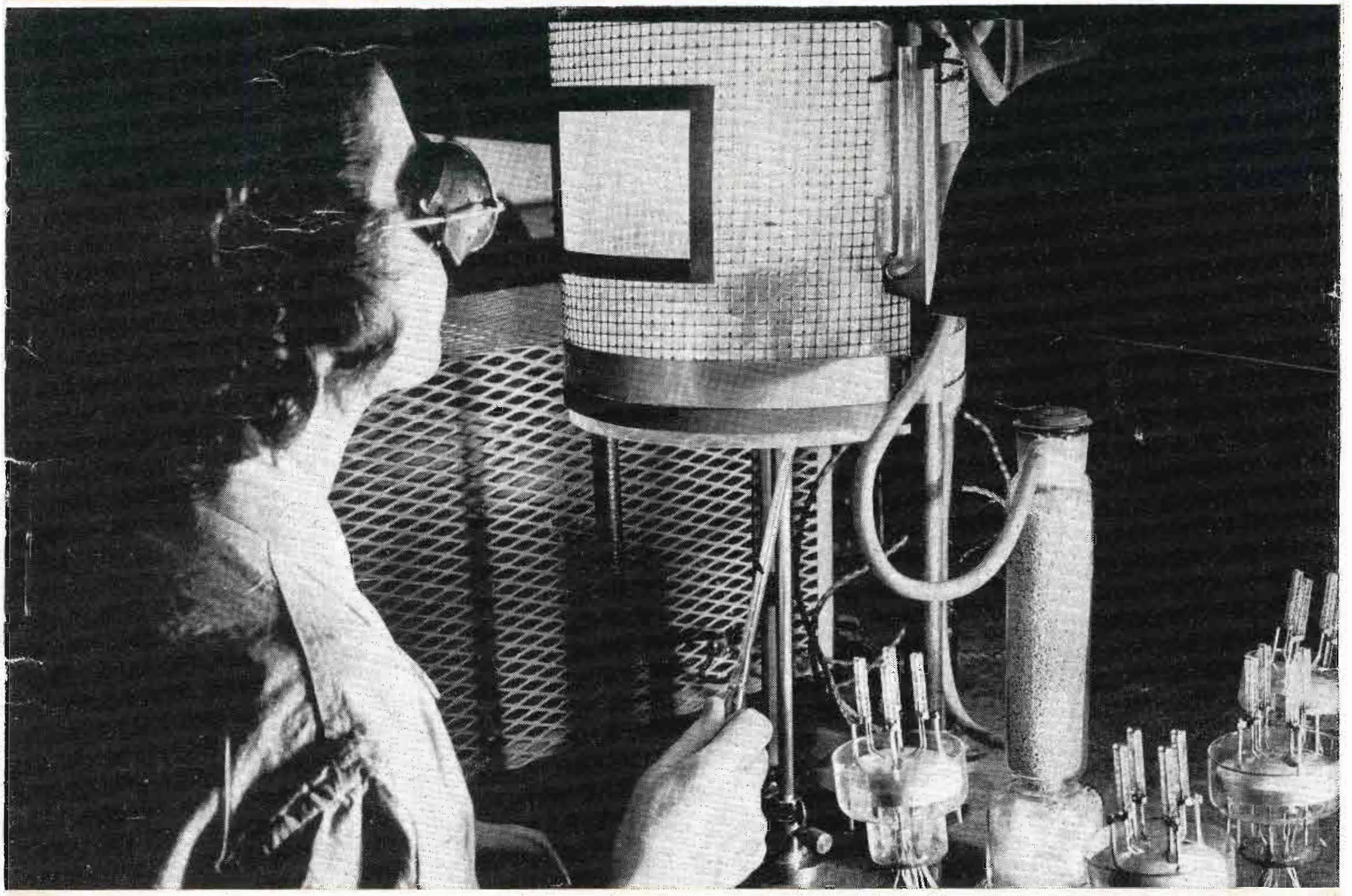
COMMUNICATIONS



APRIL

★ RADIO ENGINEERING
★ V-H-F COIL CONSTRUCTION
★ TELEVISION ENGINEERING
★ EVOLUTION OF DB AND VU
★ F-M ANTENNAE
★ AERONAUTICAL COMMUNICATIONS

1944

"I understand, Colonel, that you're interested in performance!"

There is a time and place for everything. Oscar's single-minded enthusiasm might have been better timed. On the other hand, his point is well taken.

In manufacturing electronic tubes, performance is the ultimate goal. To assure uniform reliability, Hytron tubes are painstakingly produced to standard factory test specifications tighter than customer tolerances. Then for the final verdict on actual performance, we turn to you who design, build, and operate the intricate electronic tools of war.

Those using Hytron tubes such as the 1616, OC3/VR-105, and OD3/VR-150, will not be surprised to discover that these tubes have earned the reputation of being the best in the industry.

You owe it to yourself to become familiar with these and other popular Hytron tubes, many of which appear on the Army-Navy Preferred List.

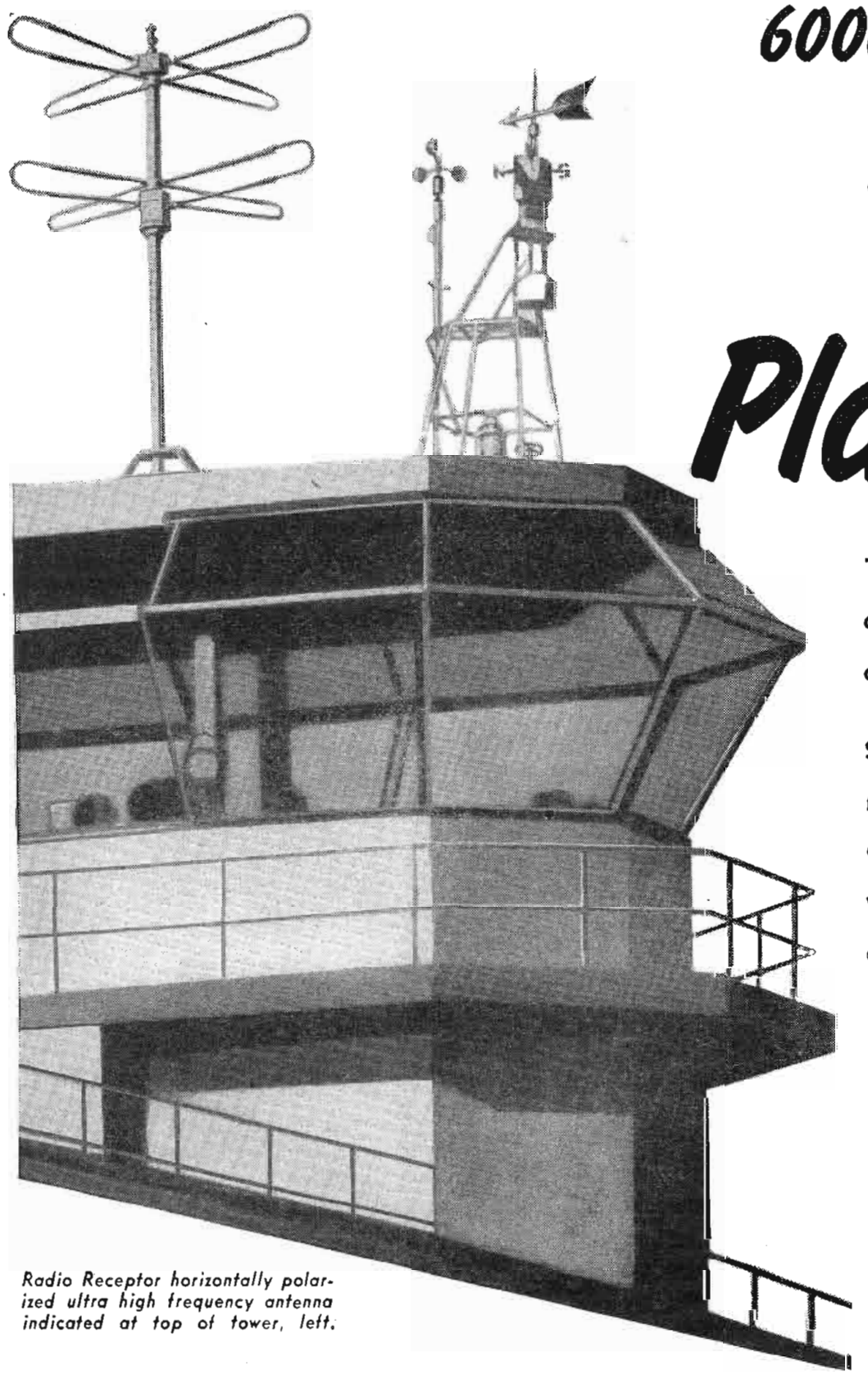
OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON CORPORATION ELECTRONIC AND RADIO TUBES

SALEM AND NEWBURYPORT, MASS.

HYTRON RADIO TUBES

BUY ANOTHER WAR BOND



Radio Receptor horizontally polarized ultra high frequency antenna indicated at top of tower, left.

"We will need 6000 AIRPORTS by 1950" - -

CHARLES I. STANTON
Civil Aeronautics Administrator

Plan Now

The planning of *radio facilities for your airport* is as important as the layout of the landing areas themselves.

Specific suggestions for *your airport traffic control radio equipment and other airport radio equipment*, based on a vast fund of experience in airport and airway radio installations, large and small, are available without obligation.

Requirements of projected airports and expanded airways may severely tax production capacity. *Act now.*

We invite an opportunity to cooperate with engineers, consultants and local contractors.

ARMY E NAVY

For Meritorious Service on the Production Front

Send for our Airport Radio Questionnaire so that we may be able to aid you now while your airport still is in the project stage. Our non-technical booklet, "Highways of the Air", free on request. Address Desk C-4

RADIO RECEPTOR CO., INC.

251 WEST 19th STREET
NEW YORK, 11 N. Y.

Engineers and Manufacturers of Airway and Airport Radio Equipment

SINCE 1922 IN RADIO AND ELECTRONICS

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

We See...

U-H-F AND V-H-F RELAY LINKS are destined to become a vital mode of transmission in standard broadcast, f-m, television, and even telephone service. A. T. & T. has already indicated that they will spend over $2,000,000 in the development and application of an u-h-f relay system to supplement the present commercial long-distance telephone facilities, and in addition provide network facilities for television transmission between New York, Boston, and intermediate points. Stations spaced at an average of about thirty miles throughout the route are planned.

Announcements have also come from G.E. and NBC that they, too, plan elaborate television and f-m networks with v-h-f satellite stations spotted along the routes. For such network operation, G.E. has revealed that they have developed a triode that is said to provide quite a few watts at frequencies as high as 1,000 mc.

Coaxial cables will also play a supplementing role in city-to-city links, particularly in television. A statement by the Bell System states that between six- and seven-thousand route miles of coaxial cable are planned in the next five or six years. The cables are expected to accommodate 4-mc bandwidths.

In the next ten years, experts say, v-h-f and u-h-f relay links will blanket the nation!

FROM WASHINGTON COMES A MEMO ON PATENTS that should be of interest to many. They advise that there are approximately 45,000 patents and pending patent applications, formerly owned by residents of enemy and enemy-occupied countries, now in the possession of the Alien Property Custodian, that any American manufacturer can obtain on a non-exclusive royalty-free basis. The charge is but fifteen dollars for each patent or patent application license. For information write to the Office of Alien Property Custodian, Washington 25, D. C., or visit your regional office of the Smaller War Plants Corporation. —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.

APRIL, 1944

VOLUME 24 NUMBER 4

COVER ILLUSTRATION

Flashing an 800-watt high-frequency tube.
(Courtesy North American Philips Co., Inc.)

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

BRYAN S. DAVIS, President — PAUL S. WEIL, General Manager
F. WALEN, Secretary — A. GOEBEL, Circulation Manager

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Endorsed in the laboratory

The use of DeJur precision meters in laboratory test equipment is an endorsement of their accuracy. In many fine laboratories, these meters are subjected to severe day-by-day service. Efficiency remains constant because 25 years of electrical knowledge go into their design and engineering. Application of DeJur components to your needs, in or out of the laboratory, will provide proof of DeJur quality. Our engineers will gladly work with you on any problem of measurement and control . . . for present or peacetime assignments.

Bring the Peace Closer . . . Buy More War Bonds

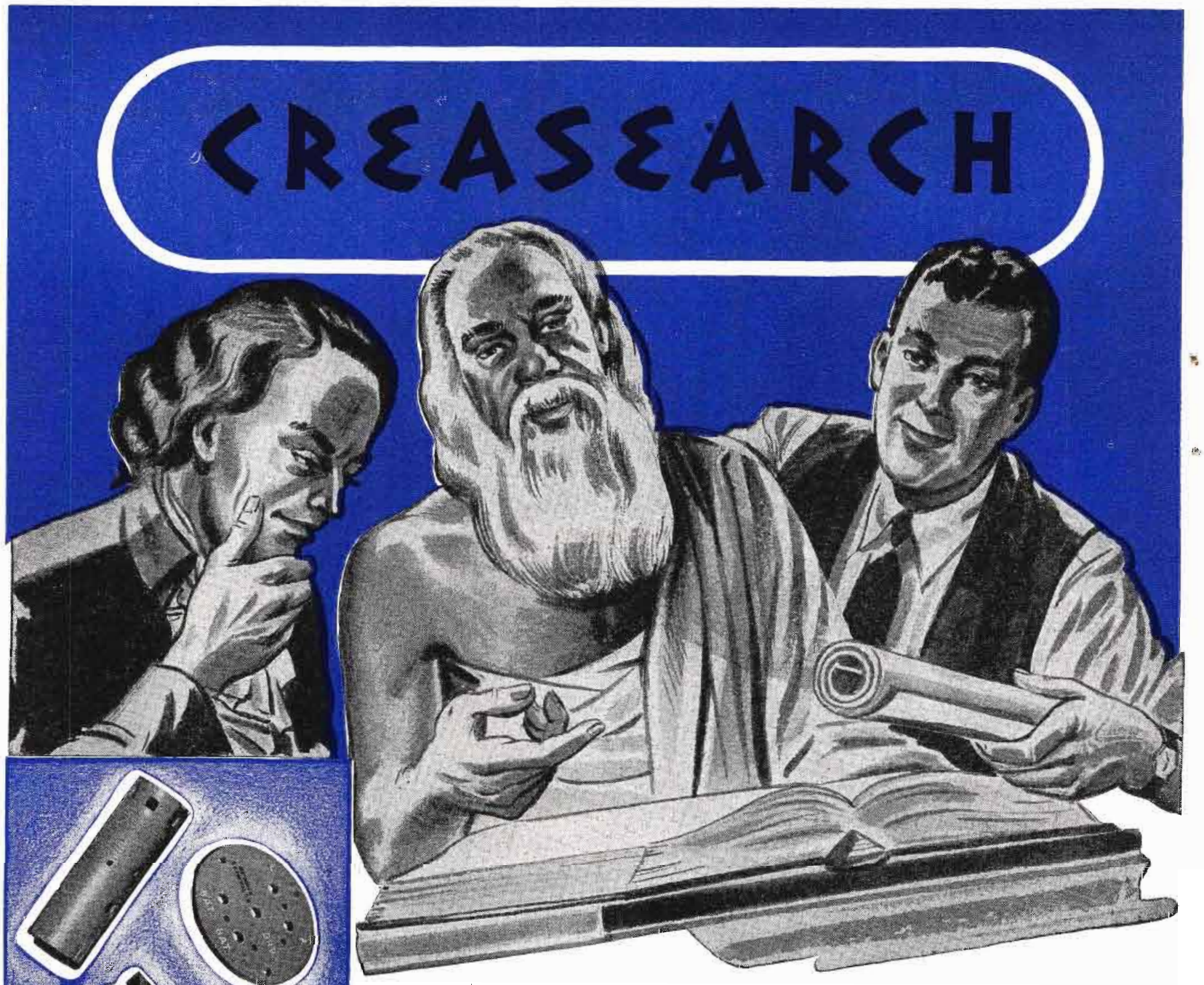
AWARDED FOR EXCELLENCE IN PRODUCTION AND QUALITY OF MATERIEL — ARMY E NAVY

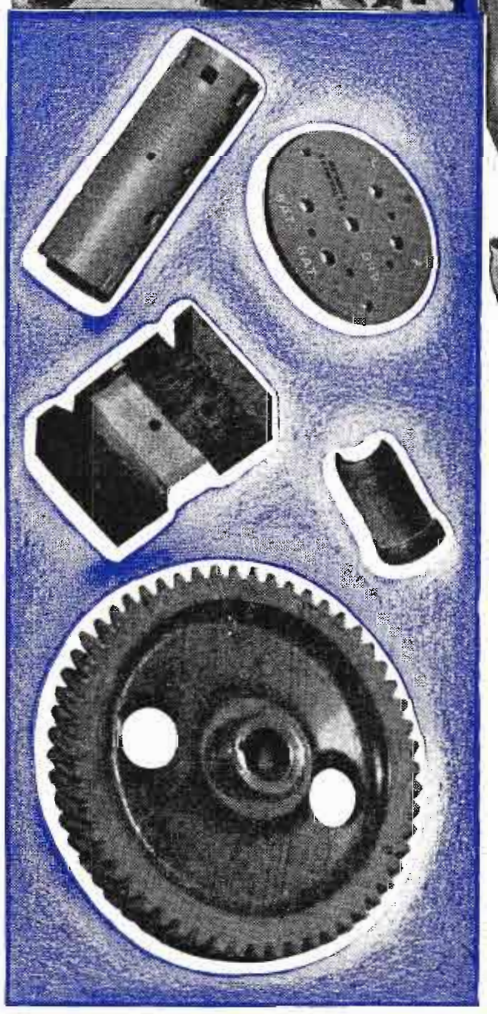
DeJur-Amsco Corporation

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

SHELTON, CONNECTICUT

NEW YORK PLANT: 99 Hudson Street, New York 13, N.Y. • **CANADIAN SALES OFFICE:** 560 King Street West, Toronto





The Greeks had no word for it and neither do we, more's the pity. Let's coin a word and a definition by starting with Webster's definition of research—"diligent protracted investigation, especially for the purpose of adding to the sum of human knowledge."

Now let's add, "More especially creation of new substances and discovery of special services they can perform better than any previously known substance".

There you have Formica research which has been going on more than 30 years through peace and war.

Formica laminated plastic has been created in various grades suitable for many uses in many industries. Strength, lightness, easy machinability, dielectric properties, acid and moisture resistance and stable dimensions are characteristic properties which vary somewhat according to the purpose of the grade.

Acquaint yourself with the past performance of Formica and its possibilities for your new or improved peacetime product.

"The Formica Story" is a moving picture in color showing the qualities of Formica, how it is made, how it is used. Available for meetings of engineers and executives.

THE FORMICA INSULATION CO.

4635 SPRING GROVE AVENUE

CINCINNATI 32, OHIO

How we make Cathode Ray Tubes OF UNIFORM QUALITY AT WARTIME SPEED

This non-stop rotating oven enables North American Philips to produce cathode ray tubes in assembly line quantities despite the complex heat treatment required for uniformly high quality.

In baking out and rendering inert the binders in the "Aquadag" and fluorescent coating on the inner surfaces of the bulb, heat must be gradually raised and as gradually lowered to prevent damaging residual strains in the glass. The oven illustrated, product of North American Philips ingenuity, accomplishes this by rotating slowly racks of bulbs through zones of increasing and decreasing temperatures within the oven from room temperature to 450*C*, then down to 200*C*.

This is but one of the many innovations in engineering and production techniques which assure for NORELCO Cathode Ray Tubes a uniformly high level of performance.

Painstaking concern for perfection and constant striving for improvement characterize *all* the activities of North American Philips in the development and manufacture of NORELCO electronic products.

Various types of cathode ray, transmitting and amplifying tubes are now being produced for our armed forces, together with quartz crystals for land, sea and air-borne communication equipment.

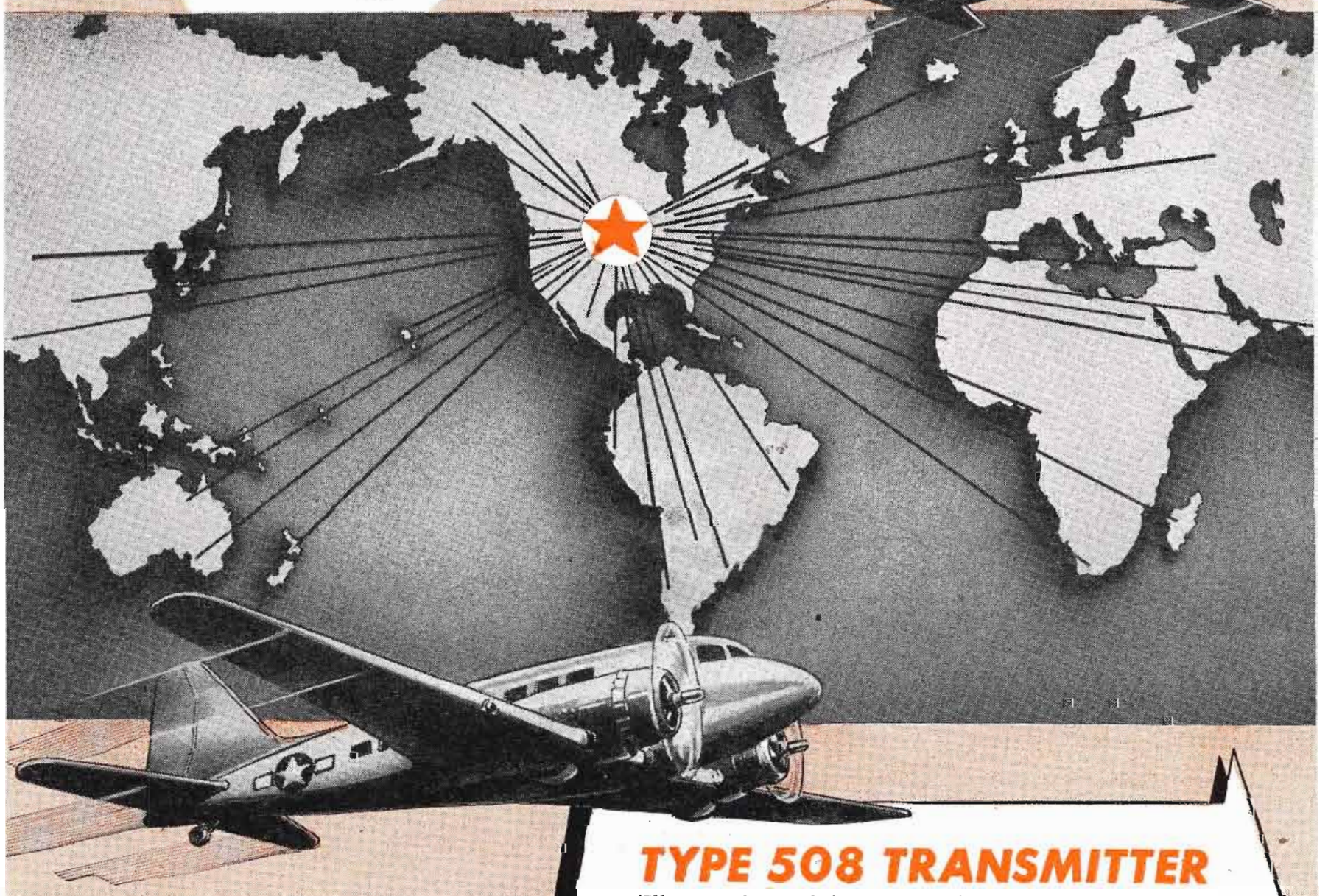
For our war industries we make Searchray (X-Ray) Apparatus for industrial and research applications; X-Ray Diffraction Apparatus; Direct Reading Frequency Meters; Electronic Measuring Instruments; High Frequency Heating Equipment; Tungsten and Molybdenum in many forms; Fine Wire in many metals and various finishes; Diamond Dies.

And For Victory We Say: Buy More War Bonds

Norelco ELECTRONIC PRODUCTS by
NORTH AMERICAN PHILIPS COMPANY, INC.

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

AAC TRANSMITTERS



TYPE 508 TRANSMITTER

(Illustrated at right). Type 508 Transmitter as designed by AAC for Army Airways Communications Service. Power output 450 watts each channel. Types of emission A1, A2, A3 and FM teletype. Five channels can be operated simultaneously. Single or dual modulator can be supplied.

E-34

AAC Products

ARMY NAVY

AIRCRAFT PRECISION RADIO

Burbank, Calif. Kansas

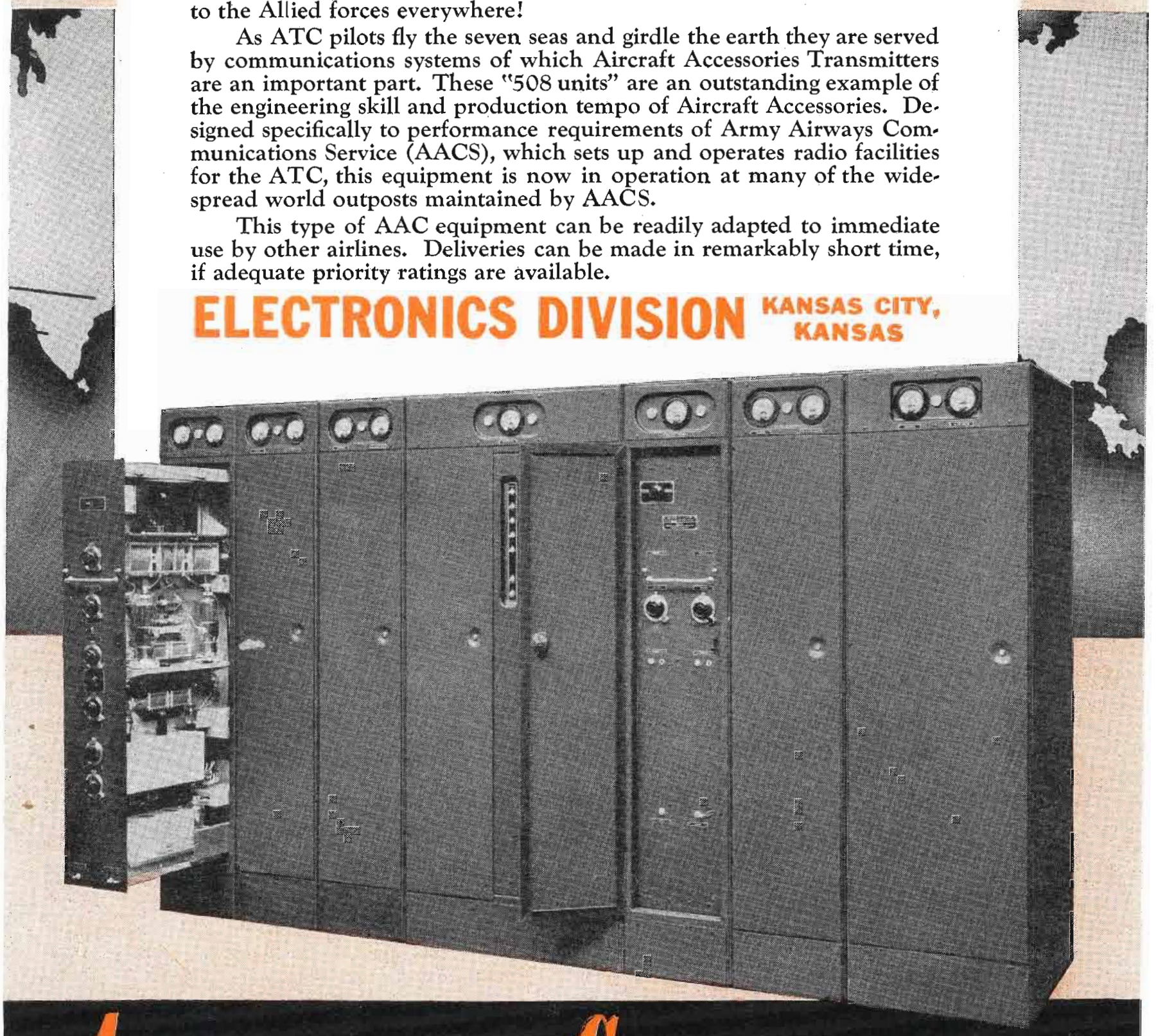
Serving the AIR TRANSPORT COMMAND Along Vital World-Wide Routes

THE Air Transport Command has become the greatest air transportation system in the world . . . delivering planes, materials and personnel to the Allied forces everywhere!

As ATC pilots fly the seven seas and girdle the earth they are served by communications systems of which Aircraft Accessories Transmitters are an important part. These "508 units" are an outstanding example of the engineering skill and production tempo of Aircraft Accessories. Designed specifically to performance requirements of Army Airways Communications Service (AACS), which sets up and operates radio facilities for the ATC, this equipment is now in operation at many of the widespread world outposts maintained by AACS.

This type of AAC equipment can be readily adapted to immediate use by other airlines. Deliveries can be made in remarkably short time, if adequate priority ratings are available.

ELECTRONICS DIVISION KANSAS CITY, KANSAS



ACCESSORIES CORPORATION

and ELECTRONICS • ENGINEERED POWER CONTROLS

City, Kans. New York, N. Y. Cable Address: AACPRO

NEW LETTER CONTEST for SERVICEMEN!

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

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

SO — HERE WE GO AGAIN!

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

RULES FOR THE CONTEST

Hallicrafters will give $100.00 for the best letter received during each of the five months of April, May, June, July and August. (Deadline: Your letter must be received by midnight, the last day of each month.)

For every serious letter received Hallicrafters will send $1.00 so even if you do not win a big prize your time will not be in vain.

Your letter will become the property of Hallicrafters and they will have the right to reproduce it in a Hallicrafters advertisement. Write as many letters as you wish. V-mail letters will do.

