recent paper.⁹

Figure 6 shows a similar comparison for a two-element array in which the sections shown are in the line of towers. The relative magnitude and phase of the base currents for the two cases were adjusted so that the shapes of the two horizontal patterns were identical. It is seen that the difference is greater in the case of arrays than in the case of a single antenna.

Bibliography

¹H. E. Gihring and G. H. Brown, *General Considerations of Tower Antennas for Broadcast Use*, Proc. IRE; April 1935.

²Morrison and Smith, *The Shunt Excited Antenna*, Proc. IRE; June 1937.

³J. E. Morrison, *Simple Method for Observing Current Amplitude and Phase Relations in Antenna Arrays*, Proc. IRE; October 1937.

⁴Brown and Swift, *Phase Meter of Many Uses*, Broadcast News; July 1938.

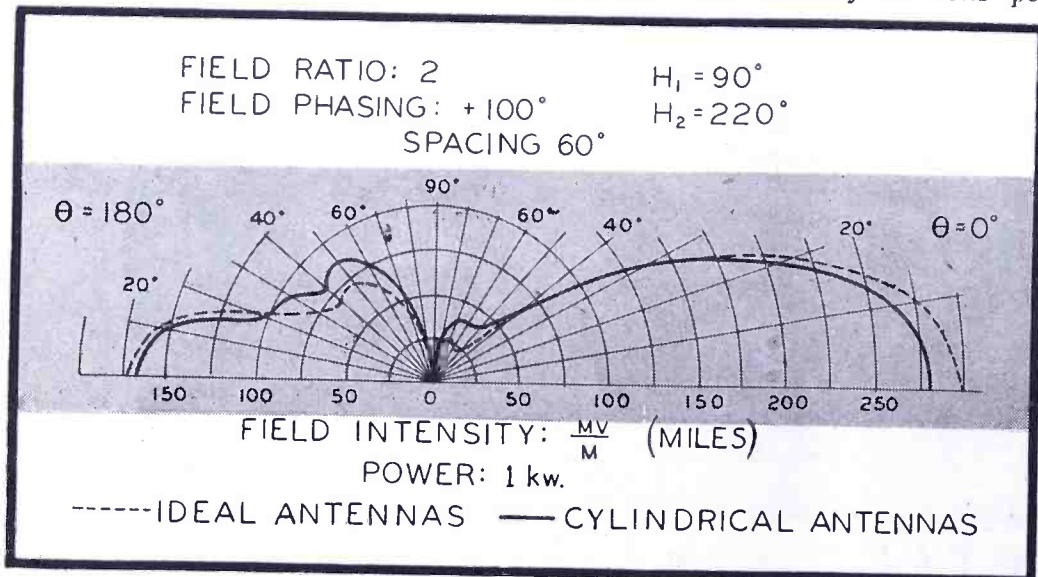
⁵Terman, F. E., *Radio Engineer's Handbook*, McGraw Hill Book Co., pp. 792-4; 1943.

⁶Everest and Pritchett, *Horizontal-Polar-Pattern Tracer for Directional Broadcast Antennas*, Proc. IRE; May 1942.

⁷Hutton and Pierce, *A Mechanical Calculator for Directional Antenna Patterns*, Proc. IRE; May 1942.

⁸C. E. Smith and E. L. Gove, *An Electromechanical Calculator for Directional Antenna Patterns*, Trans. AIEE, pp. 79-83; February 1943.

⁹King and Harrison, *Distribution of Current along a Symmetrical Center-Driven Antenna*, Proc. IRE, Figure 17; October 1943.



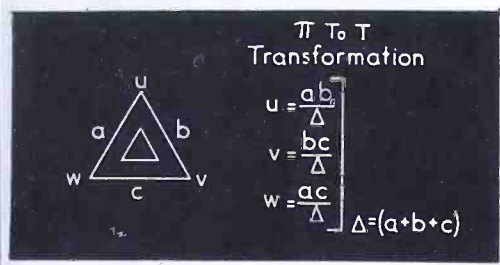


Figure 2, above
A convenient form for making the transformation from a given π network to an equivalent T type.

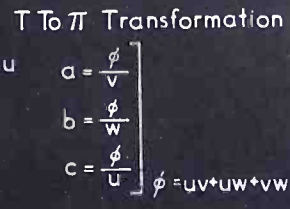
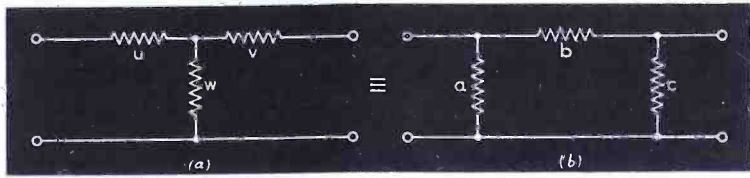


Figure 3, above
A convenient form for transforming from a given T to a π network.

RESISTIVE ATTENUATOR, PAD AND NETWORK Theory and Design

by PAUL B. WRIGHT
Communications Research Engineer

The basic theory of resistance network transformations is presented in this initial installment, together with completely tabulated functions of a real variable which form the foundation from which the whole structure of all of the standard forms of purely resistive networks may be built.

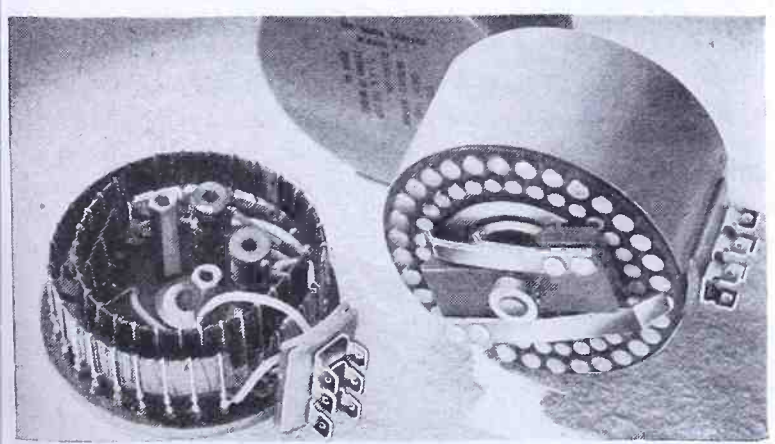
ber of primes or subscripts. However, Greek symbolic notation will be used throughout the paper in accordance with standards of past mathematical and good engineering practices to provide unity of form and compactness of expression. No attempt will be made to prove the various theorems used, but references to textbooks and papers where they may be found will appear at the conclusion of the paper.

This series will offer in compact form the major portion of the theory and design of resistive attenuating networks. Tabulated functions of a real variable over the range of attenuation from 0.01 to 150.0 db will be presented. The headings of the tables will give the relationship existing between the algebraic, exponential, hyperbolic and the symbolic functions used in this paper. Since they will all be functions of a real variable, they can also be used successfully whenever dealing with mathematical notations having the same form. This form of presentation gives a concise and accurate means of showing the transformations from algebraic to hyperbolic forms as well as the exponential and symbolic notations. The tables presented with each part of the paper will be complete. They will be extensive enough to allow the design of any of the standard forms of attenuating networks. The tables will also facilitate obtaining the constants for other forms of networks which do not come under the standard classifications ordinarily used.

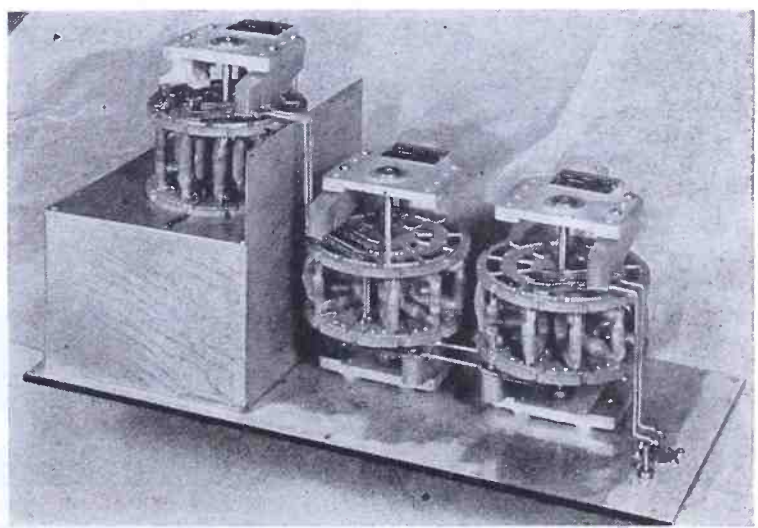
mitted. After the classic paper of McElroy in 1935, practically all notations were changed to conform to the nomenclature used in that paper wherever possible, since the writer believes that standardization in symbolical notation for networks of standard or common configurations should be used whenever it is convenient to do so. This policy has been adopted for this paper. Other notations of the author have been for the sake of completeness and clearness wherever no precedence in symbols has been set or whenever translation of existing theory into the conforming symbolic notation of this paper has been found necessary.

IN the design of attenuating networks, the factors of most usual interest are those of insertion loss and the impedances between which the network must be placed to give the loss required. The insertion loss is defined as ten times the logarithm, to the base 10, of the ratio of the power delivered to a given load before insertion of a network to that delivered after its insertion. Since considerable simplification of the theory, as well as the practice of network design and operation is obtained if the network is assumed to be properly matched on an image basis, this is the usual assumption made in the design of standard attenuating networks or pads as they are commonly called. On the image
(Continued on page 52)

Whenever and wherever compression of mathematical equations were usable without sacrificing clarity of detail or purpose, suitable symbols have been used. Another important simplification applied in the treatment of pure resistance types of networks encompasses the use of English characters with a minimum num-



Above, a bridged T attenuator, with and without case. (Courtesy Daven). At right, a 100-ohm balanced shielded attenuator. (Courtesy Leeds and Northrup).



THE LATEST, UP-TO-THE-MINUTE RADIO AND ELECTRONIC CATALOG IN THE COUNTRY TODAY!

COMMUNICATIONS

(Continued from page 40)

by NBC and are being operated by NBC under special arrangement with the OWI. A similar set-up at Dixon is under construction on the same basis and should be in operation within a few months.

These short-wave transmitters are of the most modern design. They feed an array of twenty or more antennas so oriented as to make programs available to all European countries, Latin America and South America. The California transmitters will provide programs for the Antipodes, the Orient and the USSR.

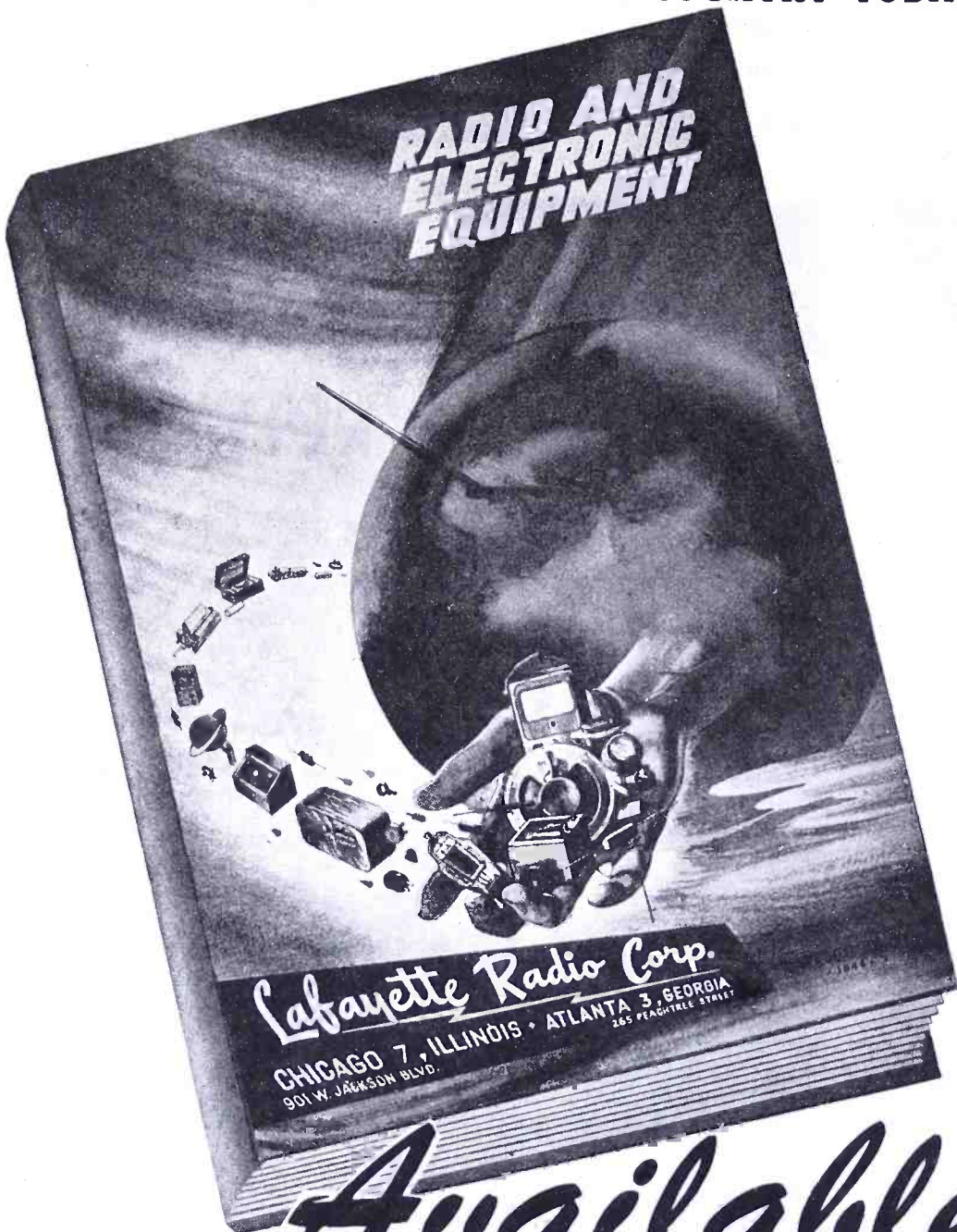
Television and f-m, as the public now realizes, are certain to be two of the most active postwar radio services. But here too, military priorities have held civilian development in close check. Limited program experimentation has been carried out, but receivers have not been manufactured since early in 1942. However, it is known that manufacturers are making plans for the resumption of set production in both f-m and television as soon as facilities can be converted from war to peace time production.

by **J. R. POPPELE**

Chief Engineer, WOR

THAT the war has not hindered the progress of the communications art to as great an extent as is generally thought by the layman is affirmed by the great strides taken in the production of complex Army and Navy communications matériel. Especially during the last year the public eye has been trained upon the progress in direction equipment, the use of f-m broadcasting in communications work, and allied apparatus most of which, of course, are still enwrapped in military secrecy.

When the victory is attained, and it is possible to learn of the progress made by research and manufacture in this equipment, it will be found that an unbelievable amount of advancement has been made. And it will remain for the engineers to adapt these processes, which will be released, into the multitudinous articles and facilities for civilian consumption. Undoubtedly there will be many rough edges to be smoothed and we must, by no means, expect to reach perfection overnight. But the field is vast and fraught with innumerable possibilities.



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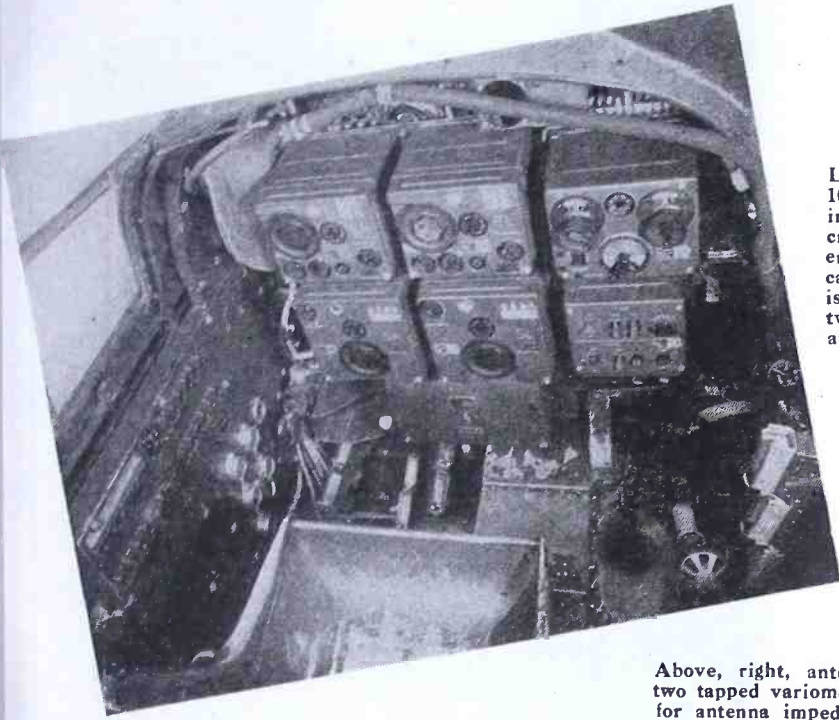
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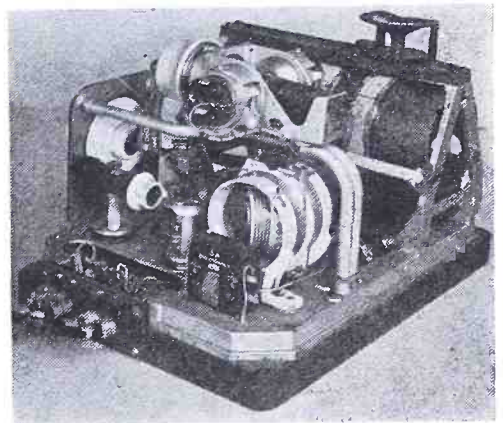
ENEMY AIRBORNE RADIO

All photos courtesy British Air Ministry

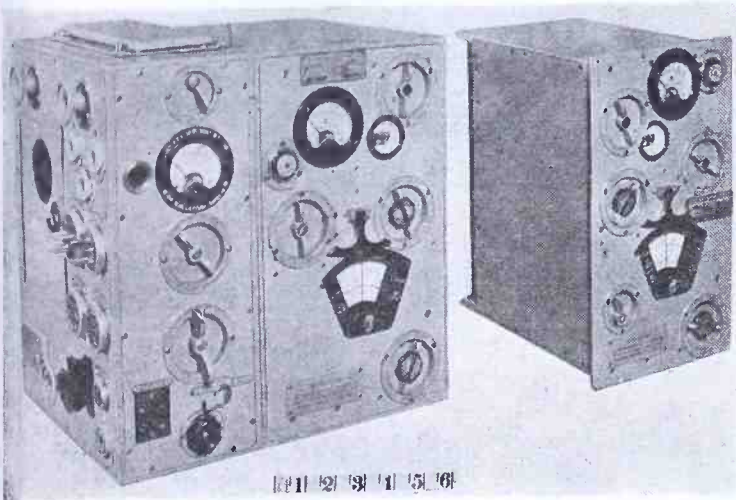
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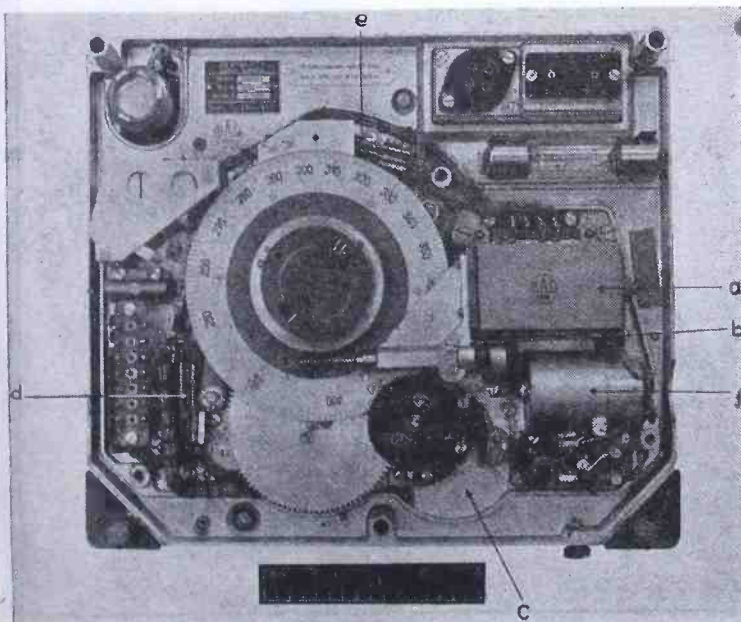
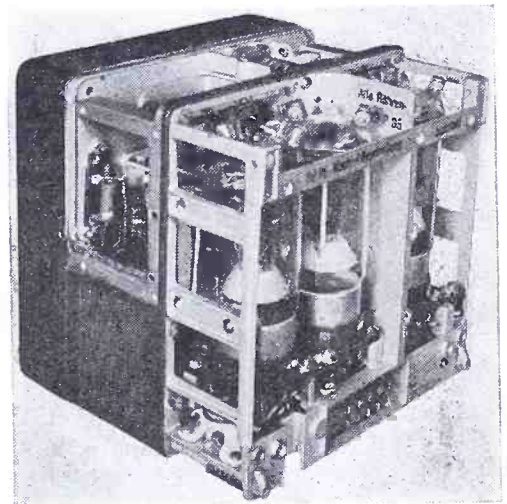
Left, Funk Gerät (FuG 10) equipment panel in Junkers 88 aircraft. This is a general purpose communications equipment and is used on bombers, twin-engined fighters and some flying boats.



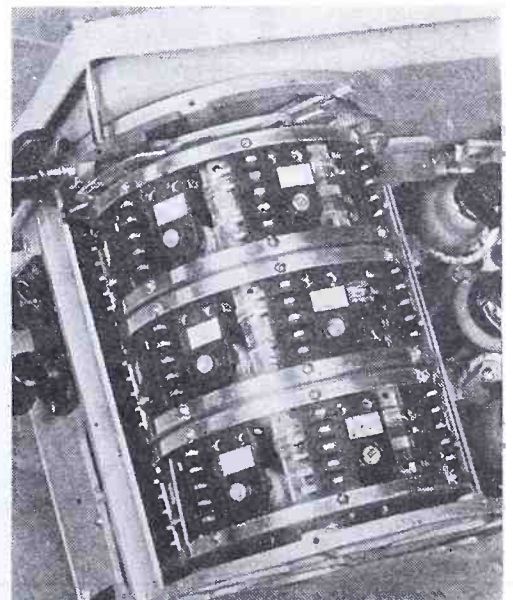
Above, right, antenna matching unit of the FuG 10 installation. In this section are two tapped variometers for tuning on h-f and m-f ranges, and iron-cored auto-transformers for antenna impedance matching to 50-ohm feeders. A vacuum type relay and current-transformer rectifier are also included. The unit weighs 18 pounds.



At left appears an Italian general purpose transmitter, type 350H. Covers 550-1119 and 820-1509 kc, and 3.5-9 mc. Triodes are used. Output in c-w is 10 to 20 watts. Right, FuG 10 transmitter with rear covers removed. Master oscillator used is Colpitts type.



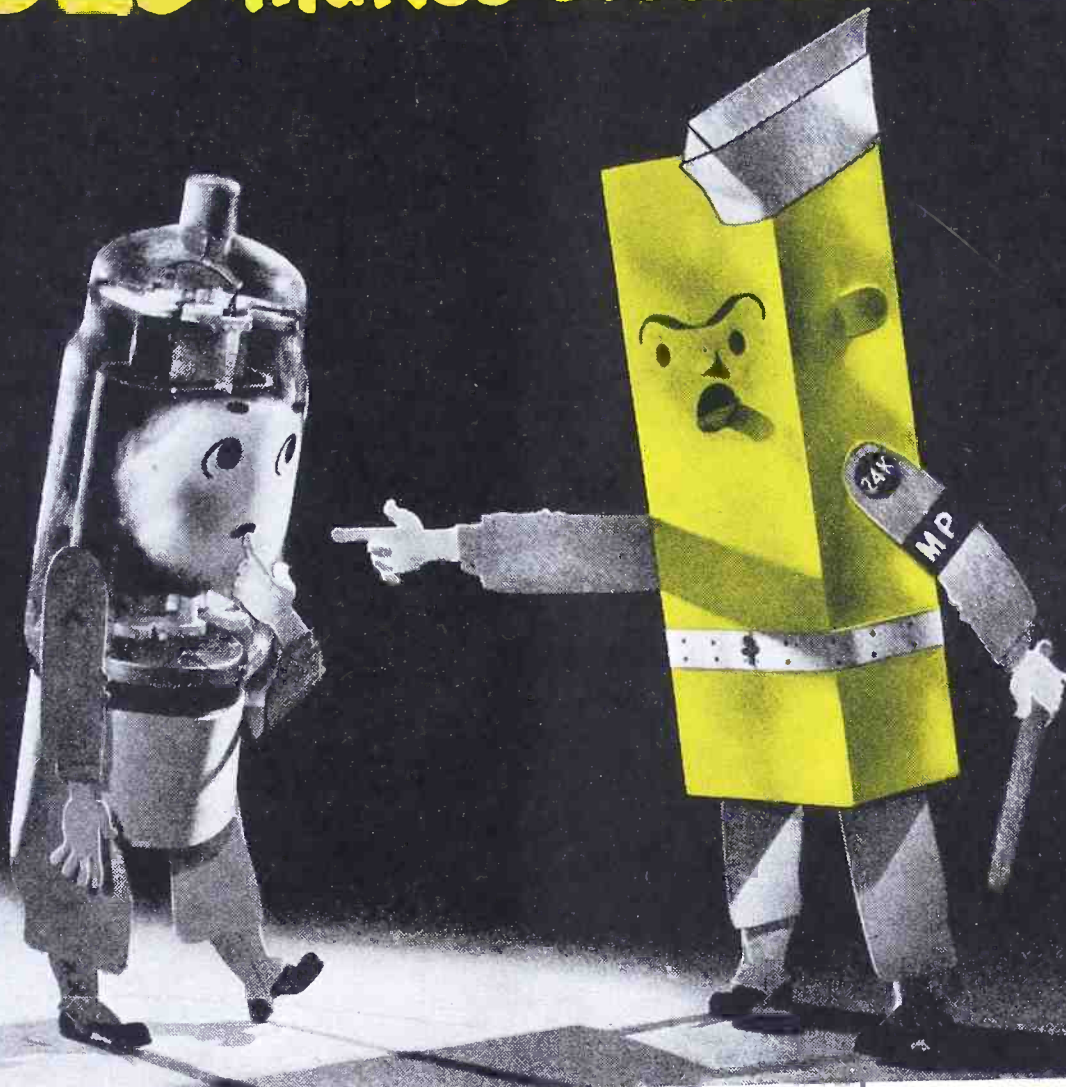
At left, German direction finding receiver, EZ4, used on single-engine dive bombers. Has electrical remote control system for 2-frequency selection. At *a*, electromagnet; *b*, armature carrying worm drive; *c*, manual tuning control; *d*, stopping contacts; *e*, reversing contacts; *f*, reversible motor. At right, interior of Italian receiver AR-8, with frequency range of from 200 kc to 22 mc, in seven continuous ranges. Also tunes from 520-700 kc. Single r-f is used, with all coils mounted on a 3-gang turret.



No (db)	$\log \frac{1}{\epsilon} r$	$\frac{1}{2} \log \frac{1}{\epsilon} r$	$\frac{1}{2} \log \frac{1}{\epsilon} r$	$2 \log \frac{1}{\epsilon} r$	$\frac{1}{r}$	$\epsilon^{-\theta}$	$\left(\frac{1}{r}\right)^2$	r^2	N	2N	N^2	n	$\frac{n}{2}$	No (db)
$20 \log_{10} \epsilon \theta$	θ	$\frac{\theta}{2}$	$\frac{1}{2} \log \frac{1}{\epsilon} r$	2θ	ϵ^{θ}	$\epsilon^{-2\theta}$	$\left(\frac{1}{r}\right)^2$	$\epsilon^{-2\theta}$	$(\epsilon^{\theta} - 1)$	$2(\epsilon^{\theta} - 1)$	$(\epsilon^{\theta} - 1)^2$	$(\epsilon^{\theta} - 1)$	$2(\epsilon^{\theta} - 1)$	$20 \log_{10} \epsilon \theta$
$20 \log_{10} k$	$\log k_{\epsilon}$	$\frac{1}{2} \log k_{\epsilon}$	$\frac{1}{2} \log k_{\epsilon}$	$2 \log k_{\epsilon}$	k	$\frac{1}{k}$	k^2	$\left(\frac{1}{k}\right)^2$	$(k - 1)$	$2(k - 1)$	$(k - 1)^2$	$(k - 1)$	$2(k - 1)$	$20 \log_{10} k$
0.00	0.0000000	0.0000000	0.0000000	0.0000000	1.000000	1.000000	1.000000	1.000000	0.000000	0.000000	0.000000	∞	∞	0.00
.01	.0011513	.0005756	.0002878	.0023026	.998849	.997700	1.000000	.997700	.001151	.002302	1.3225x10 ⁻⁶	868.76	434.38	.01
.02	.0043025	.0021513	.0010756	.0046052	.997700	.995405	1.00231	.995405	.002302	.004605	5.2900x10 ⁻⁶	433.72	216.86	.02
.03	.0094539	.0047270	.0023635	.0094578	.995552	.993116	1.00462	.993116	.004605	.009210	1.19716x10 ⁻⁶	289.02	144.51	.03
.04	.0166052	.0083026	.0041513	.0166104	.993405	.989832	1.00925	.989832	.009210	.018420	2.13449x10 ⁻⁶	217.66	108.83	.04
.05	.0257565	.0128783	.0064391	.0257630	.992650	.988553	1.01158	.988553	.009210	.018420	3.32929x10 ⁻⁵	173.20	86.60	.05
.06	.0369078	.0184539	.0092270	.0369156	.991116	.986280	1.01391	.986280	.009210	.018420	4.80249x10 ⁻⁵	144.26	72.13	.06
.07	.0500591	.0250296	.0125148	.0500682	.989173	.981618	1.01625	.981618	.009210	.018420	6.54481x10 ⁻⁵	123.59	61.79	.07
.08	.0652104	.0326052	.0163026	.0652208	.987448	.9791748	1.01859	.9791748	.009210	.018420	8.55625x10 ⁻⁵	108.07	54.03	.08
.09	.0823617	.0411809	.0205905	.0823734	.985962	.979490	1.02094	.979490	.009210	.018420	1.08576x10 ⁻⁴	96.009	48.004	.09
.10	.1015130	.0507565	.0253783	.1015260	.984553	.977237	1.02329	.977237	.009210	.018420	.00013410	86.361	43.180	.10
.11	.1226643	.0613322	.0306661	.1226786	.983246	.974990	1.02565	.974990	.009210	.018420	.00016256	78.461	39.230	.11
.12	.1458156	.0729078	.0364539	.1458312	.982031	.972747	1.02802	.972747	.009210	.018420	.00019349	71.883	35.941	.12
.13	.1709669	.0854835	.0427418	.1709838	.980818	.970510	1.03039	.970510	.009210	.018420	.00022741	66.317	33.158	.13
.14	.1981182	.0990591	.0495296	.1981364	.979601	.968278	1.03276	.968278	.009210	.018420	.00026406	61.543	30.771	.14
.15	.2272695	.0112695	.0056348	.2272890	.978881	.966051	1.03514	.966051	.009210	.018420	.00030380	57.408	28.704	.15
.16	.2584208	.0168416	.0084208	.2584426	.978248	.963829	1.03753	.963829	.009210	.018420	.00034559	53.787	26.893	.16
.17	.2915721	.0234142	.0117071	.2915962	.977686	.962720	1.03992	.962720	.009210	.018420	.00038985	50.596	25.298	.17
.18	.3267234	.0309869	.0154935	.3267498	.977181	.961645	1.04232	.961645	.009210	.018420	.00043688	47.755	23.877	.18
.19	.3638747	.0395594	.0197297	.3639034	.976733	.960611	1.04472	.960611	.009210	.018420	.00048629	45.218	22.604	.19
.20	.4030260	.0491321	.0245650	.4030566	.976340	.959693	1.04713	.959693	.009210	.018420	.00053825	42.931	21.465	.20
.25	.4821773	.0617047	.0308524	.4822146	.975000	.958406	1.05260	.958406	.009210	.018420	.00065115	34.245	17.122	.25
.30	.5613286	.0762773	.0381387	.5613769	.973727	.957254	1.05817	.957254	.009210	.018420	.00077607	28.455	14.227	.30
.35	.6404800	.0928500	.0464250	.6405280	.972510	.956227	1.06384	.956227	.009210	.018420	.00091307	24.320	12.160	.35
.40	.7206313	.0111113	.0055557	.7206826	.971343	.955311	1.06961	.955311	.009210	.018420	.00106221	21.219	10.608	.40
.50	.8517826	.0137226	.0068613	.8518340	.970227	.954493	1.07548	.954493	.009210	.018420	.00122410	16.877	8.438	.50
.60	.9829339	.0171339	.0085669	.9829853	.969406	.953727	1.08181	.953727	.009210	.018420	.00140007	13.982	6.991	.60
.70	1.1140852	.0212452	.0106226	1.1141366	.968640	.953025	1.08820	.953025	.009210	.018420	.00159057	11.915	5.457	.70
.80	1.2452365	.0260565	.0130283	1.2452879	.967927	.952374	1.09472	.952374	.009210	.018420	.00179607	10.365	5.182	.80
.90	1.3763878	.0316678	.0157339	1.3764392	.967260	.951764	1.10137	.951764	.009210	.018420	.00201718	9.1600	4.580	.90
1.00	1.5075391	.0380791	.0188396	1.5075905	.966643	.951194	1.10817	.951194	.009210	.018420	.00225310	8.1954	4.0977	1.00
1.10	1.6386904	.0451904	.0223952	1.6387418	.966076	.950661	1.11511	.950661	.009210	.018420	.00250425	7.4069	3.7039	1.10
1.20	1.7698417	.0529017	.0262466	1.7698931	.965559	.950161	1.12220	.950161	.009210	.018420	.00277107	6.7499	3.3749	1.20
1.30	1.9009930	.0612130	.0304013	1.9010444	.965092	.949693	1.12943	.949693	.009210	.018420	.00305390	6.1939	3.0969	1.30
1.40	2.0321443	.0701243	.0349019	2.0321957	.964676	.949254	1.13681	.949254	.009210	.018420	.00335310	5.7176	2.8588	1.40
1.50	2.1632956	.0795356	.0400025	2.1633470	.964300	.948840	1.14434	.948840	.009210	.018420	.00366853	5.3050	2.6025	1.50
1.60	2.2944469	.0894469	.0457031	2.2944983	.963964	.948443	1.15202	.948443	.009210	.018420	.00399952	4.9439	2.4719	1.60
1.70	2.4255982	.1000582	.0519037	2.4256497	.963668	.948076	1.15984	.948076	.009210	.018420	.00434634	4.6258	2.3129	1.70
1.80	2.5567495	.1113695	.0589043	2.5568009	.963402	.947734	1.16781	.947734	.009210	.018420	.00470912	4.3427	2.1713	1.80
1.90	2.6879008	.1233808	.0664049	2.6879522	.963166	.947411	1.17593	.947411	.009210	.018420	.00508829	4.0897	2.0448	1.90
2.00	2.8190521	.1360921	.0744055	2.8191035	.962950	.947104	1.18420	.947104	.009210	.018420	.00548313	3.8620	1.9310	2.00
2.10	2.9502034	.1495034	.0829061	2.9502548	.962754	.946811	1.19262	.946811	.009210	.018420	.00589407	3.6563	1.8281	2.10
2.20	3.0813547	.1636147	.0918067	3.0814061	.962576	.946531	1.20119	.946531	.009210	.018420	.00632152	3.4692	1.7346	2.20
2.30	3.2125060	.1783260	.0999073	3.2125574	.962415	.946264	1.20993	.946264	.009210	.018420	.00676507	3.2985	1.6492	2.30
2.40	3.3436573	.1936373	.0108079	3.3437087	.962270	.946011	1.21884	.946011	.009210	.018420	.00722472	3.1421	1.5710	2.40
2.50	3.4748086	.2095486	.1197085	3.4748600	.962140	.945771	1.22793	.945771	.009210	.018420	.00769957	2.9983	1.4991	2.50
2.60	3.6059599	.2260599	.1296091	3.6060113	.962024	.945544	1.23720	.945544	.009210	.018420	.00818992	2.8657	1.4328	2.60
2.70	3.7371112	.2431712	.1395097	3.7371626	.961921	.945331	1.24665	.945331	.009210	.018420	.00869537	2.7429	1.3714	2.70
2.80	3.8682625	.2608825	.1494503	3.8683139	.961831	.945131	1.25628	.945131	.009210	.018420	.00921632	2.6289	1.3144	2.80
2.90	3.9994138	.2791938	.1594409	3.9994652	.961753	.944944	1.26609	.944944	.009210	.018420	.00975227	2.5229	1.2614	2.90
3.00	4.1305651	.2981051	.1694815	4.1306165	.961687	.944771	1.27608	.944771	.009210	.018420	.01030372	2.4240	1.2120	3.00
3.10	4.2617164	.3176164	.1795721	4.2617678	.961633	.944611	1.28625	.944611	.009210	.018420	.01087107	2.3298	1.1658	3.10
3.20	4.3928677	.3377277	.1897027	4.3929191	.961590	.944464	1.29660	.944464	.009210	.018420	.01145472	2.2404	1.1250	3.20
3.30	4.5240190	.3584390	.1998733	4.5240705	.961558	.944331	1.30713	.944331	.009210	.018420	.01205427	2.1552	1.0819	3.30
3.40	4.6551703	.3797503	.2099839	4.6552219	.961536	.944211	1.31784	.944211	.009210	.018420	.01266932	2.0742	1.0436	3.40

Basic data from which all of the hyperbolic functions of a real variable required for the design of purely resistive networks may be obtained. (Continued on page 54)

GOLD makes Electrons Behave



It was a great day for radio communication when National Union engineers developed the technique of gold plating certain tube parts. For by this ingenious means they measurably extended the life of power tubes.

The object, here, was not to make power tubes structurally stronger—or even more durable. Already these tubes were sound enough mechanically to do a bang-up job. What the N. U. process of gold plating did, was to make the electrons behave. N. U. engineers demonstrated that by gold-plating the grid wire, they automatically eliminated a very disturbing factor in power tube performance, known as

grid emission. The source of this undesirable primary emission was imprisoned within the gold. No longer could it interfere with the planned and controlled electron flow within the tube. Result—power tubes of a higher performance level and longer life.

Thanks to the greatly expanded electronic research program at National Union Laboratories, many such improved tubes with wide application in America's homes and industries will be available at the war's end. *Count on National Union.*

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



NATIONAL UNION

RADIO AND ELECTRONIC TUBES

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

(Continued from page 52)

No (db)	$\log \frac{1}{\epsilon} r$	$\frac{1}{2} \log \frac{1}{\epsilon} r$	$\frac{1}{2} \log \frac{1}{\epsilon} r$	$\frac{1}{r}$	$\frac{1}{r}$	$\left(\frac{1}{r}\right)^2$	r^2	N	2N	N^2	n	$\frac{n}{2}$	No (db)
$20 \log_{10} \epsilon^\theta$	θ	$\frac{\theta}{2}$	$2 \log \frac{1}{\epsilon} r$	ϵ^θ	$\epsilon^{-\theta}$	$\epsilon^{2\theta}$	$\epsilon^{-2\theta}$	$(\epsilon^\theta - 1)$	$2(\epsilon^\theta - 1)$	$(\epsilon^\theta - 1)^2$	$\frac{1}{(\epsilon^\theta - 1)}$	$\frac{1}{2(\epsilon^\theta - 1)}$	$20 \log_{10} \epsilon^\theta$
$20 \log_{10} k$	$\log k$	$\frac{1}{2} \log k$	$2 \log k$	k	$\frac{1}{k}$	k^2	$\left(\frac{1}{k}\right)^2$	$(k-1)$	$2(k-1)$	$(k-1)^2$	$\frac{1}{(k-1)}$	$\frac{1}{2(k-1)}$	$20 \log_{10} k$
3.5	.40295	.20148	.80590	1.49623	.66834	2.23872	.446684	.49623	.99246	.246244	2.0152	1.0076	3.5
3.6	.41447	.20723	.82894	1.51356	.66069	2.29087	.437516	.51356	1.02712	.263744	1.9472	0.9736	3.6
3.7	.42598	.21299	.85196	1.53109	.65313	2.34423	.426589	.54109	1.06218	.282037	1.8829	.9414	3.7
3.8	.43749	.21875	.87498	1.54882	.64565	2.39883	.416869	.54822	1.09644	.300545	1.8221	.9110	3.8
3.9	.44900	.22450	.89800	1.56674	.63827	2.45471	.407380	.55674	1.13348	.321194	1.7644	.8822	3.9
4.0	.46052	.23026	.92104	1.58489	.63096	2.51189	.398107	.56489	1.16978	.342096	1.7097	.8548	4.0
4.5	.51808	.25904	1.03616	1.67880	.59566	3.54813	.316228	.67880	1.35760	.460769	1.4732	.7366	4.5
5.0	.57565	.28782	1.15130	1.77828	.56234	3.16228	.281838	.77828	1.50556	.605720	1.2849	.6424	5.0
5.5	.63321	.31661	1.26642	1.88365	.53088	3.54813	.251189	.88365	1.67330	.780837	1.1317	.5658	5.5
6.0	.69078	.34539	1.38156	1.99526	.50119	3.98107	.221838	.99526	1.99052	.990542	1.0048	.5024	6.0
6.5	.74834	.37417	1.49668	2.11349	.47315	4.46684	.202387	1.1135	2.2270	1.23988	.89807	.44903	6.5
7.0	.80590	.40295	1.61180	2.23872	.44668	5.01187	.185926	1.2387	2.4774	1.53438	.80730	.40365	7.0
7.5	.86347	.43173	1.72694	2.37137	.42170	5.62342	.177828	1.3714	2.7428	1.88074	.72918	.36459	7.5
8.0	.92103	.46052	1.84206	2.51189	.39811	6.30957	.168489	1.5119	3.0238	2.28584	.66142	.33071	8.0
8.5	.97860	.48930	1.95720	2.66072	.37584	7.07946	.161254	1.6607	3.3214	2.75792	.60216	.30108	8.5
9.0	1.03616	.51808	2.07232	2.81838	.35481	7.94327	.155892	1.8184	3.6368	3.30658	.54993	.27496	9.0
9.5	1.09373	.54686	2.18746	2.98107	.33497	8.91251	.151202	1.9854	3.9708	3.55473	.50368	.25184	9.5
10.0	1.15129	.57565	2.30258	3.16228	.31623	10.00000	.147827	2.1623	4.3246	4.67554	.46247	.23123	10.0
10.5	1.20886	.60443	2.41772	3.34965	.29854	11.22018	.144668	2.3497	4.6994	5.21099	.42559	.21279	10.5
11.0	1.26642	.63321	2.53284	3.54813	.28184	12.58924	.141254	2.5481	5.0962	6.49281	.39245	.19622	11.0
11.5	1.32399	.66199	2.64798	3.75837	.26607	14.12537	.138489	2.7584	5.5168	7.60877	.36253	.18126	11.5
12.0	1.38155	.69078	2.76310	3.98107	.25119	15.84893	.135926	2.9811	5.9622	8.86906	.33545	.16772	12.0
12.5	1.43912	.71956	2.87824	4.21696	.23714	17.78279	.133542	3.2170	6.4340	10.3491	.31085	.15542	12.5
13.0	1.49668	.74834	2.99336	4.46684	.22387	19.95262	.131202	3.4668	6.9336	12.0187	.28845	.14422	13.0
13.5	1.55425	.77712	3.10850	4.73151	.21135	22.38722	.128924	3.7315	7.4630	13.9241	.26799	.13399	13.5
14.0	1.61181	.80590	3.22362	5.01187	.20193	25.11887	.126838	4.0119	8.0238	16.0953	.24926	.12463	14.0
14.5	1.66937	.83469	3.33874	5.30884	.18836	28.18383	.124981	4.3088	8.6176	18.5658	.23208	.11604	14.5
15.0	1.72694	.86347	3.45388	5.62342	.17783	31.62278	.123208	4.6234	9.2468	21.3758	.21629	.10814	15.0
15.5	1.78450	.89225	3.56900	5.95662	.16788	35.48134	.121584	4.9566	9.9132	24.5679	.20175	.10087	15.5
16.0	1.84207	.92103	3.68414	6.30957	.15849	39.81072	.120119	5.3096	10.6192	28.1918	.18834	.09417	16.0
16.5	1.89963	.94982	3.79926	6.68344	.14962	44.66836	.118850	5.6834	11.3668	32.3010	.17595	.08797	16.5
17.0	1.95720	.97860	3.91440	7.07946	.14125	50.11874	.117827	6.0795	12.1590	36.9603	.16449	.08224	17.0
17.5	2.01476	1.00738	4.02952	7.49895	.13335	56.23416	.116933	6.4989	12.9978	42.2357	.15387	.07693	17.5
18.0	2.07233	1.03616	4.14466	7.94327	.12589	63.09565	.116184	6.9433	13.8866	48.2094	.14402	.07201	18.0
18.5	2.12989	1.06495	4.25978	8.41394	.11885	70.79459	.115519	7.4139	14.8278	54.9659	.13488	.06744	18.5
19.0	2.18746	1.09373	4.37492	8.91251	.11202	79.43273	.114929	7.9135	15.8270	62.6235	.12638	.06319	19.0
19.5	2.24502	1.12251	4.49004	9.44061	.10592	89.12510	.114406	8.4406	16.8812	71.2437	.11847	.05923	19.5
20.0	2.30258	1.15129	4.60516	10.00000	.10000	100.00000	.113925	9.0000	18.0000	81.0000	.11111	.05556	20.0
20.5	2.36015	1.18007	4.72030	10.59255	.09406	112.2018	.113484	9.5925	19.1850	92.0161	.10425	.05212	20.5
21.0	2.41771	1.20886	4.83542	11.22018	.08912	125.8924	.113054	10.2202	20.4404	106.0445	.09785	.04892	21.0
21.5	2.47528	1.23764	4.95056	11.88503	.08413	141.5440	.112638	10.8850	21.7700	118.4832	.09187	.04593	21.5
22.0	2.53284	1.26642	5.06568	12.58924	.07943	158.4893	.112234	11.5892	23.1784	134.3049	.08629	.04314	22.0
22.5	2.59041	1.29520	5.18082	13.33523	.07499	177.8279	.111849	12.3352	24.6704	152.1522	.08107	.04053	22.5
23.0	2.64797	1.32399	5.29594	14.12537	.07079	199.5262	.111425	13.1254	26.2508	172.2656	.07619	.03809	23.0
23.5	2.70554	1.35277	5.41108	14.96234	.06683	223.8722	.111019	13.9623	27.9246	194.9374	.07162	.03581	23.5
24.0	2.76310	1.38155	5.52626	15.84893	.06309	251.1887	.110629	14.8489	29.6978	220.4928	.06734	.03367	24.0
24.5	2.82067	1.41033	5.64134	16.78803	.05956	281.8383	.110254	15.7880	31.5760	249.2609	.06334	.03167	24.5
25.0	2.87823	1.43912	5.75646	17.78279	.05623	316.2278	.110893	16.7828	33.5656	281.6691	.05958	.02979	25.0
25.5	2.93580	1.46790	5.87160	18.83649	.05308	354.8134	.111549	17.8364	35.6728	318.1229	.05607	.02803	25.5
26.0	2.99336	1.49668	5.98672	19.95262	.05011	398.1072	.112222	18.9526	37.9052	359.2162	.05276	.02638	26.0
26.5	3.05093	1.52546	6.10186	21.13490	.04731	446.6836	.112911	20.1349	40.2698	405.4182	.04966	.02483	26.5
27.0	3.10849	1.55424	6.21698	22.38722	.04468	501.1874	.113616	21.3872	42.7744	458.4038	.04676	.02338	27.0
27.5	3.16605	1.58303	6.33210	23.71372	.04217	562.3416	.114337	22.7137	45.4274	515.9258	.04403	.02201	27.5
28.0	3.22362	1.61181	6.44724	25.11887	.03981	630.9565	.115074	24.1189	48.2378	581.7262	.04146	.02073	28.0
28.5	3.28118	1.64059	6.56236	26.60723	.03758	707.9457	.115826	25.6072	51.2144	655.7184	.03905	.01952	28.5

Basic data from which all of the hyperbolic functions of a real variable required for the design of purely resistive networks may be obtained. (Continued on page 56)



GLASS... FOR LOW LOSS INSULATION!

● When glass is used as the fibrous component in Formica laminated plastic sheets, tubes and rods the material becomes a low loss insulator comparable to ceramics, and capable of replacing ceramics for many uses. At the same time it retains typical Formica characteristics, of machinability and adaptation to rapid production processes.

Compared to ceramic insulators this glass base Formica—Grade MF 66—has high mechanical strength and resistance to impact and vibration. It is as good as other grades of Formica in that regard.

Formica glass base MF 66 is being used for antenna base insulators on airplanes and ground installations.

Other glass base grades: FF 10—Heat resistant—for such applications as motor slot wedges.

FF 41—arc resistant—for ignition parts and switch parts. It does not support combustion.

All of these grades are immune to fungus growth—a quality that is important in the tropics.

"The Formica Story" is a moving picture showing the qualities of Formica, how it is made, how it is used. Available on loan.