Military regulations prohibit the publication of winners' names and photos at present . . . monthly winners will be notified immediately upon judging.

BUY MORE BONDS!

ARMY E NAVY

hallicrafters RADIO

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

SOLAR CAPACITORS ADD "Quality Above All" TO WAR EQUIPMENT

160 PAGE CATALOG

FREE

A request on your letterhead will bring you Catalog 12 showing the full line of Solar Capacitors.

Solar SOLAR **MANUFACTURING CORPORATION**

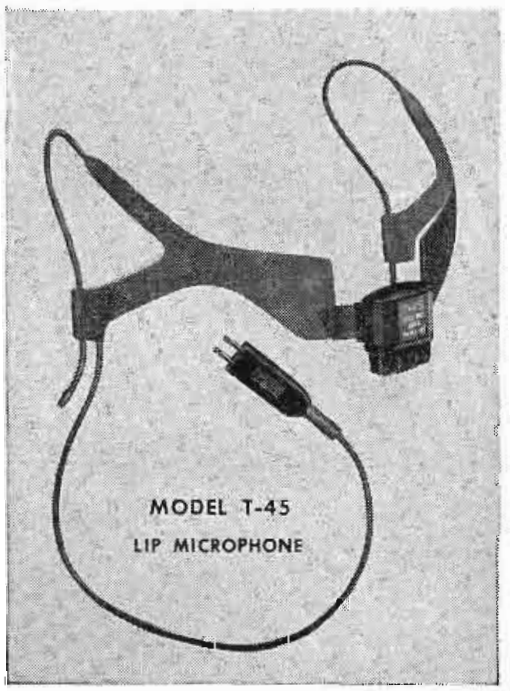
285 MADISON AVENUE • NEW YORK 17, N. Y.

CAPACITORS and RADIO NOISE-SUPPRESSION FILTERS

5218

History of Communications Number Four of a Series

SMOKE SIGNAL COMMUNICATIONS



While the puffs of our early American smoke Signals were not as complicated as the Morse Code, this type of communication was a speedy and effective means of communication at that time and could be seen for scores of miles on a clear day. Used for transmitting their battle messages, smoke signals in the days of the early American meant a progressive means of communication.

Restricted by climatic conditions this type of communication was limited in its use. Universal microphones in the part they play in modern electronic voice communication must withstand the climates of the Arctic and the Tropics all in a day's work. Built to accomplish a specific job, Universal Microphones are "getting the message through" on every Allied front.

Model T-45, illustrated at left, is the new Lip Microphone being manufactured by Universal for the U. S. Army Signal Corps. Shortly, these microphones will be available to priority users through local Radio Jobbers.

UNIVERSAL MICROPHONE COMPANY
INGLEWOOD, CALIFORNIA

FOREIGN DIVISION: 301 CLAY STREET, SAN FRANCISCO 11, CALIFORNIA ·· CANADIAN DIVISION: 560 KING STREET WEST, TORONTO 1, ONTARIO, CANADA

Accomplishment proves Federal's leadership

When the curtain goes up on the approaching post-war era, Federal does not propose to perform sleight-of-hand in producing a startling fantasia in broadcast equipment.

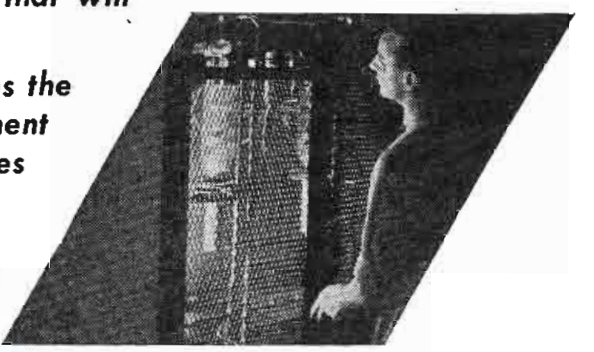
But Federal, which built WABC, the 50 Kilowatt key station of the Columbia Broadcasting System and the most modern transmitter in the country, will produce then, as it will discuss now, up-to-the-minute equipment of even greater power to meet individual needs.

Federal's long experience in building transmitters, in both high frequency and standard broadcast ranges, assures equipment that will measure to the highest standards.

Federal's scientific talent, which includes the world's best technical minds, assures equipment that will embody good engineering practices and proved refinements in design.

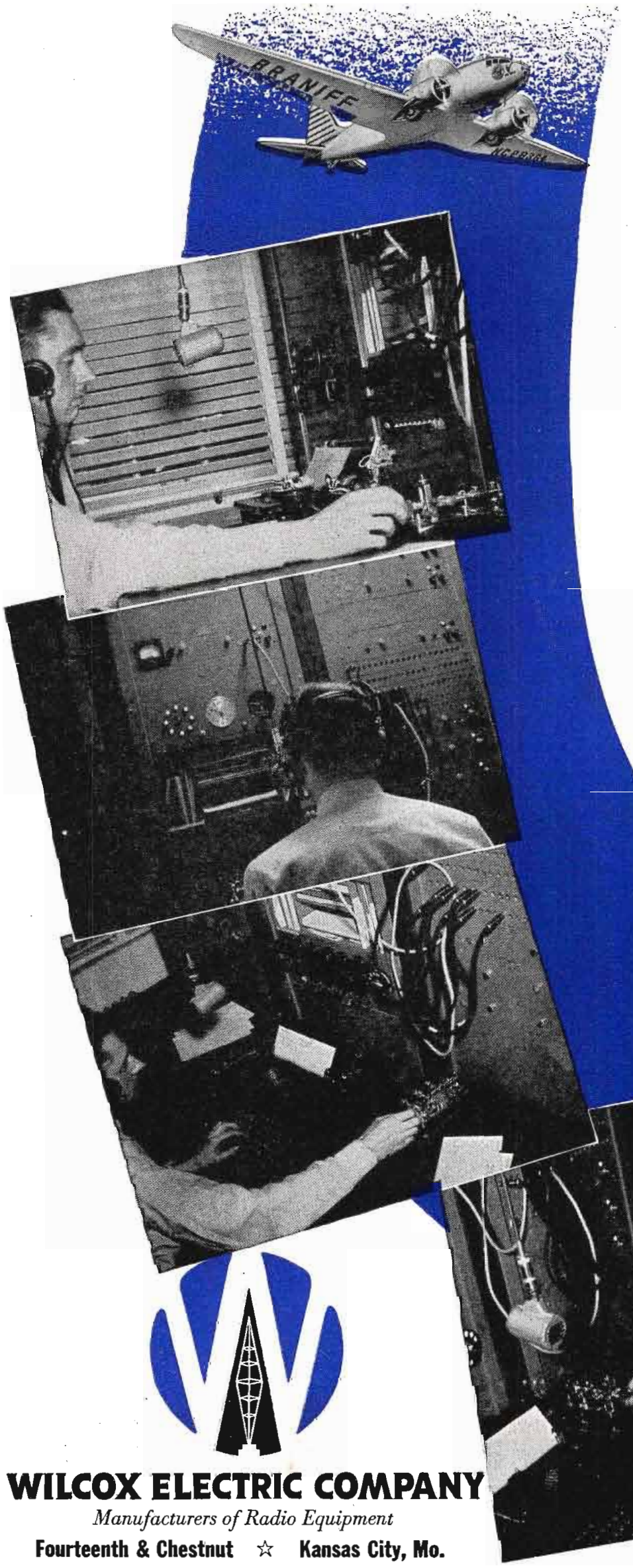
Federal invites you to discuss your ideas and its facilities for developing transmitting equipment to your particular requirements.

Most of the leading broadcast stations are equipped with Federal transmitting and rectifying tubes — known for their quality and high standard. Use Federal tubes — built with the ultimate of care and workmanship for satisfactory performance.



Federal Telephone and Radio Corporation

COMMUNICATION PRODUCTS DIVISION — AN IT&T ASSOCIATE — Newark, N. J.



Wilcox Radio Equipment Serves Braniff Airways

The major airlines of the nation depend on Wilcox equipment for reliable radio communications. In addition, Wilcox installations today are serving military operations in practically all parts of the world.

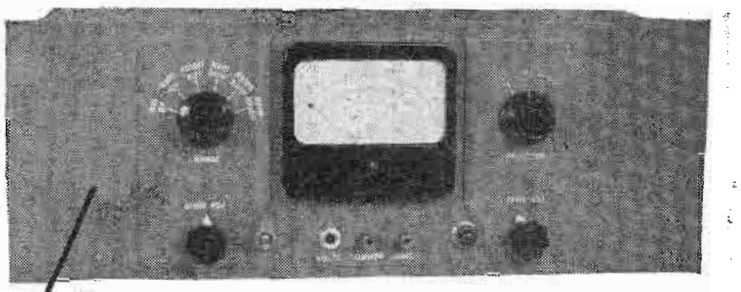
Photographs, courtesy Braniff Airways.

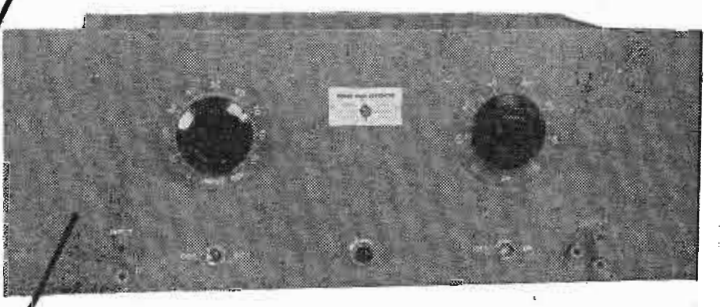
WILCOX ELECTRIC COMPANY

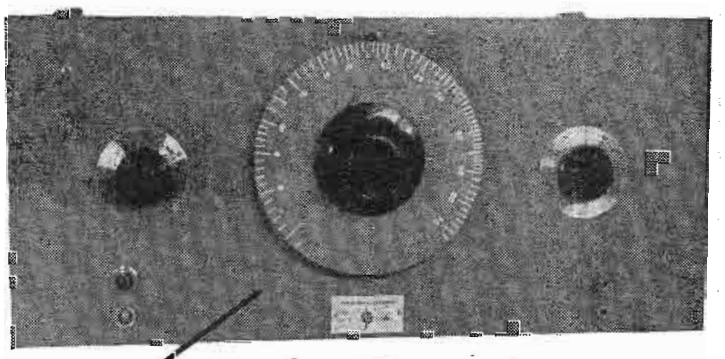
Manufacturers of Radio Equipment

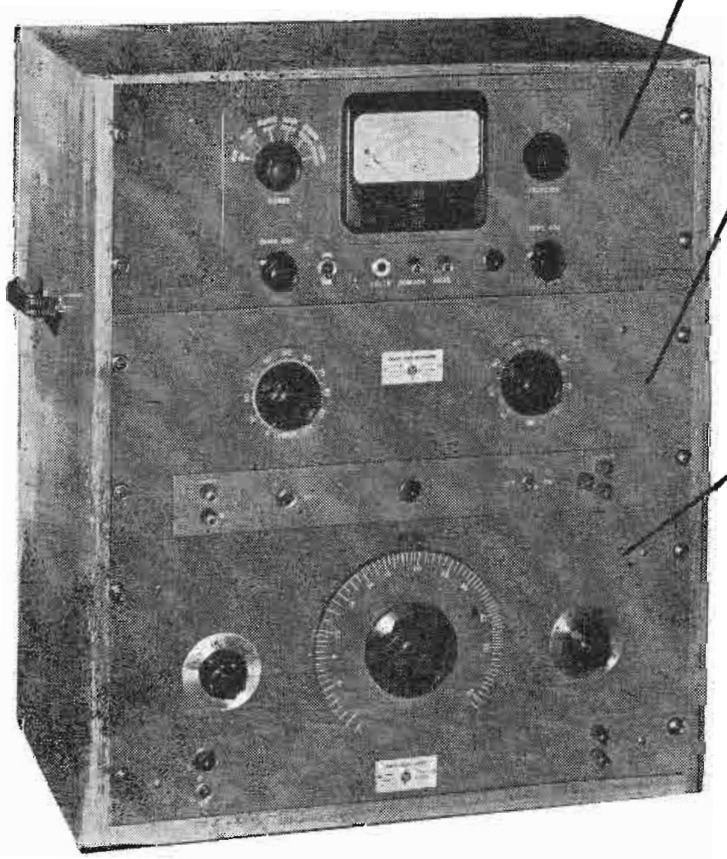
Fourteenth & Chestnut ☆ Kansas City, Mo.

3 in 1 combination









The complete combination in cabinet measuring 21 x 24 x 14 occupies minimum space on the bench. Note lack of great numbers of knobs and dials which is significant of the simplicity and speed of operation.

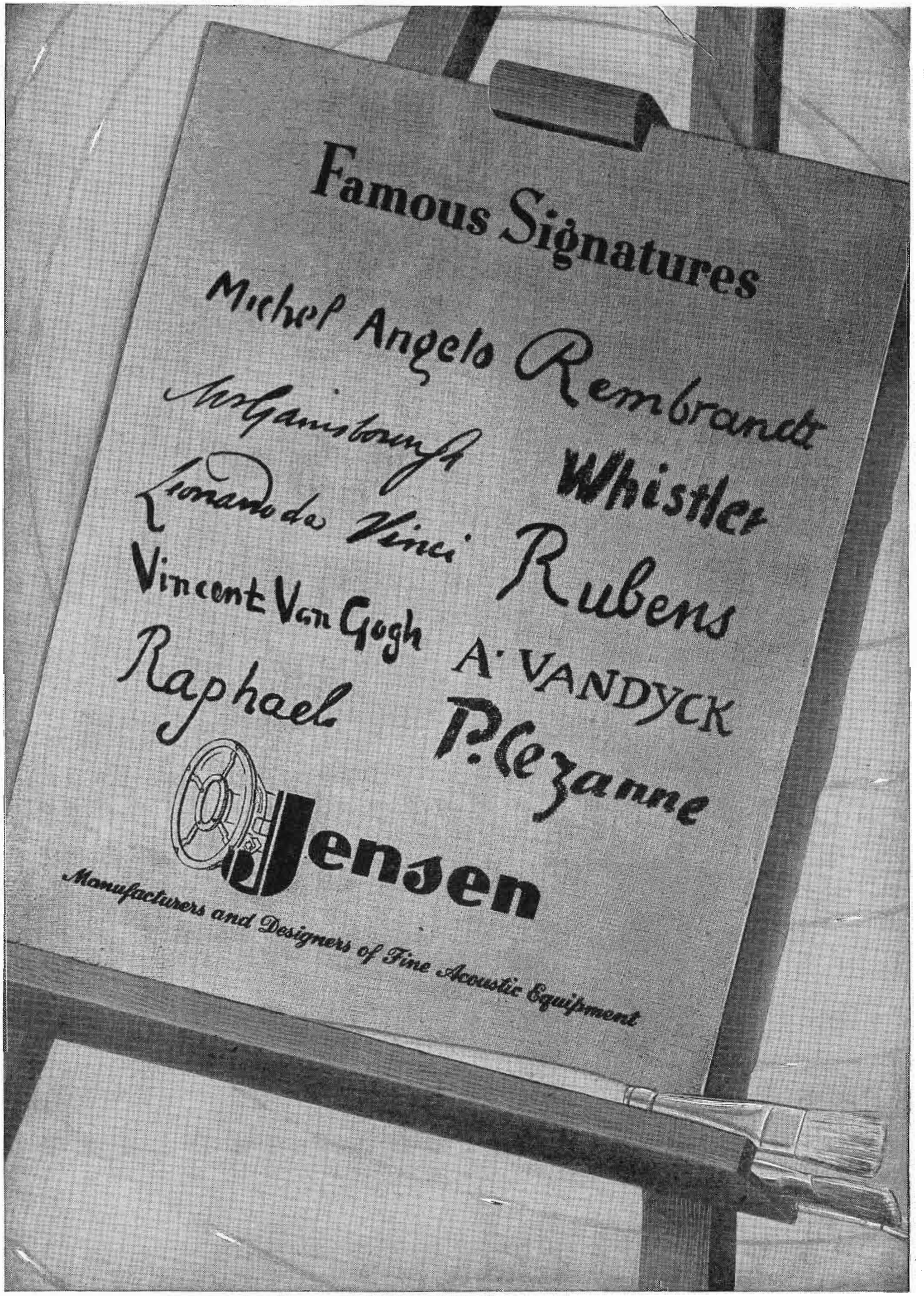
Special Vacuum Tube Voltmeter
Model No. 210 AR Square Wave Generator
Model No. 200 DR Audio Oscillator

Most all -*hp*- instruments are available for standard relay rack mounting. Thus several units may be assembled into a special cabinet to make an ideal combination for production line stations or for equipping a small laboratory. The single unit shown at left combines the three standard -*hp*- instruments shown above. With this combination you can measure volts, apply square wave to measure the response of amplifiers and networks... make distortion measurements on audio amplifiers, make accurate bridge measurements and all the valuable tests and measurements possible with -*hp*- resistance tuned audio oscillators. Complete technical data sheets are available on these three units which you may obtain without obligation. ★ Just drop a post card in the mail. Also ask for your copy of the 24 page -*hp*- catalog which gives much valuable information about electronic test and measuring equipment in addition to data on the -*hp*- instruments.

HEWLETT-PACKARD COMPANY

P. O. BOX 783E, STATION A, PALO ALTO, CALIFORNIA

783



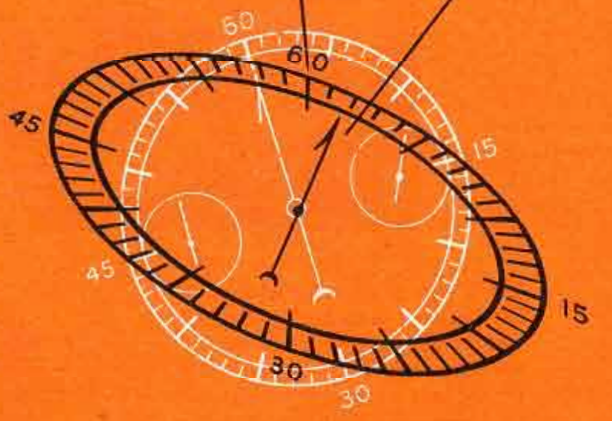
JENSEN RADIO MANUFACTURING COMPANY, 6601 S. LARAMIE AVE., CHICAGO 38, U. S. A.

When life or death is a matter of Split Seconds

"HANDIE-TALKIE" *Delivers*

IN a war of vast spaces, swift movement and violent action . . . Radio Communication must not fail. The front line scout, spotting the location and strength of the enemy, gets his vital information back to the command post with split second speed via the Handie-Talkie, the bantam-weight portable two-way radiotelephone. The signalman *talks, giving information . . . and listens, receiving instructions.*

The Handie-Talkie was conceived and developed by Motorola, makers of Motorola Radios for Home and Car, Automatic Phonograph-Radios and F-M Police Radiotelephone Systems.



HANDIE-TALKIE IS ANOTHER **Motorola Radio "FIRST"**

ARMY E NAVY

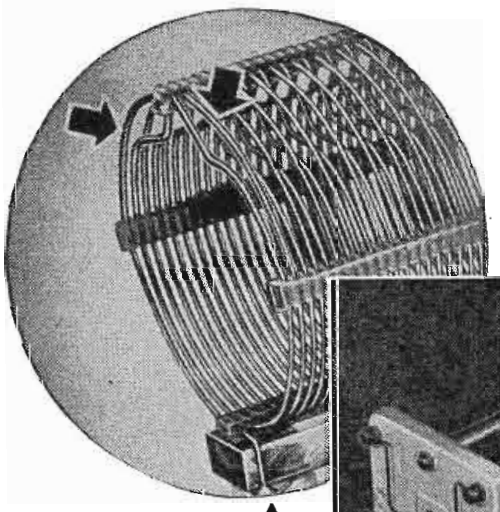
Motorola RADIO

AMERICA'S FINEST FOR HOME & CAR

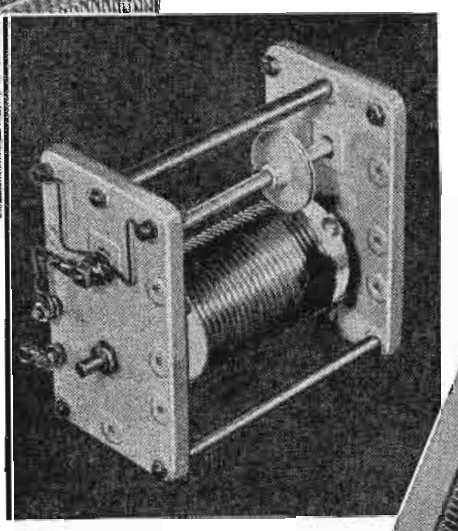
GALVIN MFG. CORPORATION · CHICAGO

When You Need
INDUCTORS...

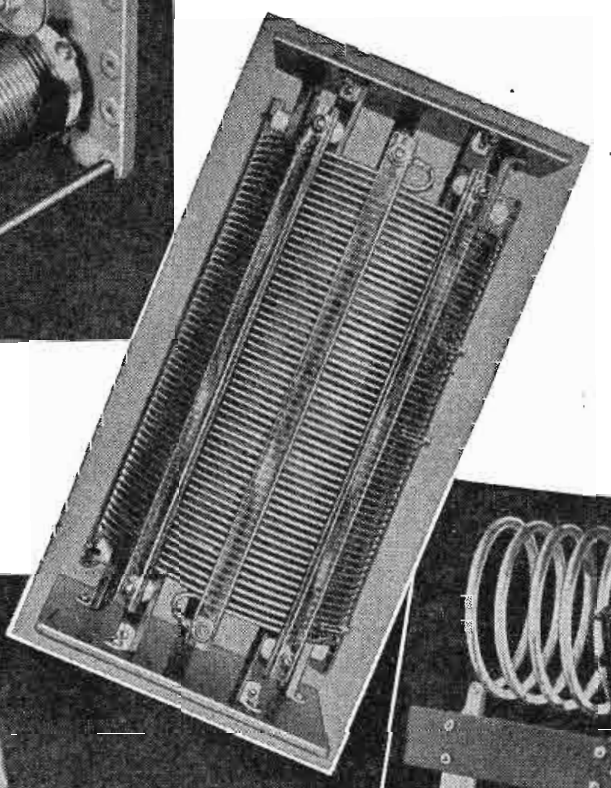
. . . you can get them at B & W—expertly engineered—designed and produced to the most exacting quality standards. In addition to the exclusive "Air Wound" types shown here, B & W offers "Air Wound" and ceramic- or phenolic-form types for practically any requirement.



▲ Indents are a special optional feature of B & W "Air Wound" construction on small, closely wound coils. Windings on either side of every turn of wire are indented, thus making tapping quick and easy, *anywhere on the inductor.*

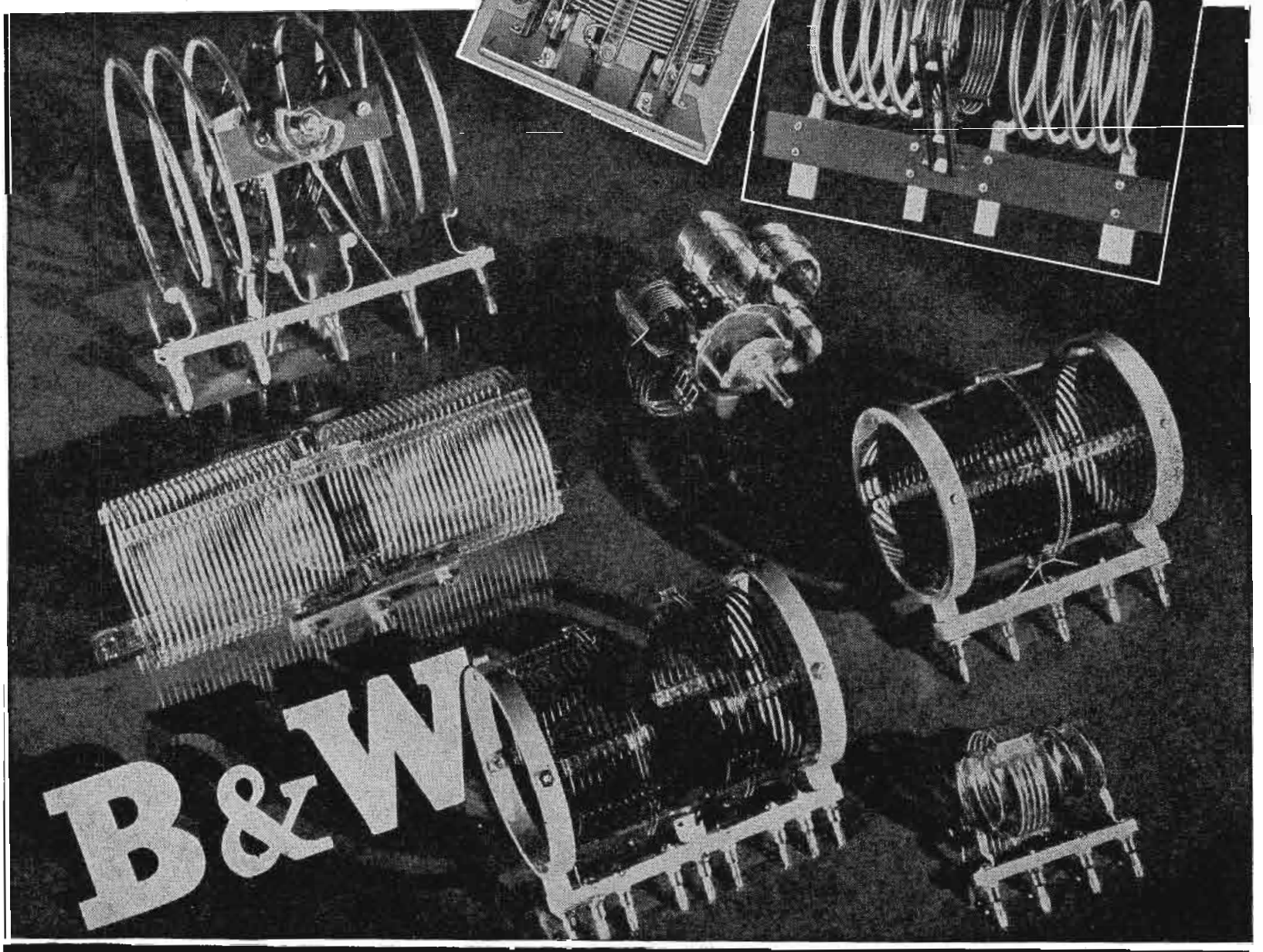


▲ B & W offers a wealth of experience backed with highly specialized facilities for the production of special rotary coils. Above is a typical unit made to exacting war equipment specifications.



◀ 20" long, and wound with #8 solid wire, this B & W Air Inductor carries a conservative continuous rating of 7.5 amps. Aside from special bracing, however, it is simply a "grown up" version of B & W Junior Coils of amateur radio fame.

Designed for 10 KW. service, this variable-link final amplifier plate coil is a good example of B & W on the job of matching modern inductor requirements. B & W units of this type are wound with copper tubing as large as 1" diameter. ▼



BARKER & WILLIAMSON 235 FAIRFIELD AVENUE UPPER DARBY, PA.

The Portland Vase, most renowned achievement of Josiah Wedgewood (1730 - 1795)

Masterpiece of Skilled Hands

ARMY E NAVY

UNITED

ELECTRONICS COMPANY

NEWARK, 2 New Jersey

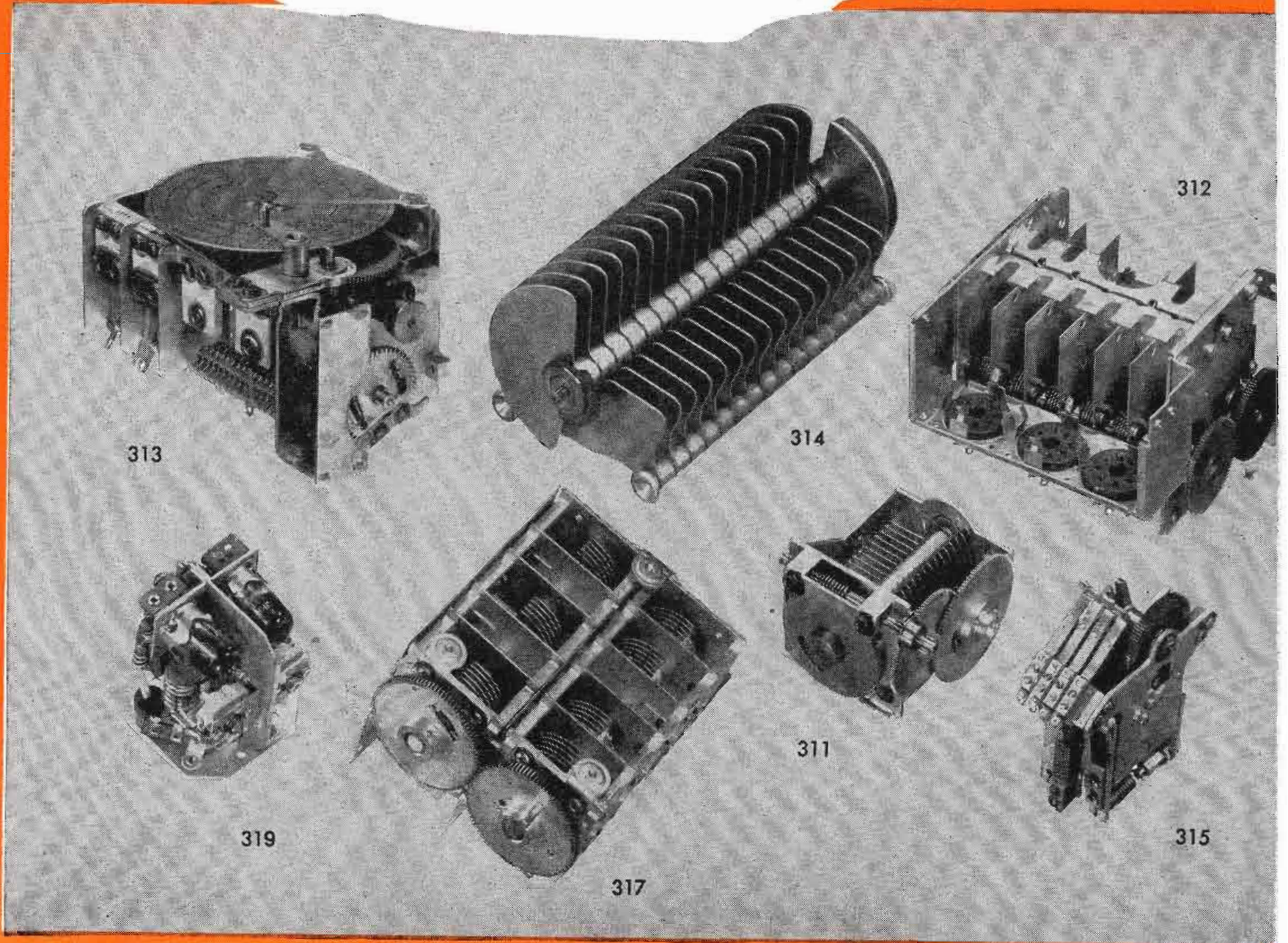
Transmitting Tubes EXCLUSIVELY Since 1934

In every art or craft, the work of a few masters will always be of a quality above all else of its kind . . . The name Wedgewood denotes rare excellence in pottery. The name Gobelins characterizes tapestries of incomparable beauty. So, too, in its field, the name UNITED stands for electronic tubes which are individual masterpieces . . . While electronic tubes are the very heart of countless machine-age devices, their manufacture is as dependent upon expert minds and skilled hands as is the fashioning of a fine vase or violin . . . UNITED Tubes are engineered to the most exacting specifications. They are constructed of the highest quality materials obtainable. Yet no tube can be one bit better than the skill that assembles its intricate component parts. Herein lies one reason why UNITED Tubes are in a class by themselves for efficiency and long life.

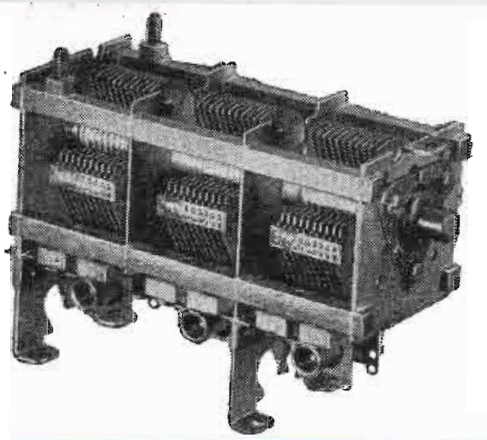
OPEN CAPACITY

51% MORE ELECTRONIC PRODUCTION WILL BE NEEDED IN 1944

WELL, WASHINGTON – We Can Help!



at G. I.

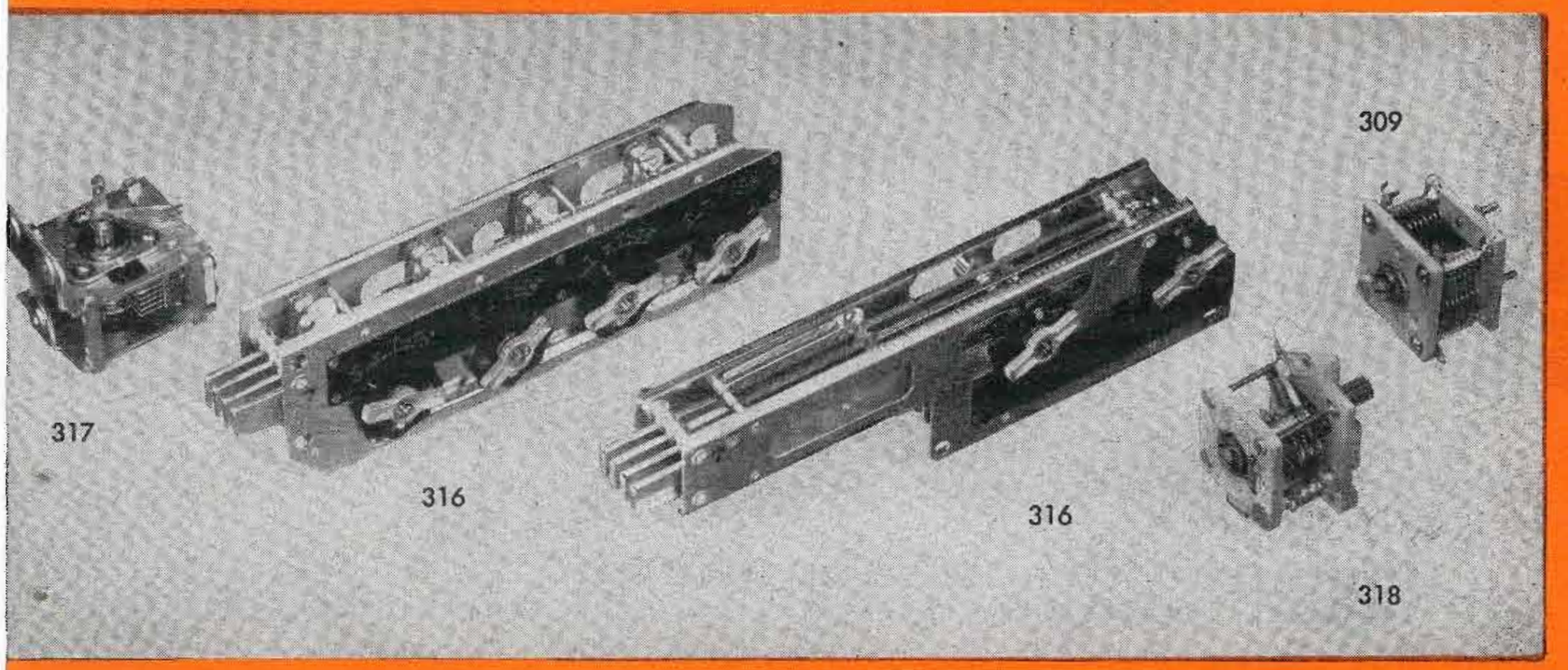


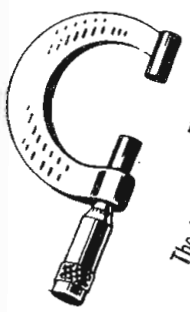
310

● A generation of experience in the mass production of precision variable condensers and more recently of automatic record changers has placed us in a position to contribute materially to the tremendously increased war requirements in the electronics field. We now have greatly expanded facilities and a remarkable system for the manufacture and assembly of precision instruments of wide variety and great complexity.

● We are ready and eager to undertake development and large scale production of the many new items in the fields of radio and radar which will utilize the special techniques we have perfected in the volume output of such items as variable condensers, automatic timing mechanisms, wired assemblies, etc.

● To insure '44 production goals we ask that you send your inquiry immediately.





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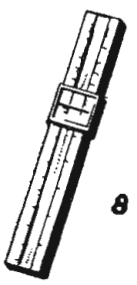

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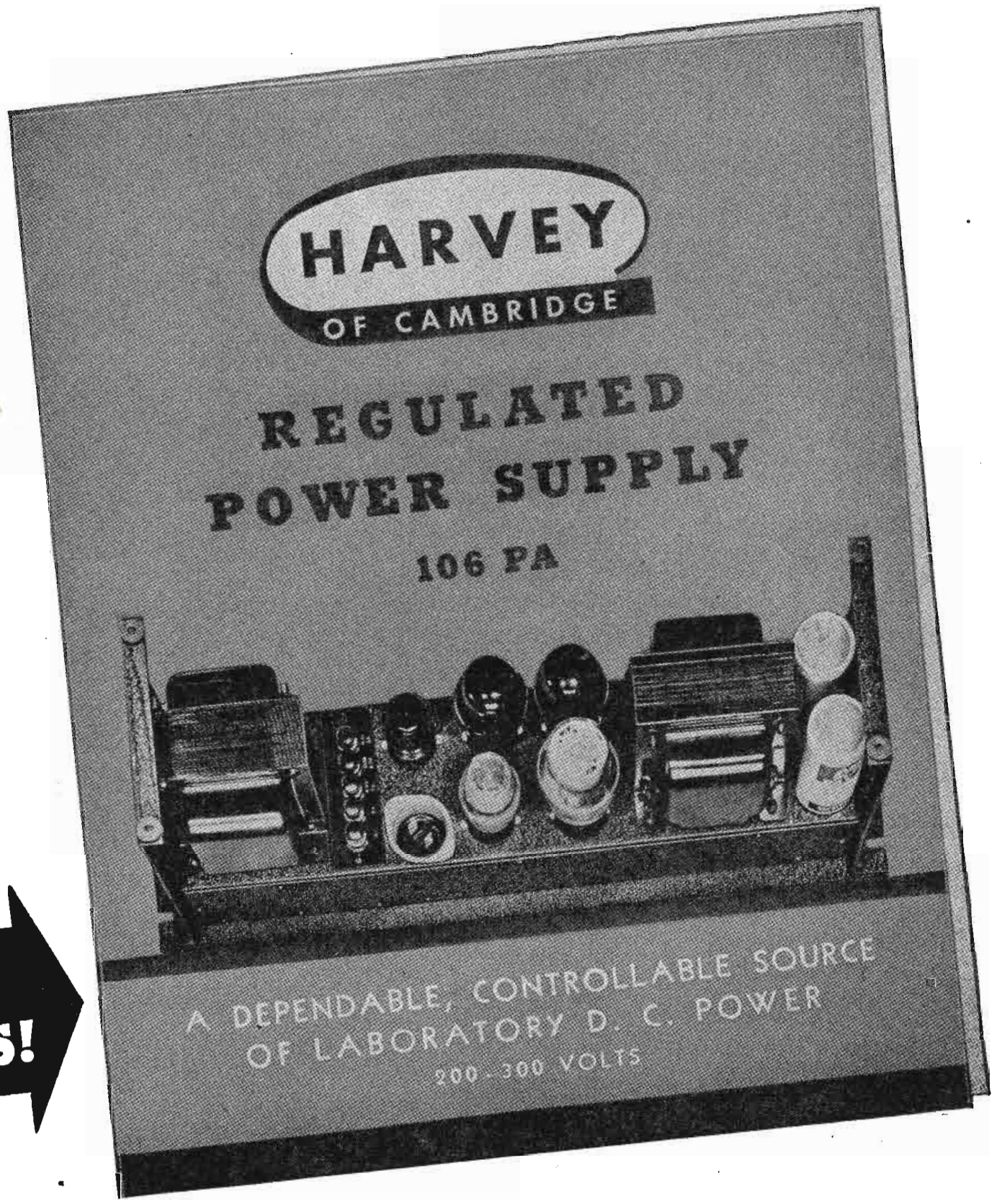

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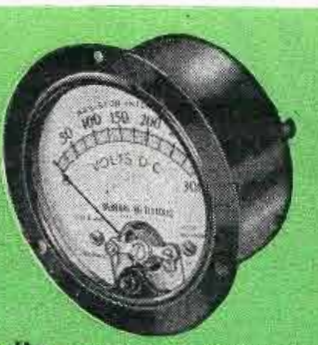

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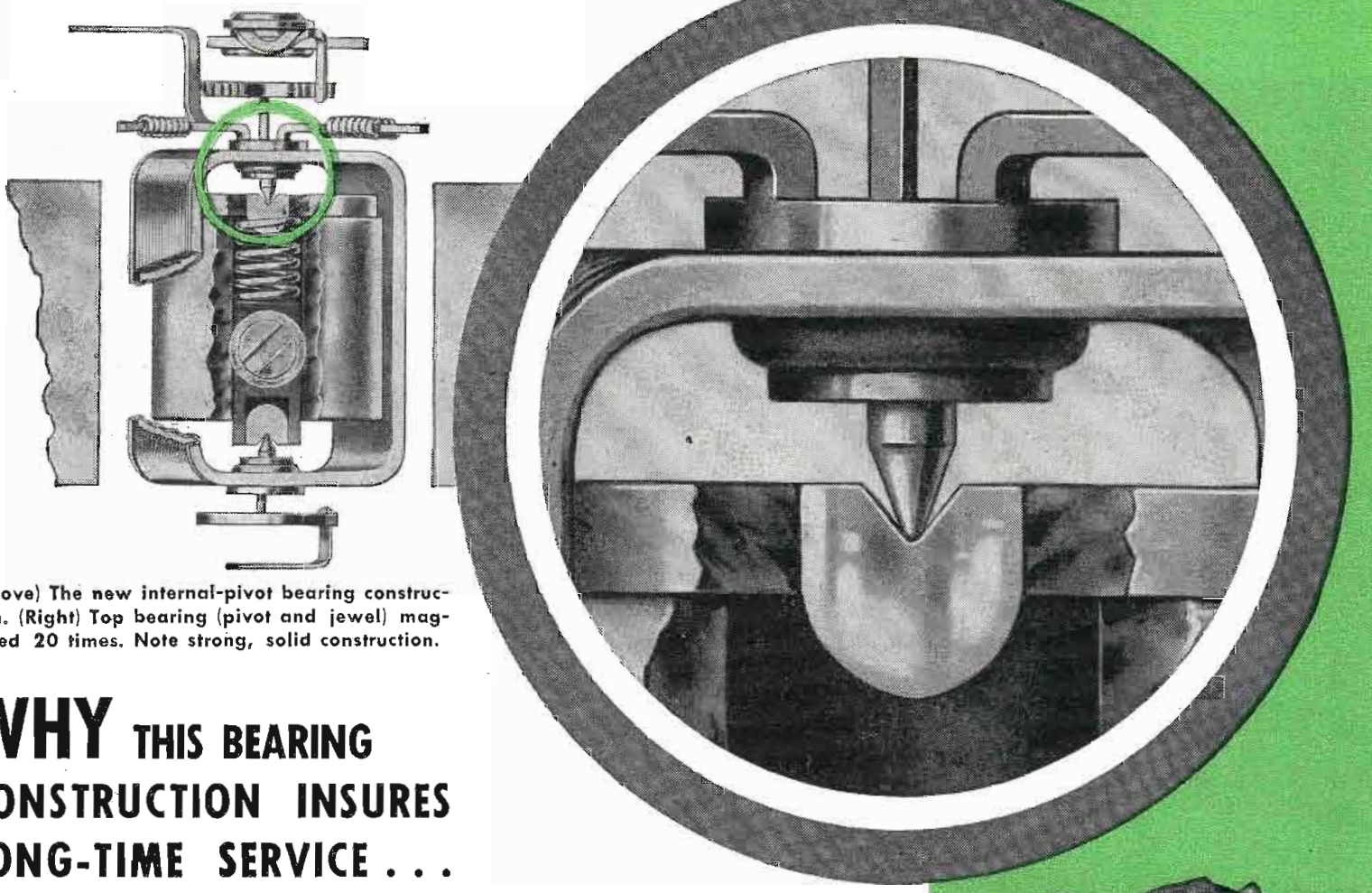

(Above) The new internal-pivot bearing construction. (Right) Top bearing (pivot and jewel) magnified 20 times. Note strong, solid construction.

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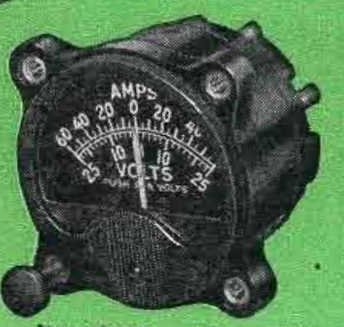

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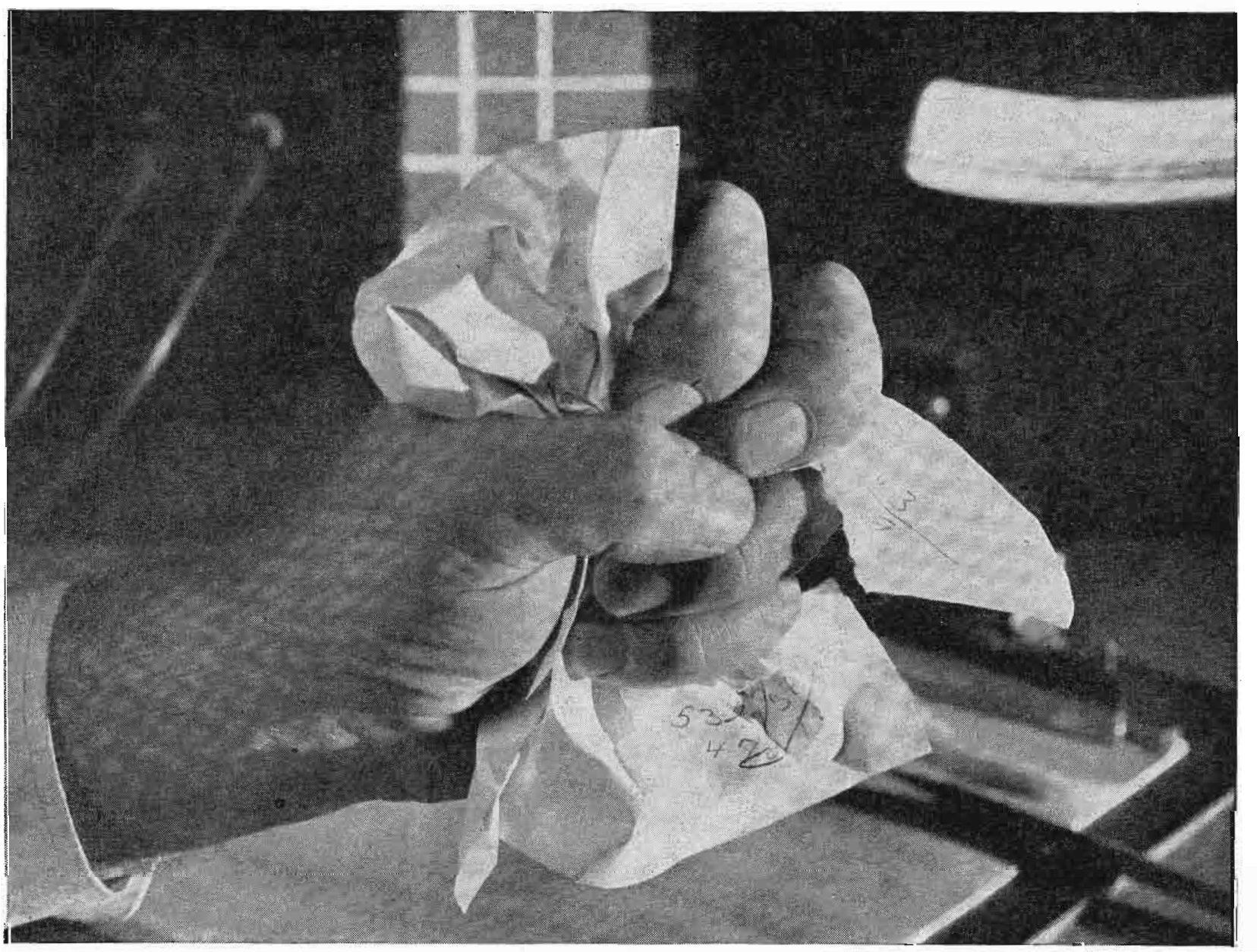

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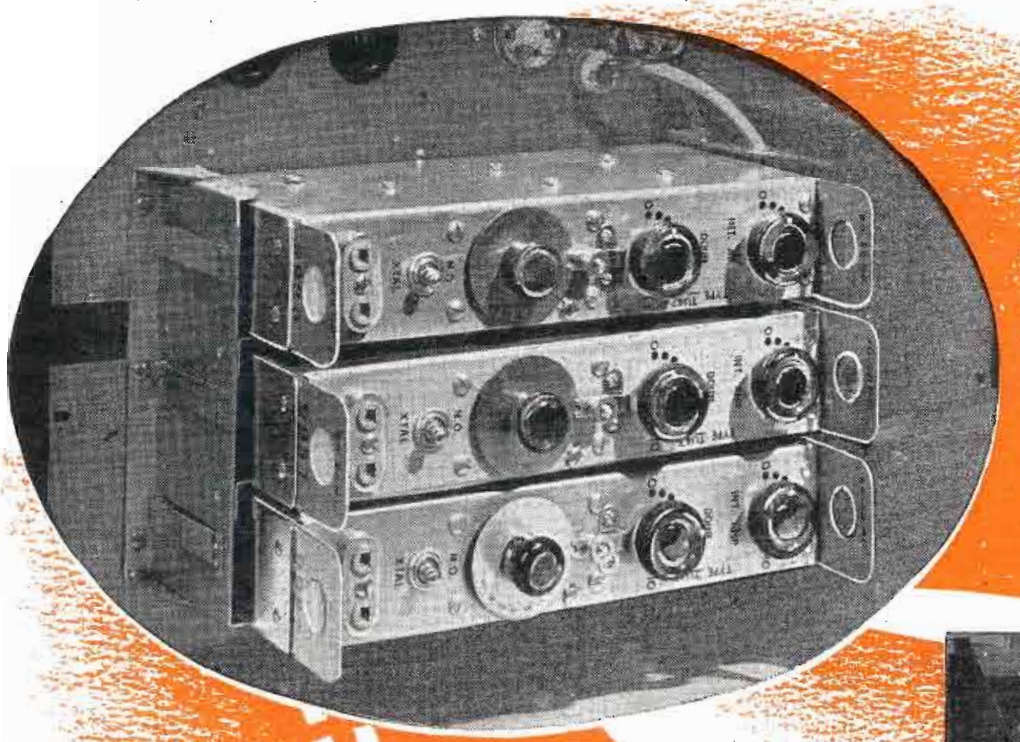

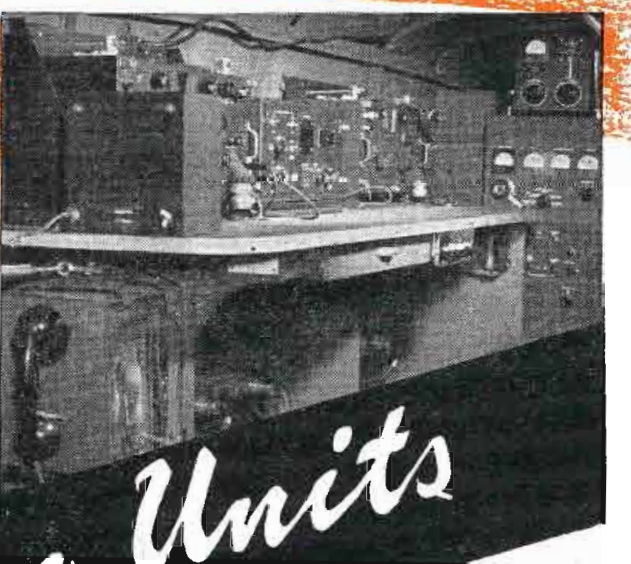

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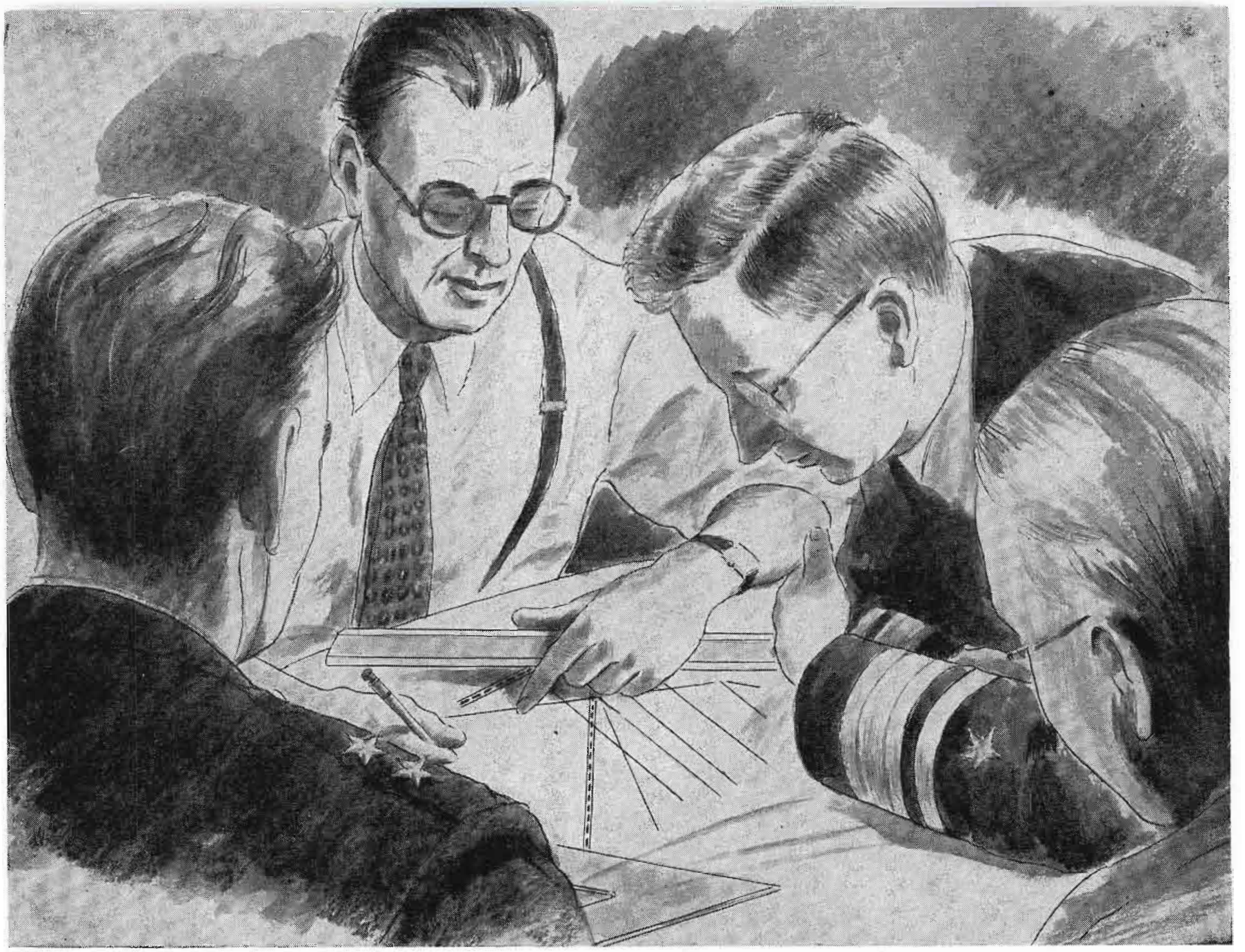

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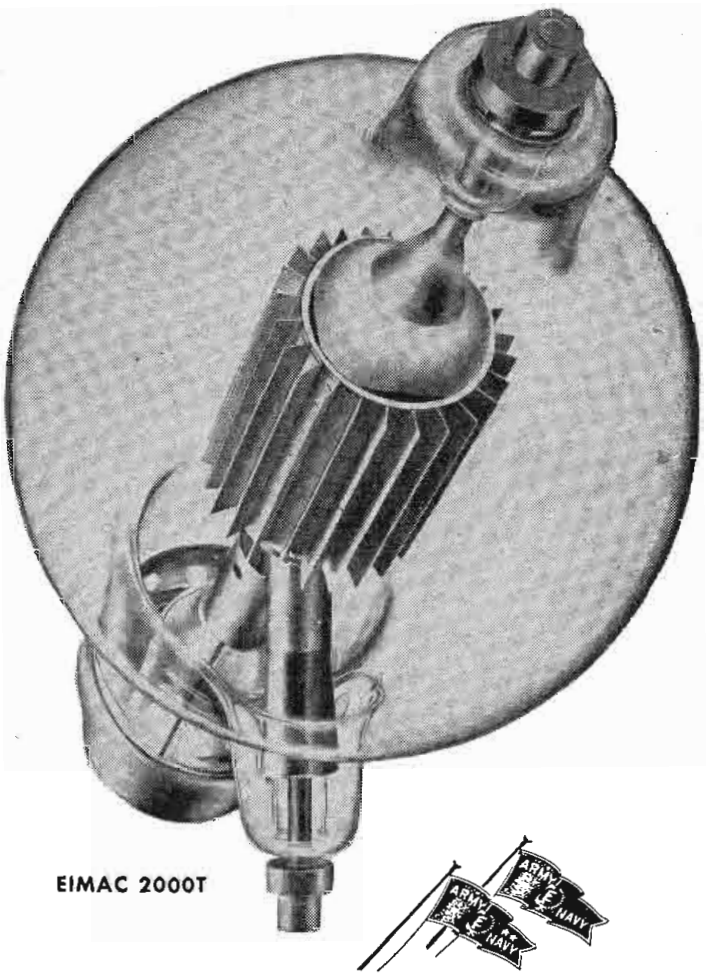