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

No (db)	$\log \frac{1}{\epsilon} r$	$\frac{1}{2} \log \frac{1}{\epsilon} r$	$2 \log \frac{1}{\epsilon} r$	$\frac{1}{r}$	$\frac{1}{\epsilon}$	$\left(\frac{1}{r}\right)^2$	r^2	N	2N	N ²	$\frac{n}{2}$	No (db)
$20 \log_{10} \epsilon$	θ	$\frac{\theta}{2}$	2θ	ϵ^θ	$\epsilon^{2\theta}$	$\left(\frac{1}{k}\right)^2$	$\epsilon^{-2\theta}$	$(\epsilon^\theta - 1)$	$2(\epsilon^\theta - 1)$	$(\epsilon^\theta - 1)^2$	$\frac{n}{2}$	$20 \log_{10} \epsilon$
$20 \log_{10} k$	$\log \frac{k}{\epsilon}$	$\frac{1}{2} \log \frac{k}{\epsilon}$	$2 \log \frac{k}{\epsilon}$	k	k^2	$\left(\frac{1}{k}\right)^2$	$\left(\frac{1}{k}\right)^2$	$(k-1)$	$2(k-1)$	$(k-1)^2$	$\frac{n}{2}$	$20 \log_{10} k$
29.0	3.3875	1.6937	6.7750	28.1838	794.3273	.0012589	.0012589	27.1838	53.3676	738.9699	.03679	29.0
29.5	3.39631	1.69816	6.79262	29.85384	891.2510	.0011220	.0011220	28.8538	57.7076	832.5533	.03466	29.5
30.0	3.40388	1.70294	6.90776	31.62278	1000.000	.0010000	.0010000	30.6228	61.2456	937.7681	.03266	30.0
31.0	3.56901	1.78450	7.13802	35.48134	1258.924	.00079433	.00079433	34.4813	68.9626	1188.939	.02900	31.0
32.0	3.68414	1.84207	7.36828	39.81072	1584.893	.00063096	.00063096	38.8107	77.6214	1309.428	.02577	32.0
33.0	3.79927	1.89963	7.59854	44.66836	1995.262	.00050119	.00050119	43.6684	87.3368	1906.894	.02290	33.0
34.0	3.91439	1.95720	7.82878	50.11874	2511.887	.00039811	.00039811	49.1187	98.2374	2412.676	.02036	34.0
35.0	4.02952	2.01476	8.05904	56.23416	3162.278	.00031623	.00031623	55.2342	110.4684	3050.795	.01810	35.0
36.0	4.14465	2.07233	8.28930	63.09565	3981.072	.00025119	.00025119	62.0956	124.1912	3855.913	.01610	36.0
37.0	4.25978	2.12989	8.51956	70.79459	5011.874	.00019953	.00019953	69.7946	139.5892	4596.162	.01433	37.0
38.0	4.37491	2.18746	8.74982	79.43273	6309.565	.00015850	.00015850	78.4327	156.8654	6151.736	.01275	38.0
39.0	4.49004	2.24502	8.98008	89.12510	7943.273	.00012589	.00012589	88.1251	176.2502	7766.016	.01135	39.0
40.0	4.60517	2.30258	9.21034	100.0000	10000.00	.00010000	.00010000	99.0000	198.0000	9801.000	.01010	40.0
41.0	4.72030	2.36015	9.44060	112.2018	12589.24	.000079433	.000079433	111.202	222.404	12365.88	.00899	41.0
42.0	4.83543	2.41771	9.67086	125.8924	15848.93	.000063096	.000063096	124.892	249.784	15597.51	.00801	42.0
43.0	4.95056	2.47528	9.90112	141.2538	19952.62	.000050119	.000050119	140.254	280.508	19670.06	.00713	43.0
44.0	5.06569	2.53284	10.13138	158.4893	25118.87	.000039811	.000039811	157.489	314.978	24803.10	.00635	44.0
45.0	5.18082	2.59041	10.36164	177.8279	31622.78	.000031623	.000031623	176.828	353.656	31268.85	.00566	45.0
46.0	5.29595	2.64797	10.59190	199.5262	39810.72	.000025119	.000025119	198.526	397.052	39414.16	.00504	46.0
47.0	5.41107	2.70554	10.82214	223.8722	50118.74	.000019953	.000019953	222.872	445.744	49671.04	.00449	47.0
48.0	5.52620	2.76310	11.05240	251.1887	63095.65	.000015850	.000015850	250.189	500.378	62595.04	.00400	48.0
49.0	5.64133	2.82067	11.28266	281.8383	79432.73	.000012589	.000012589	280.838	561.676	78871.11	.00356	49.0
50.0	5.75646	2.87823	11.51292	316.2278	100000.0	.00010000	.00010000	315.228	630.456	99369.95	.00317	50.0
51.0	5.87159	2.93580	11.74318	354.8134	125892.4	.000079433	.000079433	353.813	707.626	125181.52	.00283	51.0
52.0	5.98672	2.99336	11.97344	398.1072	158489.3	.000063096	.000063096	397.107	794.214	157696.35	.00252	52.0
53.0	6.10185	3.05093	12.20370	446.6836	199526.2	.000050119	.000050119	445.684	891.368	198630.66	.00224	53.0
54.0	6.21698	3.10849	12.43396	501.1874	251188.7	.000039811	.000039811	500.187	1000.37	250190.04	.00200	54.0
55.0	6.33211	3.16605	12.66422	562.3416	316227.8	.000031623	.000031623	561.342	1123.68	315102.59	.00178	55.0
56.0	6.44724	3.22362	12.89448	630.9565	398107.2	.000025119	.000025119	629.956	1259.91	396849.60	.00159	56.0
57.0	6.56237	3.28118	13.12474	707.9459	501187.4	.000019953	.000019953	706.946	1413.89	499778.30	.00141	57.0
58.0	6.67750	3.33875	13.35500	794.3273	630956.5	.000015850	.000015850	793.327	1586.65	629372.5	.00126	58.0
59.0	6.79263	3.39631	13.58526	891.2510	794327.3	.000012589	.000012589	890.251	1780.50	792545.1	.00112	59.0
60.0	6.90775	3.45388	13.81550	1000.000	1000000.0	.00010000	.00010000	999.000	1998.00	998001.0	.00100	60.0
65.0	7.48340	3.74170	14.96680	1778.279	3.162278x10 ⁶	.00056234	.00056234	1777.279	3554.56	3.158795x10 ⁶	.00056	65.0
70.0	8.05905	4.02952	16.11810	3162.278	10 ⁷	.00031623	.00031623	3161.278	6322.55	9.993818x10 ⁶	.00032	70.0
75.0	8.63469	4.31735	17.26938	5623.416	3.162278x10 ⁷	.00017783	.00017783	5622.416	11244.8	3.161138x10 ⁷	.00018	75.0
80.0	9.21034	4.60517	18.42068	10 ⁸	10 ⁸	10 ⁻⁸	10 ⁻⁸	9999.00	19998.0	9.99980x10 ⁷	10 ⁻⁸	80.0
85.0	9.78599	4.89299	19.57198	1.778278x10 ⁸	3.162278x10 ⁸	3.1623x10 ⁻⁸	3.1623x10 ⁻⁸	1.7782x10 ⁸	35365.6	3.161995x10 ⁸	3x10 ⁻⁸	85.0
90.0	10.3616	5.18082	20.7232	3.162278x10 ⁸	10 ⁹	10 ⁻⁹	10 ⁻⁹	3.1622x10 ⁸	63243.6	9.99980x10 ⁸	1.5x10 ⁻⁸	90.0
95.0	10.9373	5.46864	21.8746	5.623416x10 ⁸	3.162278x10 ⁹	3.1623x10 ⁻⁹	3.1623x10 ⁻⁹	5.6234x10 ⁸	112468.	3.162150x10 ⁹	2x10 ⁻⁹	95.0
100.0	11.5130	5.75656	23.0260	10 ⁹	10 ⁹	10 ⁻⁹	10 ⁻⁹	9.9999x10 ⁸	199998.	9.99990x10 ⁹	10 ⁻⁹	100.0
105.0	12.0886	6.0443	24.1772	1.778278x10 ⁹	3.162278x10 ¹⁰	3.1623x10 ⁻¹⁰	3.1623x10 ⁻¹⁰	1.7782x10 ⁹	353654.	3.16215x10 ¹⁰	5x10 ⁻¹⁰	105.0
110.0	12.6642	6.3321	25.3284	3.162278x10 ⁹	10 ¹¹	10 ⁻¹¹	10 ⁻¹¹	3.1622x10 ⁹	632454.	9.99999x10 ¹⁰	3x10 ⁻¹⁰	110.0
115.0	13.2399	6.6199	26.4798	5.623416x10 ⁹	3.162278x10 ¹¹	3.1623x10 ⁻¹¹	3.1623x10 ⁻¹¹	5.6234x10 ⁹	1.12468x10 ¹¹	3.16215x10 ¹¹	1.5x10 ⁻¹⁰	115.0
120.0	13.8155	6.9078	27.6310	10 ¹⁰	10 ¹²	10 ⁻¹²	10 ⁻¹²	9.9999x10 ⁹	1.99999x10 ¹⁰	9.99999x10 ¹¹	10 ⁻¹⁰	120.0
125.0	14.3912	7.1956	28.7824	1.778278x10 ¹⁰	3.162278x10 ¹²	3.1623x10 ⁻¹²	3.1623x10 ⁻¹²	1.7782x10 ¹⁰	3.55656x10 ¹²	3.16215x10 ¹²	3x10 ⁻¹¹	125.0
130.0	14.9668	7.4834	29.9336	3.162278x10 ¹⁰	10 ¹³	10 ⁻¹³	10 ⁻¹³	3.1622x10 ¹⁰	6.32454x10 ¹²	9.99999x10 ¹²	3x10 ⁻¹¹	130.0
135.0	15.5425	7.7712	31.0850	5.623416x10 ¹⁰	3.162278x10 ¹³	3.1623x10 ⁻¹³	3.1623x10 ⁻¹³	5.6234x10 ¹⁰	1.12468x10 ¹³	3.16215x10 ¹³	1.5x10 ⁻¹¹	135.0
140.0	16.1181	8.0590	32.2362	10 ¹¹	10 ¹⁴	10 ⁻¹⁴	10 ⁻¹⁴	9.9999x10 ¹⁰	1.99999x10 ¹³	9.99999x10 ¹³	10 ⁻¹¹	140.0
150.0	17.2694	8.6347	34.5388	3.162278x10 ¹¹	10 ¹⁵	10 ⁻¹⁵	10 ⁻¹⁵	3.1622x10 ¹¹	6.32454x10 ¹³	3.16215x10 ¹⁴	3x10 ⁻¹¹	150.0

$\theta = 0.115129 \times \text{no. of db. } k^2 = \text{ratio of input and output powers of any resistive network. } K > 1. \epsilon = 2.718282, \text{ the mathematical base.}$
 (Continued on page 70)

Have you this kind of Faith in your instruments?

If you didn't have faith in your alarm clock you'd spend a restless night. As it is, you sleep soundly because you know that this clock won't fool you—at least not more than once.

But an electrical instrument is different. It doesn't reveal its faithlessness by ringing at the wrong time or by letting you oversleep. It may slowly begin to vary just a little from the truth, and this may not be discovered until great damage has been done.

The only way you can enjoy complete faith in your metering, measuring and testing equipment is to know how it is made. In the case of Boes instruments, we invite this kind of acquaintance. We want you to know how we engineer our instruments, how we earn your faith and confidence by building Boes instruments to meet incredibly stiff standards, how we provide for *sustained accuracy*.* We believe that an investi-

gation of our facilities, our products, and our methods will reward you with complete confidence in any Boes instrument that you may ever use.

* **SUSTAINED ACCURACY** is not an easy quality to achieve. It must take into account all factors of use—must then employ the design, the alloys, the construction that infallibly protect an instrument against all threats to its reliable performance. Such instruments, obviously, must be built with performance—not price—in mind. We invite the inquiries of those who are interested in such standards.

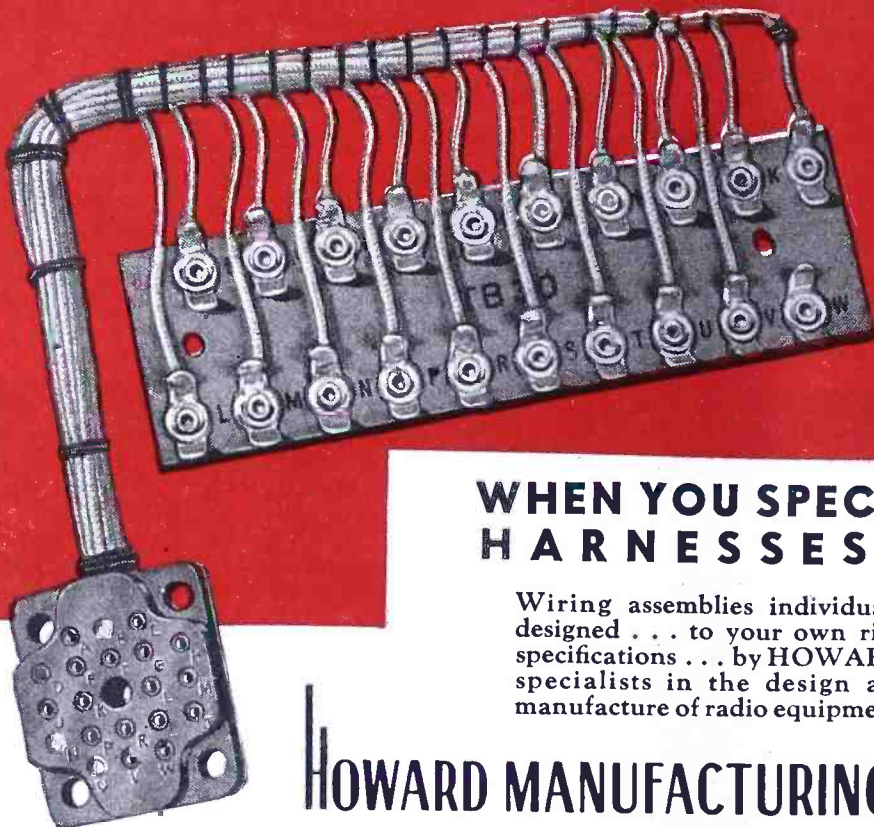


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for Measuring, Metering & Testing Equipment ☆ The W. W. Boes Co., Dayton, Ohio

COMMUNICATIONS FOR AUGUST 1944 • 57

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WHEN YOU SPECIFY HARNESSSES...

Wiring assemblies individually designed... to your own rigid specifications... by HOWARD, specialists in the design and manufacture of radio equipment.

HOWARD MANUFACTURING CORP.

★ BUY WAR BONDS ★

COUNCIL BLUFFS, IOWA

Two-Course System—Instrument Landing System," by Charles A. Stanton, CAA Administrator; and "The Army Airways Communication System" by Lieut. Walter W. Fawcett, AAF, an analysis of the system's purpose, operation and equipment, reprinted from a recent issue of COMMUNICATIONS.

This and future issues of the magazine will be sent without charge to airport, airline and municipal officials, and others, upon request.

WALKER NOW V-P OF AAC

John B. Walker has been elected vice president in charge of sales of Aircraft Accessory Corporation, Kansas City, Kansas, and will make his headquarters at the company's office at 60 East 42nd Street, New York City. Mr. Walker has been a director of AAC for the past two years. Previous to this, he was associated with United Air Lines, T. W. A., and the Greyhound Bus Lines.



GENERAL RADIO EXPANDS

An additional building housing administrative sales and publicity offices and research laboratories, has been opened by General Radio Company at 275 Massachusetts Avenue, Cambridge 39, Massachusetts.

WESTINGHOUSE AWARD TO R. E. STOWE

Richard E. Stowe, manager of the Dayton office of Westinghouse Electric & Manufacturing Company, was awarded the company's highest honor recently, the "Order of Merit" Mr. Stowe, with Westinghouse for seventeen years, was cited for his distinguished service in the application of electricity to aircraft.

HALLICRAFTERS DONATES \$5,000 TO ARMY HOSPITAL

A total of \$5,000 was presented recently by management and employees of the Hallicrafters Company, Chicago, to the Army's new Vaughn General Hospital at Hines, Illinois. The donation represents overtime earnings of employees on D-Day, and the company's fund set aside for the workers' annual picnic which they voted cancelled this year.

PHILIP F. SILING OF FCC JOINS RCA

Philip F. Siling, assistant chief engineer in charge of broadcasting, Federal Communications Commission, Washington, D. C., has been appointed engineer-in-charge of the frequency bureau of the Radio Corporation of America effective October 1.

In his new post, Mr. Siling, who has been associated with the FCC for nine years, will handle matters pertaining to frequency allocations and licenses for RCA, its subsidiaries and services.

Mr. Siling will maintain offices in the RCA Building, 30 Rockefeller Plaza, New York, at 1625 K Street, N. W., Washington, D. C. The duties of the engineer-in-charge of the RCA Frequency Bureau have been administered by Dr. B. E. Shackelford since the post was relinquished two years ago by Dr. C. B. Jaffe, former chief engineer of the FCC, who became chief engineer of the RCA Victor Division, Camden, N. J. Dr. Shackelford will retain general direction of the Bureau's activities. C. E. Pfautz is manager of the New York office of the Bureau.

REX MUNGER RETURNS TO TAYLOR TUBES

Rex L. Munger has returned to his old post with Taylor Tubes, Inc., 2312 Wabansia Avenue. (Continued on page 78)

NEWS BRIEFS OF THE MONTH...

NBC TELEVISION COURSE FOR AFFILIATED STATION ENGINEERS

A special four-week course in television for the engineering personnel of its affiliated stations is being sponsored by the National Broadcasting Company. Beginning October 2nd, the faculty of the RCA Institutes and executives and network engineers of NBC will conduct a series of twenty sessions on the major elements of the television system, including the theory of component units such as the design and operation of electronic tubes, control circuits, and wide-band amplifiers.

Commercial engineering and economic considerations of television will be discussed by William S. Hedges, NBC vice president in charge of stations, O. B. Hanson, NBC vice president and chief engineer, and Philip I. Merryman, NBC director of facilities development and research. Among others of NBC's engineering staff who will take part in the lectures and field trips are Robert E. Shelby, George M. Nixon, Raymond F. Guy, Albert W. Protzman, Fred A. Wankel, Thomas J. Buzalski, John L. Siebert, Harold See and A. L. Hammerschmidt.

"E" AWARDS

The continued maintenance of high production standards by the radio industry has been evidenced by the number of Army-Navy "E" flags and white stars awarded manufacturers during the past months. Three recent winners of "E" flags included Universal Microphone Company of Inglewood, California, Electro-Voice Manufacturing Company, Inc., of South Bend, Indiana, and Aerovox Corporation, New Bedford and Taunton, Mass.

Electronic Enterprises, Inc., of 67 Seventh Avenue, Newark, New Jersey, received a white star for its "E" flag recently. Second white star awards were presented to General Electric Company's Bridgeport plant, and the Sumner-Tubing Company of Bridgeport. Four other companies received their third white stars:

Philco Corporation of Philadelphia, Sheffield Corporation of Dayton, Ohio, the Hallicrafters Company of Chicago, and the four divisions of Raytheon Manufacturing Company of Newton and Waltham, Massachusetts.



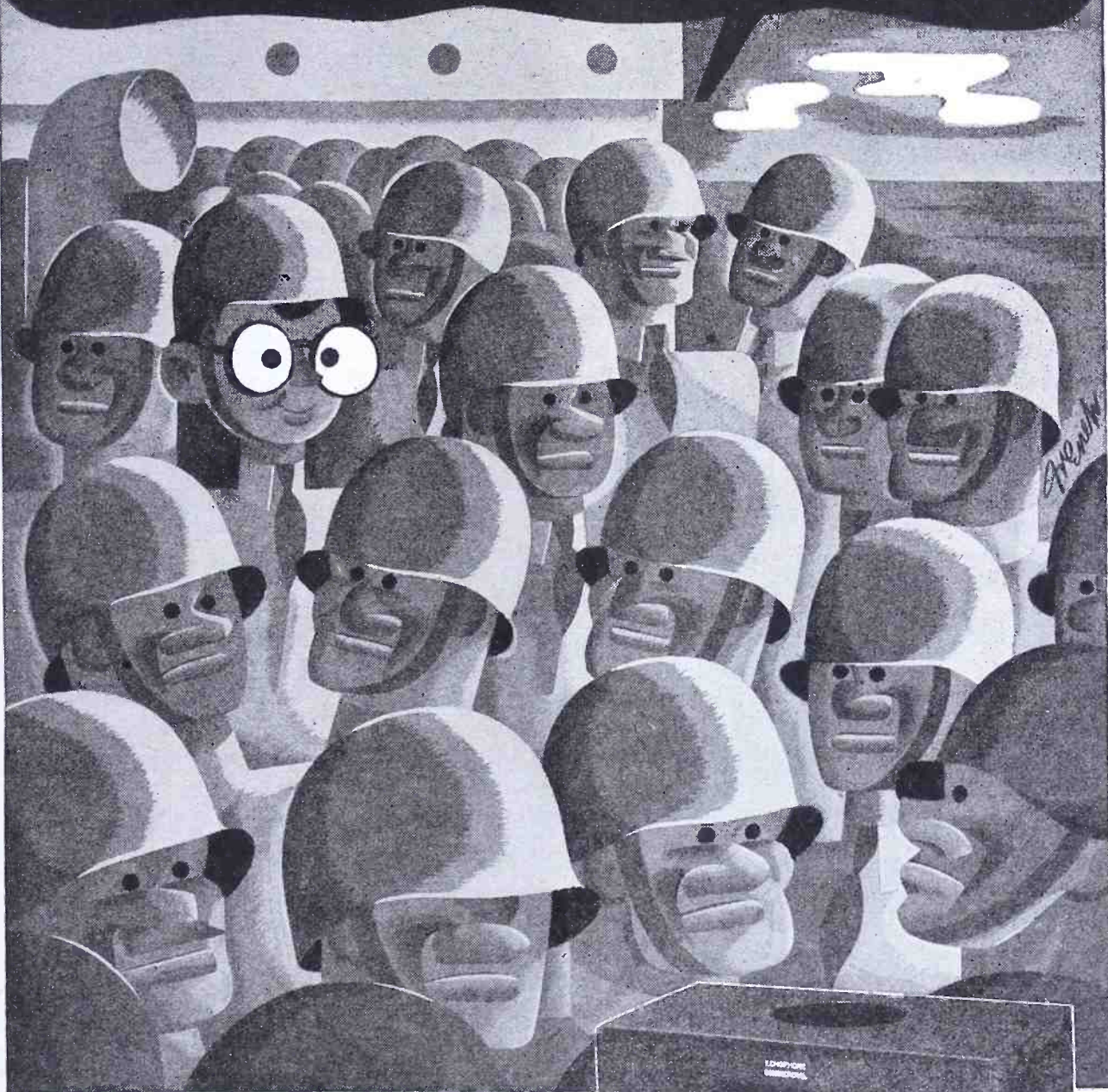
At Universal Microphone "E" award, left to right: Col. S. W. Stanley, chief Signal Branch, Forward Echelon, 9th Service Command, who presented award; James L. Fouch, U. M. president; Commander Edwin F. Keyes, USNR, assistant inspector of naval materials, Los Angeles district, who presented citation.

RADIO AVIATION BOOKLET ISSUED BY RADIO RECEPTOR

The first issue of "Highways of the Air," devoted to promotion of radio in aviation, has been released by Radio Receptor Company, Inc., 251 West 19 Street, New York 11, New York.

Four articles on aeronautical radio appear in this initial issue, including a fifth reprint of a booklet originally published by the company in 1935 outlining radio navigation aids. The papers presented are: "Airway and Ground Facilities of the Future" by William A. M. Burden, Assistant Secretary of Commerce; "Radio in Aviation—CAA's U-H-F Range Program—The

HOGARTH DOESN'T MIND—HE'S USED TO HAVING
A CROWD AROUND HIS **ECHOPHONE EC-1**



ECHOPHONE MODEL EC-1

(Illustrated) a compact communications receiver with every necessary feature for good reception. Covers from 550 kc. to 30 mc. on 3 bands. Electrical bandspread on all bands. Six tubes. Self-contained speaker. 115-125 volts AC or DC.



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RCA BUILDING, 30 Rockefeller Plaza, New York, N. Y.

GEORGE H. CLARK, Secretary

Personals

A RETIRED Chief Radioman of the United States Navy, more recently a supervisor in the broadcast program department of the American Telephone and Telegraph Company, is back in the front lines as a USN Chief Radioman. We are referring to Fred McDermott, CRM USN, who wishes to be remembered to all the boys and requests them to *keep the home fires burning*. Fred's address is Navy 1925 C/O Fleet P. O. New York, N. Y. . . . Willard S. Wilson, our resident agent in Delaware, is now Major Wilson, Communications Officer of the Tenth Air Force in India. Good luck, Willard! . . . Jack Poppele states that Robert Cooper of Cincinnati desires information on membership in our Association. . . . We are reserving a Year Book for Harold D. Kaulback of the Bureau of Ships, Navy Department, Washington, D. C. . . . Glad to see Jim Maresca, one of our first Association secretaries, at our recent dinner-cruise in New York. Jim is back in the Signal Corps down Jersey way. He was in there pitching in the last war, too. . . . An interesting letter has come in from T/SGT Preston L. Stocum, now an instructor at the Signal Corps School at Camp Crowder, Mo. . . . Glad to welcome R. J. Iverson of the *New York Times* staff back into our activities again. . . . "Bill" Simon, treasurer and executive secretary, gratefully acknowledges the splendid cooperation of the majority of our membership in bringing their dues up to date. Did you? . . . We noted with interest that a memorial, honoring the graduates of the Maritime Service Radio Training Station at Gallups Island who lost their lives in the service of their country, was dedicated at the station recently. Commander Sherman W. Reed, the superintendent, paid tribute to the bravery of the nineteen men. . . . "Bill" Beakes, VWOA life member, continues to enjoy the splendid Florida weather. . . . Jack Poppele, chief engineer of WOR, was recently appointed consulting radio engineer to the New Jersey State Police. . . . From Captain P. H. Boucheron, USNR, we've



The late William A. Winterbottom, life member of VWOA, who was awarded posthumously, the Signal Corps Certificate of Appreciation for his services to the U. S. Army Signal Corps.

received a letter, saying in part: "Sorry couldn't be there on the 27th of April since I just received your note and it is a little too far—9,000 miles from New York. Regards and best wishes to all." . . . Harold Ellis, formerly of the Tropical organization, is now stationed at the Mare Island Navy Yard. . . . Our sincere sympathies to member Wm. W. Pearson on the recent loss of his wife. . . . Looking back, Tom Stevens, life member, notes: "It looks as though all the old ships on which I served as *Sparks* are doomed. The Merida lies deep off Hatteras, the Harvard was wrecked out here on the Pacific Coast, and now the City of Atlanta has been sunk." . . . Martell E. Montgomery, one of our oldtimers, is now chief communications engineer, Reconstruction Finance Corporation, Deteuss Supplies Corp., American Republics Aviation, with headquarters at Rio de Janiero, Brazil. He received his first class operator's license in 1922, and has held on to it ever since. . . . Peter Podell, one of VWOA's best friends, is now an FCC Intercept Officer of New York. "Pete" began his radio career in 1913 as radio operator for the Marconi Wireless Telephone Company. In World War I he served as chief radio man in the United States Navy. Two of his boys are now in the Armed Forces, one being a sergeant in the Signal Corps, and another a technical sergeant in the Ordnance Department. . . . Edward J. Content,

veteran VWOA man, and in radio since 1917, was with the Rainbow Division of the Army and later was in the Coast Guard. . . . Oliver W. Penney, master control operator of WMCA, entered radio to avoid a dental career, *and it took*. . . . Jim Maresca, a charter member, is now with the Signal Corps at Belmar N. J., with 33 years of radio and sound. He was also in the Signal Corps during World War I. . . . E. D. Van Duyne, in radio since 1919 when he started with A. H. Grebe, is now with RCA as a field engineer. . . . "Bill" Simon, our treasurer, was mustered out of the Marine Corps in 1920 as a Technical Sergeant and has been with Tropical Radio these many years. . . . Dick Sanford, a former wireless operator, is now a songwriter and member of American Society of Composers and Publishers.

In Memoriam

WILLIAM A. WINTERBOTTOM, old-time wire and cable operator, and vice president and general manager of RCA Communications, Inc., died recently. Only a month before his death, he had celebrated his thirtieth anniversary of association with the radio communications industry. He joined the Marconi Wireless Telegraph Company of America on June 1, 1914.

He was an active life member of the Veterans Wireless Operators Association. He always saw to it that his company was represented in every way in the Association's activities whether it be on the pages of the *Year Book*, or at the gatherings of old-timers from year to year.

The Signal Corps awarded him posthumously the Certificate of Appreciation, for his "services of immense value" to the United States Army Signal Corps.

The presentation was made at the RCAC offices, 66 Broad Street, by Col. Jay D. B. Lattin, Signal Officer of the Second Service Command, to Mr. Winterbottom's son, Arthur W. Winterbottom, manager of the Plan Valuation Division of RCA Communications.

Truly, indeed, we mourn his loss.

WHERE TOMORROW MEETS TODAY

Up there
above the clouds
the Dreams of Tomorrow
are being proven
today



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Vision and inventive genius are required to originate such new developments, and in this field Small Electric Motors (Canada) Limited have been privileged to make important scientific contributions. Out of the experience gained today by forward-looking firms like this, substantial benefits will accrue to the world of tomorrow.

At the moment, Small Electric Motors is in full production for Victory but in the post-war field of electrical equipment the influence of this aggregation of creative engineering minds will also be recognized for specialized services of a high order.

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E A S I D E • T O R O N T O • C A N A D A

COMMUNICATIONS FOR AUGUST 1944 • 61

PORTABLE POWER PROBLEMS

No. 4—Veneer Drying Control



Photo — Pluswood, Inc.

FAMOUS ALL-WOOD "MOSQUITO" of the Royal Air Force is

of tough, durable wood veneer — made to a rigid engineering specification. The physical characteristics of this veneer must be as uniform as metal. Most vital step in production is the drying where precision control of moisture content assures its stability and strong cell structure . . . guarded by electronic moisture-meters powered by Burgess batteries.



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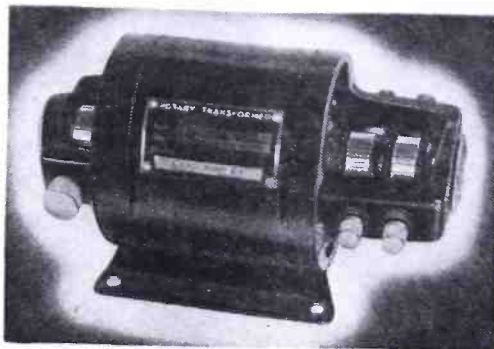
80-page manual of basic data and characteristics of dry batteries for all electronic applications. Tabbed for ready reference. Write Dept. 6 for free copy. Burgess Battery Company, Freeport, Illinois.

BURGESS BATTERIES

THE INDUSTRY OFFERS...

CARTER MULTI-OUTPUT DYNAMOTORS

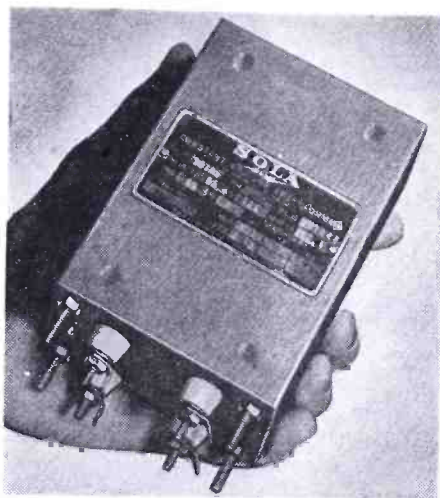
A multi-output dynamotor has been developed by the Carter Motor Company, 1608 Milwaukee Avenue, Chicago.



SOLA CONSTANT VOLTAGE TRANSFORMER

A hermetically sealed constant voltage transformer for chassis mounting, has been announced by Sola Electric Company, 2525 Clybourn Ave., Chicago 14, Ill.

Rated at 6.3 volts, 17 va output, manufacturer says that unit will maintain value within $\pm 1\%$ regardless of line voltage variations as great as ± 12 to 15%.



CURTIS FEED-THRU TERMINALS

Feed-thru terminal blocks consisting of individual feed-thru terminals, molded in bakelite, permanently held in a metal strip and having any number of units between 1 and 16, have been announced by Curtis Development and Manufacturing Company, 1 No. Crawford Avenue, Chicago, Illinois. Factory is in Milwaukee, Wisconsin.

Terminals are said to have ample clearances and leakage distances for circuits carrying up to 300 volts, 20 amperes. Center-to-center distance between terminal units is $\frac{5}{8}$ ". No. 8 screws are used on each side of terminal units for securing connection. The two mounting holes at each end of the terminal base take No. 8 machine screws.

Blocks with any terminals needed can also be supplied.

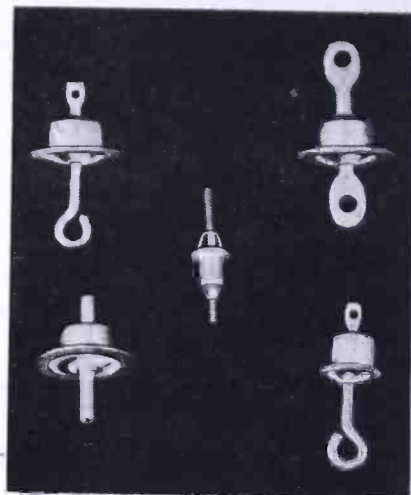


E. I. SEALED LEADS

Hermetically sealed leads constructed of pyrex glass with Kovar electrodes and Kovar metal collars have been announced by Electrical Industries, Inc., 42 Summer Ave., Newark 4, N. J. The pyrex glass is said to assure high dielectric strength, immunity to any reasonable thermal or mechanical shock as well as freedom from absorption of moisture and humidity. The surface of the glass insulator is such as to provide maximum water shedding properties.

The pyrex glass and Kovar metal are said

to form an absolutely gas and moisture tight to form gas and moisture tight chemical bond, so that internal gas pressure may be maintained in units employing these leads.



ANDREW COAXIAL PLUGS AND JACKS

Coaxial plugs and jacks with built-in sliding sections, to simplify disassembling and soldering have been produced by Andrew Co., Chicago, Ill.

Plugs and jacks are machined from bar brass stock. Inner conductor contacts are silver plated to give maximum conductivity. Insulation is Mycalex.



JENNINGS VACUUM CONDENSERS

Vacuum type condensers with capacity ranges of 50, 75, 100, 150, 200, and 250 mmfd, are now available from Jennings Radio Mfg. Co., San Jose, California. Known as the VC-50 and VC-250 types, the condensers have a maximum voltage peak of 20,000; maximum current, peak, 60 amperes. Frequency range is said to be 60 cycles to u-h-f. Has a ferrule type mounting. Other features include zero power factor, no cold emission, and plug-in bases.

NATIONAL INSTRUMENT TIMER

An electrically operated counter to automatically register the total number of hours that an electrical device or motor driven machine has been in operation is now available from National Instrument Co., 246 Walnut St., Newtonville, Mass.

A small slow-speed self-starting synchronous motor drives a set of numbered wheels through a gear train.

Size: 3 9/16" x 3 1/4" x 2 1/8". Registration of 99,999.9 hours, maximum is said to be possible. Right hand figure reads tenths of hours. Can be supplied to read minutes and tenths.

For 100-125 volts, 60 cycles, 2 watts; other voltages and frequencies can also be supplied.

Can be also supplied with a relay for special applications, such as measurements of direct current devices, flow of gases or liquids in pipes, motions, e. g., conveyor belts.

PRECISION PAPER TUBE COMPANY MANDRELS

Approximately 750 mandrels, small to large, for the forming of round, square, and rectangular dielectric paper tubes, as coil bases, are included in a new list just issued by Precision Paper Tube Company, 2023 West Charleston St., Chicago 47, Illinois.

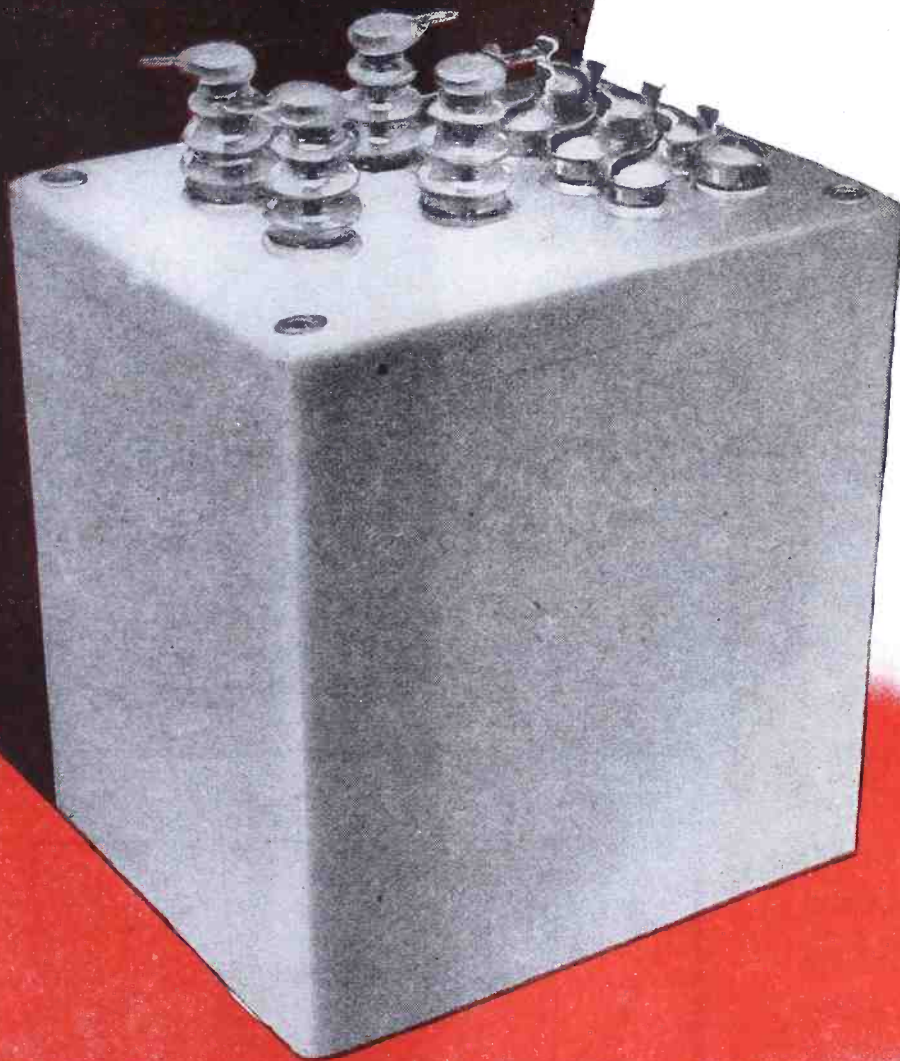
This new list of mandrels provides for practically all sizes and shapes, any length, any i-d or o-d, of tubes made to specifications, of dielectric kraft, fish paper, cellulose acetate, or combinations.

FIBRON PLASTIC TAPE

A vinylite plastic tape, "Fibron," has been announced by Irvington Varnish & Insulator Company, Irvington 11, N. J. It is used for insulating wires, cables and electrical equipment; for splicing cables; and for protecting wiring, piping, and equipment exposed to caustics.

(Continued on page 84)

**POWER SUPPLY
COMPONENTS
FOR WAR**



The complex power supplies of war apparatus require components of maximum dependability. The unit illustrated is a typical power transformer for cathode ray application. In addition to the tapped primary, this unit provides a low voltage filament winding . . . a 5,000 volt anode supply winding . . . and a filament winding insulated for 15,000 volts peak inverse.

For hermetic sealing this unit employs an all metal enclosure . . . glass seal terminals . . . sealing compound which neither cracks nor flows from -55°C to $+130^{\circ}\text{C}$.

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PRE-FLIGHT COMPASS TESTS

(Continued from page 35)

tenna of 50-mmfd capacity and 0.25-meter effective height. This condition cannot be readily determined by measurements on the test set-up on the aircraft as referred to in Figures 1 and 2. The oscillator output and sense voltage value can be readily adjusted to the optimum value by using available circuit functions and a dynamometer type meter. The particular type referred to is that which is generally used with the left-right type radio compass. The *l/r* indicator is connected in the automatic compass circuit in place of the loop director circuit, i. e., in place of the thyatron circuit. This can be easily accomplished in an installation where the circuits are designed in separate units and the interconnection cables can be intercepted at the terminal junction box. The circuits may also be intercepted by use of adaptor cable plugs. More specifically the temporary test hook-up consists essentially of connecting one of the two *l/r* meter coils to the 48 cps source and the other coil to the output of the compass amplifier tube. Based upon the aforementioned field strength, the *l/r* meter will give full scale deflection for 6° rotation (within 1°) of the loop antenna from the homing position, i. e., rotation of the loop antenna from 0° (homing) to 6° or 7° for a full left meter deflection and likewise for a full right meter de-

flection. During this calibration test we must make sure that the aircraft supply voltage input is of normal value. Low battery voltage will give erroneous readings. (Receiver sensitivity varies with input primary power and is apt to occur when external battery is used. During flight the dual generators and voltage regulators maintain a constant supply.) For example, with all other factors being correct, a drop in battery voltage of 12 to 9 volts will result in a 6° to a 37° rotation of the loop antenna to give full deflection of the *l/r* indicator. For reference, a curve expressing quantitative values for a specific condition is given in Figure 5. (Normal operating voltage is 14, however for ground test a 6-cell battery is used hence the reference to 12 volts.)

This method of calibration was arrived at by making a series of tests on a comparison basis with the model of the test oscillator on the aircraft, to the equivalent test made in the radio compass screen room in conjunction with the *l/r* meter. A field-strength value determined in the screen room can be duplicated on the aircraft with the required degree of accuracy for the overall compass installation check. The important factor here is that for a specified $\mu\text{v}/\text{m}$, the full scale *l/r*

(Continued on page 66)

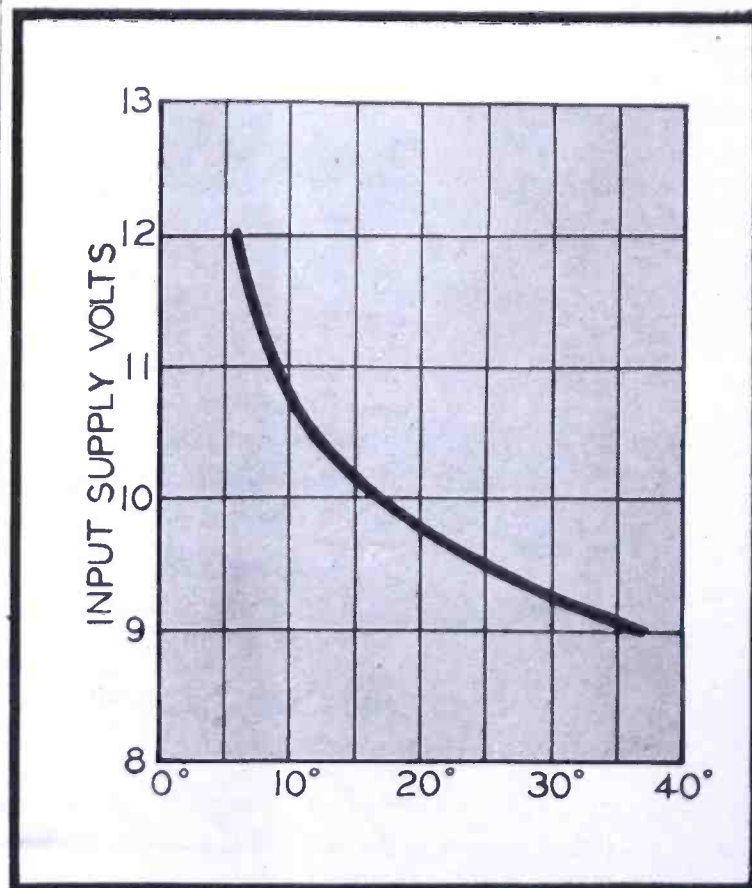


Figure 5
For one specific test condition, the degree rotation of the loop antenna (1000 $\mu\text{v}/\text{m}$) to give full scale *l/r* indicator deflection as a function of input supply volts to the compass equipment. Test voltage reference is usually 12. The equipment is designed for operation on a normal supply of 14 volts, which is the voltage delivered when aircraft generators are operating.

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2. Resistance values: $\frac{1}{2}$ watt—from .24 ohms to 800 ohms; 1 watt—from .5 ohms to 5000 ohms; 2 watt—from 1.0 ohms to 8000 ohms.
3. Have wire wound stability and are physically interchangeable with carbon types.
4. Available in matched pairs to 1% or 2% for close-tolerance, high-stability applications.
5. Element is space wound with copper-nickel or nichrome bare wire securely crimped and molded integrally with leads.

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Electro-Voice MICROPHONES

ELECTRO-VOICE MANUFACTURING CO., INC. — 1239 SOUTH BEND AVENUE, SOUTH BEND 24, INDIANA

PRE-FLIGHT TESTS

(Continued from page 64)

meter deflection is a function of loop antenna angular displacement from 0° (homing position). It is evident that use of the l/r meter as a medium of calibration-oscillator output, for a given $\mu\text{v}/\text{m}$ when made on the plane, will take in account the actual loss factors existing in the aircraft test *set-up* without the necessity of actually measuring them; in Figure 2, for instance, the r-f loss in the beacon antenna leadin.

Known and controlled values within

required limits of the loop antenna field strength as well as sense-antenna effective height are available in a screen room *set-up*. Briefly, the screen room *set-up* comprises a transmission line located directly above the center of the loop antenna. One end of the line is connected to a signal generator. The other end of the line is terminated to the shield of the room through a resistor equal to the characteristic impedance of the transmission line. For a given set of conditions, including distance of loop antenna center to the transmission line, and the distance of the line from the top shield and bot-

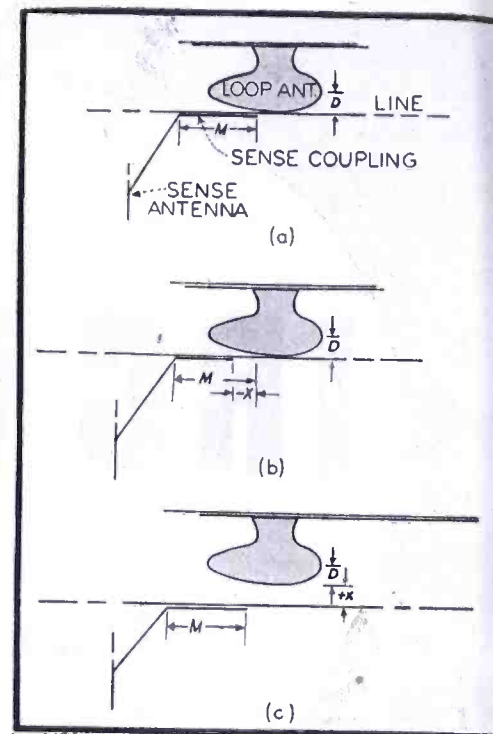


Figure 6

The l/r meter deflection for a given field strength is a function of the loop antenna to sense antenna voltage ratio, i. e., same deflection may be obtained for two entirely different field strength values by juggling of height of sense antenna or coupling from the line to the loop antenna. *Condition (a)*: A selected value of overall receiver gain must be maintained, as well as a standard reference spacing of the loop antenna center to the line. *Condition (b)*: The carrier amplitude is decreased when sense coupling is decreased. Thus the percentage of modulation is increased. Therefore, the angular change of loop antenna position is less for a given l/r meter deflection. *Condition (c)*: As the distance between the loop antenna and the line is increased, the loop coupling voltage is decreased. The result is a reduction of 48 cps side band amplitude. Therefore, the percentage of modulation is decreased and a greater angular loop antenna displacement is required for a given l/r meter deflection.

tom shield of the screen room, the $\mu\text{v}/\text{m}$ field strength can be determined by a constant multiple of the signal generator attenuator scale reading. This condition would be very difficult to duplicate on the aircraft and for that reason it is better to work from a comparison basis. The l/r meter was found to be an ideal tool to do the job.

The l/r test instrument in complete form is shown on pages 33 and 68. Designed especially for use with the Bendix MN31 radio compass, it is only necessary that the MN31 loop-director cable plug be connected to the adaptor cable plug assembly. Mounted on the panel are the l/r meter, supply line input meter, a selector switch for automatic radio compass or l/r meter, operation and a loop antenna rotator switch. The latter permits remote rotation control of the loop antenna at desired rate of speed and direction. (The l/r indicator circuit presented here is *not* to be considered as an adoption of a l/r compass for navigational purposes.)

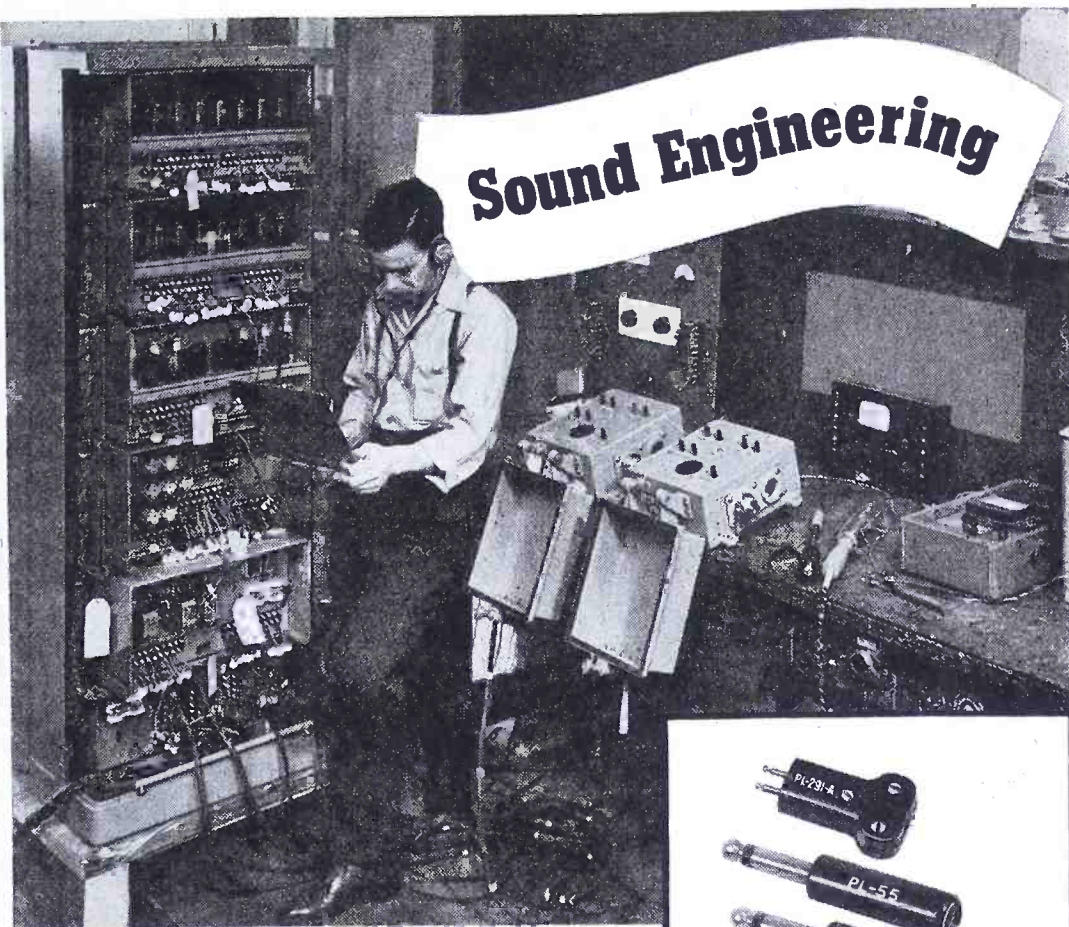
In the l/r indicator, when loop antenna is in the null position, the meter

indicating needle is centered. When the loop antenna is rotated to one side of the null, the meter is deflected from center in one direction and a reversed deflection occurs when the loop antenna is rotated in the opposite direction from the null. This means that the meter is *sensed* so that the center position of the dial represents the airplane nose. A left meter deflection indicates that the signal direction is approaching from the forward left of the plane of the loop antenna, and a right deflection indicates when the signal direction is from the forward right of the plane of the loop antenna. A signal arriving at the back side of the loop antenna (other than null) will give a reverse indication. From this we can see that with a meter deflection opposite to the direction of loop antenna rotation the source of signal is from a forward point. Conversely a meter deflection that follows the same direction of the loop antenna rotation indicates that the signal source is to the rear. This is based on reference to the azimuth reading as to the front of the loop antenna. This is not to be confused with the old *standard* used prior to 1939 which is now obsolete. The present standard was adapted to conform with the aeronautical flight instrument standards. These are . . . "to fly into the indication" for the correction. For example, when the airplane heading is 30° and directly toward the radio transmitter, the *l/r* needle is at center point of the scale. If the airplane heading is altered to 45° (15 degrees to right of the station) then the *l/r* indicator gives a left deflection. The signal source is to the forward left of the plane of the loop antenna. For a correction, to again fly a heading toward the station, the heading is altered to the left . . . "fly into the indication, to enter the meter."

The *l/r* test instrument is quite versatile, in that it can be used to isolate a loop antenna, antenna relay, separate loop antenna transmission line double from loop director or autosyn double, when symptoms of incorrect sense are given.

The fixed coils in the circuit, Figure 4 (terminals 1, 3, 5 of the dynamometer type *l/r* indicating meter), are resonated at 48 cps. When connected in the circuit by SW₁ it becomes the oscillator tuned circuit of the transmitter and replaces the tuned circuit of T₆. The latter is in operation when the automatic compass is used. The compass amplifier output is connected to the moving coil (terminals 2-4). This

(Continued on page 68)



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59	67	109	127	
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
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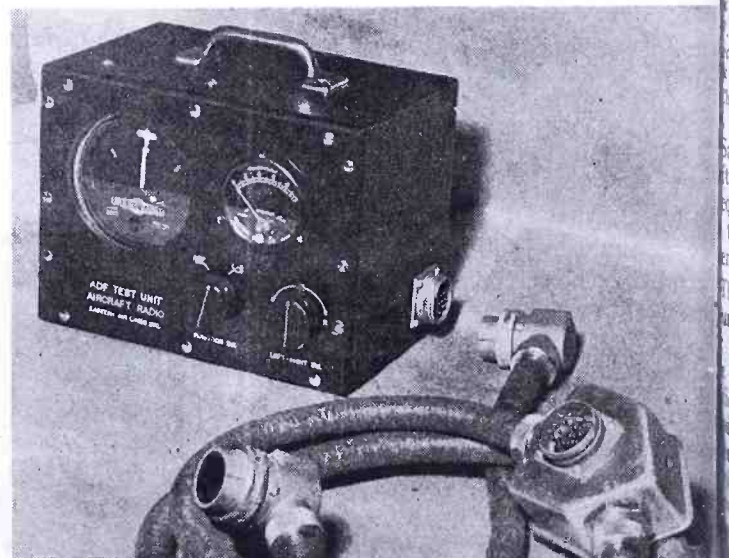
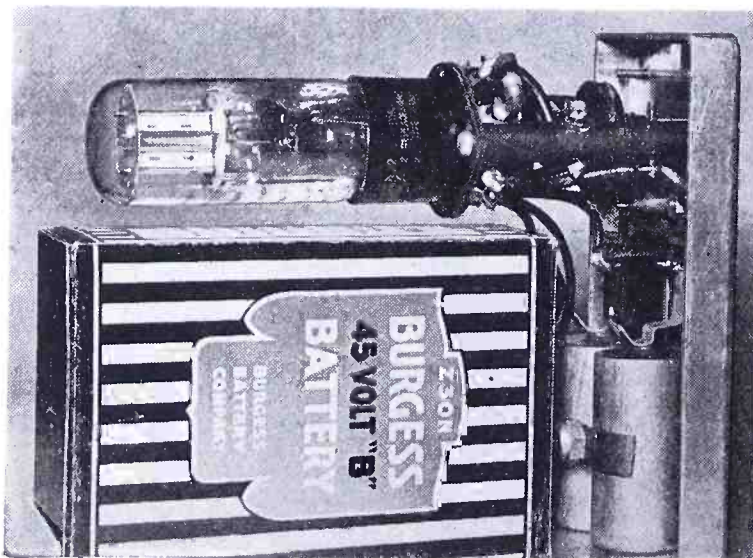
THE MAGNAVOX COMPANY

Fort Wayne, Indiana

supplies the 48 cps modulated signal. For a loop antenna position at other than a null, the moving coil 48 cps phase relation to the fixed coil, determines the direction of deflection of meter. With the loop antenna at null position the moving coil does not receive a 48-cps modulated signal voltage and the *l/r* indicator is centered.

For reason of safety, it is necessary to provide a departure check of aircraft's radio compass when plane is in the clear on the engine run-up ramp. During this check the accuracy of the radio compass is observed by taking bearings on two or more stations. This is done by setting the azimuth dial index to the magnetic compass heading. The bearing accuracy is determined by comparing it with the known bearing from run-up ramp being used, to the radio station to which the receiver is tuned. The engine run-up test is made shortly before the trip departure time. To avoid a plane departure delay, it is obviously an advantage to determine whether a radio compass installation defect exists long before the plane is scheduled to be towed to the run-up ramp. This requirement prompted the development of this radio compass test oscillator device. At any convenient time during the service period, regardless of whether the plane is in hangar or not otherwise in the clear of metal objects, the test oscillator used in conjunction with the transmission line will permit a radio compass overall installation test. It

At left, below, internal view of the oscillator unit. Battery power supply is held in place by clips and these clips on the parallel *A* battery also serve to make circuit connections. Below, *l/r* test instrument interconnecting cable. On the panel of the *l/r* meter, and the input line meter. The controls are *sw1* two-position function switch and the *l/r* loop antenna rotator control. Cable plug adjacent to unit plug is programmed in Figure 4 as *P1*; *P3* is the foreground plug, and the *P2* plug is mounted on conduit box.



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STANDARD or SPECIAL

Here you see a large B&W low-frequency variometer-type inductor, tailor-made for a war equipment application, compared in size to the B&W 75-watt "Junior" of amateur radio fame. If a 25-watt "Baby" were put in the picture you'd hardly see it—and some of the new coils just coming off B&W production lines are many times smaller than that!

The point is that B&W offers inductors in the broadest assortment of shapes, sizes, and types on the market today. Whatever your requirement, write for recommendations and suggestions.