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COMMUNICATIONS

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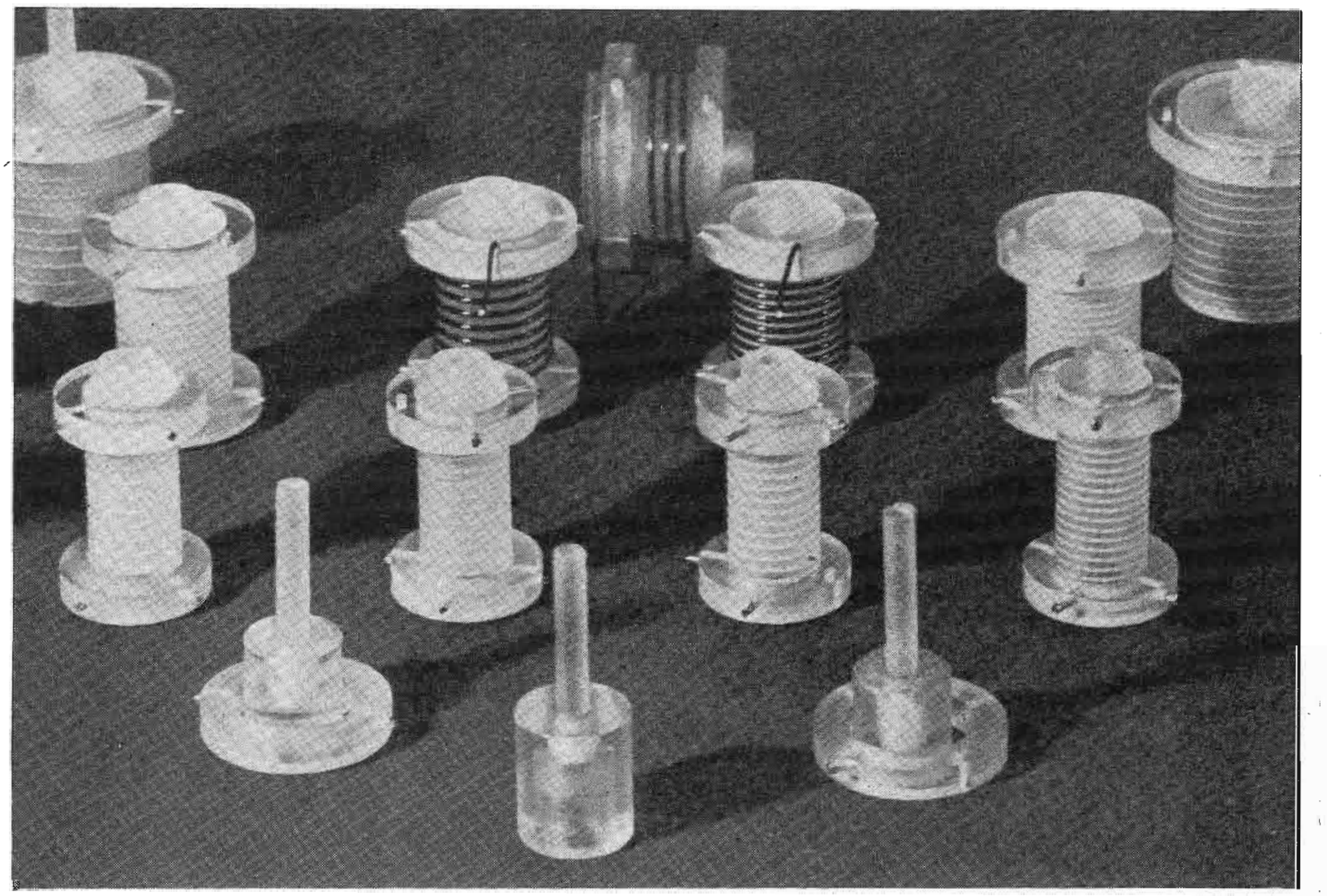
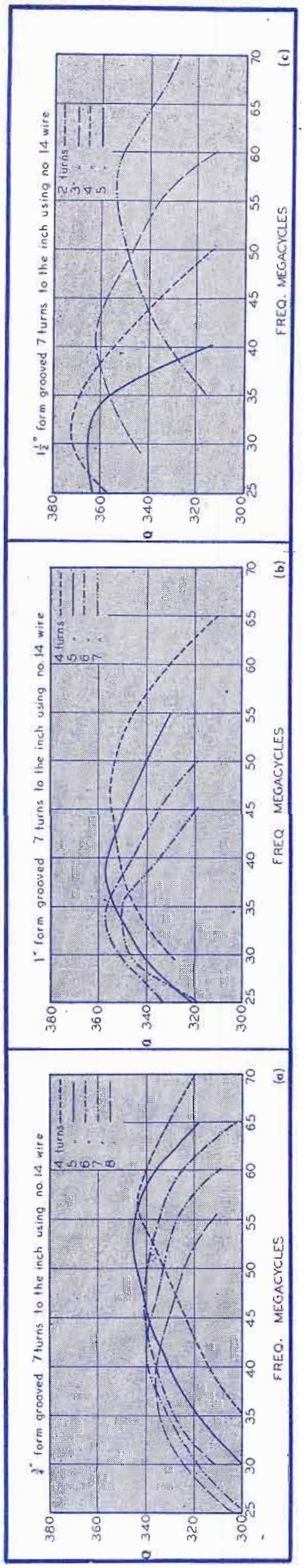


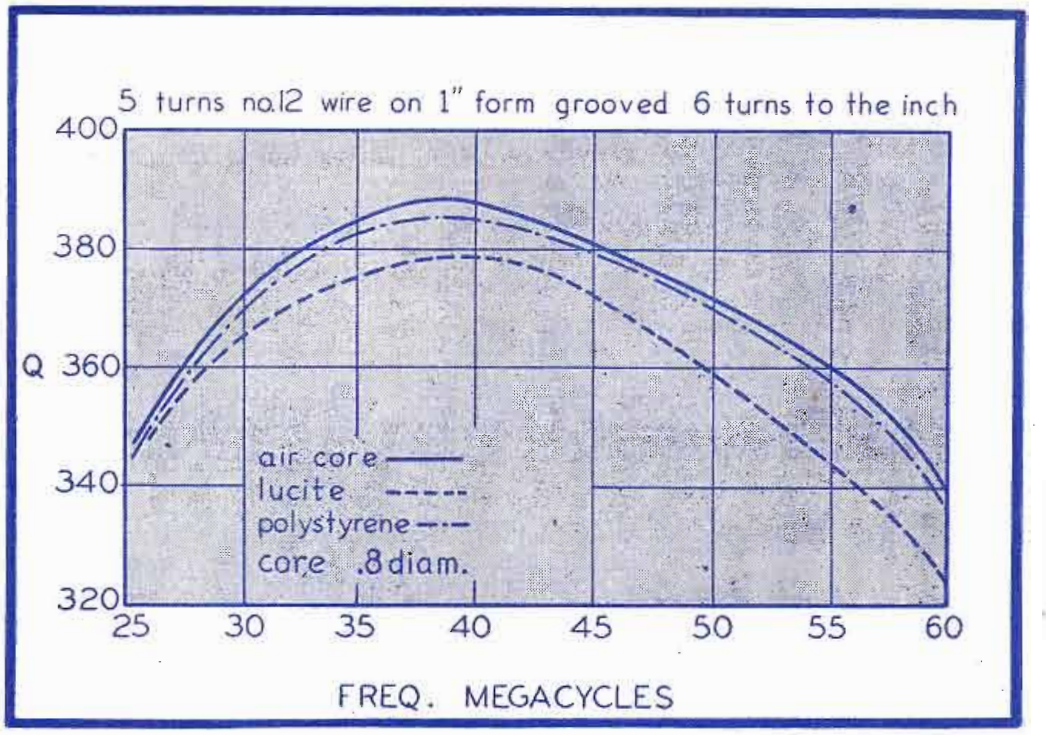
V-H-F COIL CONSTRUCTION

by ART H. MEYERSON
New York Fire Department Radio Laboratory

IN the course of constructing coils of exacting dimensions for use as standard inductances, and also for investigating *Q* and stability factors, it was found necessary to use wire sizes ranging from 12 to 18 on lucite and polystyrene coil forms varying from ½" to 1½" in diameter. The usual problems involved in getting uniform results and winding these heavier wire sizes were encountered, as well as considerable variation in inductance values due to differences of coil form dielectric constants and variation in wire diameter.

To overcome these differences, two methods were developed. The first method involved grooving for uniform distance between turns and the use of a tension flange to secure uniform strain on the wire. This procedure also minimized the winding time problem. Above appear coil forms constructed in accordance with this method. The complete form consists of four parts: the grooved coil form, two tension flanges, and a variable core. In making this type coil, one flange is first attached to one end of the coil form with pins or set screws, and the winding started, with the flange acting as an anchor for the wire end. When the required number of turns has been wound, the other flange is slipped on the coil form. The wire then is secured by slipping it through a hole in the second flange at right angles to the direction of winding, and finally tightened to the required tension. With coils using seven or more turns of 16 wire or larger, it may be necessary to loosen the first flange and retighten, since it is difficult to take up all the wire slack with the second. Another point is that grooving should be quite





Figures 1 (left) and 2 (above)

In Figure 1, abc, appear the Q results of the varying of the number of turns of 14 wire on grooved forms of ¾", 1" and 1½" diameter, grooved 7 turns to the inch. In Figure 2 are Q results obtained on different types of cores. It will be noted that the Q decreases rapidly for lucite.

deep, .0025" to .0035", and triangular in shape.

The second method, used to overcome slight differences in inductance values, entailed the use of polystyrene or lucite cores, so arranged as to create a negative temperature coefficient. The core consisted of a lucite rod and core, the rod being threaded 32 turns to the inch on a ¼" form. The core was so arranged that it entered the coil from its furthest extended position. The effect of the threaded rod on coil Q was found to be negligible, while the coefficient of expansion of the rod was found to be so high that it tended to partially correct for increases in inductance value due to heating. The coefficient of expansion of copper is 1.7×10^{-5} per degree Centigrade, while that of lucite is 10×10^{-5} average between 25 and 75 degrees Centigrade.

	Q		
Frequency	Enamel	Bare	Silver Plated
25 mc	330	329	329
30 mc	354	351	351
35 mc	366	365	363
40 mc	363	363	361
45 mc	361	362	360
50 mc	353	354	352
55 mc	343	343	342
59 mc	327	327	327

Chart 2
For 5 turns 14 wire on 1" form spaced 7 turns to the inch.

The compensating value of lucite as a variable core was very slight. At 30 mc, a core of .875" diameter used in a 1" form inductance of .6μh, varied the frequency 39 kc maximum.

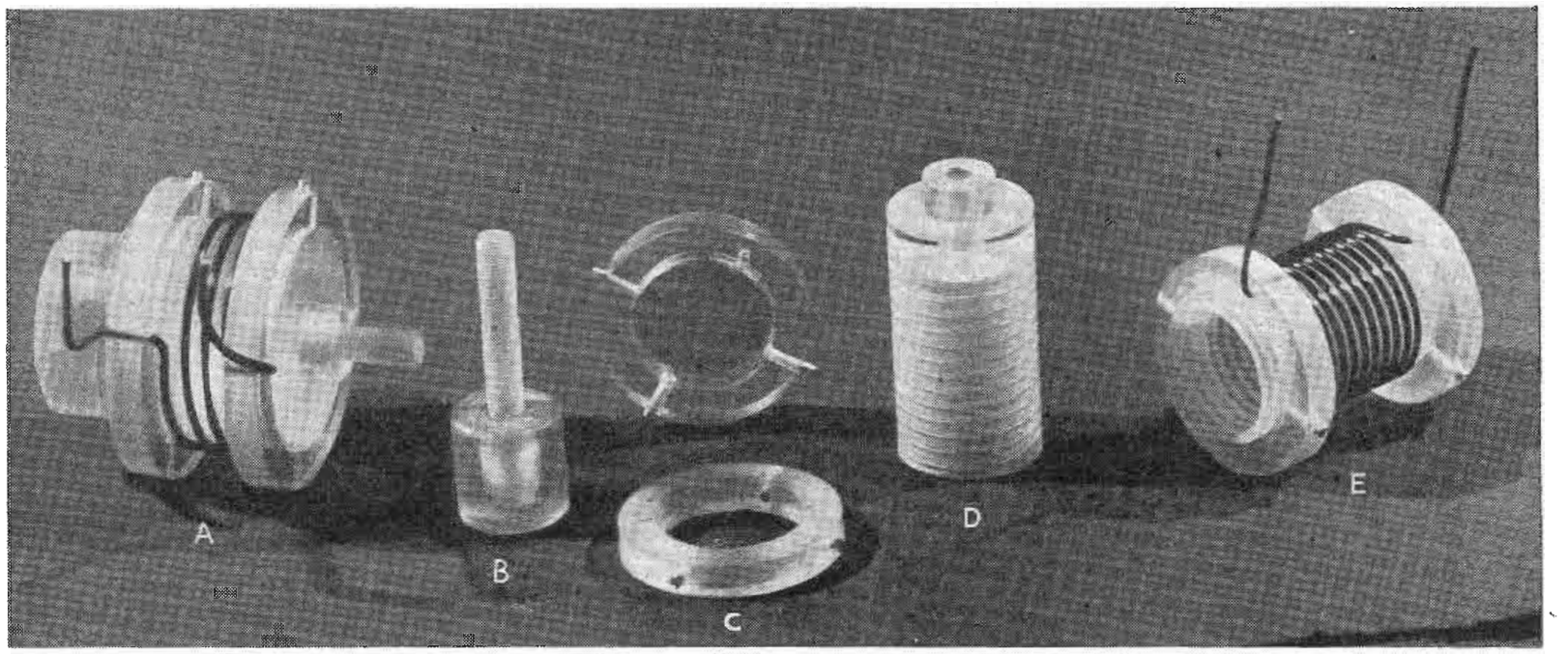
Typical Coil Results

In Chart 1 appears some typical results for these coils. It will be noted that the equivalent effect of a .875" lucite core is a copper rod .078" in diameter. The loss in Q was negligible for lucite or polystyrene cores, but increased more rapidly with frequency for lucite than polystyrene. (Figure 2.)

Investigations made on coils for use in the 30 to 60 mc band, with particular emphasis on the end frequencies, brought about the development of the coil form. For example, since the control of inductance values was made possible to a very high degree through the use of the special coil form, data could be gathered accurately as to the effects of enamel and silver plating on copper wire. Chart 2 shows the effect on Q of using enamel, bare or silver-

Material	Frequency	Q	ΔF
no core	30 mc	354	0
plexiglas	30 mc	343	—37 kc
lucite	30 mc	343	—39 kc
912A	30 mc	347	—35 kc
14 copper wire, core in lucite	30 mc	340	—15 kc
14 steel wire, core in lucite	30 mc	305	—40 kc
.078" diameter copper rod in lucite	30 mc	339	0 kc
.078" diameter copper rod	30 mc	347	+40 kc

Chart 1
For 5 turns 14 wire on 1" polystyrene form spaced 7 turns to the inch; L = .606 μh; core size, 1" by .875" diameter.



plated copper wire. Enamel wire inductances were made up on two identical forms and were found to have identical characteristics. The wire was then removed and cleaned of enamel for the bare wire figures. This particular experiment was tried several times, including the silver plating. A possible explanation for the consistently higher Q for the enamel wire may be the scratching and stretching of the wire when removing the enamel, although the wire was polished as thoroughly as possible.

Q Graphs

The graphs in Figure 1 provide some interesting data. Incidentally when preparing coil Q graphs, it is difficult to determine just what factors should be recorded graphically. There are five variable factors involved. They are coil diameter, winding pitch, wire size, number of turns, and frequency. Comparison is difficult, except in a broad sense, since inductance values change with variation in any factor. For example, three turns of 14 or 16 wire on a 1" form; three turns of 14 wire on a 1" form, or a 1½" form; and three turns of 14 wire spaced 7 or 8 turns to the inch, all produce considerable variation in inductance value.

The best approach seemed to be a limitation in parameters with a view toward determining trends. In addition, investigation was concentrated on usable forms. The three coil forms used were of ¾", 1", and 1½" diameters. Winding pitch varied from 4 to 14 turns to the inch, and wire sizes from 12 to 20. Not all the graphs are included, but a representative group are shown to indicate trends.

Frequency Range Trends

To determine trends the frequency range was limited to 25 to 60 mc,

Figure 3
A, a completely assembled coil form. *B*, lucite core for a 1" form. *C*, coil tension flanges used for tightening the wire and fastening ends. *D*, form of 1" diameter. *E*, an assembled 1" coil form.

with some of the data gathered at 70 mc.

The following procedure was used in constructing the various coils and recording the results.

Forms of 1" varying in grooving from 4 to 10 turns to the inch were selected. The wire size used was 14 bare copper wire annealed. Seven turns were wound on the 10 turns-to-the-inch form, and readings taken for from 25 to 60 mc. The wire and the tension flanges were then carefully removed, and rewound on the 8 turns-to-the-inch form, and so on down to the 4 turns-to-the-inch form. In this way, the length of wire used was always the same. The same method was used on the ¾" and 1½" forms, and for wire sizes ranging from 10 to 20. Thousands of readings were taken and the trends noted. A Boonton 170A Q meter was used, and the results spot checked against two other Q meters for accuracy. While there is a possible error of 2% in actual results, the graphical relationships are correct within less than 1%, since they were taken in runs.

Turn Varying Results

Figure 1, abc, shows the results of varying the number of turns of 14 wire on grooved forms of ¾", 1" and 1½" diameter, grooved 7 turns to the inch. The results are typical. It will be noted that the following relationships occur: (1) peak value of Q moves upward with a decrease in the number of turns; (2) Q increases with coil diameter; (3) the peak value of Q is highest at a ratio of 5 or 6 turns to 7 turns to the inch, regardless of coil diameter.

Additional Q Data

In a subsequent paper further relationships betwen the various factors affecting coil Q will be shown. In addition some experimental data on non-uniform coil-shapes will also be presented.

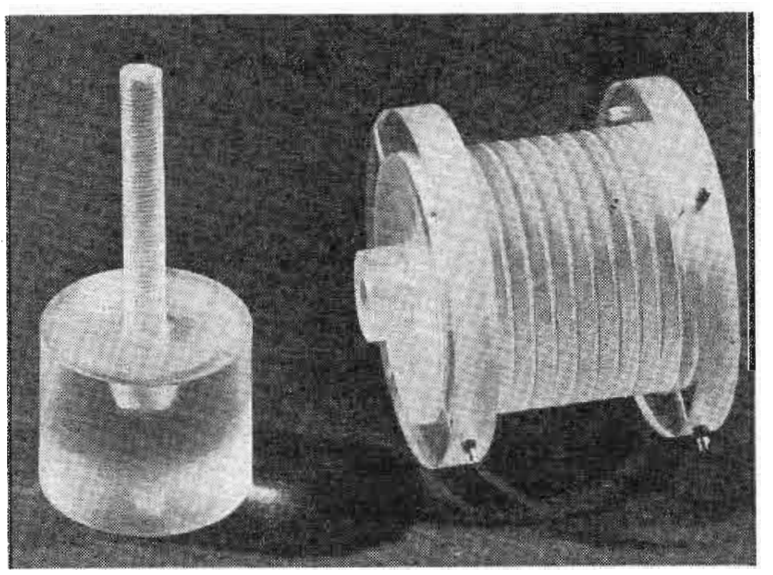


Figure 4
A lucite compensating core appears at the left. At right, a coil form with the two tension flanges in place.

HIGHLIGHTS OF AERONAUTICAL COMMUNICATIONS

Presented by Charles I. Stanton, P. Mertz and R. E. Shelby

RADIO IN AVIATION

Charles I. Stanton

THE important role that communications has played and will play in aviation was effectively analyzed by CAA administrator Charles I. Stanton in a recent address before a joint meeting of the New York sections of the IRE and the AIEE.

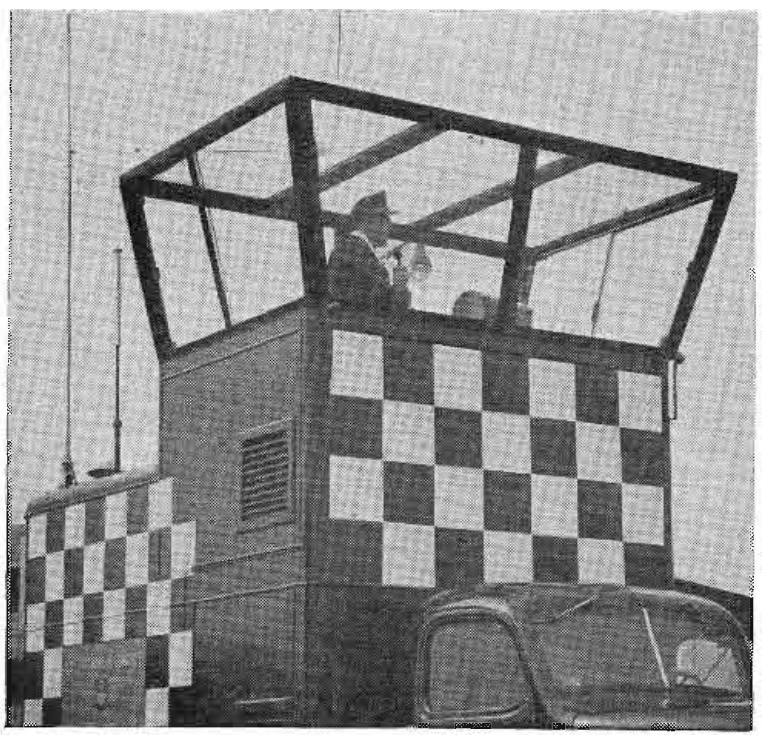
In stressing this importance, Mr. Stanton pointed out that aircraft movements handled by CAA traffic control centers have increased from about 25,000 a month in 1938 to over a million a month in 1943, a 40-fold increase in five years. Part of this increase, he said, was due to the creation of 15 additional control centers. With 23 now in operation, he explained, the country has been divided into the smallest areas practical for handling traffic which moves, in most cases, at about 180 miles an hour. Nevertheless, every indication points to a further increase, he said. To accommodate this traffic, a five-year program was initiated in 1941 to shift radio ranges over to ultrahigh frequency, explained Mr. Stanton. War caused a halt, however, on many of these plans, he said.

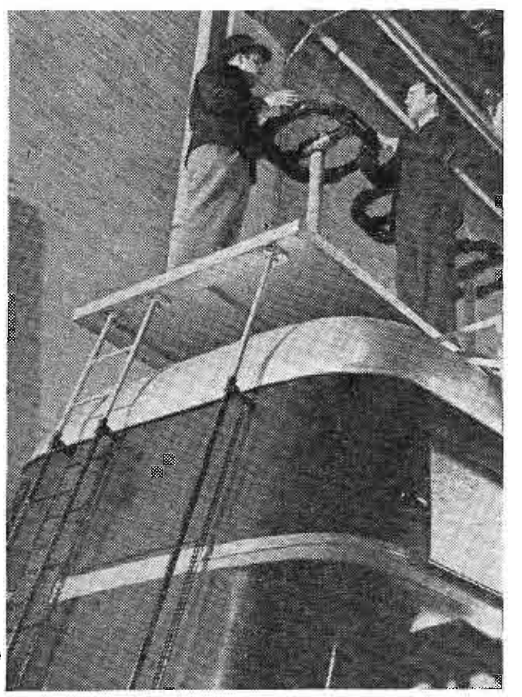
In diagnosing the limitations on the use of the present type of ranges, four principal ones were cited. These were crowded condition of the 200-400 kc band; capacity for interference over long distances of stations in this band; night-effect or signal distortions resulting from reflections from the ionsphere; vagaries resulting from distortion of the radiation pattern due to the effect of irregular terrain; high degree of interference from atmospheric static, and precipitation static. He pointed out that present radio range frequency assignments are spaced only 3.0 kilocycles apart, and thus it is necessary to operate a number of stations on each available frequency, relying upon geographical separation to limit interference. A saturation point has already been reached, he said, with few if any low frequencies available for future expansion of the range system.

To overcome these limitations the CAA has been developing equipment to operate in the 119-126 mc band. At these frequencies atmospheric and precipitation static interference is practically non-existent, pointed out Mr. Stanton. Interference between stations on the same frequency will not occur, at practical flying altitudes, provided their geographical separation is 200 miles or more, he said.

The CAA u-h-f system operates on a somewhat different principle from the low frequency ranges, explained Mr. Stanton. It provides one pair of courses indicated visually by a zero-center left-right indicator; and another pair of courses at right angles to the visual courses, which are indicated by D-U interlocked keying of a 1,020-audio cycle tone modulation.

In explaining the two-course-aural





Left, mobile airport traffic control tower developed by the air traffic control division of the CAA in collaboration with the Engineering and Signals Division of the Army. Operated by two men. Incorporates a power plant capable of producing 5,000 volts for the operation of six intermediate frequency receivers, four u-h-f receivers, a low frequency transmitter and an u-h-f transmitter. Right, portable experimental u-h-f localizer.

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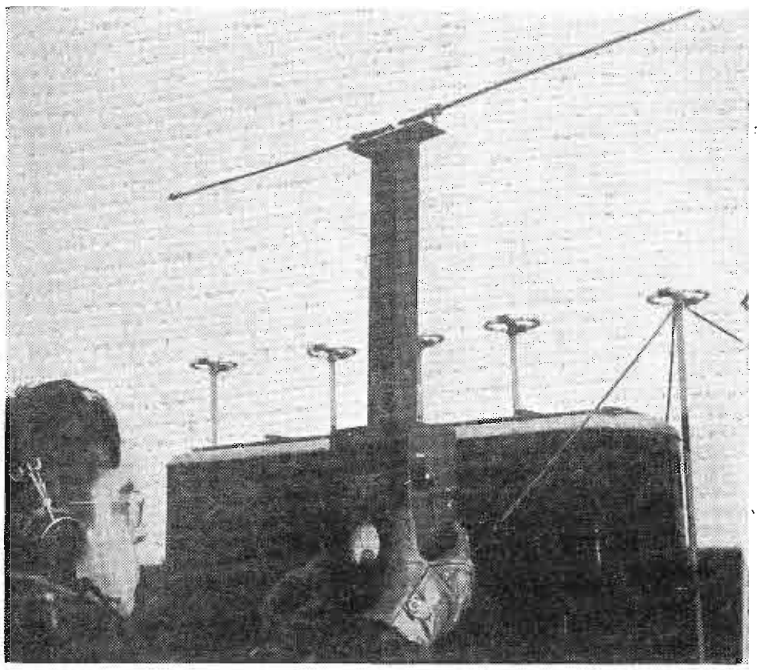
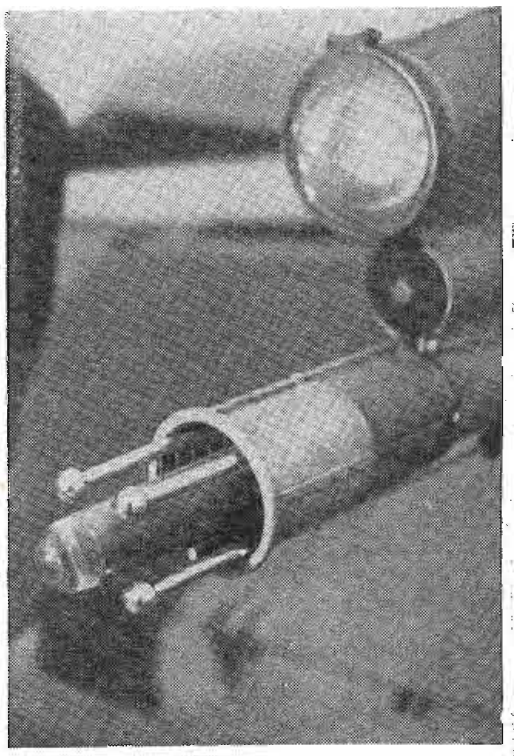




Left, operating one of the portable experimental u-h-f localizers, discussed by Mr. Stanton. Right, an experimental static eliminator, developed by CAA.

and two-course-visual range system, Mr. Stanton said that this system has a number of important advantages over the four-course-aural range. In the four-course range, the same *off-course* signal is heard in two opposite quadrants, he pointed out. A pilot who is completely lost and dependent on a four-course range for orientation, may find it tedious and time-consuming to determine which of two quadrants he is in, said Mr. Stanton. However, the two-course-aural and the two-course-visual range has no quadrant ambiguity, since its courses are formed by four unidirectional patterns rather than two bi-directional patterns. Course indications here are produced by varying modulation levels in the field about the station, explained Mr. Stanton, while the carrier itself is radiated in a circular pattern and does not vary with azimuth. Thus automatic volume control can be used. This helps to eliminate or reduce fades and surges in the signal level over rough terrain without affecting the definition of the courses, said Mr. Stanton.

Satisfactory service tests in these ranges on the Chicago-New York airway were made in 1941. It appears now that installations of the v-h-f systems may soon be resumed.

Mr. Stanton also pointed out that the CAA, in cooperation with the War Department, is installing at more than 100 airports, ultrahigh-frequency radio transmitting equipment designed to permit properly equipped aircraft to make instrument approaches in very low ceilings and visibilities—or even landings in zero-zero conditions. At present, only military aircraft are so equipped, he said.

Mr. Stanton described a complete instrument landing system. He said that it consists essentially of four separate transmitting stations located on or near the airport. These four elements are known as the localizer, glide path, boundary marker, and outer marker. A middle marker is being installed at some airports. Although any number of markers may be used, two are usually sufficient, said Mr. Stanton.

The localizer provides a very accurate lateral guidance so that approaching aircraft can maintain a heading that will lead them over the center of the runway, explained Mr. Stanton. The glide path, said Mr. Stanton, provides vertical guidance enabling the aircraft to maintain the proper rate of descent. And the markers provide reference points or *fixes* along the approach paths, which permit pilots to verify their positions and altitudes.

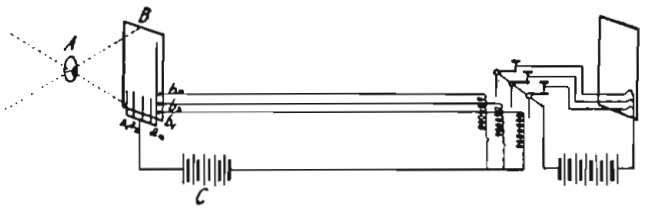
Mr. Stanton cited that no glide path is included in current installations, for equipment is not available. But, he stressed, the glide path equipment is expected to be installed as soon as it is available.