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COMMUNICATIONS FOR AUGUST 1944 • 69

e influenced by external effects. equipment deficiencies and the ing can readily be determined his device: (1)—correct sense ng of compass component; (2)— ul indicator needle hunt; (3)— l performance and in particular ll seeking ability of the compass; check for correct sense and loop a cable connections; and (5)— t autosyn indication.

h reference to the latter, it has found that a spinning needle is o an autosyn rotor slip ring having intermittent contact. A ve angle indication is usually l by reversed phase stator wind- onnections; an indication over arc, only, is most likely due to an stator phase winding. A normal ying indication of the autosyn in- or with abrupt 180° ambiguity be due to open rotor circuit. It previously mentioned that some e above referred-to symptoms will hhibited solely because of the near- of metal objects or ground wires. efore the trouble should be double ed to make certain that it is not d by a source external to the in- tion.

e approved type aircraft radio ass, even though it is in the class omplicated apparatus has proved e remarkably free from defects. ever, the need for a thorough per- ance test is apparent since it is a gnized fact that the compass, as any type of equipment, is subject alfunctioning because of operating itions encountered. These condi- may be extreme variations of erature and pressure as well as ation and humidity which con- te to deterioration of components.

ography

ebb and Essex, *Automatic Radio Compass*, nautical Engineering Review, Nov., 1942.

Edward K. Morgan, *Aircraft Radio and ical Equipment*, Pitman Publishing Co.

S. Bond, *Direction Finders*, McGraw-Hill Co.

E. Terman, *Radio Engineers Handbook*, tion Finding, page 873, McGraw-Hill Co.

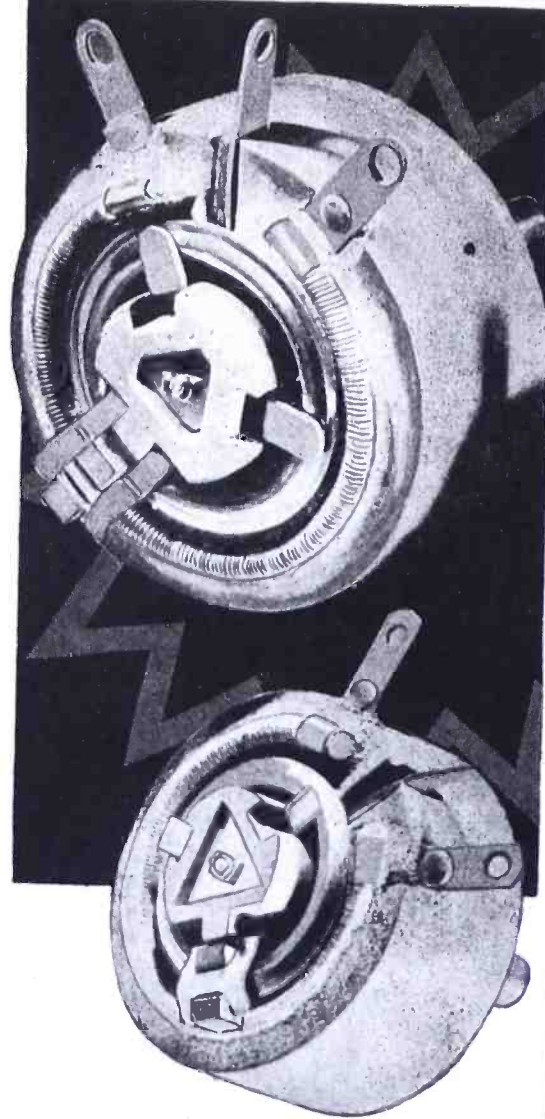
Charles M. McKee, *Radio Compass Calibra-* COMMUNICATIONS, March 1943.

safety regulations require that air- t while on the ramp or in the hangar quipped with a ground wire in a man- to prevent existence of difference of ntial between the aircraft and ground.

he test oscillator design and test pro- re described was devised by Eastern Lines Communications Department. basic idea is shown in the Sperry io Compass instruction book. The dard radio compass screen room test edure is given in Bendix Radio Test ublication Notes and also on page 140, *inciples of Aeronautical Radio Engi-* ng by P. C. Sandretto, McGraw- l Book Co.

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RESISTIVE NETWORKS

(Continued from page 56)

basis treatment of networks, the terminations are of such values that looking either way at each of the terminal ends, the impedance seen is the same as that which would be provided by an infinite series of such networks connected in tandem.

The development of pure resistance networks may conveniently be made by means of matrix theory. And under conditions of proper methods of combination and the use of ideal transformers, networks having physically realizable constants in the majority of cases may be realized. The main field of usefulness of the matrix theory, where purely resistive networks are concerned, is that it enables us to combine several networks together in symbolic form to obtain a single network which will give the equivalence of the combination. A great saving in time of manipulation of network equations is generally obtained because of the compression of the mathematical forms of the mesh equations. It provides a powerful tool for analysis purposes, and the answers to many problems may be arrived at by matrix transformations without the actual necessity of making many and laborious calculations. However, since the present paper deals with single networks rather than groups of them in combination, the matrix forms will not be utilized.

The use of various theorems is very helpful to the network design engineer for purposes of analyses, and generally permit considerable simplification of many complex circuits into more manageable forms. However, the design of most commonly known and standard forms of purely resistive attenuating networks fortunately require only a few theorems to provide all of the tools necessary for the majority of applications.

Equivalent Networks

The most useful transformations to the amateur, experimenter, sound studio and radio broadcasting engineer are those which transform one type of network to another, in order that more convenient and perhaps more economical commercial values of resistances may be used for either very high or very low values of attenuation.

π to T and T to π Transformations

The T network of pure resistance type is equivalent at all frequencies to the π network shown in Figure 1, when the parameters have the values in Figures 2 and 3, as developed from

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he theory provided in equations 1 to 14 inclusive.

It should be noted that the transformations and formulae which follow throughout this series are perfectly general, and apply to networks having parameters or elements with impedances which are functions of a complex variable, as well as to resistances which are functions of a real variable which is a special case of the complex variable, in which the imaginary component equals zero. However, this fact will not be stressed in this paper because the elements of the networks considered here are assumed to be purely resistive over a frequency range extending into the megacycles. When the range of frequencies extends into the ultrahigh frequencies, special technique must be used, as the element which may resemble a pure resistance, with zero phase angle at a relatively low frequency, becomes a complex impedance at some higher frequency. This means that each resistance taken as a single unit becomes a highly complex network when the frequency is increased to a sufficiently high value. Self capacitance and lead inductance effects, as well as capacity to ground, then enter into the problem of design. It should not be interpreted by these remarks that the capacity to ground is of no importance in low frequency work, for this is far from being the case, especially if the level at which the networks are operated is low and high gain is required for an amplifier following the network.

π to T Transformation

The impedances looking into terminals 1 and 3, 1 and 2, and 3 and 4 of both the T and π networks of Figure 1 must be equal if equivalence is to exist at all frequencies. Therefore we must have

$$u + v = \frac{b(a+c)}{a+b+c} = \frac{b(a+c)}{\Delta} \quad (1)$$

$$u + w = \frac{a(b+c)}{a+b+c} = \frac{a(b+c)}{\Delta} \quad (2)$$

and

$$v + w = \frac{c(a+b)}{a+b+c} = \frac{c(a+b)}{\Delta} \quad (3)$$

where $\Delta = a + b + c$.
Subtracting 3 from 1 + 2, and solving for u in terms of a, b, and c,

$$u = \frac{ab}{\Delta} \quad (4)$$

Subtracting 2 from 1 + 3, and solving for v in terms of the π elements, a, b, and c,

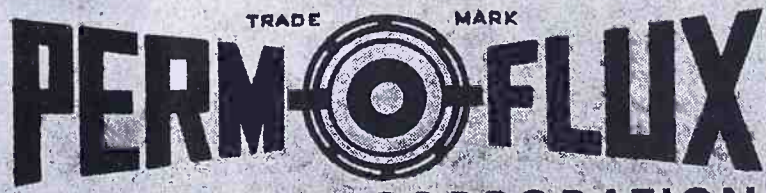
$$v = \frac{bc}{\Delta} \quad (5)$$



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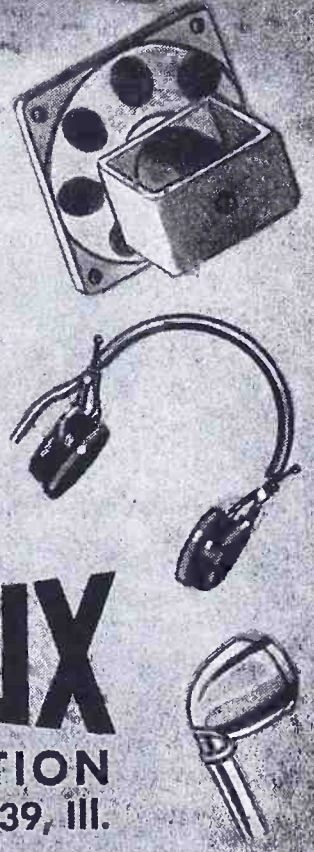
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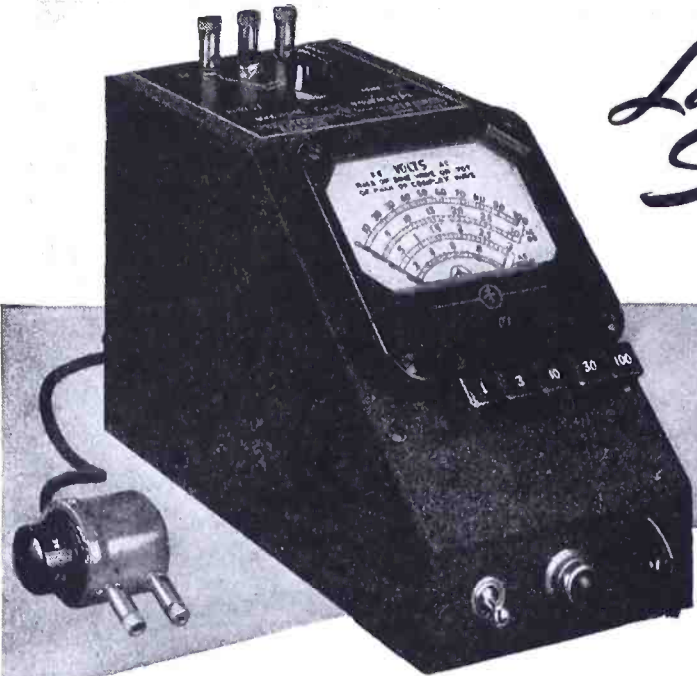


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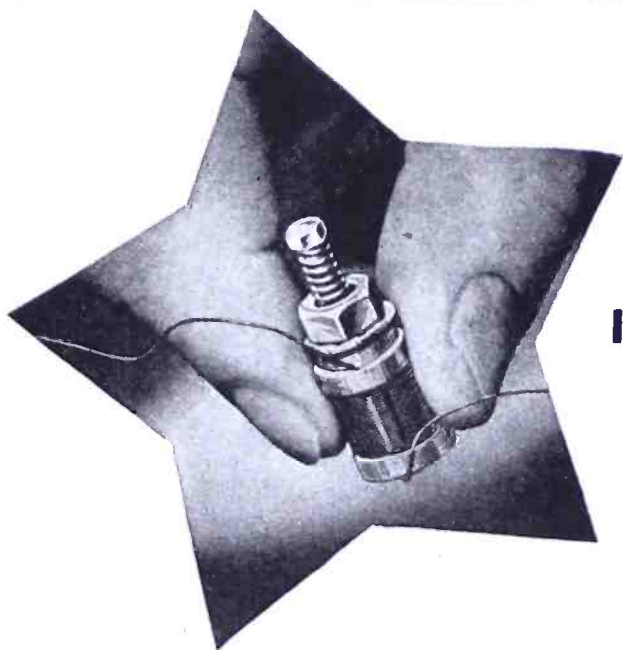
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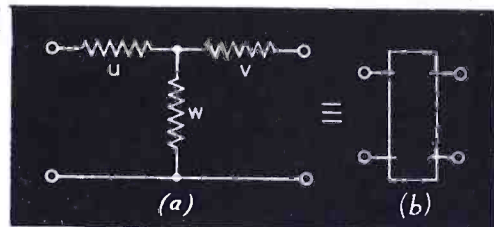


Figure 4

The equivalence of a network having one set of elements within a four-terminal box to a simple *T* configuration.

Subtracting 1 from 2 + 3, and solving finally for *w* in terms of the known π network parameters, *a*, *b*, and *c*,

$$w = \frac{ac}{\Delta} \quad (6)$$

This transformation holds for all values of *a*, *b*, and *c*, whether they are composed of simple resistances or are complex impedances, and for pure resistance networks over all frequencies for which the treatment of the network elements as lumped constants is valid.

T to π Transformation

When the elements of the *T* network are given and it is desired to have the equivalent π network, the equations 4, 5 and 6 may be solved for *a*, *b*, and *c* in terms of *u*, *v* and *w*. Thus, taking the sum of the products of 4·5 + 4·6 + 5·6, we have

$$uv + uw + vw = \frac{ab^2c + a^2bc + abc^2}{\Delta^2} = \frac{abc}{\Delta} \quad (7)$$

and letting

$$\phi = uv + uw + vw \quad (8)$$

from 7 and 8

$$\frac{abc}{\Delta} = \phi \quad (9)$$

Taking the quotient of 9 and 5, 9 and 6, then 9 and 4 successively, term by term, the equations required are obtained as

$$a = \frac{\phi}{v} \quad (10)$$

$$b = \frac{\phi}{w} \quad (11)$$

and

$$c = \frac{\phi}{u} \quad (12)$$

where $\phi = uv + uw + vw$.

As in the π to *T* transformation, these equations are perfectly general and apply for complex impedances as well as for simple resistances. This is valid in resistive networks for all frequencies over the range for which the lumped element circuit theory holds true.

For the special case of a symmetri-

cal π network, $a = c$, and equations 4, 5, and 6 for the equivalent T become

$$u = \frac{ab}{2a + b} = v \quad (13)$$

$$w = \frac{a^2}{2a + b} \quad (14)$$

and for the symmetrical T with $u = v$, equations 10, 11, and 12 for the equivalent π become

$$a = u + 2w = c \quad (15)$$

$$b = \frac{u^2 + 2uw}{w} \quad (16)$$

A convenient form of showing the relationship between the T and π networks is given by Figures 2 and 3, where it may be seen that by placing the T and π elements at the vertices and sides of a triangle and in clockwise order as indicated, a workable "rule of thumb" method may be used for conversion purposes.

By repeated application of T to π and π to T transformations, any complicated network may be reduced to the standard form of T or π configuration.

Equivalent T from Measurements of a 4-Terminal (2-Terminal Pair) Network

The equivalent T network for any configuration of elements, real, negative or complex, may always be found, although in many types of reactive networks it may not be physically realizable. However, in the pure resistance types considered here, the equivalent network is always physical and real over all frequency ranges for which the resistance elements have zero phase angles, and may be treated as lumped constants.

Let

Z_{o1} = open circuit measurements with terminals 3 and 4 open, measured at terminals 1 and 2.

Z_{o2} = open circuit measurements with terminals 1 and 2 open, measured at terminals 3 and 4.

Z_{s1} = short circuit measurements with terminals 3 and 4 shorted, measured with terminals 1 and 2.

Z_{s2} = short circuit measurements with terminals 1 and 2 shorted, measured at terminals 3 and 4.

Referring to Figure 4, these conditions may then be written

$$Z_{o1} = u + w \quad (17)$$

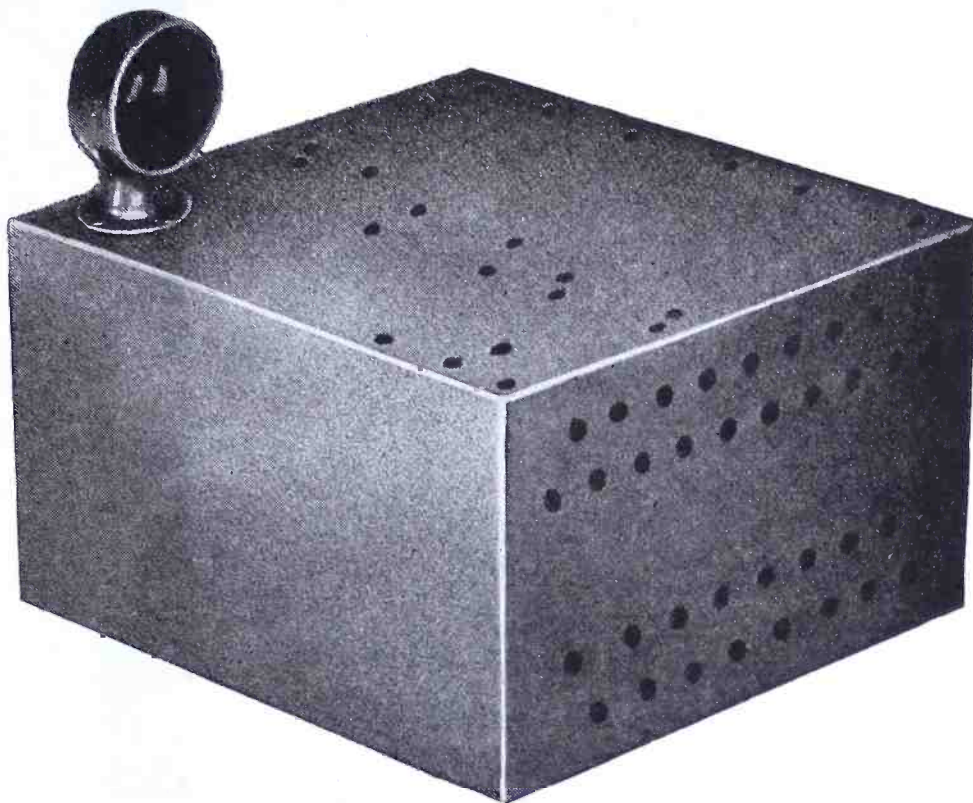
$$Z_{o2} = v + w \quad (18)$$

$$Z_{s1} = u + \frac{vw}{v + w} \quad (19)$$

$$Z_{s2} = v + \frac{uw}{u + w} \quad (20)$$

The products of equations 17 and 20,

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and 18 and 19 respectively give

$$Z_{01} Z_{02} = uv + vw + uw = Z_{02} Z_{03} = \Delta \quad (21)$$

This shows that if any three measurements of these four are made, the fourth can always be determined. Substituting 17 and 18 in 19 and solving for w , in terms of the measurements

$$w = \sqrt{Z_{02} (Z_{01} - Z_{03})} \quad (22)$$

Using 22 in 17 and 18 successively, the values required for the other two equivalent elements are obtained immediately as

$$u = Z_{01} - \sqrt{Z_{02} (Z_{01} - Z_{03})} \quad (23a)$$

$$= Z_{01} - w \quad (23b)$$

and

$$v = Z_{02} - \sqrt{Z_{02} (Z_{01} - Z_{03})} \quad (24a)$$

$$= Z_{02} - w \quad (24b)$$

In the special case of symmetrical networks giving equal open-circuit measurements, and equal short-circuited measurements, $Z_{01} = Z_{02} = Z_{0c}$, $Z_{01} = Z_{02} = Z_{0s}$, and equations 23, 24 and 22 become

$$u = Z_{0c} - \sqrt{Z_{0c}^2 - Z_{0c} Z_{0s}} = Z_{0c} - w = v \quad (25)$$

$$w = \sqrt{Z_{0c}^2 - Z_{0c} Z_{0s}} \quad (26)$$

Bartlett's Theorem¹

This theorem proposed by Bartlett and added to by Brune² provides one of the most useful tools of all those which are available to the communications engineer for network design problems. It treats of the bisection property of a class of artificial line sections. In essence, the theorem is stated that if an artificial line section with characteristic impedance Z_0 and propagation function θ has within itself n terminals 1, 2, 3, 4 . . . such that bisecting these terminals cuts the network into two exactly similar halves so that their behavior as determined with respect to the external terminal pairs is identical, and if each of the halves as considered from the original external pairs as a two-terminal impedance has an impedance Z_{oc} when terminals 1, 2, 3, 4 . . . are open and Z_{sc} when 1, 2, 3, 4 . . . are short circuited, then

$$Z_{oc} = Z_0 \coth \frac{\theta}{2} \quad (27)$$

and

$$Z_{sc} = Z_0 \tanh \frac{\theta}{2} \quad (28)$$

where $\coth \theta/2$ and $\tanh \theta/2$ are the hyperbolic cotangent and tangent respectively of the angle subtended by



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ch half of the complete network.
 Since these hyperbolic functions are
 reciprocal to one another, or

$$\tanh \theta/2 = \frac{1}{\coth \theta/2}$$

om 27 and 28, the characteristic im-
 pedance may be found in terms of the
 open and short circuited impedances
 of the bisected network as

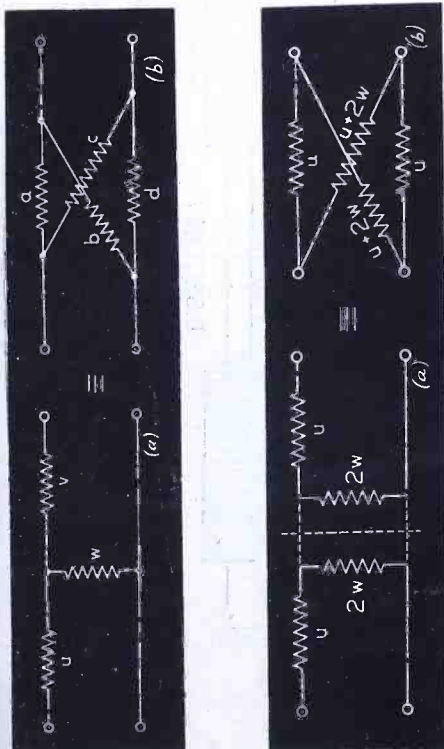
$$Z_0 = \sqrt{Z_{oc} Z_{sc}} \quad (29)$$

Relations 27 and 28 are exactly the
 same as those for a symmetrical lattice-
 type network and therefore any type
 of network, for which the theorem is
 valid, may be transformed into a lattice
 configuration. Figures 6a and 6b show
 the equivalence of a T-type network
 to the lattice using these relationships.
 Hence, we may note that the series,
 shunt lattice equivalent is given by the
 short circuited condition of the bisected
 network and stated by equation 28,
 while the shunt arms of the lattice
 equivalent is given by the open cir-
 cuit condition of the bisected net-
 work and stated by equation 27. For
 a lattice network equivalent of this

¹Bartlett, A. C., *Phil. Mag.*, Vol. 4, pp. 902;
 Nov. 1927.
²Brune, O., *Phil. Mag.*, Vol. 14, Series 7,
 p. 806; Nov. 1932.

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

Figure 5, the equivalence between elements of
 the T and lattice networks. By imposing vari-
 ous restrictions upon the lattice network, a
 number of interesting and useful T networks
 may be obtained. In Figure 6 (a) we have
 a T-network which has been bisected and forms
 two equal halves which have mirror-like sym-
 metry. In (b), a lattice equivalent of the T-
 network is obtained by inspection and the use
 of Bartlett's Theorem applied to the bisected
 network of (a).



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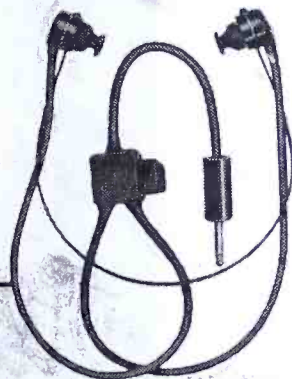
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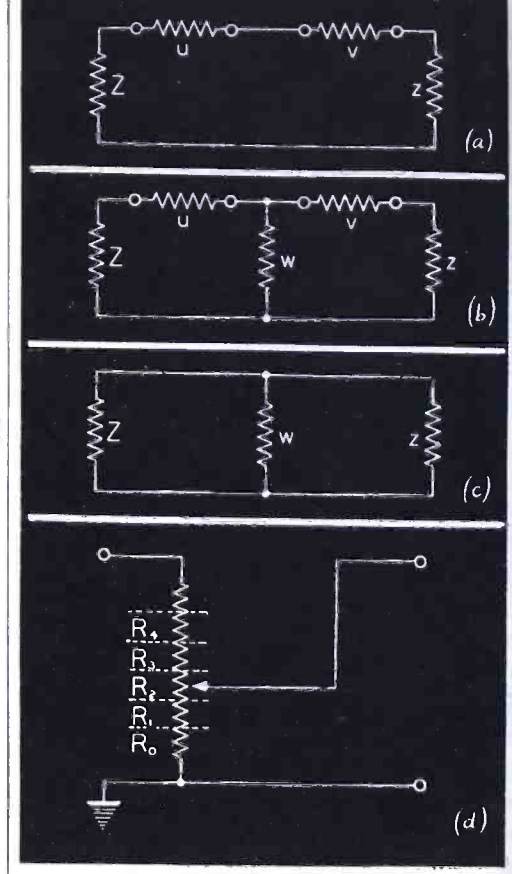
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Figures 7, 8, 9, and 10
 Typical cases of a few of the classes of networks used in communications work.

type having series arms *a*, and shunt arms *b*,

$$a = Z_0 \tanh \phi/2 \quad (30)$$

$$b = Z_0 \coth \phi/2 \quad (31)$$

The characteristic impedance is from

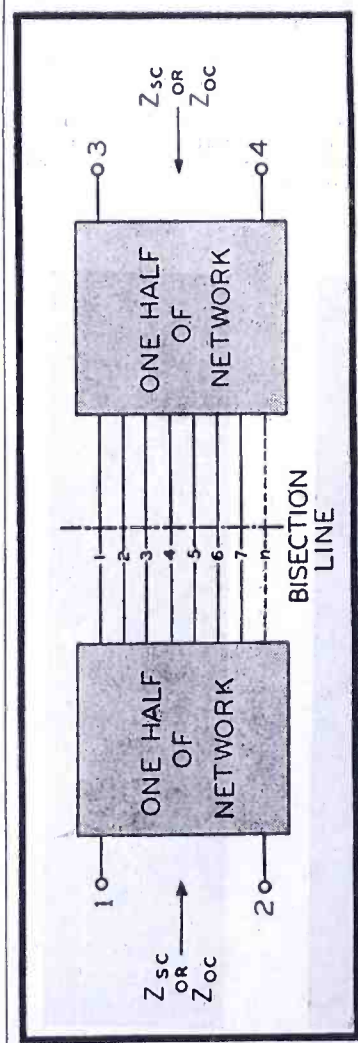

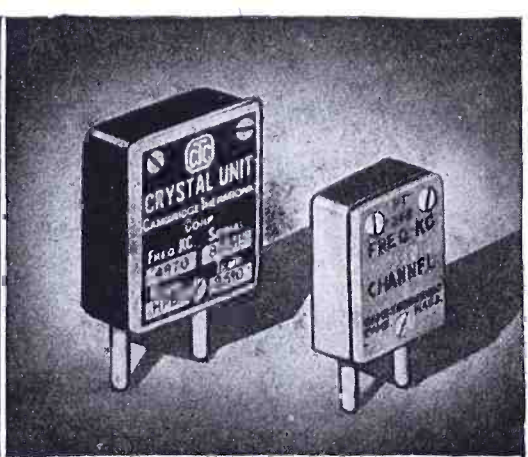


Figure 14
 An example of Bartlett's Bisection Theorem as applied to a network with all connections taken straight through.



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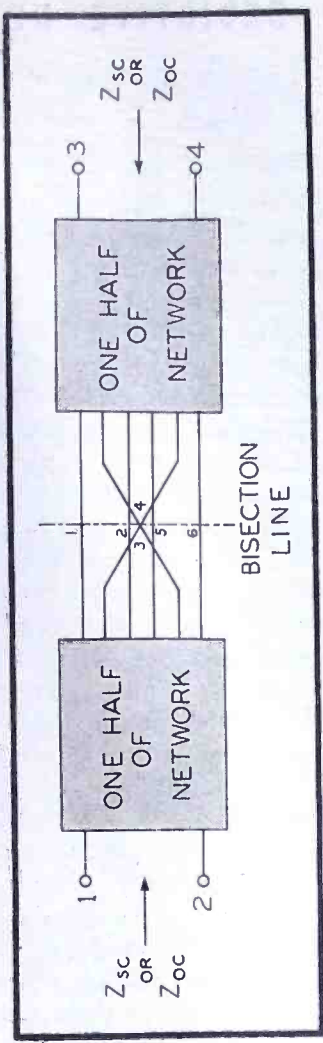
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Figure 12 is an example of Bartlett's bisection theorem applied to a symmetrical network having eight and crossed connections. (See text for Z_{sc} and Z_{oc} legend.)



and 31; therefore

$$= \sqrt{V_{ab}} \quad (32)$$

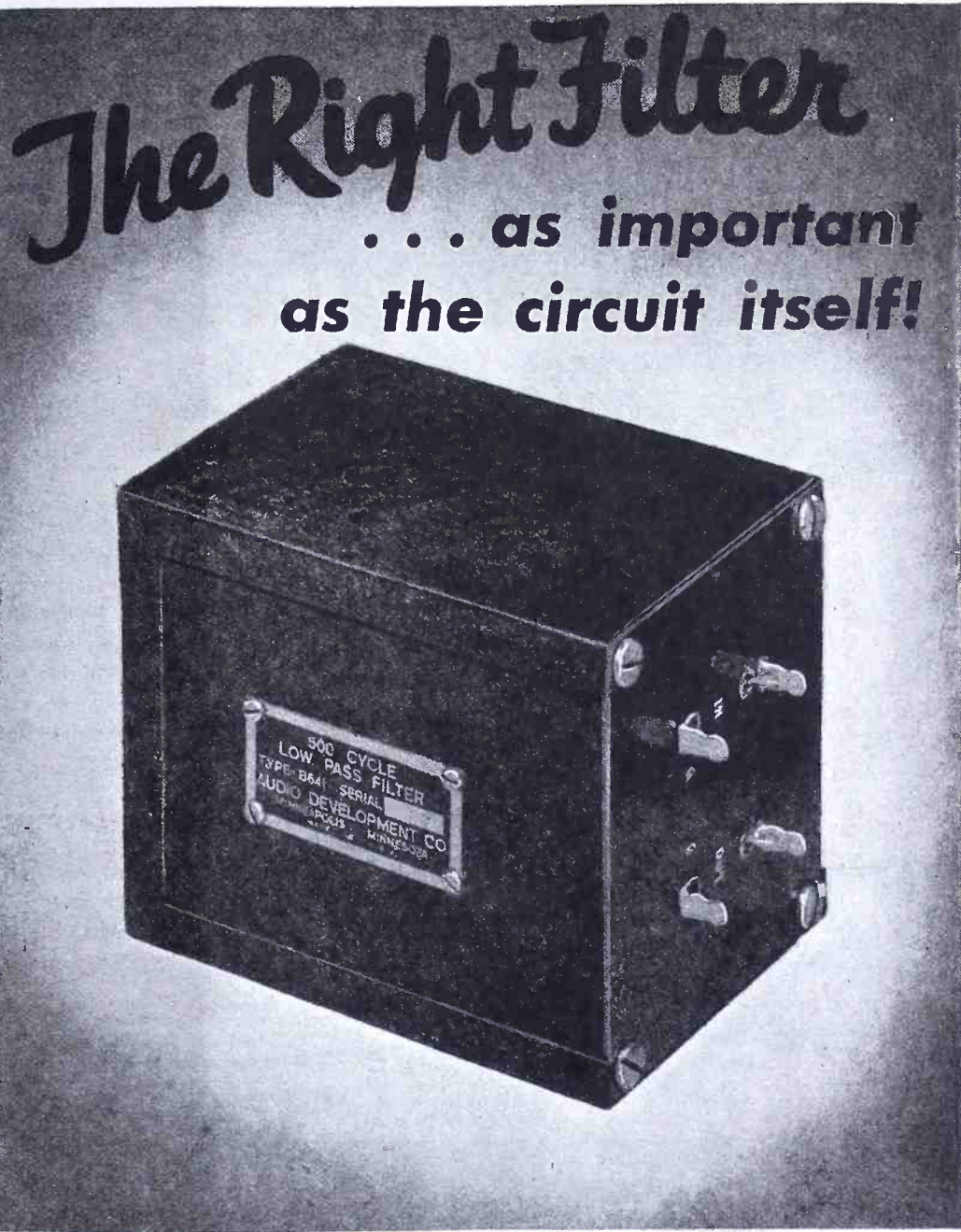
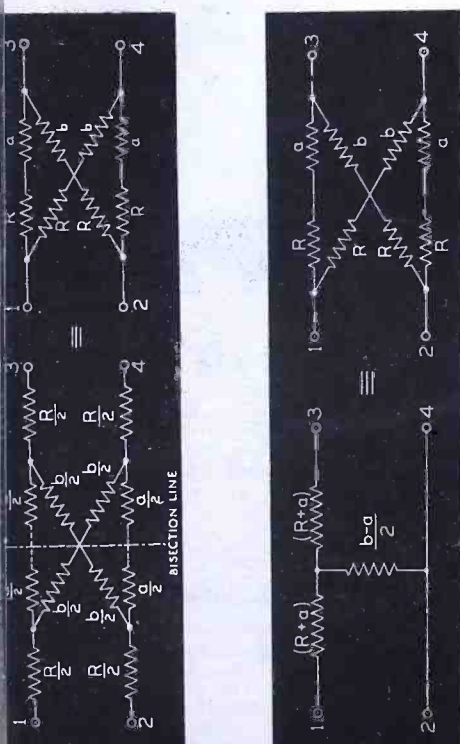
The propagation function for the given network is found by the quotient of equations 28 and 27 as

$$= 2 \tanh^{-1} \sqrt{Z_{sc}/Z_{oc}} \quad (33)$$

and for the lattice equivalent, by equations

Figures 13 (below, left) and 14 (below, right)

Figure 13, an illustration of the application of the example shown in Figure 12. Figure 14, equivalent T of the lattices shown in Figure 13 by Bartlett's Theorem.



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RESISTIVE NETWORKS

(Continued from page 77)

tions 30 and 31,

$$\theta = 2 \tanh^{-1} \sqrt{a/b} \quad (3)$$

Another class of networks having straight through and symmetric crossed connections may be reduced to a balanced lattice equivalence by applying the theorem, so that the equivalent series arm equals the input impedance of the bisected network when the straight through connections are all short circuited together and the crossed connections open circuited while the shunt arm of the equivalent lattice will be the input impedance of the bisected network when the straight through connections are all open circuited and the crossed connections are all short circuited together. This application of the theorem has a wide usage in transforming a lattice network having dissipative resistances within the lattice, to another lattice having the dissipative elements external to the equivalent lattice. Or the reverse may equally well be applied so that dissipative elements outside a lattice structure may be moved inside the equivalent lattice. These relationships may also apply to the transformation of the lattice network to the T , π or bridged-types of networks.

NEWS BRIEFS

(Continued from page 58)

Chicago, as sales and advertising manager after serving for 2½ years with the Douglas Aircraft Co. in Africa and the Middle East as a technical adviser and representative. M. Munger has announced the appointment of Magazines, Inc., as public relations counsel.



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GOTHARD PILOT LIGHT CATALOG

A 24-page catalog and data book of pilot-light assemblies has been published by Gothard Manufacturing Company, 1300 North 9 Street Springfield, Illinois. The catalog contains illustrations, diagrams, specifications, prices, and other information on pilot-light assemblies for panel board and instrument signaling. Also in

led are photos and descriptions of lamps, brackets and accessories.

A REPORTS 65 APPLICATIONS FOR COMMERCIAL TELEVISION STATIONS

Eighty-five applications from twenty-four states, for permission to erect commercial television stations, are now pending in FCC files in Washington, according to the Television Broadcasters Association, Inc. Proposed new stations are located in Boston, Hartford, New York, Philadelphia, Newark, Baltimore, Washington, D. C., Pittsburgh, Cleveland, Detroit, Cincinnati, Chicago, Milwaukee, New Orleans, St. Louis, Oklahoma City, Omaha, Denver, Lake City, Los Angeles, San Francisco, Spokane, as well as Rochester, New York; Richmond, Virginia; Jacksonville, Florida; Charleston, West Virginia; Lafayette, Indiana; Riverside, California; Stockton, California, and Albuquerque, New Mexico.

OHMITE NEWS BULLETIN

The June-July issue of "The Ohmite News" bulletin features an article on Army-Navy teletype equipment which is capable of sending twelve teletype messages simultaneously. A similar terminal system, which is now being used at the Kearney Works of Western Electric Company, is pictured. The bulletin also illustrates and describes Ohmite's close control and low resistance circular slide-wire rheostats, etc.

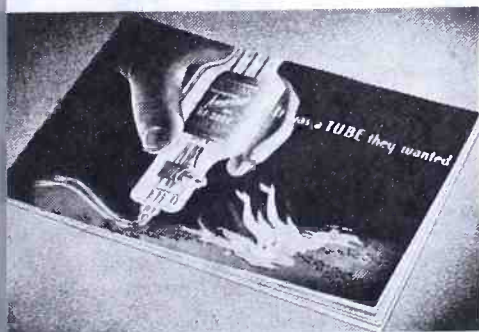
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AMPEREX TUBE BROCHURE

A 24-page illustrated brochure entitled "It Was Tube They Wanted!" has been released by Amperex Electronic Corporation, 79 Washington Street, Brooklyn 1, New York. One section of the booklet photographically shows the plant operations at Amperex today. Mention is also made of the expected postwar activities of the company in producing their custom-built electronic tubes.



O. B. HANSON NAMED TBA CONFERENCE CHAIRMAN

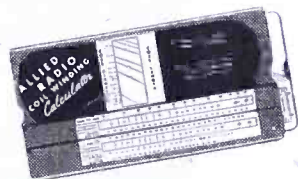
The first annual conference of the Television Broadcasters Association, Inc., will take place in New York City on Thursday and Friday, December 7 and 8, 1944. O. B. Hanson, vice president and chief engineer of the National Broadcasting Company and a director of TBA, will serve as chairman of the conference committee. Jack R. Poppele, secretary and chief engineer of WOR will be conference coordinator, and Will Baltin, secretary-treasurer of TBA will be in charge of press and public relations for the event.

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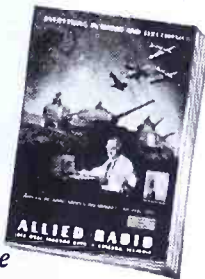
The American Standards Association has just (Continued on page 80)



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RCA	IRC	Sprague	Littlefuse	Astatic
Raytheon	Centralab	Aerovox	Stancor	Amperite
Hickok	Burgess	Halicrafters	Thordarson	Jensen
Triplett	Knight	Hammarlund	Belden	Utah
Supreme	Bliley	E. F. Johnson	Meissner	Sangamo
Mallory	General Electric	Cutler-Hammer	Amphenol	Dumont
Ohmite	Cornell-Dubilier	Hart & Hegeman	Shure	Bussman

ALLIED RADIO

NEW

Gothard

NAVY SPEC.—BAKELITE BASE PILOT LIGHT

for 110 volt operation



This new light, with 1" jewel, is available in three models: #1032 faceted jewel; #1033 plain jewel, and #1034 frosted jewel, colored disc. Sockets are molded of bakelite to meet Navy specifications, 17P4-CFG. Removable jewel holder, of snap-in type, permits change of lamp from front of panel. 3/8" between terminals. Designed for Mazda 6S6 lamps. Selection of jewel colors: red, green, amber, blue, opal and clear—specify choice when ordering.

Ask for the New Gothard Catalog of other models.

Gothard

MANUFACTURING COMPANY
1335 North Ninth Street
Springfield, Illinois

20-WATT UNIVERSAL AMPLIFIER

Plug in for A.C. or 6-volt auto battery; no power pack necessary. Uses mike and built-in phono at same time. 78 R P M motor, 9-inch turntable, crystal pick-up, separate on-off switch. Long-playing needle included. Continuously variable tone control on

inclined eye-level control panel. Use one or two 8-ohm speakers without need of extra transformer. Has one 6SJ7GT, one 6SC7, two 6L6Gs in push-pull, two 6X5GTs. Model 6720, with tubes, F.O.B. New York \$56.28 Model 6721, same as 6720, less phono player, \$42.87

TERMINAL RADIO CORP.

85 CORTLANDT ST. NEW YORK 7, N. Y.
PHONE WOrth 2-4415

NEWS BRIEFS

(Continued from page 79)

approved a revision of the American Standards for Lightning Arresters, first approved in 1936. These apply to substantially all the arresters designed for the protection of alternating current power circuits.

The standard enumerates certain operating conditions to be considered when selecting the arrester rating to avoid unnecessary damage to the arrester by misapplication. The standard is intended to be self-contained in respect to definitions, and new definitions for wave front, wave tail and wave shape are included. Standards also cover performance characteristics, service conditions and tests for lightning arresters.

One of the revisions made in this standard improves the technique of impulse testing in the measurement of both voltage waves and current waves.

These standards (C62.1-1944), are available from ASA, 29 West 39 Street, New York 18, N. Y. at 30 cents a copy.

FARNSWORTH TELEVISION BROCHURE

A 26-page booklet entitled "The Story of Electronic Television" has been released by the Farnsworth Television & Radio Corporation. The booklet offers a simplified analysis of television reception and transmission. It is profusely illustrated with color pictures.

CROCKETT NOW MERIT COIL S-M

John I. Crockett, Jr., has been named sales manager of Merit Coil & Transformer Corp., 311 No. Desplaines St., Chicago 6, Ill. He was previously with Thordarson Electric Mfg. Co., where he was chief expediter.

WM. H. KELLEY JOINS MOTOROLA AS SALES MANAGER

Wm. H. Kelley has been named general sales manager of the Galvin Manufacturing Corp., 4545 Augusta Blvd., Chicago 51, Ill.

Mr. Kelley was formerly with RCA as regional manager of the San Francisco district.

The management of the Motorola sales and products organization is otherwise unchanged, according to Paul V. Galvin, president. Elmer H. Wavering will continue to head the car radio division, Walter H. Stellner will continue as manager of the home radio division, and N. E. Wunderlich remains sales manager of the police radio division. Advertising and sales promotion activities will be handled by Victor A. Irvine.



PIONEER GEN-E-MOTOR NOW CORP.

The properties, assets and effects of Pioneer Gen-E-Motor of Chicago, a limited partnership, have been transferred to Pioneer Gen-E-Motor Corporation.

FLOYD MASTERS NEW STEWART-WARNER RADIO DIV. MANAGER

Floyd Masters, midwest district manager for Stewart-Warner Corporation appliances, has succeeded L. L. Kelsey as manager of the company's radio division. This division will be reconverted to the manufacture of a-m and f-m consumer radio sets as soon as the war is over. Mr. Kelsey is now with Belmont Radio.

AMPEREX REORGANIZES

Amperex Electronic Products, Brooklyn, N. Y., will hereafter be known as Amperex Electronic Corporation, and A. Senauke will serve as president.

N. Goldman, senior partner, has retired because of illness.

Nicholas Anton will serve as vice president

AT 100 MC

POWER FACTOR 0.0033

DIELECTRIC CONSTANT 3.57

DILECTENE

A CONTINENTAL-DIAMOND

ENGINEERED U-H-F

INSULATING PLASTIC

◆ STABLE UNDER

◆ High Humidity

◆ Temperature Extremes

◆ Mechanical Stress

◆ Chemical Conditions

◆ READILY MACHINED

For complete technical data, send for Bulletin DN

CONTINENTAL-DIAMOND FIBRE COMPANY

NEWARK 51
DC

DELAWARE

PREMAX

ON SEA ON LAND IN THE AIR

Premax Antennas are serving the armed forces in every part of the world. When it's over, we'll be back with complete lines.

After V-Day Comes
Watch For
Premax

RADIO ANTENNA

Premax Products

Division Chisholm-Ryder Co., Inc.
4401 Highland Avenue, Niagara Falls, N. Y.

charge of manufacturing and Samuel Norris vice president in charge of sales. In the reorganization, Amperex becomes affiliated with North American Philips Company,



Samuel Norris

WEXLER AND DENIUS JOIN MECK

Charles R. Wexler and Homer R. Denius have joined the staff of John Meck Industries, Plymouth, Indiana. Mr. Wexler, who is taking over the post of chief engineer, was formerly with Ken-Rad Tube & Lamp Works and the Magnavox Corporation of Fort Wayne. Mr. Denius, new plant manager of Meck's electronic division, was previously associated with the Mosley Corporation.



Chas. R. Wexler

H. R. Denius

ALTEC-LANSING AUDIO REACTOR DATA

An 8-page reprint of a paper "High-Q Audio Reactor Design and Production," which originally appeared in the March issue of COMMUNICATIONS, has been released by Altec-Lansing Corporation, 1210 Taft Building, Hollywood 28, California. Colin A. Campbell, plant engineer, is the author.

CANNON ELECTRIC CHART NO. 3

A publication of Chart No. 3, "The Cannon Type K & RK Wall Chart," has been announced by Cannon Electric Development Company, 3209 Humboldt Street, Los Angeles, California. The chart may be used as a visual aid on K and RK connectors by aviation schools, aircraft plants, air depots, flying fields, aircraft repair shops, and others, for the instruction, identification, assembly, ordering, servicing or repair of the connectors. It measures 38"x50", and may be obtained without cost upon request.

G. E. POSTWAR RADIO-TELEVISION CATALOG

A 28-page, four-color catalog on postwar prospects of radio and television has been issued by General Electric Company, 1 River Road, Schenectady, New York. The catalog, "Your Coming Radio," forecasts through illustrations, the innovations which will be available to the public after the war, from improved tubes to late model cabinet designs.

WCEMA ADDS SIX MEMBERS

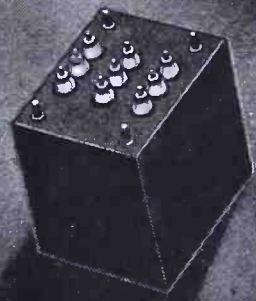
Six new members have been accepted into the West Coast Electronic Manufacturers Association. They are: Brittain Sound Equipment Co., Los Angeles; Merle F. Faber—Manufacturing, San Francisco; Harvey Machine Co. Inc., Los Angeles; Howard Pacific Corp., Los Angeles; The Lake Mfg. Co., Oakland; and Special Electric Laboratories, Los Angeles. This brings the total membership to more than fifty.

JENNINGS VACUUM CONDENSER FOLDER

A 4-page folder describing the 20-ampere series VC 6-50 vacuum condenser, is being distributed by Jennings Radio Manufacturing Company, San Jose, California. The folder features a (Continued on page 82)



Battle-Tested!

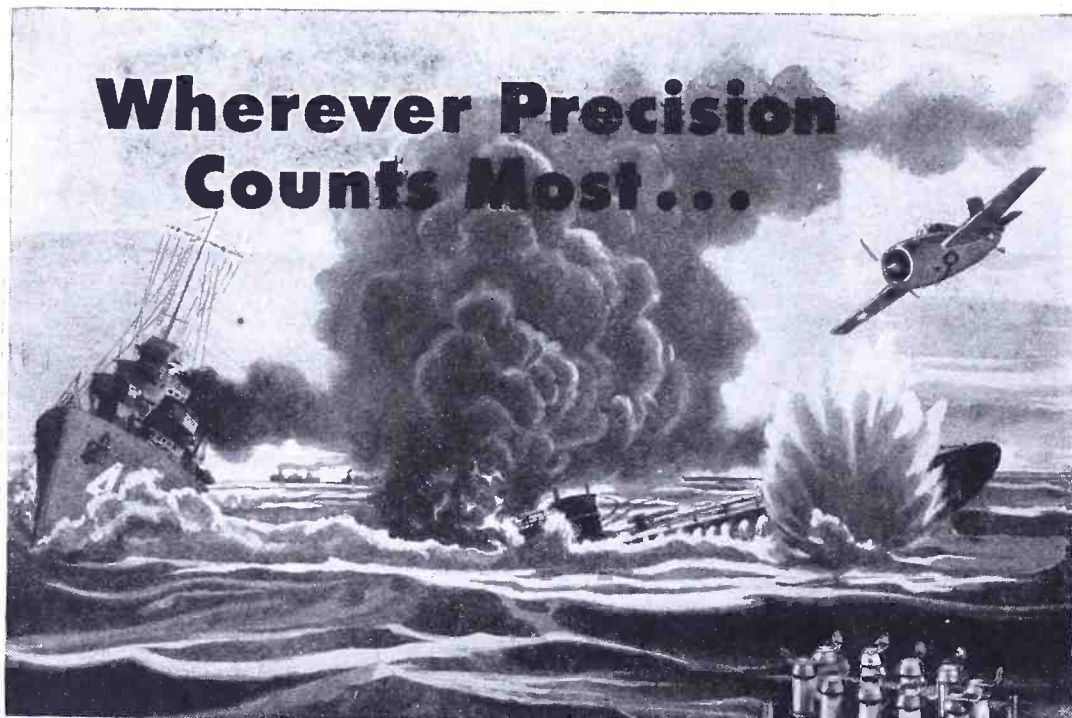


Before a Stancor Transformer is shipped, it is "certified for service" by engineers whose tests simulate actual conditions in the field... Because "Stancor" is battle-tested—right in our extensive laboratories—it has covered itself with glory on the battlefield. This is your assurance of the efficient performance of Stancor Products to which you may confidently look when the domestic market returns.

STANDARD TRANSFORMER CORPORATION
1500 NORTH HALSTED STREET • CHICAGO 22, ILLINOIS



**ANTENNAE
& ASSOCIATED PRODUCTS**



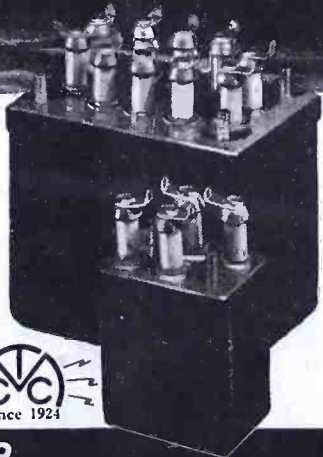
Products of "MERIT" are passing the test

Complying with the most exacting requirements for precision workmanship and durable construction. MERIT has established its ability to produce in quantity and deliver promptly—

Transformers • Coils • Reactors • Electrical Windings of All Types for Radio, Radar and Electronic Applications.

Today these dependable MERIT precision parts are secret weapons; tomorrow when they can be shown in detail as MERIT standard products you will want them in solving the problems of a new electronic era.

Illustrated: High Voltage Transformers A-2123 (small) and A-2124. Designed for high altitudes. Oil-filled and Hermetic sealed.



MERIT COIL & TRANSFORMER CORP.
311 North Desplains St. CHICAGO 6, ILL.

NEWS BRIEFS

(Continued from page 81)

temperature versus capacity curve, operating characteristics, and design data.

**LESLIE THOMAS NOW
SOLAR WORKS MANAGER**

The Solar Manufacturing Corporation of Bayonne, New Jersey, has appointed Leslie C. Thomas as works manager. Mr. Thomas was formerly vice president and works manager of International Resistance Corporation.



**SPRAGUE DRY ELECTROLYTIC
CAPACITOR CATALOG**

A 28-page catalog, No. 10, describing dry electrolytic capacitors has been released by Sprague Electric Company, North Adams, Mass. The catalog describes the combination of capacity and voltage ratings available, with special electrical characteristics and in containers for every mechanical requirement. Types cataloged include cardboard and metal tubulars, cylindrical metal container types, high-capacity low-voltage cylindrical "FP" types, octal base, a-c motor starting, and special purpose types. Pages are also devoted to application notes including a number of typical characteristic charts.



**LAPORT AND KNOX RECEIVE NEW
RCA INTERNATIONAL POSTS**

Edmund A. Laport has been appointed staff engineer for international communications systems and special apparatus at RCA, Camden, N. J. James B. Knox succeeds Mr. Laport as chief engineer for engineering products at RCA's Canadian subsidiary, RCA Victor Ltd.

In 1928 Mr. Laport built three mobile railway transmitter stations for the Chinese government at Peking and Tsientsin. Later he installed Rome's 1 RO (located near the Anzio beach head) and Milan's 1 MI.



J. B. Knox



E. A. Laport

OPERADIO DISTRIBUTOR BULLETIN

The first issue of a news-letter, "The Operadio Bulletin," is being mailed to distributors, source service men, and industrial music outlets by Operadio Manufacturing Company, St. Charles, Illinois. Additional news-letters are expected.

EASTERN PUMPS FOR VACUUM TUBE COOLING SYSTEMS

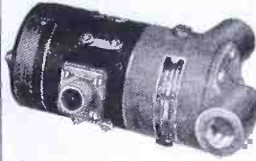
Five different models of small centrifugal pumps designed for circulating water through the cooling systems of communication and X-ray tubes have been successfully designed by Eastern Engineering Company, long a leading manufacturer of small pumps for big jobs. These pumps may be had for either land, sea or airborne installations.

AIRBORNE MODELS

(Designated as the AR Series)

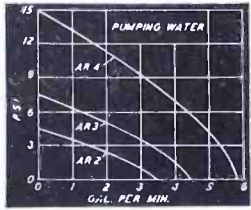
These are designed in conformance with Army and Navy standards. They have the following outstanding features:

- EXTREMELY LIGHT WEIGHT • COMPACT • INTEGRAL PUMP AND MOTOR UNIT • EXPLOSION PROOF • VARIED PERFORMANCES AVAILABLE • OPTIONAL VOLTAGES • LONG LIFE - CONTINUOUS DUTY • DEPENDABLE OPERATION • UNIVERSAL MOUNTING



The pump and motor are one integral unit weighing but two and one-third pounds and measuring over-all 5 3/8" x 4 1/2" x 2 1/2".

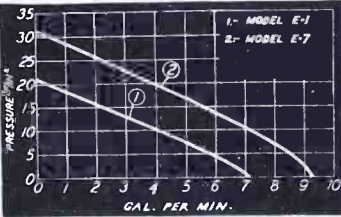
Performance up to 11 P. S. I. and up to 5 gallons per minute. Models are available in standard 12 and 24 volt D. C. ratings. Shown are performance curves for the AR2, 3 and 4. All models have long life and are rated for continuous duty with the exception of model AR4, which under 8 P. S. I. is rated for intermittent duty. While the curves shown are those for which production is now standard, it is readily possible to obtain other characteristics where quantity is involved.



The pump is equipped with a mechanical rotary seal which positively seals against any leakage. This seal is adjusted at the factory and tested under excessive pressure. Once the pump has been released from the test room no further attention or maintenance is necessary for either motor or pump during the life of the unit.