The use of the localizer and markers alone permits instrument approaches under weather conditions much less favorable than those now required, he said. Thus, approaches to an airport with 100′ ceiling and ¼-mile visibility will become feasible, whereas present minimums are 400′ ceiling and one-mile visibility.

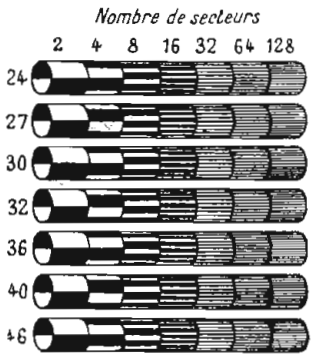
Analyzing the localizer, Mr. Stanton said it is basically a two-course radio range operating at very high frequencies. In this system he showed that a linear array of horizontal loops placed at right angles to the axis of the runway, radiates what amounts to two space patterns. These patterns represent modulation of the same carrier, at 90 cycles and 150 cycles which are rectified and separated in the aircraft receiver. The two resulting d-c voltages are applied to a right-left indicator, he said. This indicates the difference between these voltages. The two patterns cross only at the two points where the two signals are equal in amplitude.

The aircraft receiving apparatus consists of a small marker receiver and a localizer receiver, explained Mr. Stanton. The output of the former is fed into three filters, each of which controls a pilot light. Thus, he said, if the modulation happens to be 400 cycles, the corresponding filter functions to close the power circuit to its pilot light. Thus the pilot knows which marker is being received.

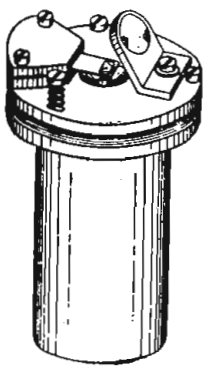
Discussing other developments, Mr.



Fernsehvorrichtung unter Benutzung einer photographischen Platte von Carey.



Analyseur optique à secteurs tournants imaginé par Fournier d'Albe. La vitesse de rotation varie depuis le tube n° 24 jusqu'au tube n° 46.



Résonateur acoustique de Fournier d'Albe.

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

Early television proposals discussed by P. Mertz in his talk on fundamental principles of television. In Figure 1 appears the television suggestion of von Carey proposed in 1875. This is a checkerboard system with individual wire lines between the transmitter and receiver. Figure 2 shows the television idea of Fournier d'Albe, proposed in 1924, where the beam reaching the selenium cells is interrupted at the different checkerboard points to produce a carrier signal. A Helmholtz resonator, used to separate the components of the signals of the frequencies corresponding to the checkerboard element, is shown in Figure 3.

TELEVISION PRINCIPLES

P. Mertz

IN view of the growing interest in television, the communications group of the AIEE and the New York section of the IRE recently announced the joint sponsorship of a series of six lectures on television covering fundamental principles, pickup, broadcasting, reception, television in color, and inspections and demonstrations.

The first lecture covering fundamental principles was presented by P. Mertz of the Bell Telephone Laboratories. He discussed the evolution of the art beginning with the semaphore in the days of Napoleon. He pointed out that there is rather a peculiar twist in the history of television picture transmission. He said, "An early working telegraph system used electromagnetic waves of very short length with an extremely sharp beam and an antenna directivity well below one degree. The particular interference with this telegraphic communication is noted to be principally fog and rain. This system was none other than the visual semaphore system used in the days of Napoleon. After this experiment with the light waves, the telegraph art reverted to the use of direct current. After a period, radiated electromagnetic waves were again used, first of extremely long wavelength, and then in the course of time of shorter and shorter wavelength. Electrically transmitted signals of the telegraphic type have been used conversely to carry the signals for a remote visual or television system."

In Figure 1 appears a very early television proposal, analyzed by Mr. Mertz. This is a checkerboard system with individual wire lines between the transmitter and receiver, and was suggested by von Carey in 1875. Another odd development in the art of television covered by Mr. Mertz appears in Figure 2. In this suggestion, conceived by Fournier d'Albe, in 1924, the beam reaching the selenium cells was interrupted at the different checkerboard points to produce a carrier signal. Mr. Mertz pointed out that the interrupting windows were graduated in number from one end of each scanning line to the others. Then the tubes which corresponded to successive scanning lines were rotated at progressively increasing speeds from top to bottom, he explained. In this way each element of the checkerboard generted its own carrier signal. In the receiver were a set of light vanes op-

Stanton said, "While we have been forced to wait for improved equipment, we have not let the war slow down our attempts to improve procedures. Approach control is one of the more important innovations we are developing. Up to now it has been customary for planes approaching an airport to maintain contact with the control tower only indirectly, through an airline or military radio station, becoming subject to airport traffic control-tower control, only when it came in sight of the field. Under the approach control system, the controller takes over when the plane comes within 15 miles. This makes possible landings only 5 minutes apart in instrument approach weather, as compared with 15-minute separation under conventional methods. This system is in operation at Atlanta, Kansas City, and San Diego, and is being extended as rapidly as possible, subject to the approval of the chief users of each airport."

Mr. Stanton predicted that in the ten-year postwar period, there will be 500,000 civil airplanes in the U. S. and most of them will be privately owned and equipped with radio communications.

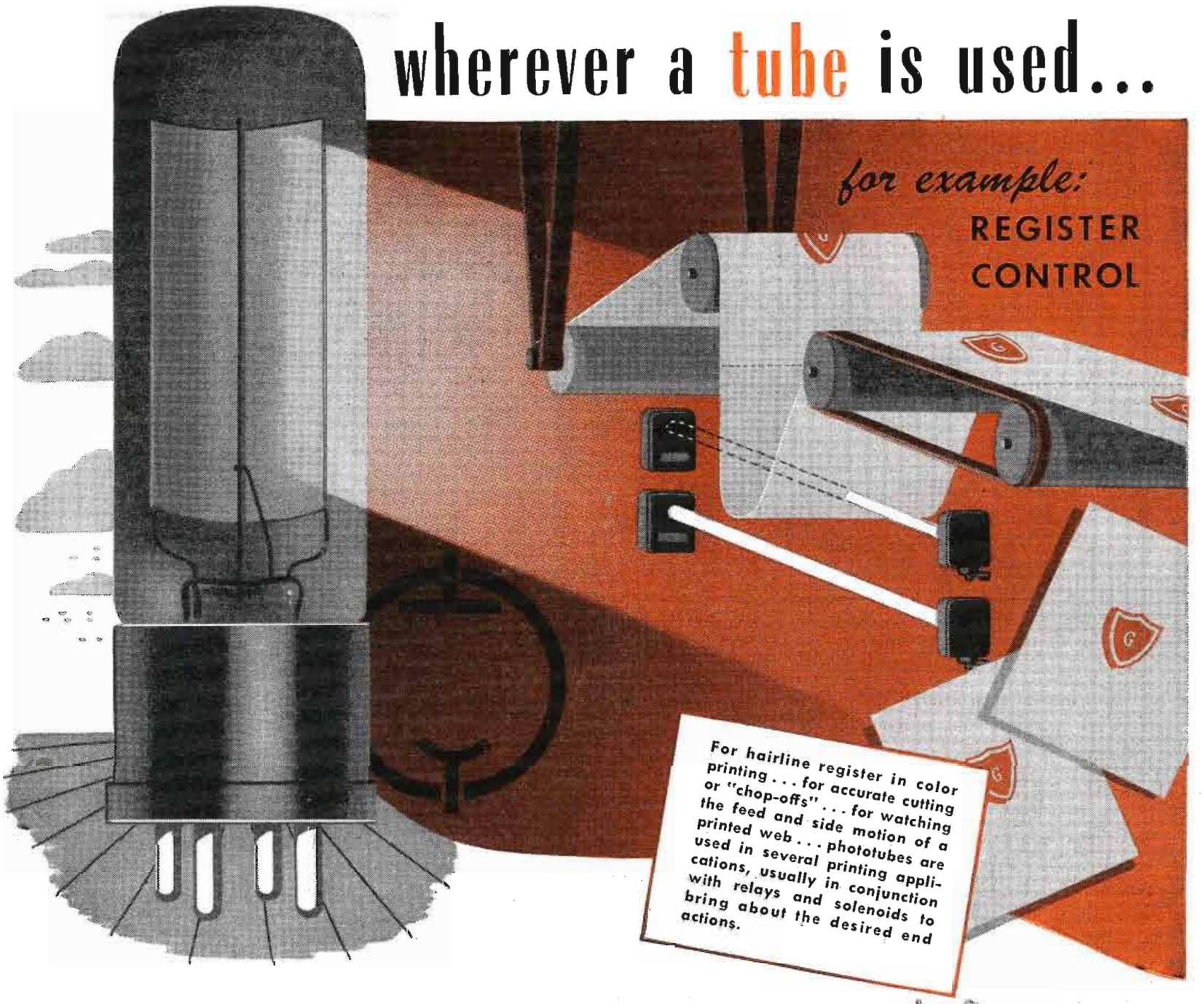
Radios will be chosen, said Mr. Stanton, because the private flier will want radio to make his flying simpler and safer. The radio compass will probably be standard factory equipment, except on the lowest priced planes and on training planes that stay near the airports on which they are based, stated Mr. Stanton.

Private fliers will also demand radio so as to obtain weather information, cited Mr. Stanton.

Low Cost Postwar Equipment

Mr. Stanton concluded his paper with a discussion of the costs of civil postwar communications equipment. He said that in quantity production, such equipment should sell for a modest price, complete installations costing no more than $150.00.

wherever a tube is used...

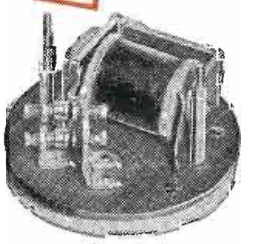


THERE'S A JOB FOR

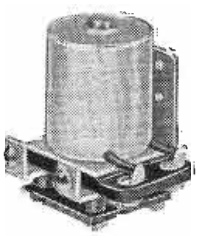
Relays BY GUARDIAN

In the electronic circuit there is usually a sensitive relay similar to Guardian Series 5, to control a heavier current in response to the weaker "signal" of the phototube. In some applications, however, the current to be handled may be greater than the contact capacity of the sensitive relay. In this case a power relay or solenoid contactor is controlled by the sensitive relay. Guardian series SC-5 is typical of this type of contactor.

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



SERIES 5 D. C. RELAY. Maximum switch capacity—two normally open, two normally closed, or DPDT contacts. Resistance range .01 up to 15,000 ohms. Send for bulletin 14.



SERIES SC-5 SOLENOID CONTACTOR. Contacts rated at 75 amps. continuous, 300 amps. surge. Contact combination—single pole single or double throw. Coil operates on 18-28 volts D. C. and consumes 7 watts at 24 volts D.C. continuous. Send for bulletin SC-5.

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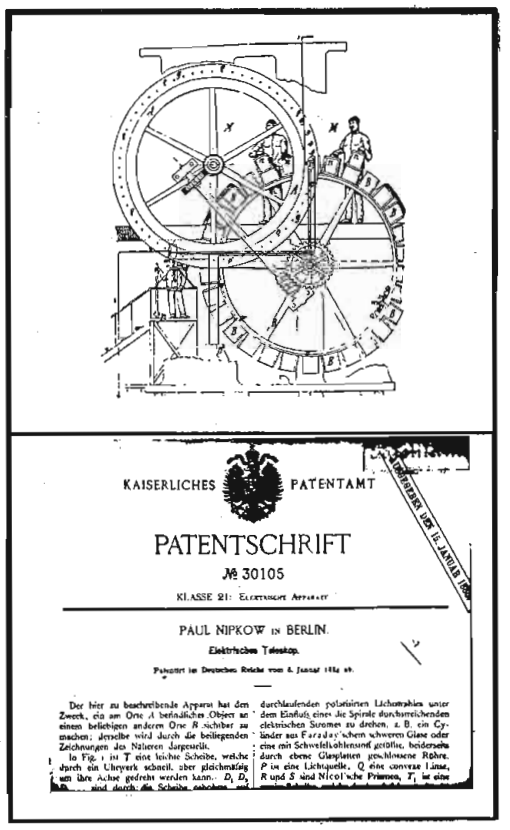


KAISERLICHES PATENTAMT

PATENTSCHRIFT

№ 30105

KLASSE 21: ELEKTRISCHE APPARATE

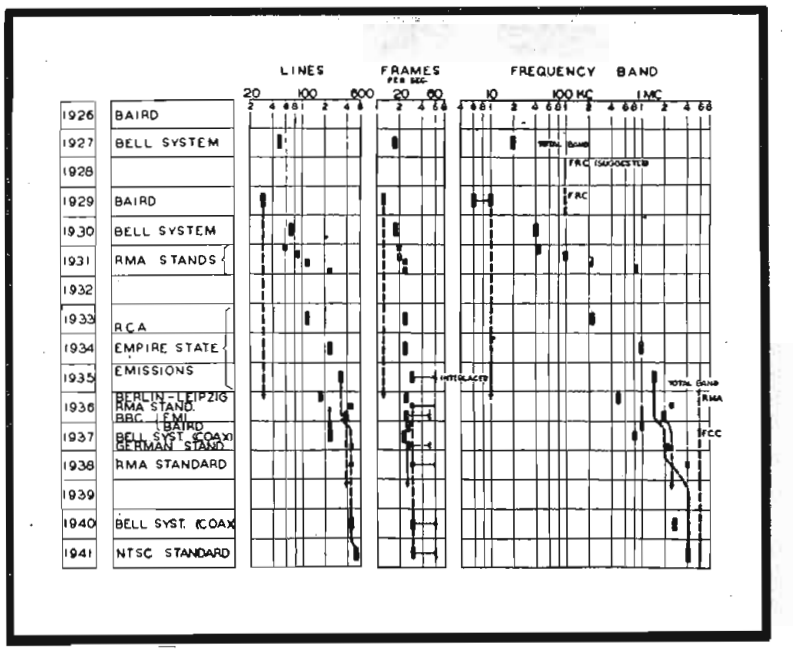
PAUL NIPKOW IN BERLIN.

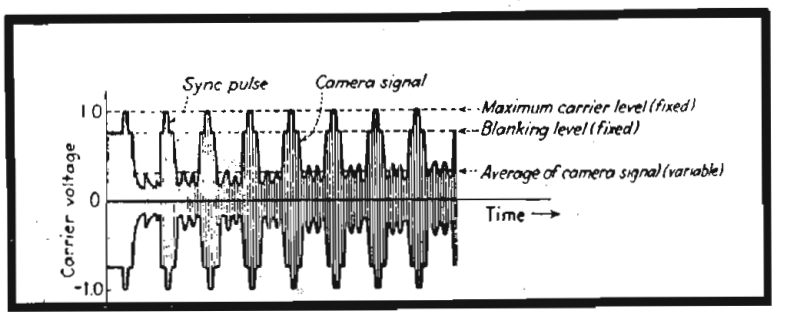
Elektrisches Teleskop.

Patentirt im Deutschen Reiche vom 6. Januar 1884 ab.

Figures 4 and 5 (left), 6 (right), and 7 (lower right)

In Figure 4 appears a television suggestion of Schöffler proposed in 1896. In this rather unique system, successive photographic plates were exposed to the subject material and placed in the plate holders around the wheel *B*. The wheel *A*, rotating much faster than *B*, scanned the photographic plates. Figure 5 illustrates a portion of the famous Nipkow patent. In Figure 6 we have the progression of standards from 1926 to 1941. Figure 7 shows a modulated television carrier signal with its characteristic carrier and blanking levels.





erted electromagnetically by the received signal. To separate the component of the signal of the frequencies corresponding to the checkerboard element, an acoustic resonating cavity known as a Helmholtz resonator was used (Figure 3).

An 1896 television suggestion by Schöffler, discussed by Mr. Mertz, is shown in Figure 4. Here only the receiving end appears. According to Mr. Mertz a similar mechanism was also present at the transmitter. In operation successive photographic plates were exposed to subject material and placed in the plate holders around the wheel *B* which rotated slowly. The wheel *A* rotated much faster and successive points on it scanned the photographic plates, taking each in turn as the previous one was completed, explained Mr. Mertz.

The title page of one of the most historic patents in the history of television appears in Figure 5. It is the patent of Nipkow. For many years this mechanical scanning system was used in television. The interesting patent of Nicolson, granted in 1917, was also discussed. This particular patent covered spiral scanning. Mr. Mertz explained that spiral scanning differs from the other forms of scanning in that two linear dimensions are constituted by a radius vector and an angle, instead of cartesian coordinates.

An early proposal for an all-electronic television system conceived by Campbell-Swinton was also analyzed by Mr. Mertz.

The progression of standards of television transmission are effectively illustrated in Figure 6. In discussing standards, Mr. Mertz pointed out that in 1927 the Bell System used 50 lines in the field of view reproduced at 17.5 frames per second and using a frequency band of about 20 mc. The British Broadcasting Company, using Baird's equipment, began in 1929 to transmit with 30 lines, 12½ frames per second and a frequency of 5 to 10 kc. Mr. Mertz pointed out that this service was maintained until 1936. In 1930 a 72-line system using 18 frames a second and a total bandwidth of about 40 kc was developed by the Bell System. The number of lines used began to increase as the years went by, until in 1941 the NTSC 525-line standards were adopted. Frame frequencies also were increased and during the process interlaced scanning was adopted in place of progressive scanning, explained Mr. Mertz.

In analyzing interlaced scanning, Mr. Mertz pointed out that in this means of scanning, alternate instead of successive lines in a field of view are explored. Thus, he said, when the field has been once covered, the lines omitted in the first scanning are taken up. In this way it is possible to achieve a rapid covering of the field from top to bottom, twice as often as by the progressive scanning method. This diminishes the flicker considerably.

In Figure 7 appears a modulated television carrier signal. Amplitude modulation is used in the NTSC standard, explained Mr. Mertz, and thus picture black and synchronization correspond to peaks of radio power, while picture white is equivalent to the minima of radio power.

Mr. Mertz described the coaxial system as applied to television signal transmission. In use, he said, the carrier frequency is placed comparatively near the zero frequency, leaving only enough room below it to handle comfortably the cutoff characteristic about the carrier. There are, at the present time, several coaxial conductors installed. These are between New York and Washington, Stevens Point and Minneapolis, and Atlanta and Macon.

TELEVISION PICKUPS

R. E. Shelby

IN the second of the series of television lectures, R. E. Shelby of the National Broadcasting Company, spoke on pickups.

Mr. Shelby introduced his paper with a discussion of scanning: the process of sending two variables, width and height, which vary with time in a single channel and then reversing the process to reproduce the original picture at the receiver. Like motion pictures, the actual television

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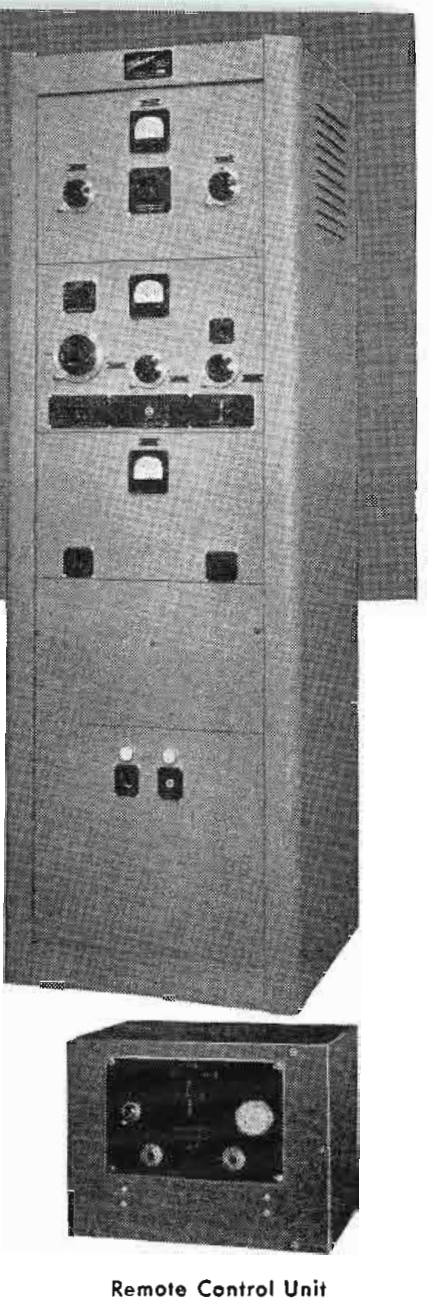

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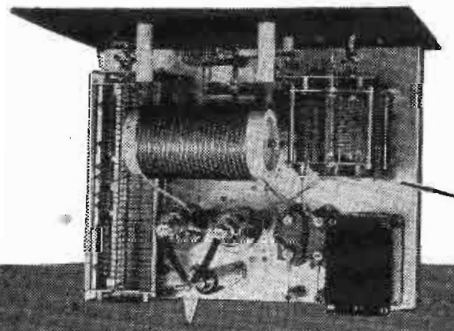

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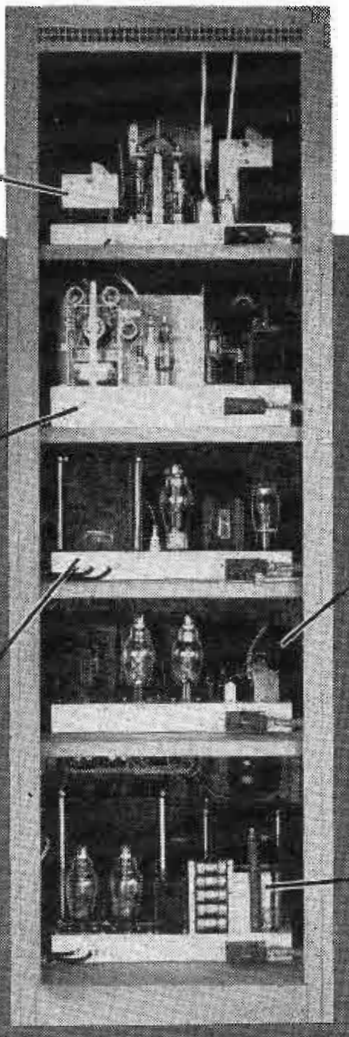
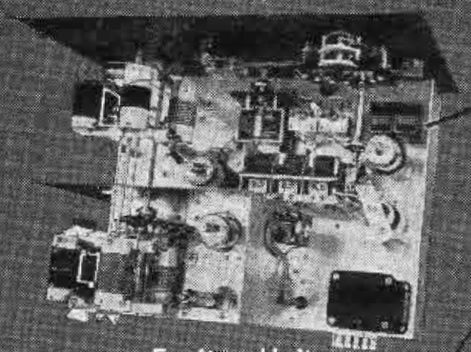
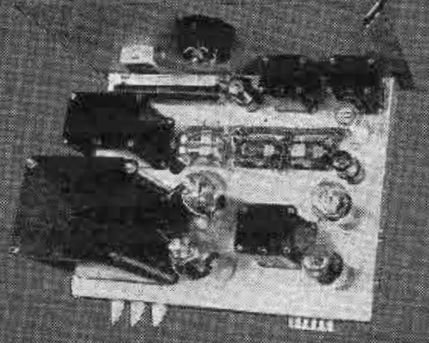
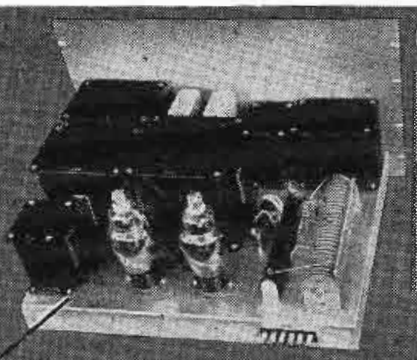




Exciter Unit



Modulator Unit



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Important Characteristics of Model 250 GSC

MECHANICAL Rack and panel construction. Chassis moves forward on shelves for removal and inspection. Grey crackle finish. Chassis cadmium plated. Antenna connections on top; power and control cables through floor. Dial clamps provided.

FREQUENCY RANGE 2 to 16 megacycles continuous tuning.

FREQUENCY DETERMINATION: Crystal (4 positions provided) or electron coupled oscillator.

MODULATION CAPABILITY 100% with — 5DB input. High level modulation. 200 or 600 ohm line input.

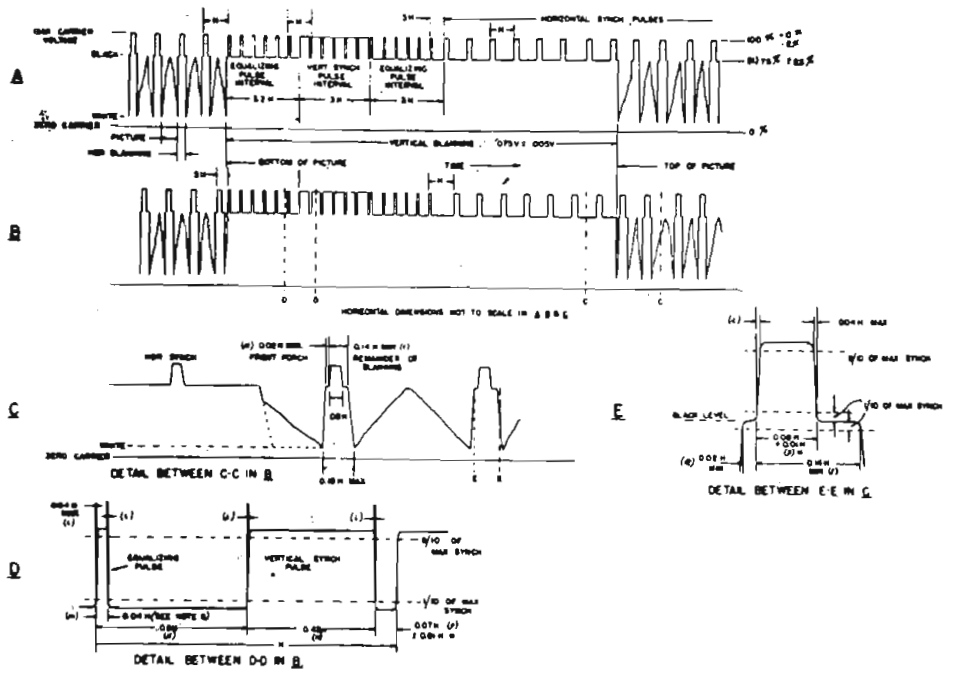
OVERALL AUDIO DISTORTION Less than 5% at 80% modulation.

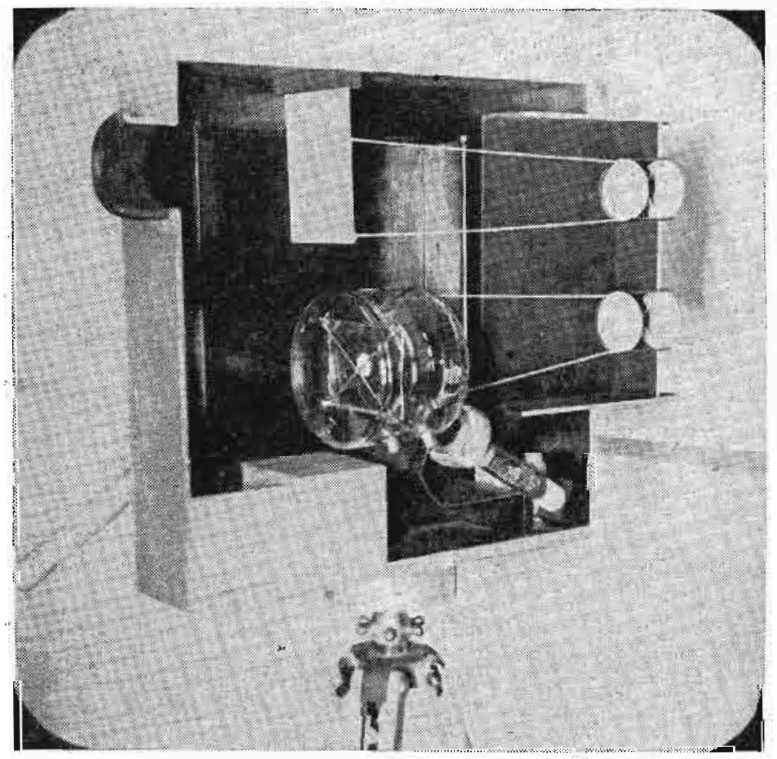
OVERALL FREQUENCY RESPONSE Less than 2DB from 200 to 7,500 CPS.

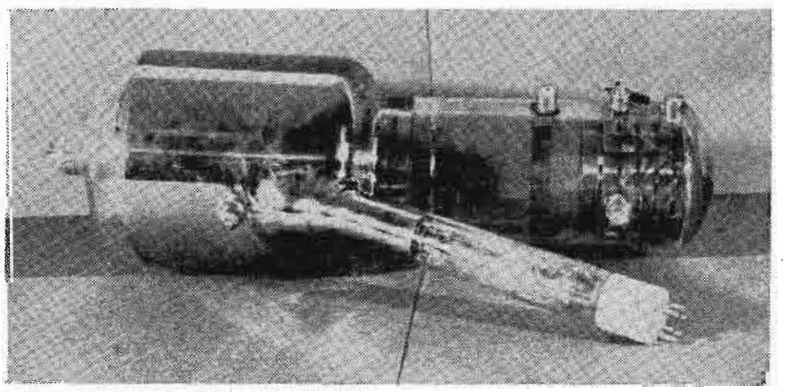
CARRIER NOISE Lower than —50DB from maximum modulation.