LAND AND SEA MODELS

(Designated as E-1 and E-7)



Both are centrifugal pumps, powered by General Electric Universal Motors. Model E-1 is 7" x 3 3/8" x 3 3/8", 1/15 H. P., weighs 6 lbs. and has a Maximum Pressure of 20 lbs. P. S. I. with a Maximum Capacity of 7 G. P. M. Model E-7 is 9" x 4" x 4", 1/5 H. P., weighs 8 lbs. and has a Maximum Pressure of 30 lbs. P. S. I. and a Maximum Capacity of 9 G. P. M. Performance curves for both models are shown above. Both of these models are designed for long life. They are equipped with mechanical rotary seals which completely seal the pumps against leakage. While the curves shown are those for which production is now standard, it is readily possible to obtain other characteristics where quantity is involved. They can be obtained with motors to meet Navy Specifications.

EASTERN ENGINEERING COMPANY
171 FOX STREET - NEW HAVEN 6, CONN.

dealers of sales developments and electronics trends. Fred Wilson, sales manager for the commercial sound division, is editorial director of the bulletin.

McNAMEE AND AKIN JOIN LITTELFUSE

Littelfuse, Inc., of Chicago, Illinois, and El Monte, California, has announced the appointment recently of Bernard F. McNamee as head of electronic research, and R. G. Akin as mid-west division sales manager.

Mr. McNamee was formerly director of the engineering department of Consolidated Engineering Corporation, Pasadena. His previous associations include service with Wagner Electric Company, the Echophone Company, Colin B. Kennedy Corporation, Rieber Laboratory, Moorehead Laboratories, and the Superior Oil Company.

GIRARD-HOPKINS CATALOG

A 12-page catalog describing dry and wet electrolytics, paper tubulars, filter capacitors, oil-filled capacitors, interference filters and power factor capacitors has been published by Girard-Hopkins, Oakland, California.

HUDSON-AMERICAN ENGINEERING DIGEST

A digest of outstanding technical papers appears in the first issue of the "Radio Engineers Digest," published by the Hudson-American Corporation, 25 West 43 Street, N. Y. City, edited by John F. C. Moore. Included in this issue is Professor Paul Hudson's paper on "Demodulation Waves" which appeared in the April issue of COMMUNICATIONS.

DIALCO DATA CATALOG

A 24-page catalog, No. 43, has been issued by Dial Light Company of America, Inc., 900 Broadway, New York 3. Photographs, diagrams, charts, physical and electrical characteristics, and other general information on Dialco pilot light assemblies and accessories are given.

Openings for . . . RADIO ENGINEERS ELECTRICAL ENGINEERS MECHANICAL ENGINEERS

In the development and production of all types of radio receiving and low-power transmitting tubes. Excellent post-war opportunities with an established company in a field having unlimited post-war possibilities.

Apply in person or in writing to:
Personnel Manager

**RAYTHEON
MANUFACTURING CO.**

Radio Receiving Tube Division
55 Chapel St., Newton 58, Mass.



MEASURES QUANTITIES

with greater
sensitivity & range
than ever before
accomplished



PATS. APP. FOR

TECH LAB MICROHMETER

. . . gives direct and instantaneous readings of resistance values down to 5 microhms and up to 1,000,000 megohms. Accuracy in all measurements to better than 2%. Output is sufficient to drive recorder. Entirely AC operated. Furnished in two models. Reasonably prompt deliveries. For complete data regarding other applications write for Bulletin No. 432.

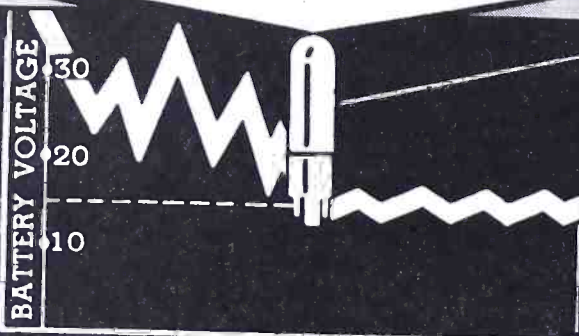


Quality manufacturers of attenuators and other electrical resistance instruments. For complete data write for Bulletin No. 431.



1 LINCOLN STREET
JERSEY CITY 7, N. J.

ENGINEERS: Here's the BIG POINT about **AMPERITE REGULATORS**



VOLTAGE OF 24V
BATTERY & CHARGER
VARIES APPROX.

50%

WITH AMPERITE
VOLTAGE VARIES
ONLY

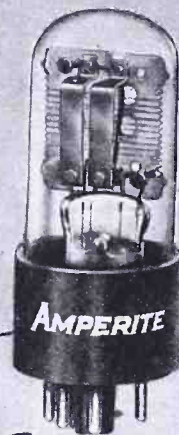
2%

DELAY RELAYS: For delays from 1 to 100 seconds.
Hermetically sealed. Unaffected by altitude. . . . Send for catalogue sheet.

NEW! 4-page folder will help you solve Current and Voltage Problems;
contains much valuable data in practical form—Write for your copy now.

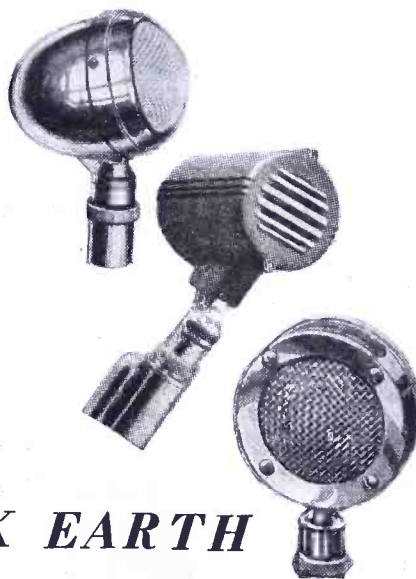
AMPERITE CO., 561 Broadway, New York (12), N. Y.

In Canada: Atlas Radio Corp., Ltd., 560 King St., W. Toronto



Features:

1. Amperites cut battery voltage fluctuation from approximately 50% to 2%.
 2. Hermetically sealed — not affected by altitude, ambient temperature, humidity.
 3. Compact . . . light . . . and inexpensive.
- Used by U.S. Army, Navy, and Air Corps.



OUT OF THE BLACK EARTH

ASTATIC has so planned it that out of black earth come beautiful flowers and the foods essential to our very sustenance. And so it is that from the darkness of the present hour . . . from the suffering and sacrifice of world war . . . will emerge a greater degree of understanding among men . . . more freedom for untold millions . . . and advanced ideas to make man's burdens lighter and life more enjoyable. Astatic, like so many other manufacturing concerns, has been broadened by the experience of war production, has employed its engineering skill and manufacturing facilities to create new products, the principles of which will be reflected in Astatic's commercial and civilian products of a new day.

ASTATIC

IN CANADA:
CANADIAN ASTATIC, LTD.
TORONTO, ONTARIO

THE ASTATIC CORPORATION
YOUNGSTOWN, OHIO

THE INDUSTRY OFFERS . . .

(Continued from page 62)

tic or corrosive fumes, oil, grease, acids, alkalis or moisture.

A general sample for testing will be sent by the manufacturer on request.

* * *

SPERTI HERMETIC SEALS

Hermetic seals of glass and a metal that has an expansion coefficient similar to glass and said to be capable of withstanding severe thermal shock, are now being produced by Sperti Inc., Cincinnati, Ohio. The seal is said to provide a vacuum-tight bond that resists any type of corrosion, atmospheric or liquid. Each seal can be soldered to plates and cases by means of high frequency oven soldering or standard soldering iron and the soldering temperature is not critical. Two small eyelets on both ends of the protruding shaft of the seal allow for wire attachment to transformers, condensers, relays and miscellaneous radio components. A hydrogen pressure-test for leaks and many other rigid inspections are part of the manufacturing process.

The glass insulation is said to provide a high flash over seal which will not carbonize. Navy immersion tests are said to show it to have a leakage resistance of 30,000 megohms, minimum. Has a thermal operating range from -70° C to 200° C.

Seals are available in special shapes and sizes either as single terminals or multiple headers. Some employ tubing instead of wire rod.



* * *

PLASTIC LACING CORD

Vinylite lacing cord for tying wire has been announced by the Art Chrome Company of America, 141 Malden Street, Boston 18, Mass.

Its specific gravity is said to be 1.30; tensile strength, 2400 psi; elongation at break, 250%; maximum operating temperature, 70° C. Power factor at 1,000 cycles per second and at 30° C is 126.

Not soluble in alcohols or carbon tetrachloride.

* * *

PRICE ROTARY RELAY

Relays operating on a rotating balanced principle have been announced by Price Brothers Company, Frederick, Md.

The basic unit of the relay, known as "Rotrol," is said to be a compact driving mechanism providing up to 30° of clockwise or counter clockwise rotation.

When used to operate switch wafers, it is said to provide a variety of contact arrangements adaptable for spaced wafer switches or switches in separate compartments. Where switch wafers are not used a special self-contained coil break switch is provided.

Measures 2½"x1½"x1¼".

* * *

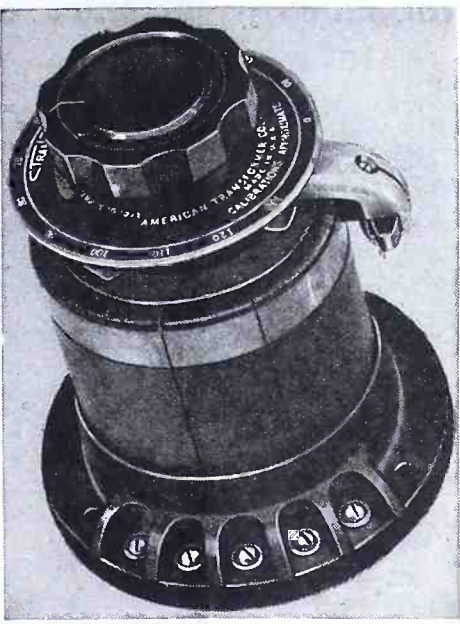
AMERTRAN TH TRANSTAT

A transformer type a-c voltage regulator, type TH Transtat, has been developed by American Transformer Co., 172 Emmet Street, Newark 5, N. J. The brush arm is a machine die casting. The shaft is independent of the brush arm assembly and can be removed by drawing one pin. Thus, the unit can be changed from panel mounting to table mounting or ganged with other units for polyphase or simultaneous single phase control. By employing a phenolic thermosetting plastic base, high dimensional conformance is said to be assured and accidental lead shorting is prevented.

Unit also features vinyl acetal insulated wire, impregnated core and coil with synthetic phenolic resin varnish of the polymerized type, and a dual-mounting arrangement for open delta three-phase control.

Type TH-2½A Transtat, 50-60 cycles, 115 volts, for single-phase operation, 35° C rise, has a nominal va of 250, output volts of 0-115 and output amperes 2.17; a maximum va of

0, output volts of 0-130, output amperes 2.17. At 50° C rise, nominal va is 300, output volts 115, output amperes 2.6; maximum va is 340, output volts 0-130, output amperes 2.6. Type TH-2X-2½A Transtat dual unit, open delta connected for 3-phase regulation, 50-60 cycles, 115 volts, 35° C rise, has a nominal va of 435, output volts 0-115, output amperes 2.17; maximum va of 485, output volts 0-130, output amperes 2.17. At 50° rise, nominal va is 520, output volts 0-115, output amperes 2.6; maximum va is 590, output volts 0-130, output amperes 2.6. Output voltages are full load voltages. No load voltages may be expected to be approximately 5% higher. Exciting current is 0.06 amperes. Voltage increments are 0.4 throughout range of control. Single unit weighs 5.5 pounds; dual unit 12 pounds.



3-POINT PIPE GAGE

A three-point pipe gage to measure pipe from 1/8" to 12", and electrical conduit and metallic tubing, has been produced by the Three-Point Gage Co., 3821 Broadway, Chicago 13, Ill. Gage is pocket size. Consists of two pivoted steel plates with edges curved at three points for contact with the pipe or tubing to be measured, together with scales which register standard sizes of electrical metallic tubing (thin-wall tubing) and conduit, and also correct sizes of pipe in terms of inside measurement. A third scale shows drill size for tapping. Also included is an inch rule and metric rule. Constructed of steel, finished in black rust proof finish. Size, when closed, 2 3/4" x 4 1/2".

FUNGUS COATING

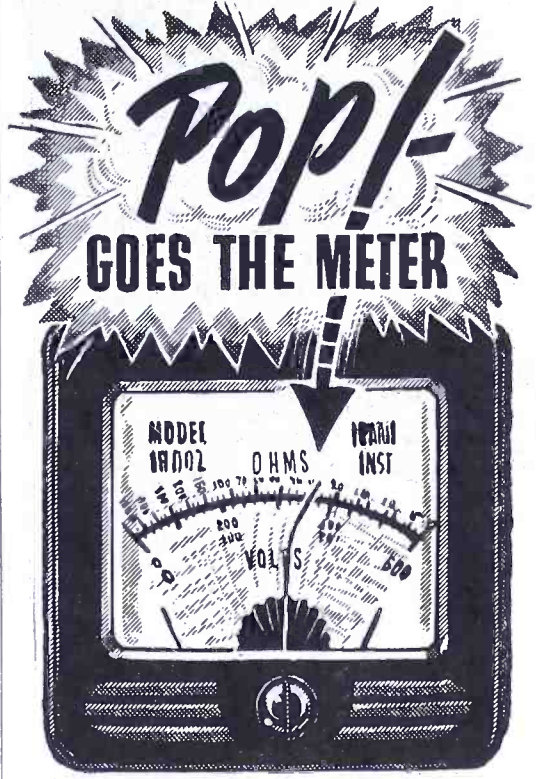
Moisture and fungus resistant coating for over-all treatment of assembled ground equipment, has been announced by Insl-x Co., 857 Meeker Ave., Brooklyn, N. Y. Approved under Signal Corps, spec. 71-2202 A. The material, Insl-x No. 25-A, is said to become "tack-free" in less than 15 minutes... hard in less than an hour. It is said to be non-toxic to humans. Official tests are also said to show Insl-x No. 25A will not cause dermatitis.

PIVOT TYPE BALL BEARINGS

Pivot type ball bearings are now available from Miniature Precision Bearings, Keene, New Hampshire, in sizes ranging from 2-10 mm o-d. Made of beryllium, stainless or chrome steel as required for the application. Bearing races are machined from solid bar stock and finished on raceway and exterior surfaces. Each bearing is equipped with four balls of the same material as the cup and fitted with a retaining cap.

VOLTAGE-BREAKDOWN TESTER

For testing voltage breakdown of materials. (Continued on page 86)

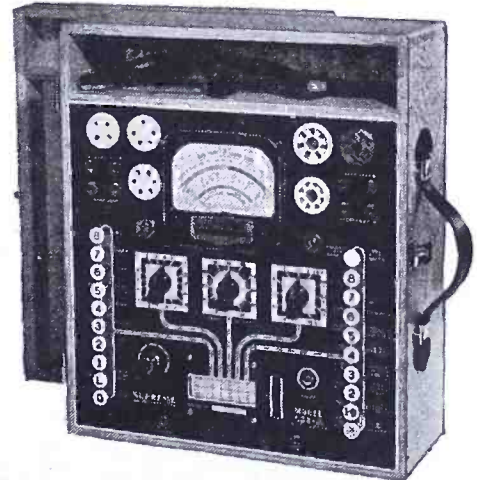


What happened to your meter when you made a miscue and slammed the pointer against the stops? Does the pointer above revive unpleasant memories?

Until Supreme started production of its own meters, the best general purpose meters available were secured for our test equipment. They were good... as good as any general purpose meter can possibly be. Today, however, Supreme built meters are designed for one specific field... the electronic service man.

Think back over the past years. How many days and dollars have you lost because of a slammed meter? No meter is indestructible, but these Supreme Meters can take it. Accurate? Yes! And double-rugged!

Investigate when considering post-war service equipment.



Supreme 504-A Tube and Set Tester. One of many test instruments incorporating a Supreme Meter.

SUPREME
SUPREME INSTRUMENTS CORP.
GREENWOOD, MISSISSIPPI, U. S. A.

The Answer
TO YOUR
PROCUREMENT PROBLEMS



MAY LIE
BETWEEN
THESE
COVERS!

OVER
10,000 ITEMS
IN STOCK

FAST DELIVERY
Assured on Priority

**RADIO PARTS
RADIO TUBES**

and

**INDUSTRIAL
ELECTRONIC
EQUIPMENT**

Send for
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800 Page
Buying Guide

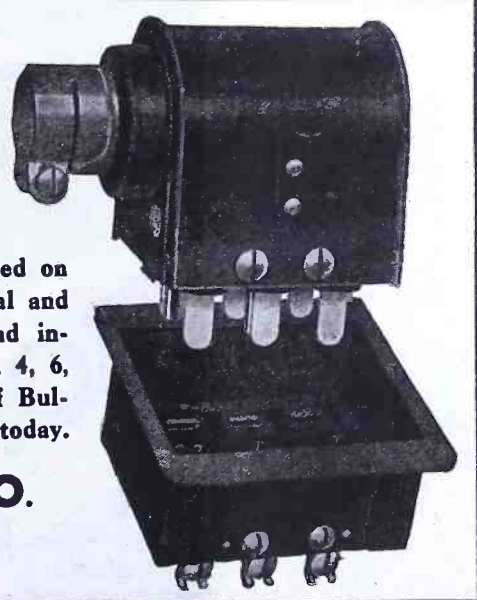
Available solely to
authorized purchasing
agents and engi-
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**SUN RADIO
& ELECTRONICS CO.**
212 Fulton Street, New York 7, N. Y.

**JONES 500 SERIES
PLUGS AND SOCKETS**

Designed for 5,000 volts and 25 amperes. All sizes polarized to prevent incorrect connections, no matter how many sizes used on a single installation. Fulfill every electrical and mechanical requirement. Easy to wire and instantly accessible for inspection. Sizes: 2, 4, 6, 8, 10, and 12 contacts. Send for a copy of Bulletin 500 for complete information. Write today.

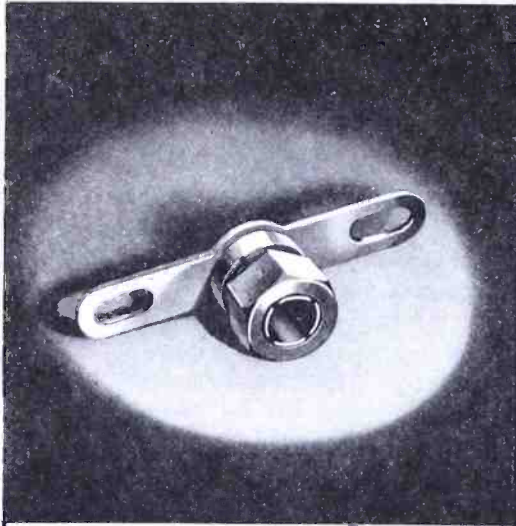


HOWARD B. JONES CO.
2460 W. GEORGE STREET
CHICAGO 18, ILL.

Designed for



Application



The No. 10060 Shaft Lock

Another exclusive Millen "Designed for Application" product is the No. 10060 shaft lock. This differs from the self-mounting No. 10061 unit in that it is mounted on a cross arm which can readily be attached to variable condenser frames, brackets, etc., for "behind the panel" applications.

**JAMES MILLEN
MFG. CO., INC.**

MAIN OFFICE AND FACTORY
MALDEN
MASSACHUSETTS



(Continued from page 85)

Industrial Instruments, Inc., 17 Pollock Ave., Jersey City, N. J., have developed a voltage breakdown tester. Operating range of instrument, type P-3, is 0 to 10,000 volts d-c, or 0 to 8,000 a-c. A lower range instrument, type P-1, with sloping panel, has a range of 0 to 4,000 volts d-c, or 0 to 3,000 volts a-c. The voltage is continuously variable over the entire range. Tester operates directly from 110-130 volt 50/60 cycle a-c line. Breakdown is indicated by a red signal light, while a built-in meter indicates the direct-reading voltage. Drawer-switch type fixtures are available. These fixtures have a jig to take given components or materials, and when the drawer is closed the voltage is applied. External connections are made by means of an insulated plug inserted in the high-potential a-c or d-c jack, with the other side grounded.

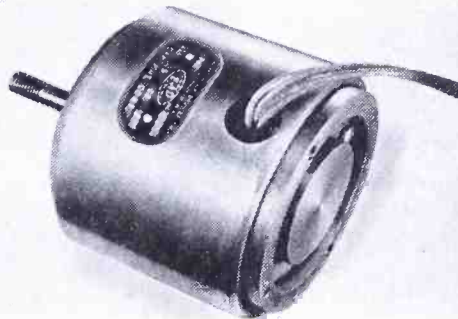
Housed in metal cabinet, 15"x21"x28".

EASTERN AIR 1/50 H-P MOTOR

Midget motors for driving blowers in high ambient temperatures and for powering small control devices of all types have been developed by Eastern Air Devices, Inc., 585 Dean Street, Brooklyn 17, N. Y.

Motors can be supplied to deliver 1/25 h-p.; can be wound for 2 or 3 phase and also furnished for 400-cycle applications at higher speeds and h-p.

Specifications: 60 cycles; 115 volts; single phase—3400 rpm; diameter 3 5/16"; overall length 3 1/8"; shaft diameter 5/16"; weight 3 pounds.



HYTRON MINIATURE TUBES

Three new miniature tube, types 6AK5 6AL5, 6AQ6, have been announced by Hytron Corporation, Salem, Massachusetts.

The 6AK5 is a sharp cut-off r-f pentode; 6AL5, a v-h-f twin diode; and the 6AQ6, a double diode triode.

VACUUM PACK STORAGE BATTERIES

A vacuum-pack type of storage battery has been developed by the Willard Storage Battery Company.

Four batteries—three 36-volt types and one 6-volt—are packed in a lead-plated metal container from which the air is exhausted. The batteries are said to retain their charge indefinitely and be ready for immediate use regardless of the time elapsed since their manufacture, or distance they have been transported from the factory.

When the batteries are about to be placed in service, the can is punctured by a special filling device and the vacuum inside the can draws the electrolyte quickly into 18 minia-

of seconds, says the manufacturer, each battery is filled with electrolyte. The 36-volt battery measures slightly over 4" in length, just under 1 1/2" in width and less than 1" in height; weighs six ounces. Its case is made of polystyrene.

GLASS-LENS INDICATING LIGHT

An indicating light for service on 120 volts, featuring a small diameter mounting hole and a threaded type lens-cap, is now available from The H. R. Kirkland Company, Morristown, New Jersey.

Known as the 590 D/E unit it mounts in a single 3/8" diameter hole.

The lens-cap is said to contain a heavy walled glass lens, cupped in shape. The tip of the S6 standard 120-volt lamp bulb extends into the cup of the lens, facilitating servicing of the bulb. This lens design is also said to provide 180° visibility. Lenses are available in red, green, blue, amber and white with the

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TECHNICAL NOTES

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

Phase Inverter Circuit

Last month, CREI presented the first part of a technical article describing the Phase Inverter Circuit. Part 2, which appears in the September issue of "THE CREI NEWS," gives a typical numerical example of the Phase Inverter Circuit and indicates the type of performance that can be expected.

Derivations are then made of the gain and stability of gain of such a stage and it is shown that very good results can be expected. Finally, an analysis of the input admittance is made, as well as remarks on some practical features of the circuit.

Each month "THE CREI NEWS" features such a technical article, in addition to other interesting features concerning The Institute and the industry. We shall be glad to add your name to the mailing list without obligation. Simply write to The Institute at the address below and request the September issue of "THE CREI NEWS" containing the article on the Phase Inverter Circuit.



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

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interior surface sand-blasted. Lenses are also available without sand-blasting in clear glass.

Socket is of the screw candelabra base type for use with the T4½ neon glow lamp bulb, as well as with the S6 tungsten bulb.

The D/E type lens-cap is also available with socket sections for use with other type lamp bulbs, such as the 555 D/E unit for G6 double-contact bayonet base bulbs, and the T3 D/E unit for single-contact miniature bayonet base T3¼ lamp bulbs.



CLAROSTAT WIRE-WOUND CONTROLS

A new version of the type 58 Clarostat wire-wound potentiometer or rheostat has been released by Clarostat Mfg. Co., Inc., 285-7 N. 6 St., Brooklyn, N. Y.

The new model has a metal strap on the shaft face, providing for a two-position locating pin. Metal strap also grounds the metal cover which is clinched to it. The cover is keyed in place on the casing. The bushing is keyed into the bakelite case. Uses high-grade molded bakelite.

The center rail and terminal comprise one piece. There is also a direct connection between winding and the *l* and *r* terminal lugs.

There is zero hopoff at terminal; 1500-volt breakdown insulation between winding and shaft. Switch can be added. Tandem units with two or more controls on common shaft, are available. Ratings: linear, 3 watts; V and W tapers, 2 watts; L, N and U tapers, 1.5 watts. Resistance values: linear, 1 to 75,000 ohms; tapered, 10 to 50,000 ohms.

STACKPOLE BRAZING CARBONS

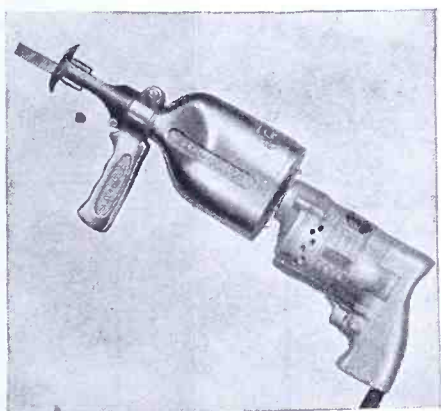
A treatment to increase the life of resistance welding or brazing carbons has been developed by the Stackpole Carbon Co., St. Marys, Pa. The treatment, known as "P" treatment, is said to reduce the need for frequent dressing of the carbons by two-thirds or better.

The new units are said to operate satisfactorily at brazing temperatures above red heat. Available in all shapes and sizes. Samples for test will gladly be sent to large users who request them on company stationery.

CHICAGO PRECISION ELECTRIC DRILL SAW AND FILE UNIT

An attachment for electric drills that is said to provide a portable power saw and file. Has been announced by Chicago Precision Equipment Company, 919 N. Michigan Ave., Chicago 11, Illinois.

According to the manufacturer, the new device will saw into metal, casting or rod, wood, plastics and other materials, by placing an ordinary hack-saw blade in the holder with the teeth toward the operator.



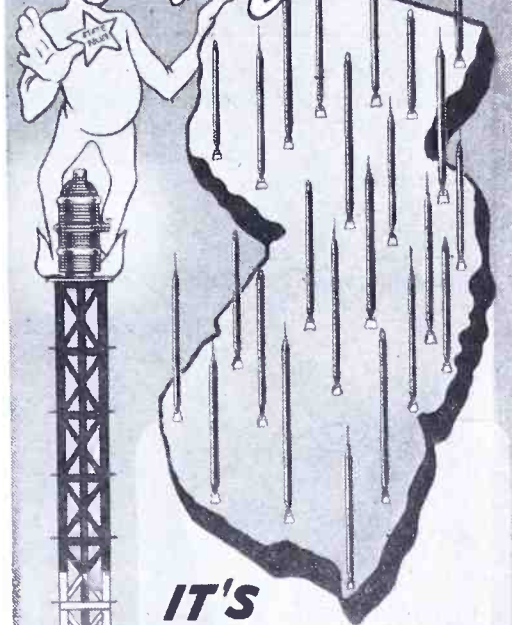
VOLT-OHM MILLIAMMETER

Six a-c/d-c voltage ranges, 7 d-c ranges, 5 resistance ranges and an a-c range are provided in a volt-ohm milliammeter developed by Superior Instruments Co., 227 Fulton Street, N. Y. 17, N. Y.

The d-c and a-c voltage ranges, at 1,000 ohms per volt, are 0 to 15/60/150/300/600/1,500. Current ranges (d-c) are 0 to 3/15/60/150 ma; 0 to

(Continued on page 90)

IN New Jersey



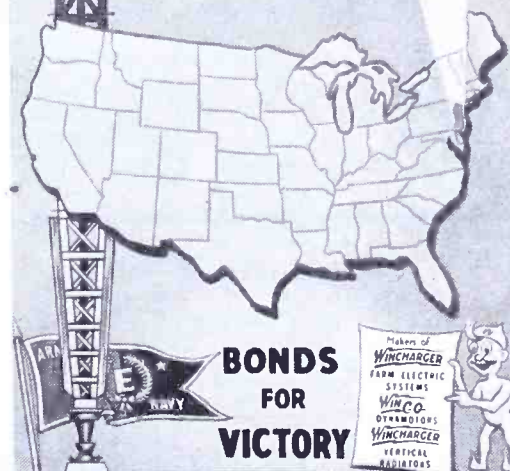
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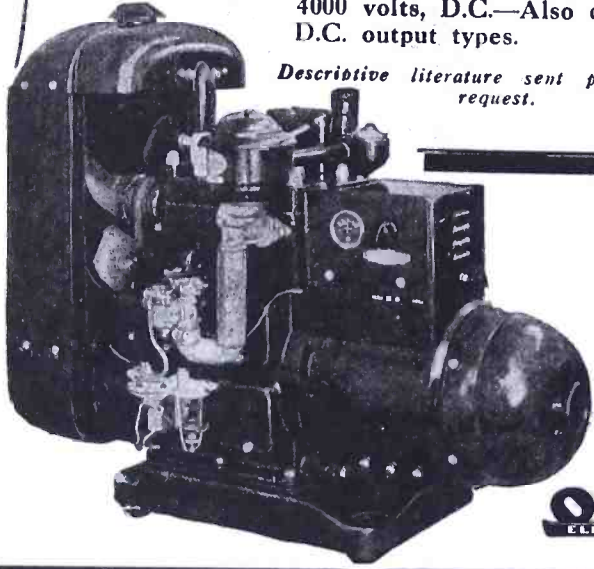
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Descriptive literature sent promptly on request.



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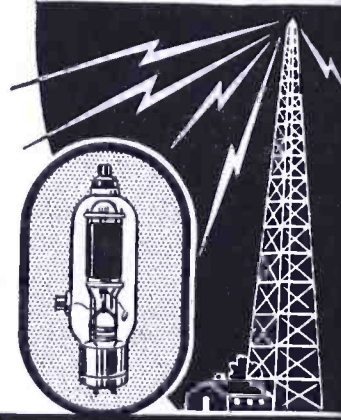
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ORDERS SUBJECT TO PRIORITY
PETERSEN RADIO CO., Council Bluffs, Iowa

ACOUSTICAL SOCIETY REPORT

(Continued from page 38)

source on a steel track, the position of the microphone being remotely controlled by *Selsin* motors. The positions of equal phase are recorded by photographing a reference scale against a steel tape

Figure 4, below
Block diagram of components in phase measuring assembly, analyzed by Professor Leonard.

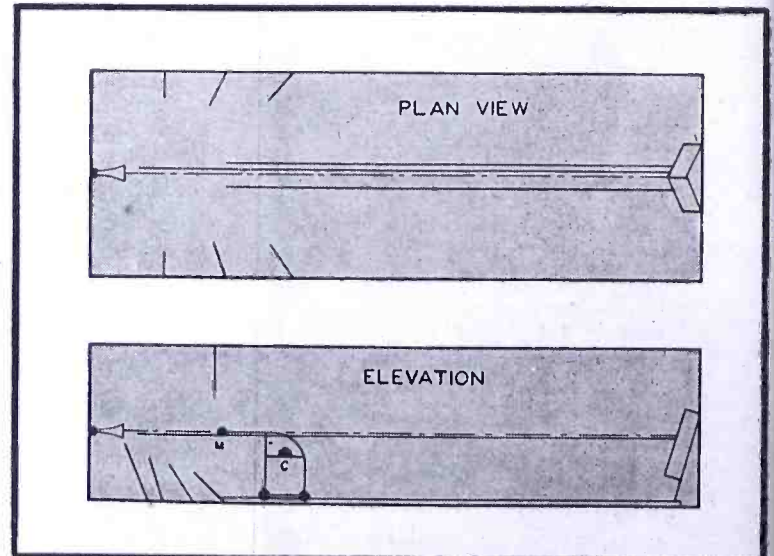
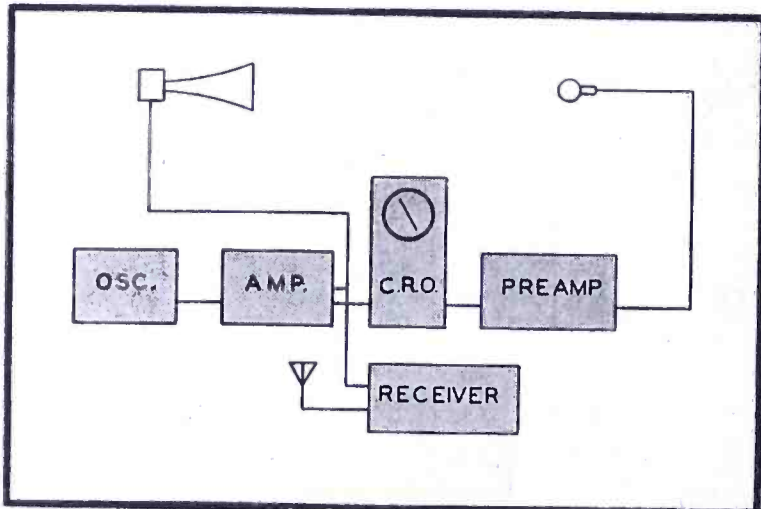


Figure 5
Plain and elevation views of the room in which measurements discussed by Professor Leonard are made. The walls and ceiling of the room are covered by 2" of rock wool backed by 6" air space. The ceiling of the room is several feet below the surface of the ground, which accounts for the minute variations, which are of the order of .03° C. during the day.

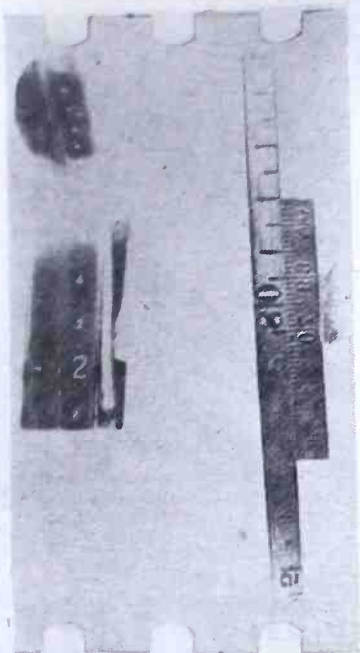


Figure 6

A typical photograph revealing the simultaneous recording of temperature and distance measurements on film. Camera is actuated by a solenoid when the proper position of the microphone is located by the pattern on the scope. Note: This negative was reversed. The tape should read from left to right.

stretched parallel to the axis of the source. The camera and reference scale move with the microphone. Wavelength measurements are made over an interval of 10 meters. The source frequency is determined by beating one of its harmonics with the carrier frequency of a commercial broadcasting station. Harmonics of the order of the 100th are generated in a suitable diode circuit.

Temperature measurements are made by means of thermocouples distributed along the line of measurement. Humidity is determined by a gravimetric method. A sample of air of known volume is passed through a drying tube and the change in weight of the tube determined. Since it is unnecessary for the operator to enter the room during or immediately previous to making the measurements, temperature gradients and turbulence are at a minimum.

Professor Leonard stated that he felt the method used has a greater potential accuracy than any yet employed for three reasons. First, it reduces to a negligible amount the diffraction effects of a large source. Second, with the proper treatment of the walls now planned, reflections will have no measureable effect on the average wavelength. And third, the room in which the measurements are made has a unique temperature and humidity stability.

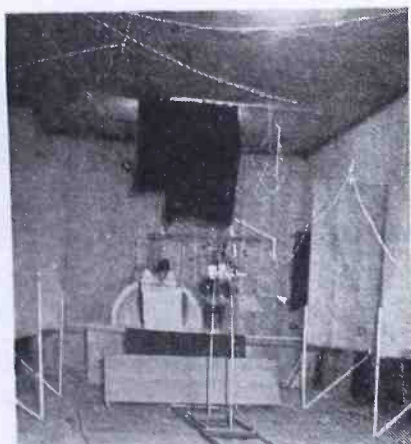
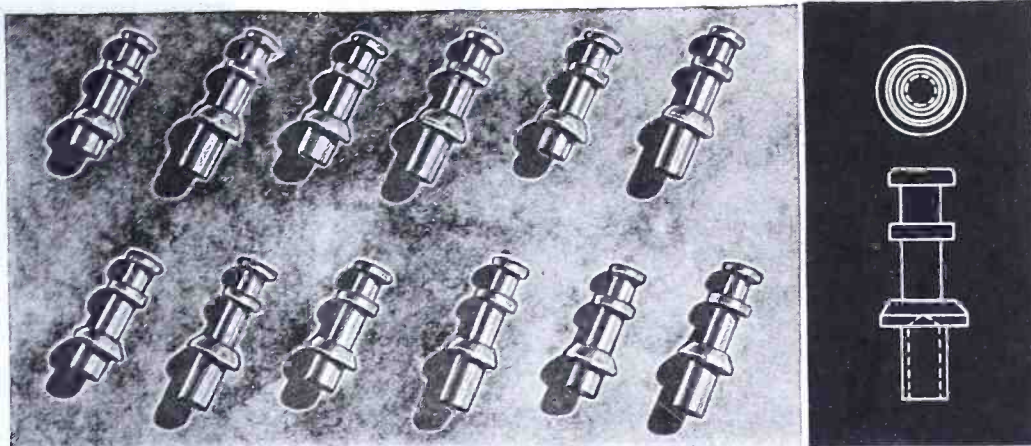


Figure 7

Room interior, looking toward sound source. Cart carrying the microphone and camera is at far end of the track.



Short Cut to TURRET TERMINALS

C.T.C. TURRET LUGS fill the bill when you want swift, sure, easy-to-apply terminals. Just swage them to the board and in a jiffy you've got uniform, firm terminals.

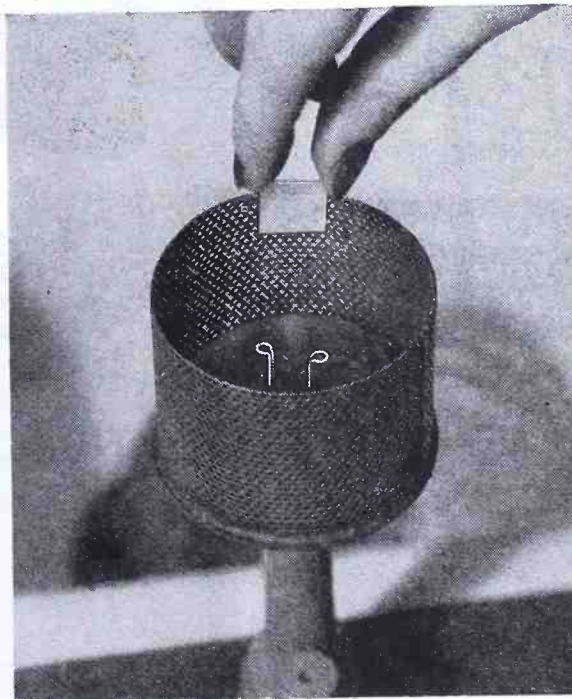
These heavily silver plated TURRET LUGS are easy to solder to and contact is perfect. The amount of metal used in their construction has been carefully calculated to give them maximum strength, yet not enough is used to draw heat, thus slowing down the soldering operation.

No time lost getting them, either. TURRET LUGS to fit a wide range of terminal board thicknesses are stock items with us. Just specify the thickness you require and we'll send them on their way to you in a hurry. Write, phone or wire



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A New TWIST TO CRYSTAL CLEANING



THIS is an actual photograph of the centrifugal air drier, or "spinner," used in Bliley production to facilitate clean handling of crystals during finishing and testing operations. Quartz blanks are dried in 5 seconds in this device which is powered with an air motor and spins at 15,000 r.p.m.

Little things like lint or microscopic amounts of foreign material can have a serious effect on crystal performance. The "spinner" eliminates the hazards encountered when crystals are dried with towels and makes certain that the finished product has the long range reliability required and expected in Bliley crystals.

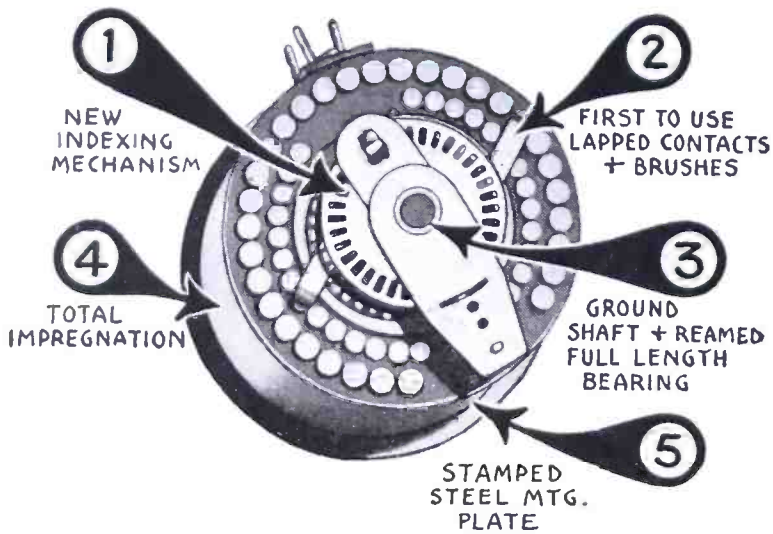
This technique is only one small example of the methods and tests devised by Bliley Engineers over a long period of years. Our experience in every phase of quartz piezoelectric application is your assurance of dependable and accurate crystals that meet the test of time.

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Bliley Crystals





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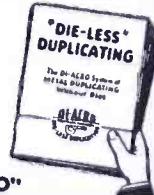


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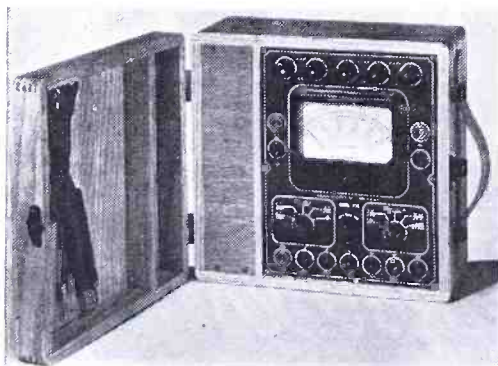
O'NEIL-IRWIN MFG. CO.

322 EIGHTH AVE. SO., MINNEAPOLIS 15, MINN.

THE INDUSTRY OFFERS . . . —

(Continued from page 87)

3/15/30 amperes. The a-c range is 0 to 3 amperes. Resistance ranges are 0 to 1,000/10,000/100,000 ohms and 0 to 1 megohm. Meter is 4 1/2" square, 0-400 microamperes. Size, 6" x 10" x 10"; weight, 11 pounds.



A-N STANDARDIZATION

(Continued from page 37)

at 85°, for example, ± 200 parts per million per degree Centigrade =

$$\frac{\pm 200}{10^6} \times 100 (85^\circ - 25^\circ) = \pm 1.2\%$$

or at -43° C

$$= \frac{\pm 200}{10^6} \times 100 (-40^\circ - 25^\circ) = \pm 1.3\%$$

This chart should prove helpful to design engineers in selecting capacitors re-

quiring definite limits of capacitance—change with temperature. It is no longer necessary to have numerous charts and data sheets showing the temperature characteristics of several manufacturers' types of capacitors.

Capacitance

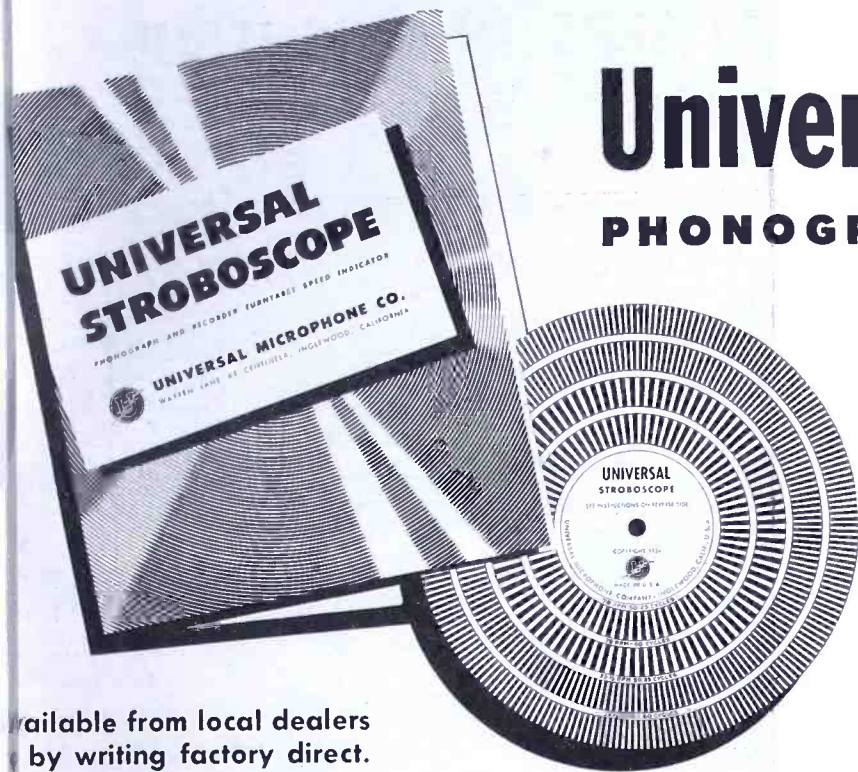
Standard capacitance values in micro-microfarads are denoted by a three-digit numerical code. The first two digits are the first two significant figures; the third digit is the number of zeros which follow: 050 = 5 mmfd; 513 = 51000 mmfd.

Tolerance

Standard tolerance values are all sym-

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Available from local dealers
by writing factory direct.

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UNIVERSAL MICROPHONE CO.

INGLEWOOD, CALIFORNIA

metrical and designated in accordance with the following table:

- G = ± 2%
- J = ± 5%
- K = ± 10%
- M = ± 20%

A typical *standard* type designation would thus be *CM20B471M*. This designation gives a complete description of the unit—maximum dimensions 51/64" × 15/32" × 7/32", B characteristic, 470 mmfd capacitance and ± 20% tolerance.

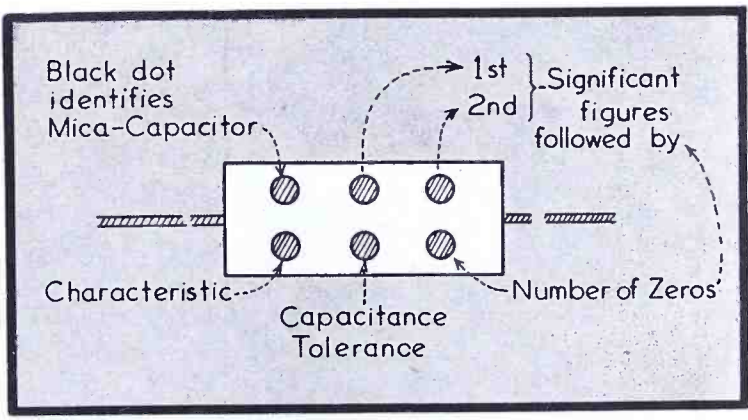
Each *standard* type designation carries a specific voltage rating as listed in the specification. For this reason the need for a voltage indicator is unnecessary in the type designation or the color code. The voltage table shows the standard voltage ratings for ranges of capacitance in each case size. It is to be noted that case sizes *CM35* and larger have multiple voltage ratings; the higher values of capacitance in a given case size of necessity have reduced voltage ratings.

Design engineers can now specify their exact needs for each application since the *standard* type designation itself specifies all-important electrical and physical characteristics. The designer knows that complete interchangeability between manufacturers' *standard* types is assured by specifying a *standard* type designation. Manufacturers and designers are thus on a common level and have a mutual understanding of exactly what is required and what is available.

Color	Capacitance		Tolerance (Per Cent)	Characteristic
	Significant Fig.	Decimal Multiplier		
Black	0	1	20 (M)	A
Brown	1	10	2 (G)	B
Red	2	100		C
Orange	3	1,000		D
Yellow	4			E
Green	5			F
Blue	6			G
Violet	7			
Gray	8			
White	9		5 (J)	
Gold	..	0.1	10 (K)	
Silver	..	.01		

Figure 3

At right, color coding guide. (Arrow following word "zeros" should be reversed.) The color code chart is shown above.



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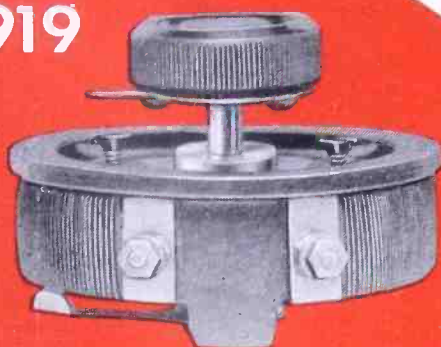
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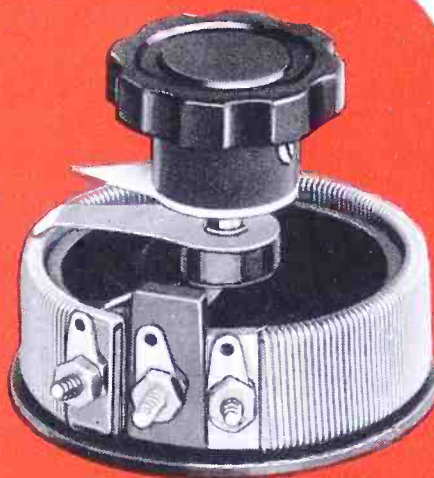
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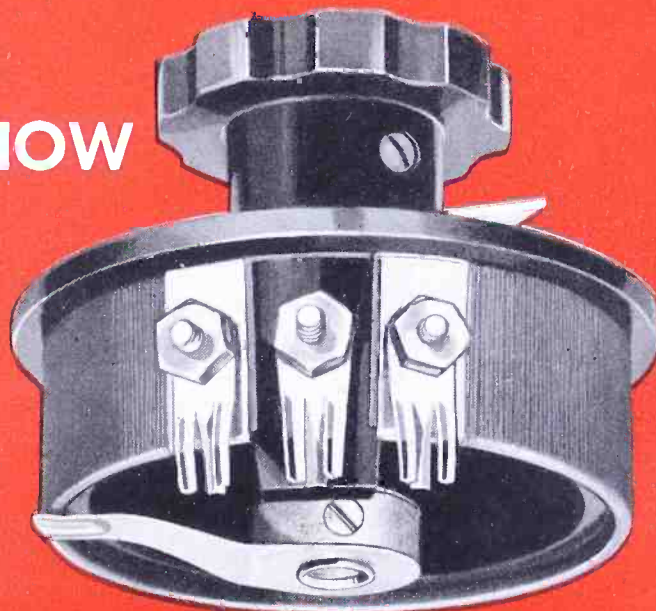
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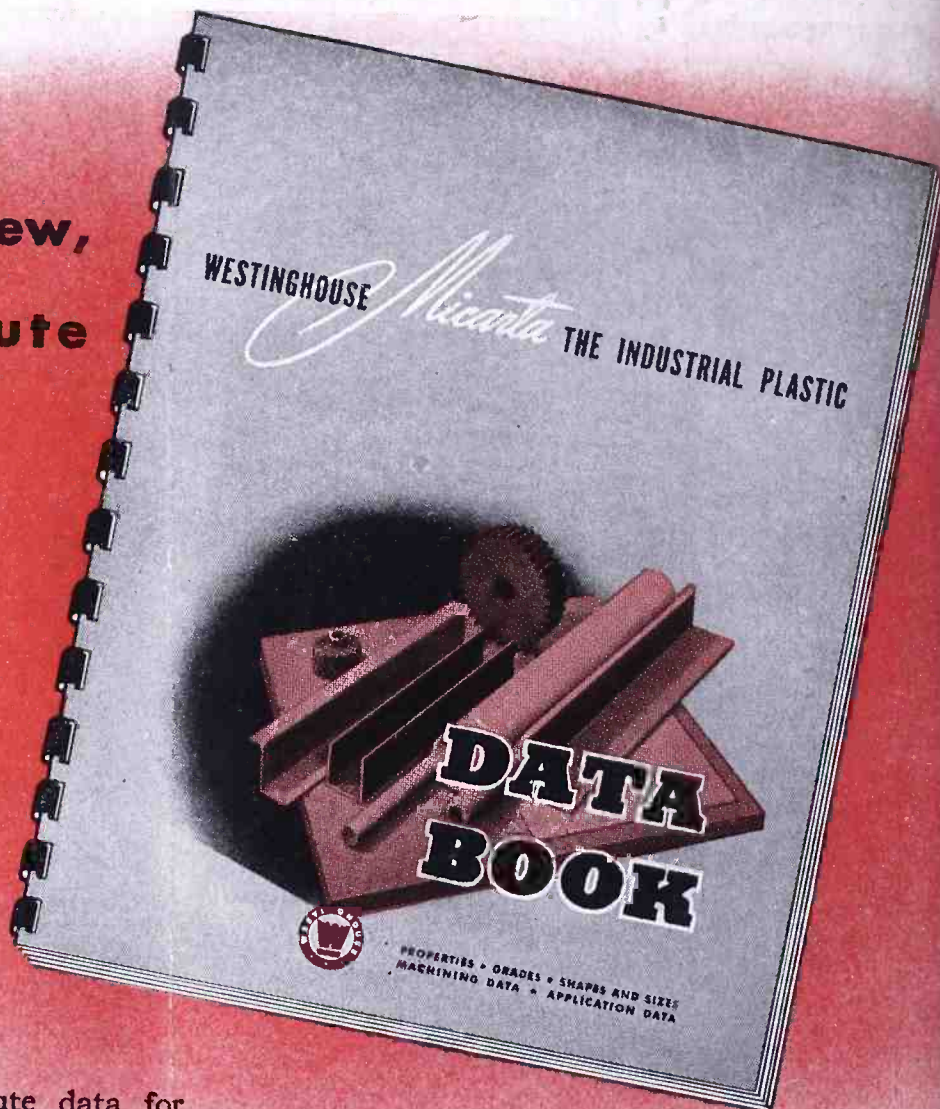
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