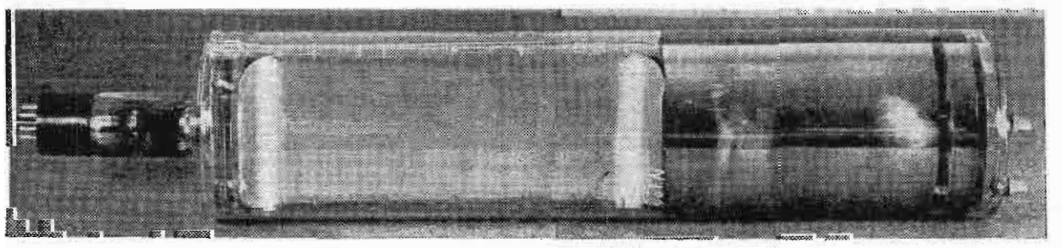
MICROPHONE Single button carbon. Push-to-talk.

OUTPUT CIRCUIT To work into an unbalanced transmission line having a characteristic surge impedance of 30 to 1,000 ohms, a quarter-wave Marconi antenna at the operating frequency, or any antenna whose resistive and reactive component does not exceed 1,000 ohms.









Figures 8 (top), 9 (left, top center), 10 (left, bottom center), 11 (bottom) and 12 (bottom, right).

In Figure 8, the FCC standard waveform discussed by Mr. Shelby. Figure 9 shows a mock-up camera with two lens systems, one for the Iconoscope and other for viewing and focussing. The image Iconoscope with an electronic lens system and photoelectric cathode appears in Figure 10. In Figure 11 is shown the Orthicon, which uses magnetic deflection for the vertical, electrostatic deflection for horizontal and a beam perpendicular to the mosaic. The Monoscope appears in Figure 12. This is a fixed picture type used for testing and station identification.

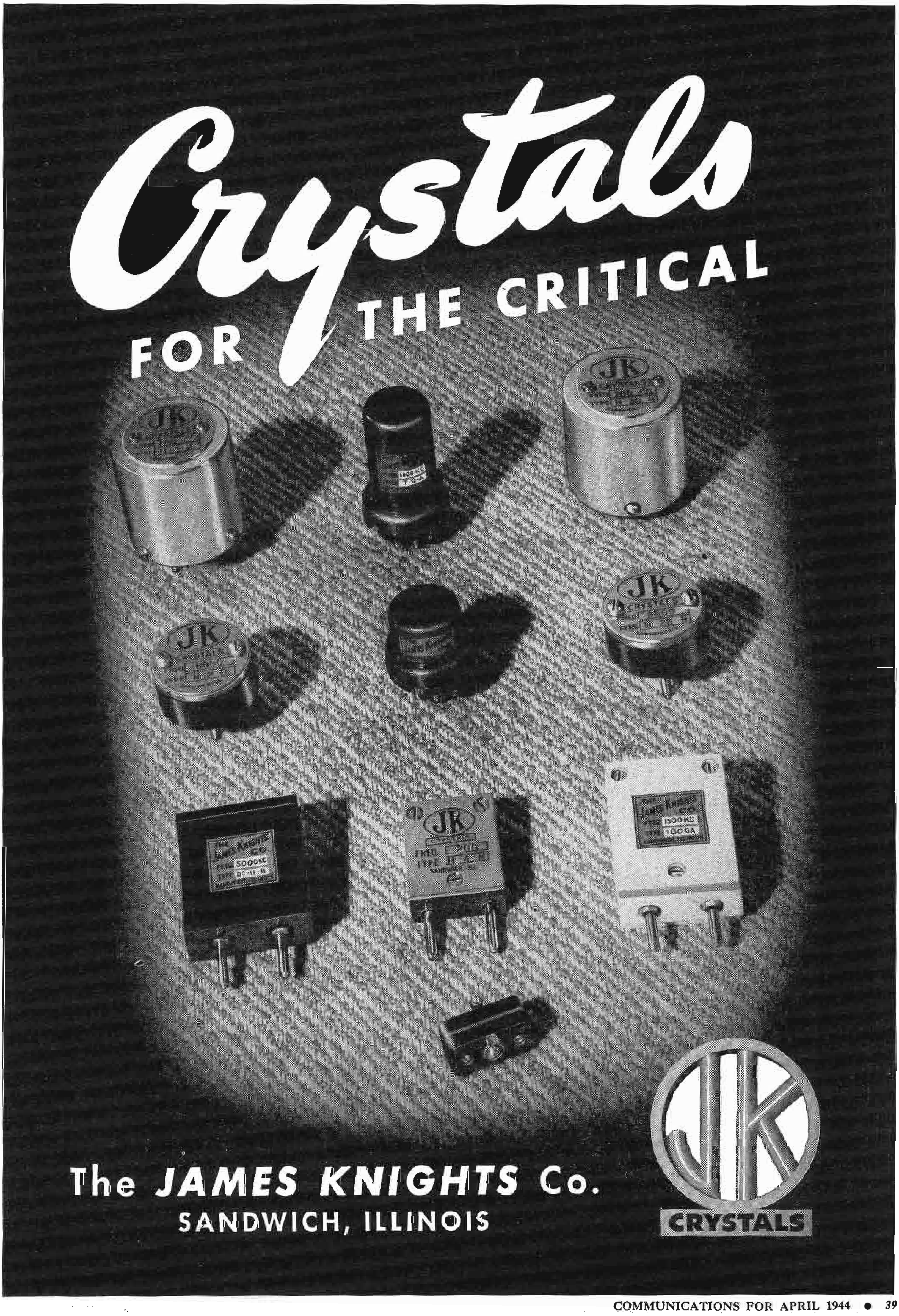
pictures are not continuous, he said, but consist of a series of stills projected with such rapidity that the eye perceives a steady, flickerless picture. A lag in response of the optic nerve, which we call persistence of vision, is the reason for this, he pointed out.

Mr. Shelby then discussed the flicker rate, the number of frames per second for both motion pictures and television: 24 for motion pictures and 30 for television. The bandwidth required by a television channel is proportional to the number of frames per second; also, it is desirable that the frame rate bear a simple ratio to the power line frequency. These are some of the principal factors which led to the choice of 30, he said. By means of interlacing, the field or flicker frequency is increased to 60 per second without increasing the frequency band. Interlacing, he explained, consists of scanning first the odd lines of the picture from the top left to the bottom right, then returning to the top and scanning the even lines. Thus the field is covered twice per picture, making the field frequency twice the picture or frame frequency.

Mr. Shelby explained that by having a fixed ratio between the power frequency and frame rate, a higher hum level could be tolerated in receivers, thus reducing their cost. The hum is synchronized with the pattern. Thus no spurious motion takes place, he said. The odd scanning field was identified as *A* and the even field, *B*; thus A + B = one frame. He pointed out that this system requires an odd number of lines; hence the previous 441-line standard and the present 525 lines adopted by the FCC in 1941.

The next subject discussed was reso-

(*Continued on page* 81)



THE Q

An Automatic Lapping Machine

by T. W. M. SCHAFFERS
Executive Engineer
North American Philips Company

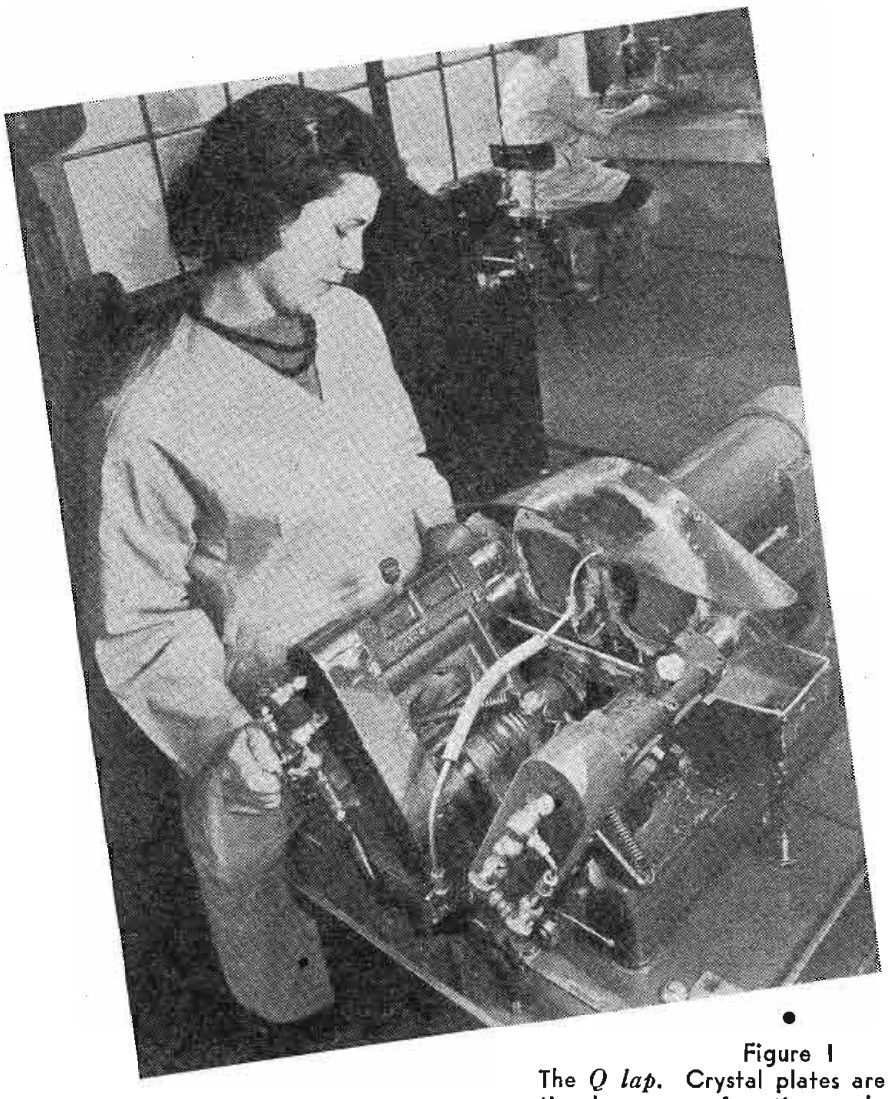


Figure 1
The *Q lap*. Crystal plates are held in position by means of suction, and ground with a diamond wheel.

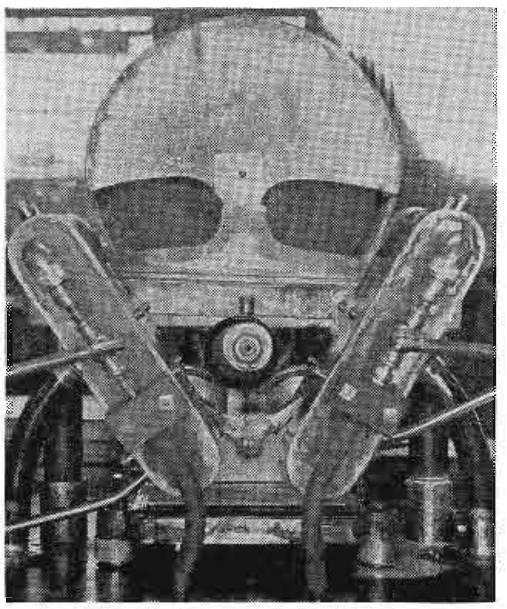
PREWAR crystal manufacture, following rather limited production schedules, utilized hand operations for many steps. Some speed was, of course, essential, but the schedules could be maintained with the hand-operation procedures. When, however, war broke out and production demands suddenly increased many thousandfold, it was soon found that these hand-operation methods would have to be supplanted by automatic equipment. Unfortunately such equipment was not generally available and thus manufacturers had to develop their own.

Conversion of available machinery played an important role in the initial equipment development stage, particularly for lapping operations. For instance, drill presses were converted for lapping.

Crystals were placed in a specially designed workholder having square holes, or straight or curved-sided pentagonal holes. The workholder rotated eccentrically between two lapping plates. Various grades of abrasive mixtures were used until the crystals, after three or four lapping operations, were thin enough to be hand finished to the final frequency. This lapping procedure, however, was very slow, for the eccentric motion of the workholder limited the speed of rotation. At that time, too, diamond saw blades were not as highly perfected as they are today. Consequently, wedge-shaped blanks varying in thickness were very common. Blanks 1/8" thick were not unusual.

A study of these deficiencies indicated that it would be prudent to develop a special machine for lapping.

Figure 2
Experimental model of the first *Q-lap* machine.



Accordingly we constructed an experimental model that would overcome the converted equipment problems. Because of the hardness of quartz, this model, shown in Figure 2, was built to accommodate a cutting wheel impregnated with diamond particles.

The best surface speed, diamond grit size and concentration to obtain the quickest cutting, were determined after extensive experiments. Various types of metal and resinoid bonded diamond wheels were tried, for in addition to rapid cutting, it was important to get such a finish as would necessitate only the lapping with 303½ abrasive before final hand finishing to the required frequency. These results were obtained by using a resinoid bonded diamond wheel with 100-grit size diamonds, and 50 concentration.

Coolant Experiments

The quartz loading of the diamond wheel was primarily influenced by the coolant used during grinding. Experiments with various coolant mixtures showed definitely that a mixture of turpentine and kerosene was most effective. The percentage in this mixture proved to be very critical, with the optimum being 20-30 per cent turpentine, and the balance kerosene. With this coolant, fast cutting and a good finish were obtained, and the diamond wheel could be held sharp and clean. Water soluble oils, on the contrary, generally left a greasy deposit

L A P

on the wheel, and in cases where too much alkaline was present, attacked the resinoid bond, leading, consequently, to rapid wearing of the diamond wheel.

Pressure Holder

During grinding, the crystals were held by suction against a special holder, Figure 3. The small holes in this plate held a half-inch square crystal against the plate with .39 pound of pressure, and a one-inch square crystal with 1.36 pounds of pressure.

Because of the construction, mass, and high specific heat of the crystal holder shaft, there was a negligible increase in the temperature of the crystal.

Improved Model

So favorably did the results obtained from this machine compare with those from the drill press, that we decided to build a new machine, incorporating improvements suggested by the experimental model. This new model, which we named the *Q-lap*, is shown in Figures 1, 4 and 6. A number of these new machines have been

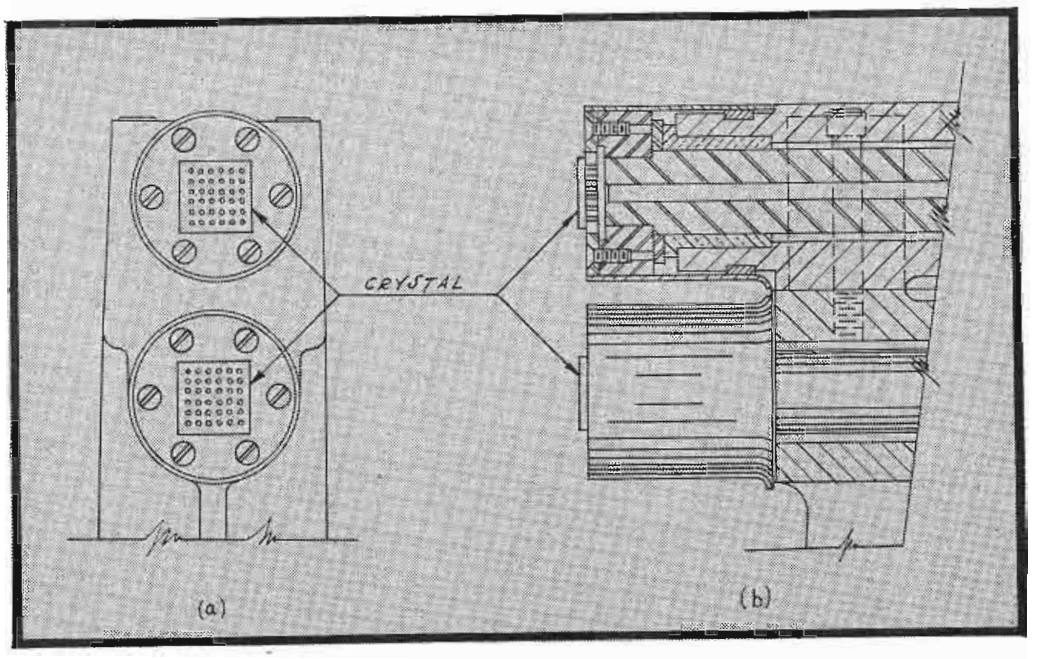


Figure 3

In (a) appears the front view of the special crystal holder developed for the *Q-lap* machine. At (b) is a side view of this device. Note the small holes through which air is fed to hold the crystals in place.

operating for the past year, and in addition to fast grinding, have displayed other advantages. These are: fast rough grinding of single crystals up to ¼" thick; parallel grinding of wedge-shaped blanks with respect to the reference surface to within .0002"; rapid grinding of angle-corrected blanks to within 2 minutes; no waxing of blanks because of suction head; depth of scratches .00055", despite rough grinding; and minimum wear of all moving parts.

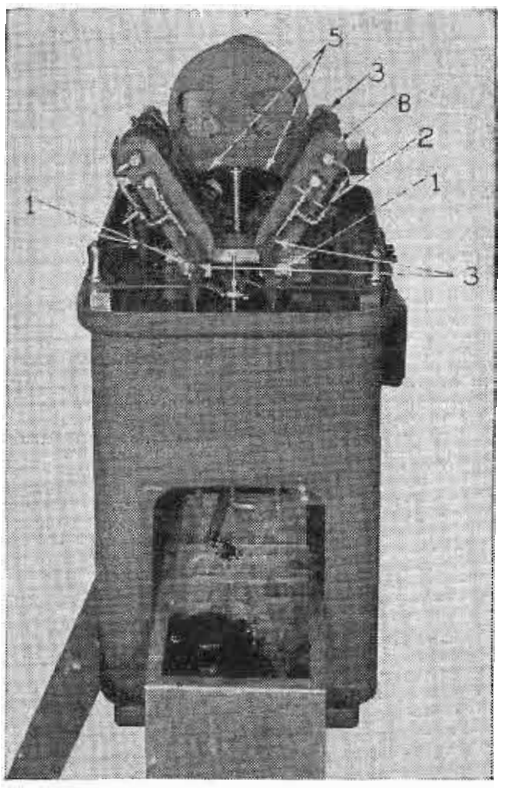
The *Q-lap* has a cast iron base in which are mounted a filter tank, coolant pump, gear reduction motor for the cam drive, and a motor with an endless flat belt drive for the precision, dynamically balanced Pope SKF spindle. Vibration is held to a minimum.

Operation of Q Lap

On the spindle a special diamond wheel is mounted, Figure 5, which has an 8½" diameter and 2½" rim width. In Figures 4 and 6 are indicated some of the *Q-lap* features. The rocker arms, *3*, are each provided with two crystal holder shafts, *4*. Ball-bearing couplings, *12*, permit the crystal holder shaft to revolve without any loss of suction. The rocker arms oscillate in a reciprocal motion over the rim of the diamond wheel by means of circular eccentric cams and roller-bearing followers attached to the lower end of the rocker arms. A spring, *5*, holds the rocker arms and followers against the cam. To place the crystals in position on the crystal holders, the rocker arms are moved sideways. A locking device, *7*, holds these rocker arms in position. Once the crystals are placed on the suction head, the valves, *6*, are opened, causing adhesion of the crystals by atmospheric pressure. When the locking pin, *7*, is pushed down, the rocker arms move inwards until the cam-roller follower rests against the cam. This cam, which is in rotation, causes the rocker arm to oscillate. By pushing the knob, *8*, on the handle, *9*, the rocker arm moves toward the grinding wheel by means of a spring. Simultaneously, the crystal holder shafts, *4*, start to rotate at about 16 rpm, due to the clutch engagement. The relationship between the rotary motion of the crystal holder and the cam shaft is such that at the same position of the rocker arm on successive cycles of motion, the angular position of the crystal is slightly displaced with respect to its former

Figure 4

The newest model of the *Q-lap* machine.



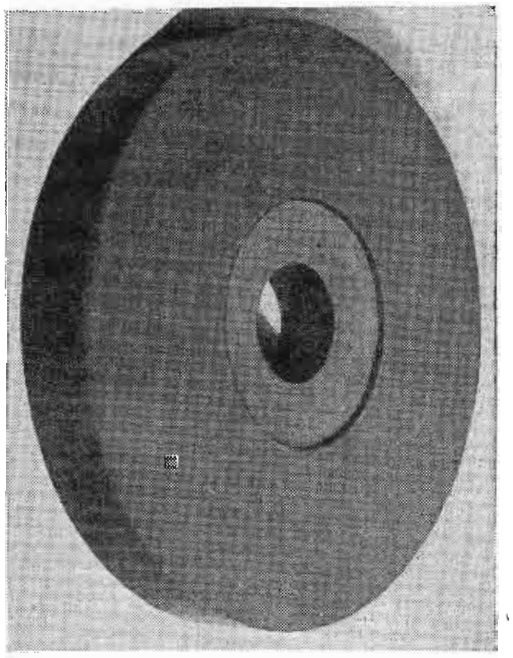
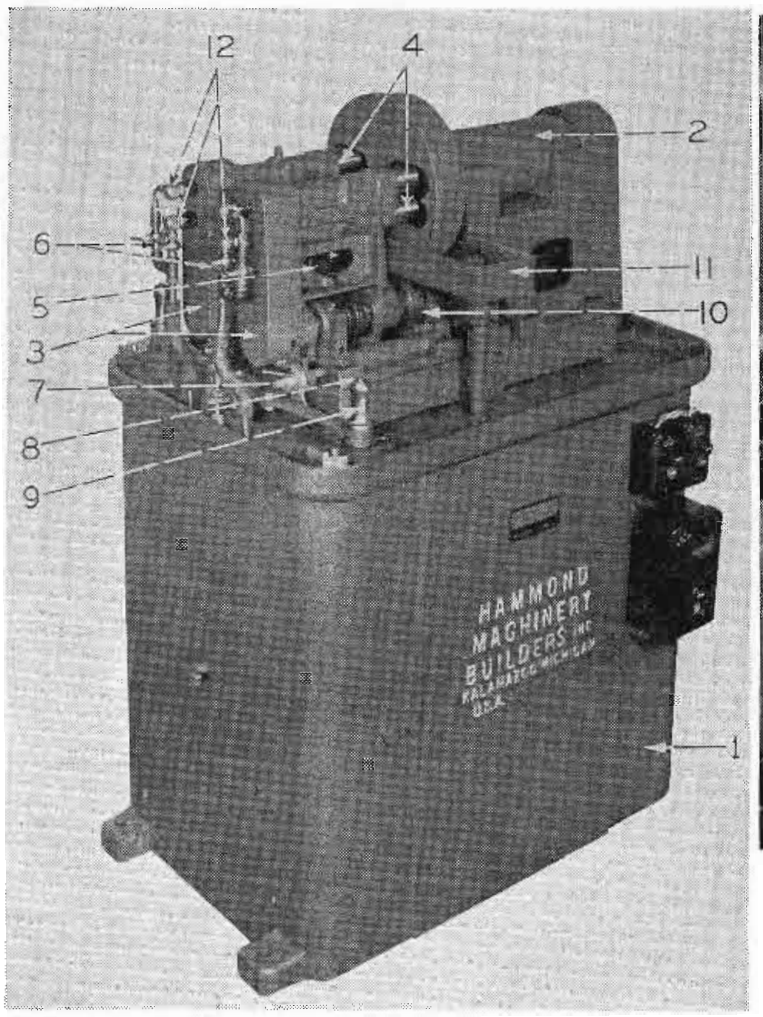
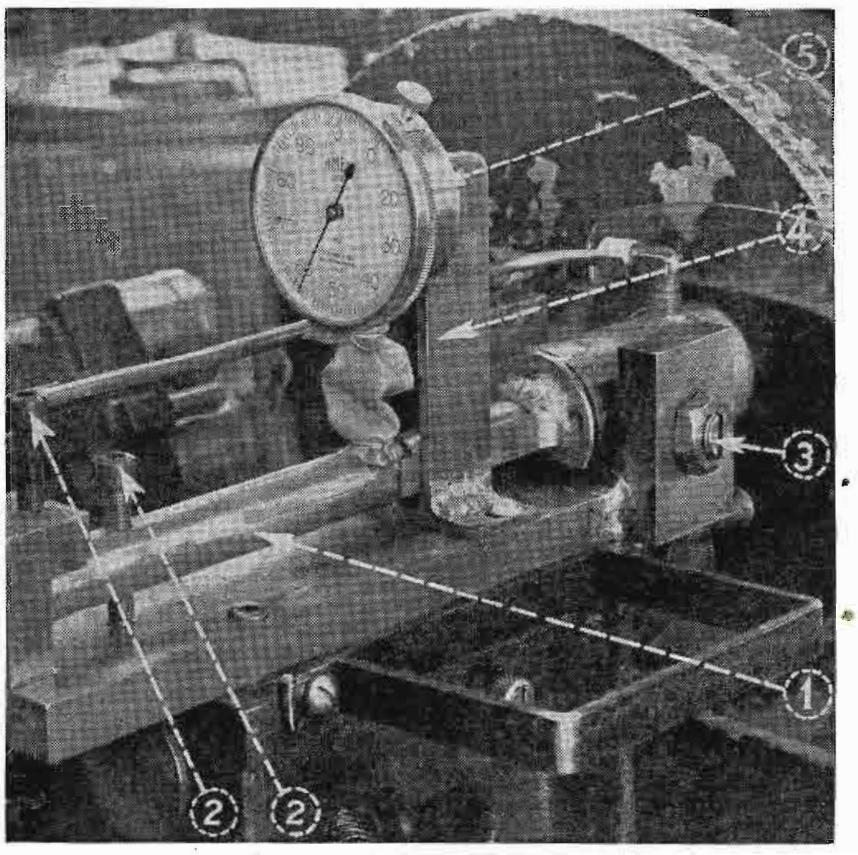


Figure 5

The diamond wheel, 8½" in diameter and with a 2½" rim width.





Figures 6 (left) and 7 (above)
In Figure 6 appears a side view of the latest model *Q-lap* machine. Figure 7 illustrates an angle correction device applied to the *Q-lap*. In this device the rocker arm is provided with a special head, and the crystal holder does not rotate. On the support 4 is mounted a dial gauge reading in .001 minutes. The angle setting, when this illustration was made, was 58 minutes.

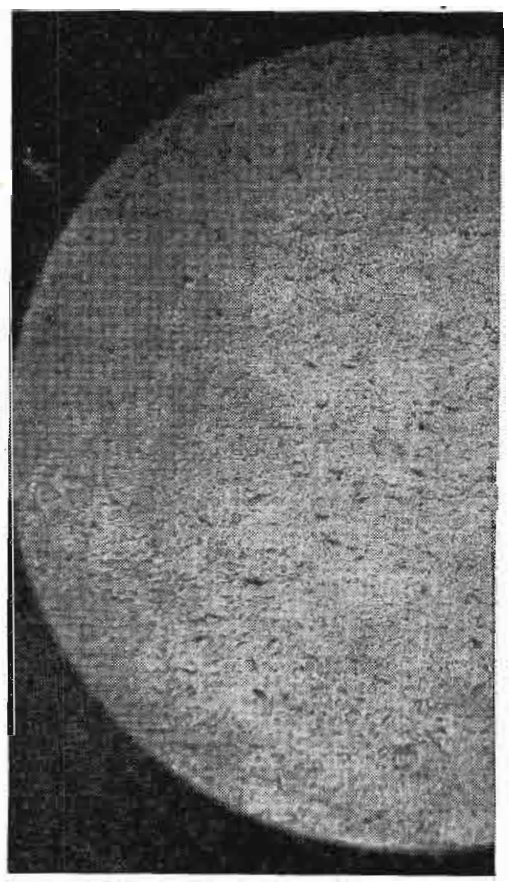
position. This results in more uniform grinding of the crystal surface. The crystal is then ground to a previously adjusted thickness. For this adjustment, each rocker arm is provided with a stop nut, *10*, which can easily be adjusted to any desired dimension in .00025″ steps. When the rocker arm strikes this stop, no more grinding can occur. At the conclusion of grinding, the handle, *9*, is retracted, and this locks the rocker arm in the idling position. The crystal-holder shaft stops rotating, and pulling the rocker arm aside, keeps it locked by means of the lever, *8*. By closing the suction valves, the ground crystals can be removed. The normal actuation cycle is generally timed so that the right arm is grinding while the left is being loaded, and vice versa.

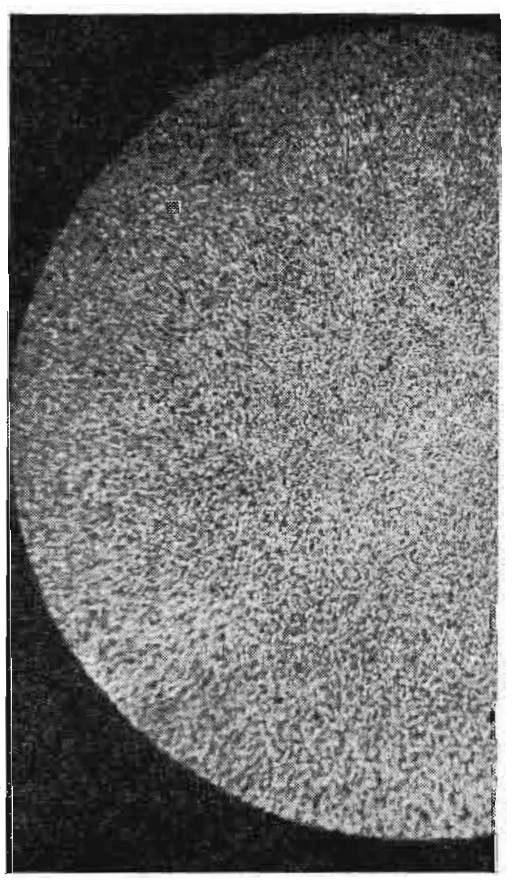
Each rocker arm is provided with two crystal holders, so that two crystals can be ground simultaneously.

The coolant is applied on the inner side of the rim of the diamond wheel in such a way that centrifugal force drives most of the coolant to the spot where grinding occurs. This coolant and the abraded quartz particles accumulate in the splash pan, *11*, and

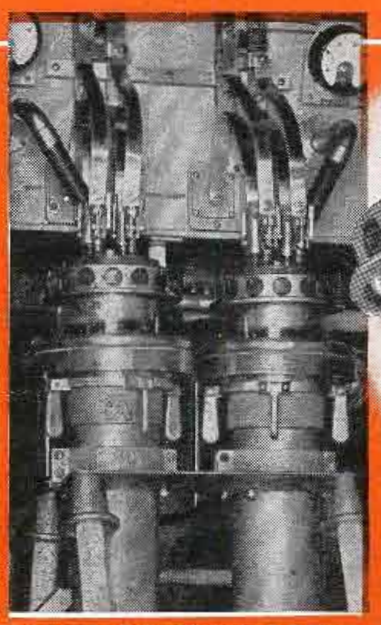
(*Continued on page* 80)

Figures 8 (left), 9 (center) and 10 (right) Figure 8, surface of a rough-ground crystal as taken from the *Q lap*. Figure 9, surface of a crystal blank finished with 303½ abrasive mixture, taken from a planetary type of lap. Figure 10, surface of a rough-lapped blank with 180 carborundum abrasive mixture, taken from a drill-press lap.

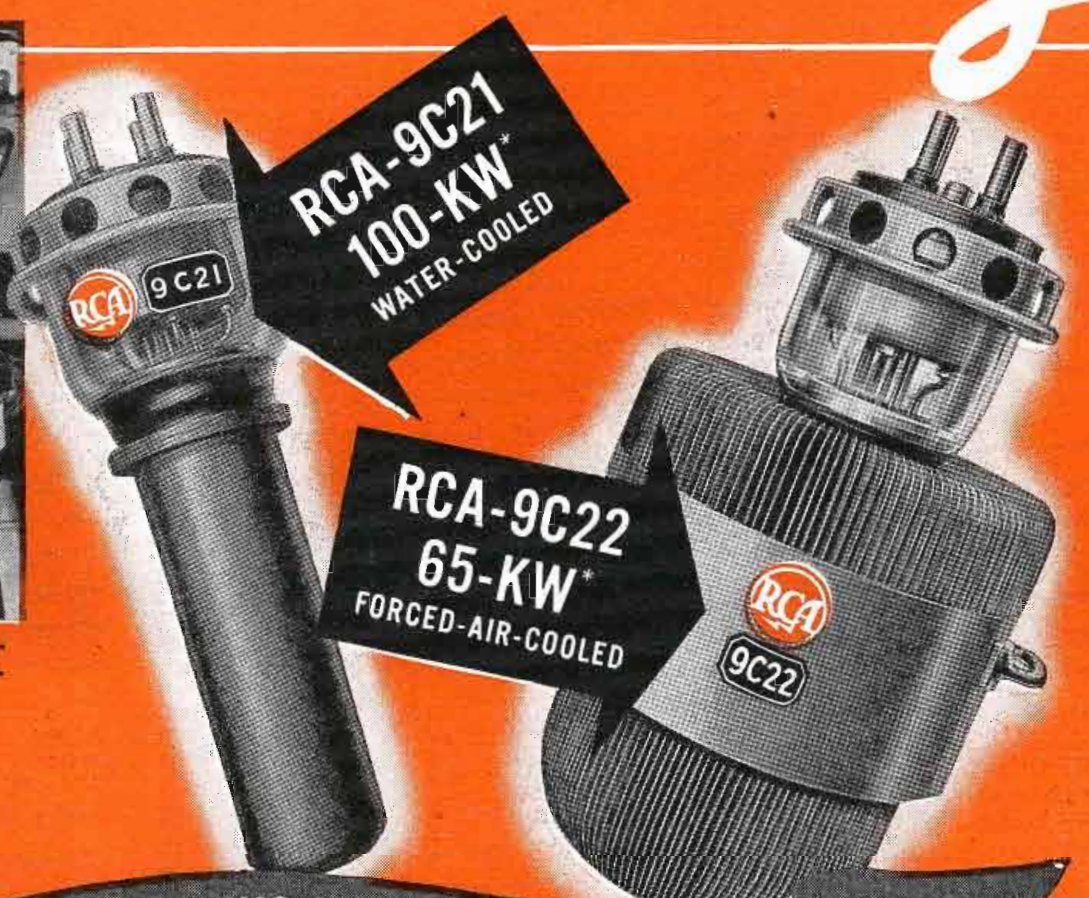




Announcing



A pair of water-cooled RCA-9C21's in a 100-KW, 25 megacycle, r-f heating oscillator.



*Power output, approx., at max. ratings

BUY MORE WAR BONDS

HERE are two new high-power triodes departing radically from "conventional" design. They are geared to the present need for higher frequencies and higher powers in r-f heating applications, and the coming need for even better performance in broadcast equipment. And once again — it's an RCA development that starts a trend.

RCA-9C21 and 9C22 feature an ultra-modern mechanical structure of rugged design — a short structure utilizing an entrant metal header which shortens internal filament leads and provides an extremely short, heavy-current, low inductance path to the grid. As a result, excellent high-frequency performance is obtainable at full ratings up to 5 Mc, and at reduced ratings, as high as 25 Mc.

Addition to the RCA high-power family of these two new types means exceptional flexibility of equipment design both for industrial uses in the war effort now and for future broadcast needs.

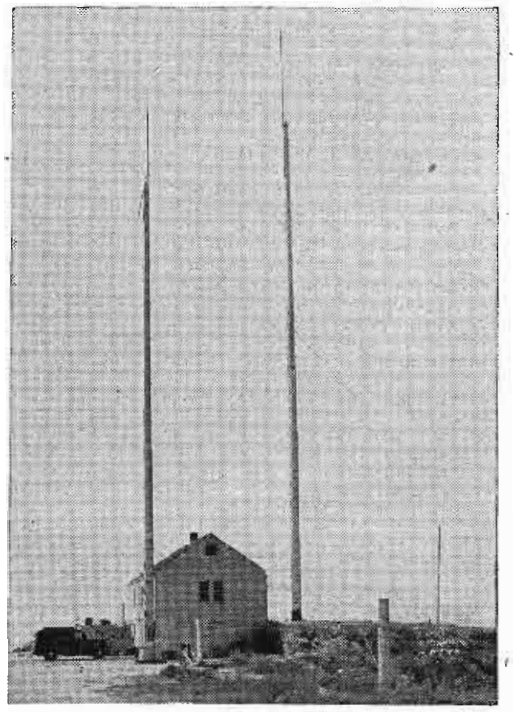
RCA application engineers will be glad to assist you in applying these tubes to your problems. Data sheets on the 9C21 and 9C22 are available on request. Address RCA, Commercial Engineering Section, 595 South 5th Street, Harrison, New Jersey.

RCA

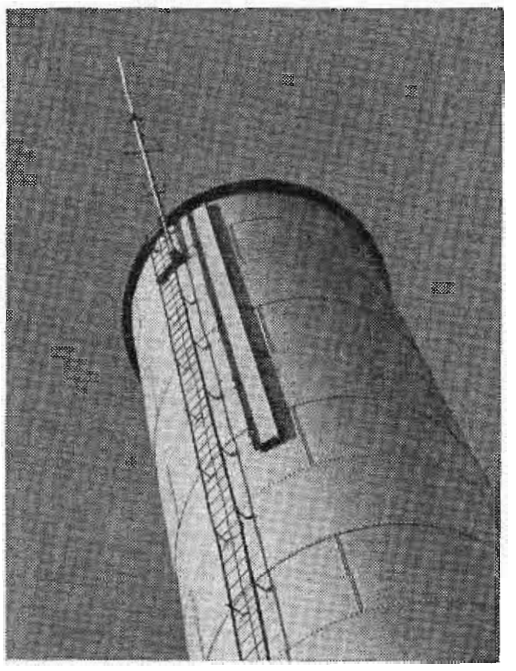
RADIO CORPORATION OF AMERICA

F - M A N T E N N A E

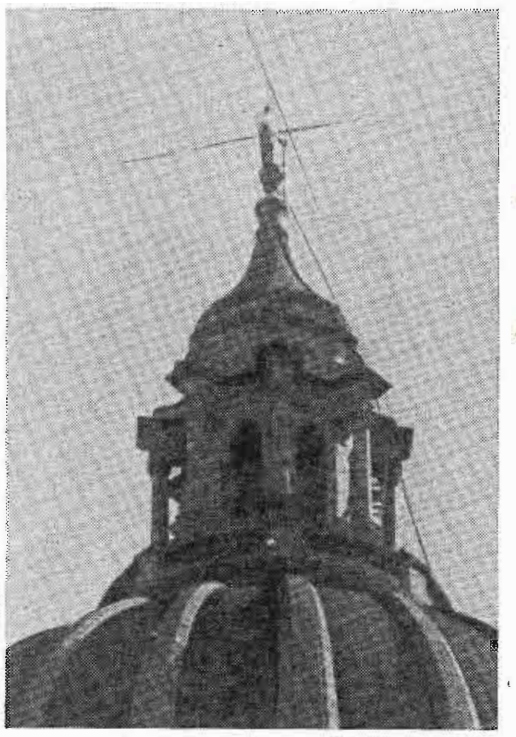
[*All photos courtesy Galvin Manufacturing Corporation*]



Above, antenna system of the Police and Fire Department, Municipal Light Company, and Sheriff's Office at Everett, Washington. A ¼-kw and 50-watt transmitter are used. The building houses all equipment, and also the operators throughout the year.



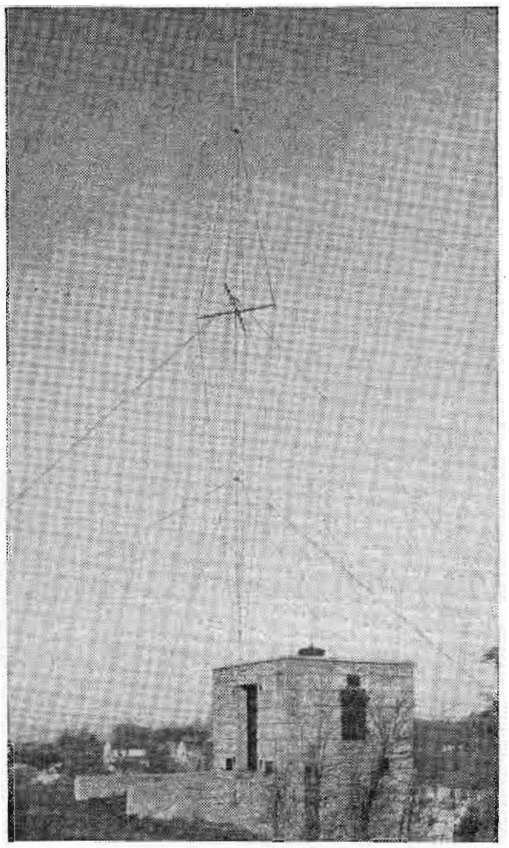
Standard antenna system used by the Dayton, Ohio, police.

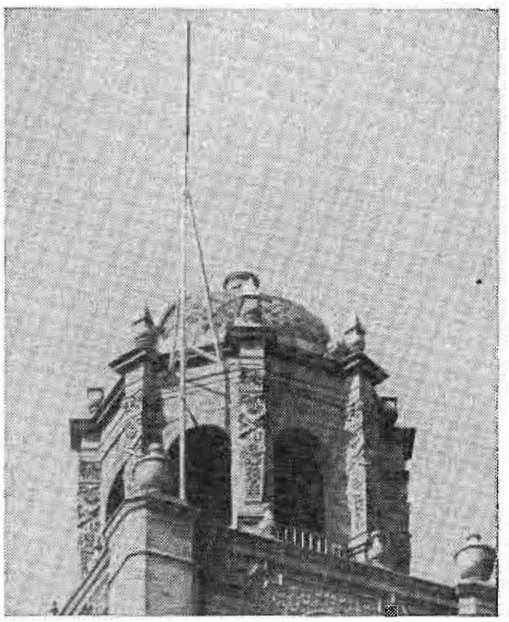


Above, coaxial antenna atop the Court House at Olympia, Washington, used by the State Highway Patrol. This is one of the central stations, with a power of 250 watts.

Below, two sets of relay antennae used by the California Highway Patrol and Ventura County at Ventura, California. The longer antenna picks up signals from cars at 39.78 mc from 30-watt transmitters. The short antenna beams signal at 118.5 mc to the main station in the valley below, approximately forty miles away.

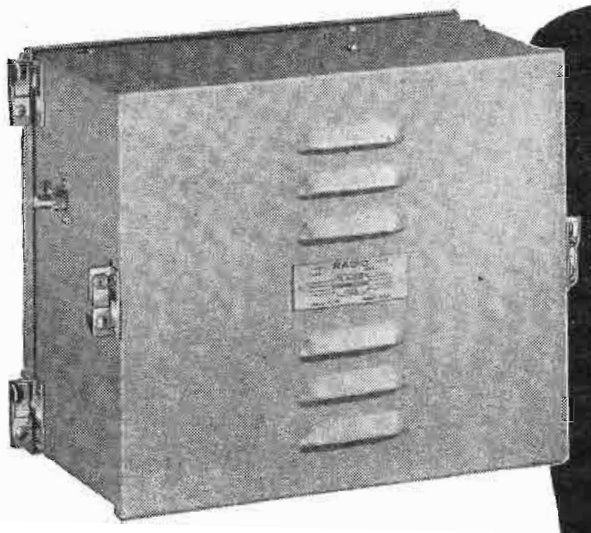
Below, the standby antenna and transmitter building used by the police in Dayton, Ohio.



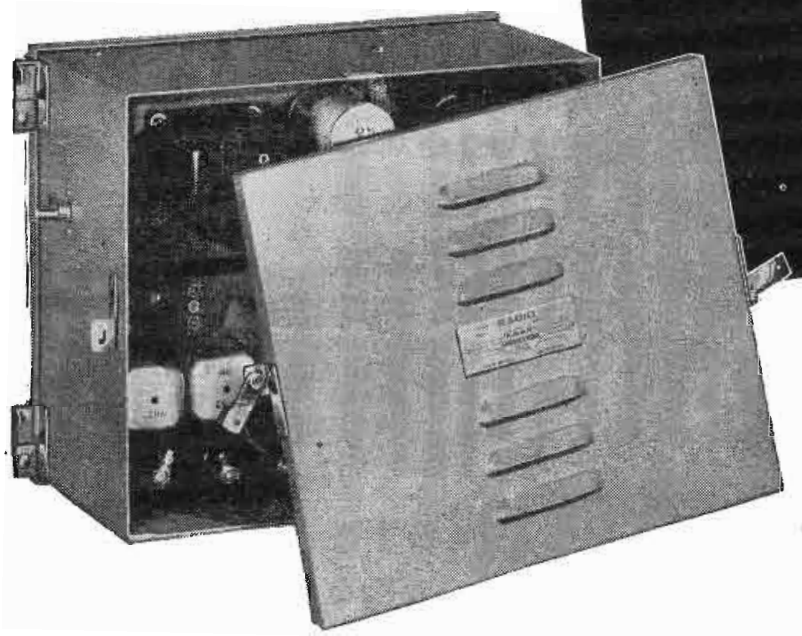


Coaxial antenna atop the Court House at Tampa, Florida, used by the Florida State Police.

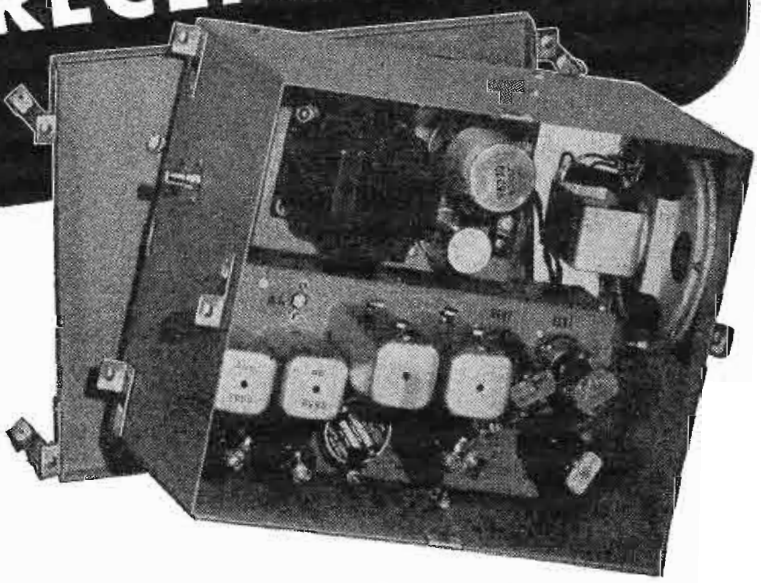
Look how easy it is to service KAAR *Mobile* RECEIVERS



1 The Kaar 11-X receiver is installed beneath the dash, and held securely by bolts through firewall.



2 For simple servicing, such as the replacement of tubes, the dust cover is removed by releasing two convenient snap catches. Takes but a moment.



3 For complete servicing, the entire chassis can be removed from the vehicle by releasing four snap catches. All wiring is instantly accessible.

FOUR CATCHES EXPOSE ENTIRE UNDERCHASSIS FOR SWIFT SERVICING

There is no "get out and get under" when it comes to servicing or checking Kaar receivers...they can be lifted out of a vehicle in a matter of seconds. In fact, the speed with which they can be serviced is one of their most popular features.

Another is the no-signal squelch circuit which automatically silences the receiver except when a call is actually being received. This is a blessing in military, civil, or private radiotelephone communication, where a wavelength must be guarded and continual background noise jangles the nerves.

The 11-X is operated by a control unit which can be mounted on the underlip of the dash. This unit contains a jewel light to indicate when receiver is on, a squelch circuit switch, and a combination volume control and power switch.

The Kaar 11-X receiver is crystal controlled, and may be tuned for any frequency from 1600 to 2900 KC.* (For frequencies between 30-40 MC. specify the Kaar PRS-9X.)

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DEMODULATION WAVES

by PAUL K. HUDSON

Assistant Professor Electrical Engineering
University of Idaho

TO illustrate the theory of non-linear demodulation in radio engineering courses, the chart shown in Figure 1 was recently prepared. This graphical treatment parallels that used in the chart on non-linear modulation discussed in the October, 1943, issue of COMMUNICATIONS, page 117. The same theory was used in drawing both charts.

Amplitude Modulated Carrier

Curves *10, 11,* and *12* are sine waves that represent an amplitude modulated carrier which is analyzed into the unmodulated carrier and two side-band frequencies. When these three voltage waves are applied to a non-linear impedance, the current that flows will have several components. There will be frequencies equal to (*a*) the original frequencies, (*b*) twice the original frequencies, (*c*) the sum of the original frequencies, considering one pair at a time, and (*d*) the difference of the original frequencies, considering one pair at a time.

Curve *13* shows the desired audio output of the detector, its magnitude being twice the magnitude of curve *14*. Curve *14* is found once by the difference between curves *10* and *11,* and again by the difference between curves *10* and *12*. The magnitude of curve *13* is the sum of the magnitudes of these two curves.

Curve *15* is another audio wave whose frequency is twice the frequency of the desired audio wave. It is formed by the two side band frequencies. Obviously it is undesirable, and represents a disadvantage of non-linear demodulation. The magnitude of this distortion wave can be reduced by reducing the percentage of modulation of the carrier.

Summation Components

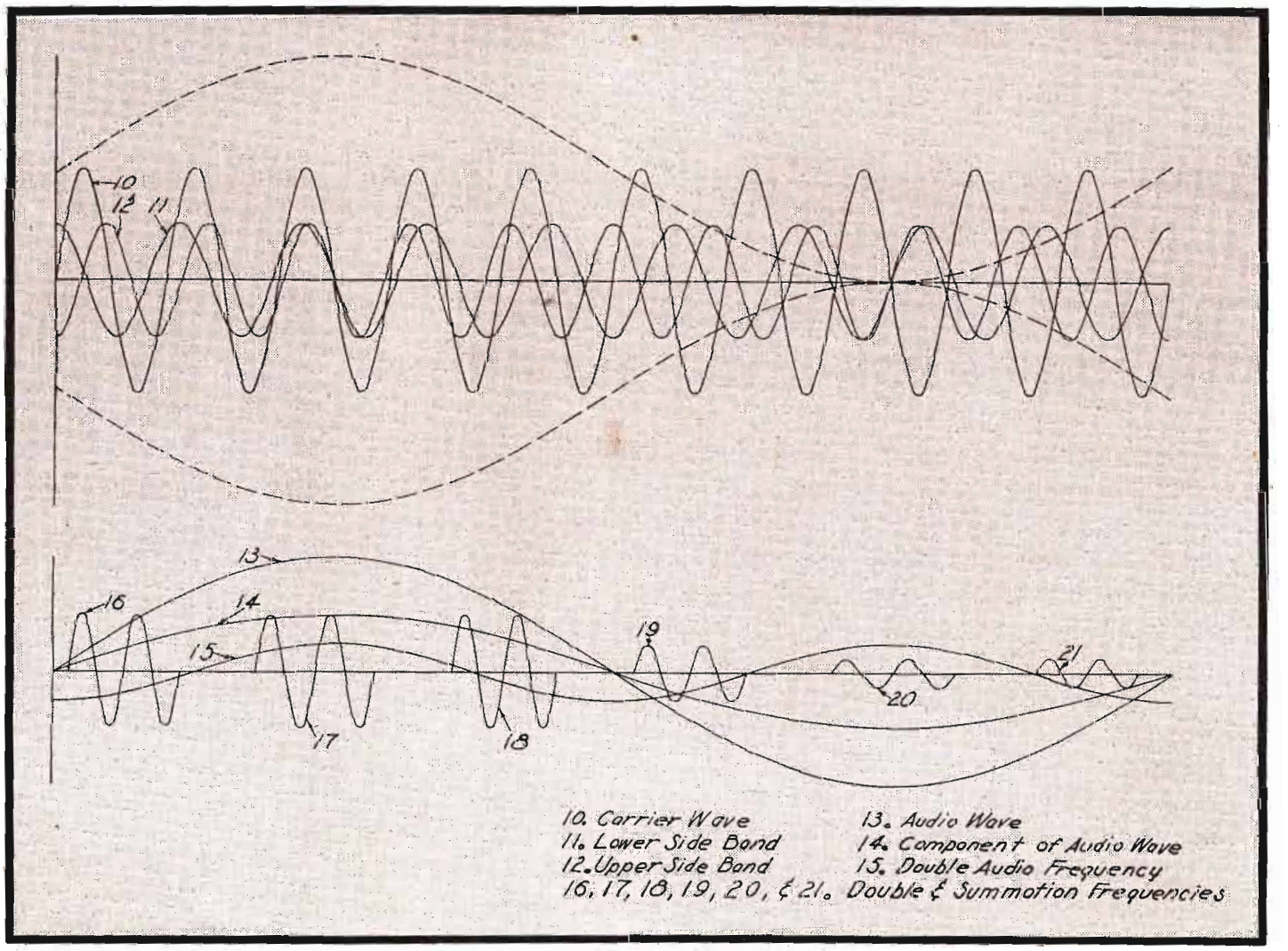
Curves *16* through *21* represent the double and summation components and are not significant because they do not pass through the audio amplifier.

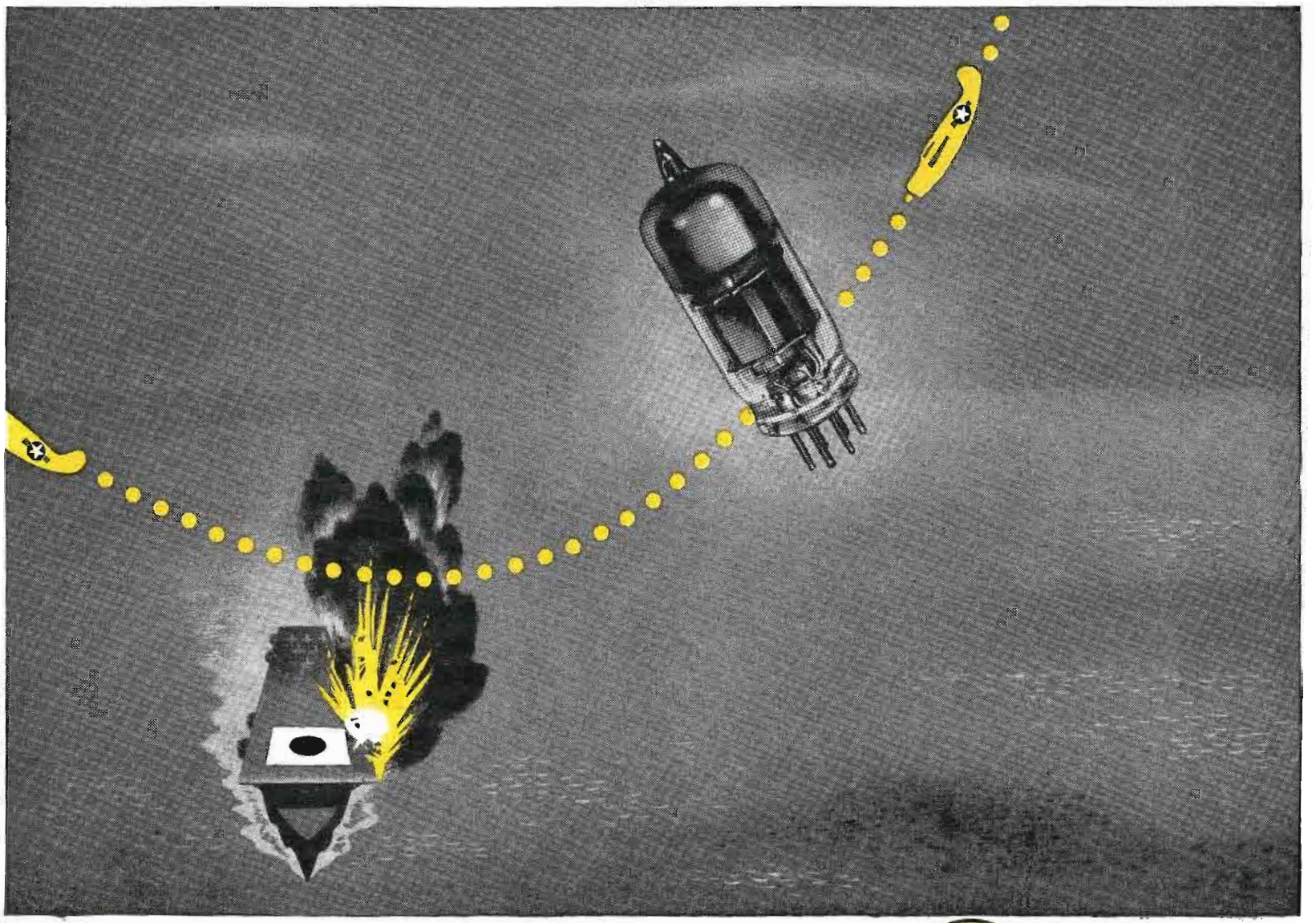
Non-Linear Modulation

In the chart shown in the October issue of COMMUNICATIONS, curve *1* represented the carrier wave of 10 cycles per second, while curve *2* repsented an audio wave of 1 cycle per second. When these two voltage waves are applied to a non-linear impedance, the current that flows will have six component waves. These component waves will have frequencies respectively equal to the frequencies of the two original voltage waves, frequencies that are twice the original frequencies, and frequencies that are equal to the sum and difference of the original frequencies. Curves *3* to *8* represented these component waves. All modulation terms above the second order were neglected so as to simplify the presentation.

Current Wave Amplitudes

The amplitudes of the current waves depend upon the non-linear impedance and the modulation factor. Accordingly, in the first graph, the operating point was taken at (1, 1) on the curve where i equals ke^2, and E_1 equals E_2 equals 0.5 volt. The modulation factor was unity.





They know their G's

What is this menace to flying men and their equipment which our scientists call "G's"? And why are N. U. engineers who design tubes for airborne radio and electronic devices taking so much pains these days, to *know* their "G's"?

In a mild form, most of us have felt "G's" at work on a roller-coaster, when we take the turns and hit the dips. However, in high speed flight, with its shifting, twisting, turning, about-face maneuvers—"G's" *really* shake your insides. Think of a dive bomber pilot as he pulls out of a high vertical power dive. That's when "G's" can become dangerously high. And when there are *too many* "G's"—look out!

Research into the effects of "G's" on the delicate, indeed flimsy filaments and other parts of tubes, has enabled N. U. engineers to provide our armed forces with tubes individually tested to withstand many more "G's" than a pilot or a plane ever has survived. Here again, science makes *sure* that N. U. Tubes deliver the goods. Where tubes *must* perform dependably—*count* on National Union.

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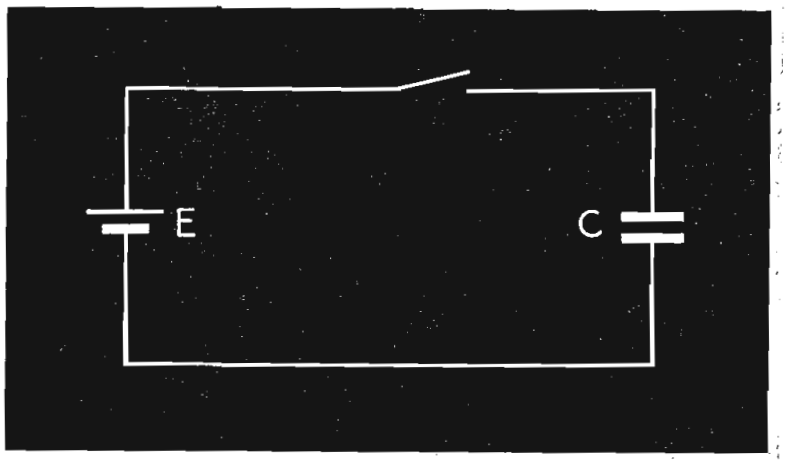
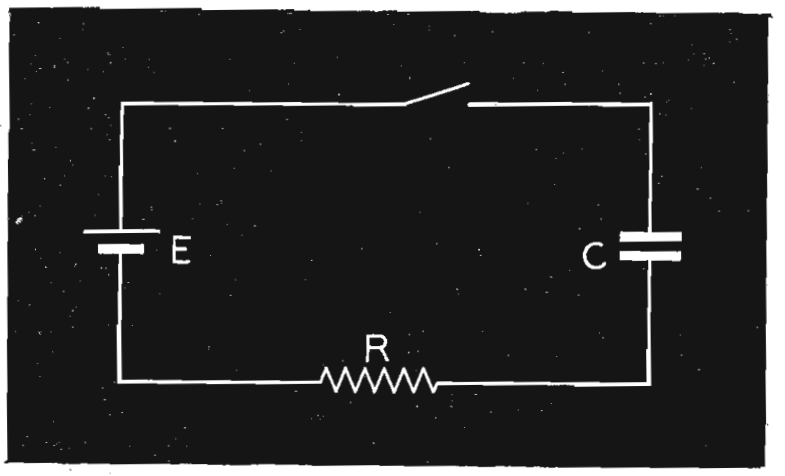




Figures 1 (upper left) and 2 (upper right)
Figure 1, a source of constant emf and a perfect condenser, initially uncharged. Figure 2, the familiar RC circuit.

ENERGY WASTED IN CHARGING A CONDENSER

by DR. VICTOR WOUK

Research Laboratories
Westinghouse Electric and
Manufacturing Company

IT is a familiar fact that when a charged condenser is made to share its charge with another condenser, the electrical energy in the system, after the charge-sharing process is completed, is less than the original energy. The question of where this energy goes is of importance in engineering problems.

For example, one condenser may be a gasoline truck charged with static electricity after a drive on a highway. The other condenser may be an insulated, underground tank to which the tank truck is to be connected by means of the gasoline filling hose, or a bonding wire. A spark may occur during the making of the contact, and it is of importance to know whether there can be enough energy dissipated in the spark to ignite combustible gasoline vapors that may be present. Also, in many condenser control systems, like Ignitron firing circuits or condenser welding circuits, it is important to know how much energy must be supplied to the system to obtain a desired amount from the condenser.

In this paper, it will be shown that whenever a condenser is charged by a source of constant emf in a circuit without valve action, an amount of energy, equal to the amount finally stored on the condenser, is expended in I^2R loss during the charging process.

General Considerations

It can be very readily shown from general considerations that whenever a condenser is charged from a source of constant emf, somehow there must be wasted an amount of energy equal to the final amount of energy stored in the condenser.

Consider a source of constant emf, and a perfect condenser, initially uncharged, as in Figure 1. Assume that when the switch is closed the condenser eventually reaches a steady voltage equal to that of the source, and that the charge on the condenser is determined by $Q = CE$; and, furthermore, this final charge Q is equal to the time integral of the current passing through the source of emf.

The energy stored in the condenser is given by

$$W = (\tfrac{1}{2})\ QV,$$

where V is the voltage and Q the charge on the condenser. By the above paragraph this reduces to

$$W = (\tfrac{1}{2})\ E^2C$$

The instantaneous rate of dissipation of energy by the source of emf is $P = EI$, where I is the current flowing through the source of emf into the condenser. The total energy expended by the source of emf is

$$(a)\ W = \int_0^\infty EI\ dt$$

But, since E is constant, the above reduces to

$$(b)\ W = E \int_0^\infty I dt$$

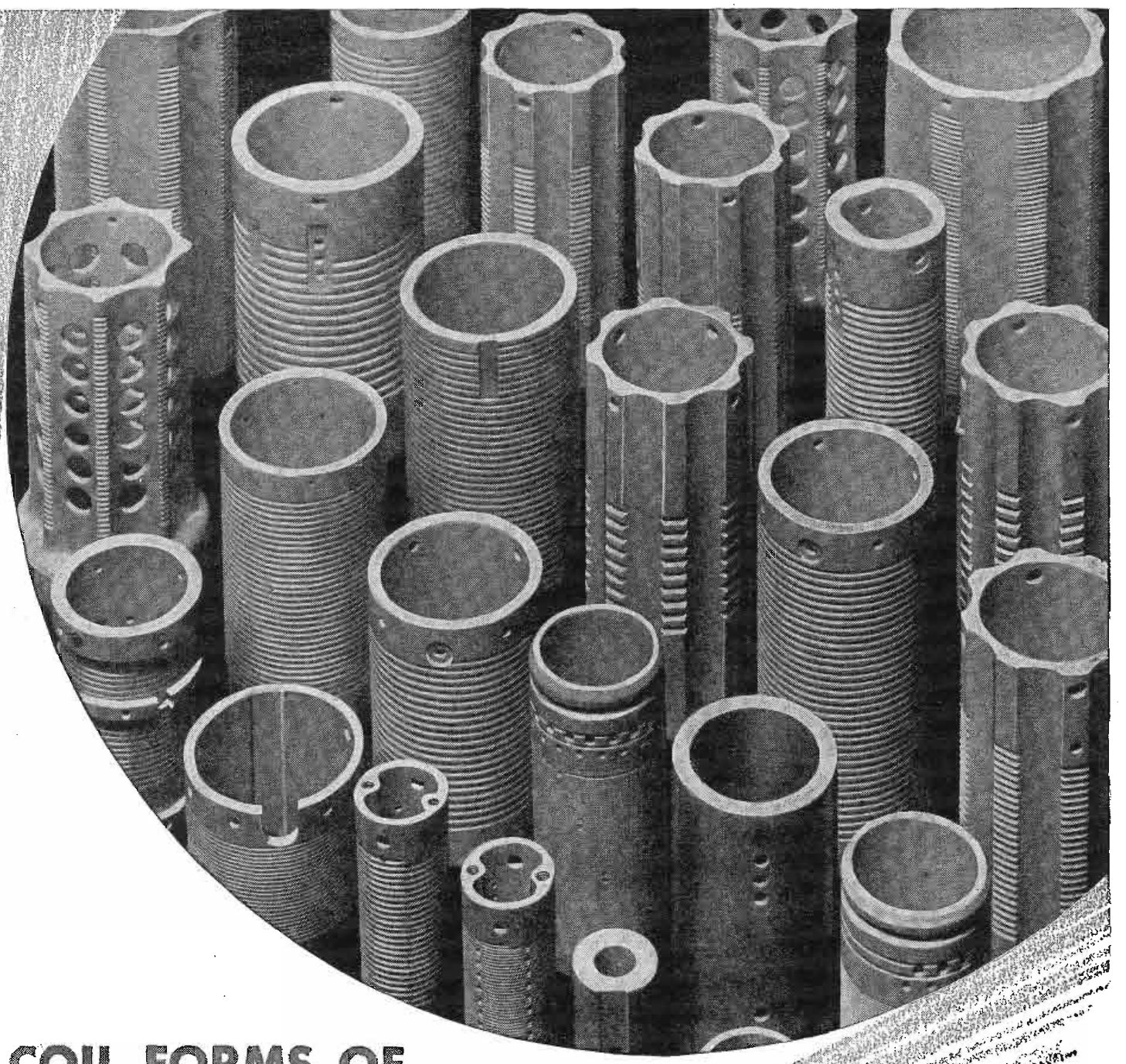
However, $\int_0^\infty I dt = Q$ the final charge on the condenser. This, it is assumed, holds true no matter how I varies with time.

Therefore, since the total energy expended by the source of emf is QE, and the energy stored in the condenser is $\frac{1}{2}\ QE$, the difference, or $(\frac{1}{2})\ QE$, must somehow be accounted for.

It will be shown that in any circuit wherein there is non-zero positive, finite resistance, this *missing* amount of energy, equal in magnitude to one-half the energy spent by the supply is dissipated in I^2R loss.

The RC Circuit

Consider the familiar *RC* circuit of



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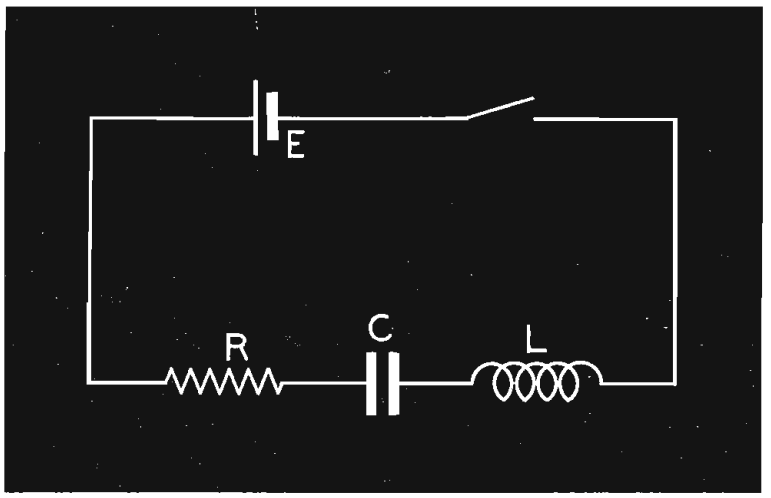

Figure 3
The RLC circuit.

Figure 2. When the switch is closed, the condenser being initially uncharged, the current is well known to be

$$I = \frac{E}{R} e^{-t/RC}$$

The total energy expended by the battery is EQ, where Q is the final charge on the condenser.

$$Q = \int_0^\infty I\,dt = \int_0^\infty \frac{E}{R} e^{-t/RC}\,dt$$

$$= \frac{E}{R}(-RCe^{-t/RC})\Big]_0^\infty = EC$$

Thus the energy delivered by the battery is E^2C.

The energy stored in the condenser is $(\frac{1}{2})E^2C$, leaving an equal amount to be accounted for.

The energy dissipated in the resistance is

$$W = \int_0^\infty I^2R\,dt = R\int_0^\infty \frac{E^2}{R^2} e^{-2t/RC}\,dt$$

$$= \frac{E^2}{R}\left[-\frac{RC}{2} e^{-2t/RC}\right]_0^\infty = \tfrac{1}{2} E^2C$$

Thus, it is seen that in the *RC* circuit the energy dissipated in the resistance accounts for the *missing* energy.

It is to be emphasized at this point, that the equality of energy stored in the condenser to energy dissipated in the resistance, exists only after the condenser is fully charged, i.e., at $t = \infty$. After an arbitrary time T, where $T \neq \infty$, this equality does not exist.

Thus, after a time T

$$Q_T = \frac{E}{R}\int_0^T e^{-t/RC}\,dt$$

$$= \frac{-ERC}{R}[e^{-T/RC} - 1] = EC\,[1 - e^{-T/RC}]$$

and

$$\tfrac{1}{2}\frac{Q^2}{C} = \tfrac{1}{2} E^2C\,[1 - 2e^{-T/RC} + e^{-2T/RC}]$$

= energy in condenser.

Similarly, to find the energy dissipated in the resistance after a time T,

$$W_T = R\int_0^T I^2\,dt = R\int_0^T \frac{E^2}{R^2} e^{-2t/RC}\,dt = \frac{E^2C}{2}[1 - e^{-2T/RC}]$$

The difference between the two energies is

$$\text{difference} = E^2C[e^{-T/RC} - e^{-2T/RC}]$$

This difference is equal to zero only at $t = 0$ and $t = \infty$. At $t = 0$, no energy has been expended in the resistance or stored on the condenser, and at $t = \infty$, the previous analysis shows that they share the total expended energy equality.

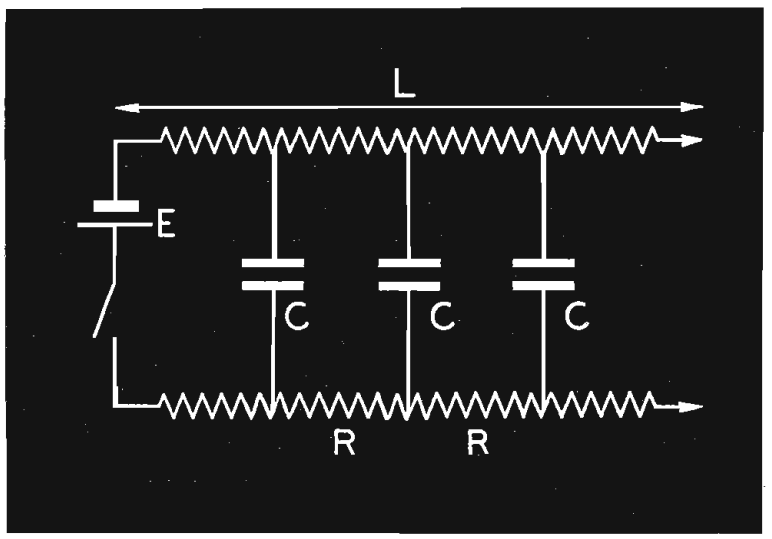

Figure 4
In this circuit covering an open-circuited cable, R is the series resistance per unit length, and C is the shunt capacitance per unit length.

The RLC Circuit

Let us write the differential equation of the circuit illustrated in Figure 3, as

$$\frac{d^2I}{dt^2} + \frac{R}{L}\frac{dI}{dt} + \frac{I}{LC} = 0$$

Let α_1 and α_2 be the two *roots* of the equation, where

$$\alpha_1 = -\frac{R}{2L} + \frac{\sqrt{R^2/L^2 - 4/LC}}{2}$$

and

$$\alpha_2 = -\frac{R}{2L} - \frac{\sqrt{R^2/L^2 - 4/LC}}{2}$$

It is easily verified that the current is given by

$$I = \frac{E}{L(\alpha_1 - \alpha_2)}[e^{\alpha_1 t} - e^{\alpha_2 t}]$$

Again, the total energy expended by the battery is EQ, where Q is the final charge on the condenser.

$$Q = \int_0^\infty I\,dt = \frac{E}{L(\alpha_1 - \alpha_2)}$$

$$\int_0^\infty [e^{\alpha_1 t} - e^{\alpha_2 t}]\,dt = \frac{E}{L(\alpha_1 - \alpha_2)}\left[\frac{1}{\alpha_2} + \frac{1}{\alpha_1}\right]$$

$$= \frac{E}{L\alpha_2\alpha_1}. \quad \text{But } \alpha_2\alpha_2 = \frac{1}{LC}$$

Hence, $Q = EC$.

Incidentally, there is no need to question whether or not the current is oscillatory. In either case, if R is not a negative quantity, the infinite integrals encountered in the analysis converge, since the *real* part of the exponents is negative. Thus, the result applies that the total energy expended by the battery is EQ, no matter what the nature of the current.

Again, the total energy expended by the battery is E^2C, that on the condenser is $\frac{1}{2}E^2C$, and an equal amount must be sought someplace else in the circuit.

To get the energy expended in the resistance,

$$W = R\int_0^\infty I^2dt$$

$$I^2 = \frac{E^2}{L^2(\alpha_2 - \alpha_1)^2}[e^{2\alpha_2 t} + e^{2\alpha_1 t} - 2e^{(\alpha_1 + \alpha_2)t}]$$

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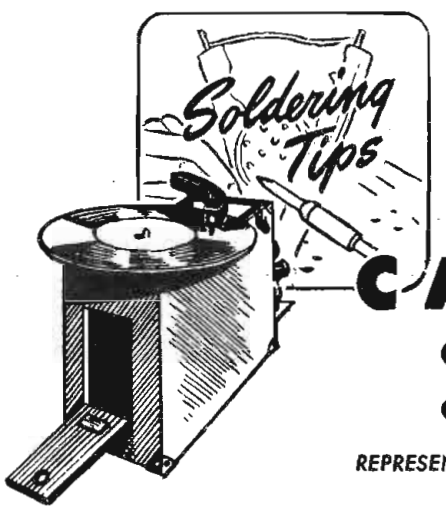

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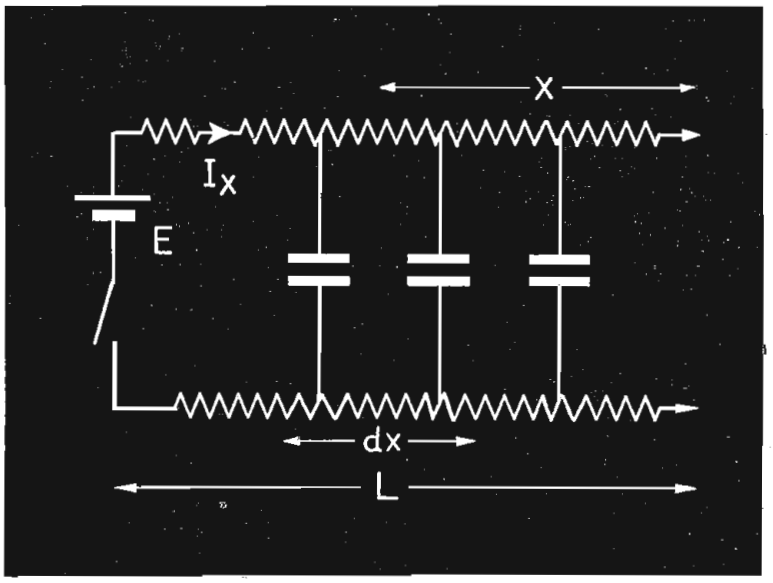

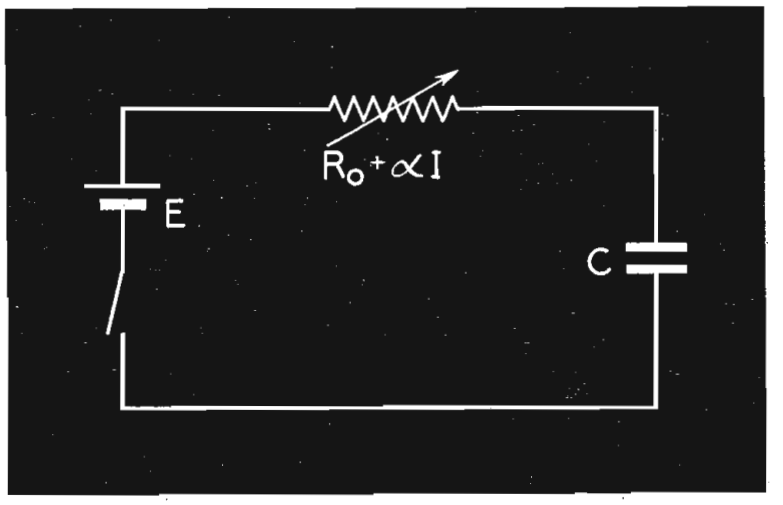

Figures 5 (left) and 6 (above)

and $$\int_0^\infty I^2\,dt = \frac{E^2}{L^2(\alpha_2-\alpha_1)^2}\left[-\frac{1}{2\alpha_2}-\frac{1}{2\alpha_1}+\frac{2}{\alpha_2+\alpha_1}\right]$$

$$= \frac{E^2}{L^2(\alpha_2-\alpha_1)^2}\left[\frac{-\alpha_1^2-\alpha_1\alpha_2-\alpha_2^2-\alpha_1\alpha_2+4\alpha_1\alpha_2}{2(\alpha_1)(\alpha_2)(\alpha_1+\alpha_2)}\right]$$

$$= \frac{E^2}{L^2(\alpha_2-\alpha_1)^2}\left[\frac{-(\alpha_2-\alpha_1)^2}{2\alpha_2\alpha_1(\alpha_2+\alpha_1)}\right]$$

$$= -\frac{E^2}{2L^2\alpha_1\alpha_2(\alpha_1+\alpha_2)}$$

But $\alpha_1\alpha_2 = \frac{1}{LC}$, and $\alpha_1+\alpha_2 = \frac{-R}{L}$

Hence $$R\int_0^\infty I^2dt = \frac{-RE^2}{2L^2\frac{1}{LC}\left(\frac{-R}{L}\right)} = \frac{E^2C}{2}$$

Again, the heat in the resistor accounts for *lost* energy in the system.

Consider an open circuited cable, Figure 4, where R is the series resistance per unit length, and C is the shunt capacitance per unit length. In Berg, *Operational Calculus*, p. 78, we see that the variation of current with time and distance is given by *1*

$$I = \frac{2E}{RL}\sum_{S=1}^{\infty}(-1)^{S+1}[\sin mx]e^{-m^2/RC\ t}$$

where x = distance from open end
L = total length of cable

$$m = \frac{2S-1}{2}\frac{\pi}{L}$$

To find the total energy expended by the battery, the total charge passing into the line at x = L must be determined. Set x = L in equation *1*, and it is readily seen that

$$I_{x=L} = \frac{2E}{RL}\sum_{S=1}^{\infty}e^{-m^2/RC\ t}$$

since sin (mL)

$$= \sin\left(\frac{2S-1}{2}\right)\pi = (-1)^{S+1}$$

The total charge Q going from the battery into the line is therefore

$$Q = \int_0^\infty I_{x=L}\,dt = \frac{2E}{RL}\int_0^\infty\left\{\sum_{S=1}^{\infty}e^{-m^2t/RC}\right\}dt$$

The mathematical validity of integrating this series term by term has been investigated by the author. By an application of a theorem concerning infinite integrals, known as Dini's Theorem, it was determined that integrating term by term is valid. The proof of this will not be gone into here. Performing this operation yields

$$\int_0^\infty I_{x=L}\,dt = \frac{2E}{RL}\sum_{S=1}^{\infty}$$

$$\int_0^\infty e^{-m^2t/RC}\,dt = \frac{2E}{RL}\sum_{S=1}^{\infty}\frac{RC}{m^2}$$

so, $$Q = \frac{2EC}{L}\sum_{S=1}^{\infty}\frac{4L^2}{\pi^2(2S-1)^2} = \frac{8ECL}{\pi^2}\sum_{S=1}^{\infty}\frac{1}{(2S-1)^2}$$

But $\sum_{S=1}^{\infty}\frac{1}{(2S-1)^2}$ is a well-known series whose sum is $\pi^2/8$; see Berg, page 168, formula 62.

Hence, $$Q = \int_0^\infty I_{x=L}\,dt = ECL$$

The quantity CL is the total capacitance of the line. Therefore, the net result, as expected, is that the battery supplies a total charge that would be absorbed by a condenser of magnitude equal to the total shunt capacitance of the cable.

Accordingly, the total energy expended by the battery is

$$W = EQ = E^2CL$$

When the cable is fully charged, the energy stored in it is

$$(\tfrac{1}{2})Q_2/CL = (\tfrac{1}{2})E^2CL$$

Again $(\tfrac{1}{2})E^2C$ is missing and it will be shown that this amount is represented by I^2R loss.

Consider an element of the line, dx in length, and at a distance x from

(*Continued on page* 88)

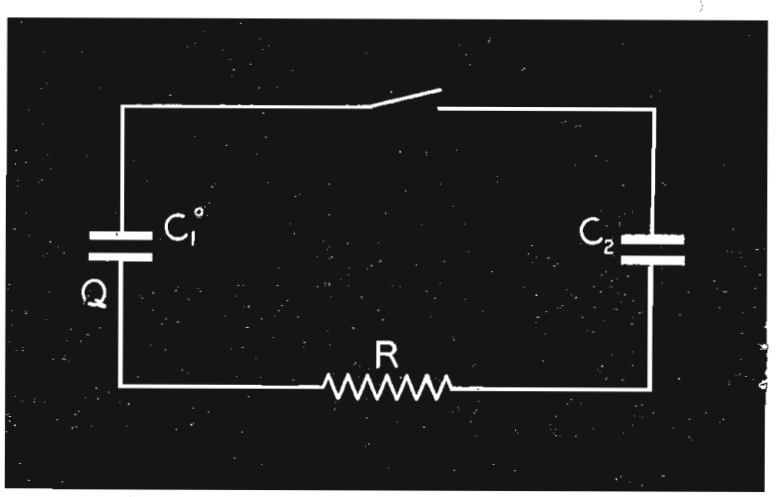

Figure 7
Here we see two condensers sharing a charge where condenser C_1 has an initial charge Q, and C_2 is uncharged initially.

Three attitudes that hamper the War Effort

IGNORING NATIONAL DESTINY

Many men are solving the problems of war as they would ordinary business difficulties. Having solved them, they ignore the most important phase. Their attitude toward the war's meaning and its effect on national destiny is apathetic and disinterested.

USING VITAL ISSUES TO PERSONAL ADVANTAGE

To further their own selfish aims, many men seize upon vital issues to confuse and confound the average citizen. When the times call for statesmanship, America is treated to a sorry spectacle of demagoguery, greed, blocs, distortion, shrewd manipulation of emotions.

PULLING IN DIFFERENT DIRECTIONS

While commands in various war theatres are being consolidated and strengthened, here at home there are men who have forgotten the unity after Pearl Harbor. Each is off on his own particular project, seldom remembering that thousands of other men will die before the conflict is over.

THERE IS NO PLACE IN THE COUNTRY FOR SUCH MEN

We of ECA are working not only to produce the materials of war but, like all good citizens, to help attain the objectives of the war. We know that we must be vigilant . . . especially so now. Men of evil intent have come out of hiding. In smoke-filled rooms attractive bargains are being arranged — with the "little people" included out. Energy which should be devoted to the support of the Commander-in-Chief, and those under him, is being used to stir up distrust and dissension. What appears to be overlooked is that the ultimate aim of victory is a decent world . . . where men of good will live and work together with a full understanding of each other's needs and hopes and aspirations. We have already learned, the hard way, what isolationism and selfishness and disunity can mean. Must history again repeat itself?

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Figure 1

At *A*, tape used for transmitting impulses over long submarine telegraph cables; *B*, tape used for automatic reception of radio telegraph signals. This was recorded on a Seattle, Washington-Ketchikan, Alaska, circuit in 1929. Speed of reception was 60 words per minute. Recording was done with a Muirhead submarine-cable siphon recorder. *C*, type of signals received in 1926 over a Ketchikan-Seattle submarine cable using a Muirhead siphon recorder at 45 words per minute. This cable has since been abandoned because of insulation difficulties and the high cost of maintenance.

EVOLUTION OF THE DB AND VU

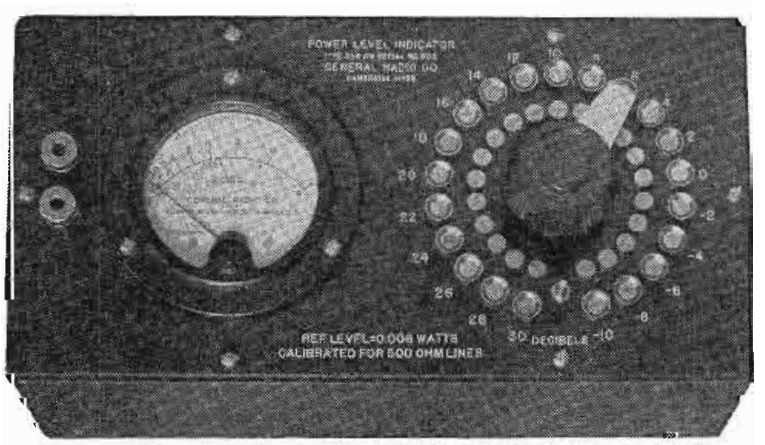
In This Initial Installment Appears A Review Of Developments That Prompted Adoption Of The Decibel As A Transmission Unit

by PAUL B. WRIGHT
Communications Research Engineer

(PART I)

MANY unusual events preceded the actual introduction of any form of sound unit. The inauguration of a practical system for the purpose of transmitting intelligence along guiding wires in this country in 1844 began the chain of events. In that year the first telegraph line was built between Washington and Baltimore. A single wire was used with a ground return in series with battery, key and sounder at each end of circuit.

Effective transmission of intelligence was accomplished by impressing upon the line approximately rectangular impulses of irregular lengths variously grouped and spaced, and having a constant maximum amplitude. The actual spacing of the signals was arranged to gain a maximum speed of signaling, by taking into account the repetition rate of the letters of the English language, and choosing the most frequently repeated letters with the shortest impulses. For example, the letter *e* had one short pulse assigned to it, while *i* was assigned two short pulses, and *t* one longer pulse equivalent in time length to three short pulses. Thus a complete code was made up to transmit by manual means any desired message. This required the receiving operator knowing the code also in order to transcribe or unscramble the message. Effective speeds of transmission were also increased by compressing the language of words, abbreviating several thousand of the most commonly used words and phrases. For example, a message reading "will see you at the station tomorrow morning," would have been sent by the



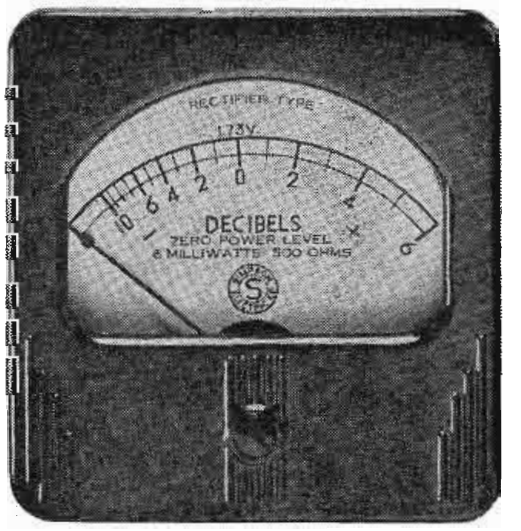


Figure 2 (left) and 3 (right)
Figure 2, power-level indicator. Figure 3, a typical db meter.

Echophone Model EC-1

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

Phillips code system as "wi c u at t stn tw mng." This simple example represents an approximate effective doubling of the speed of transmission, since there are thirty-seven letters and seven spaces between words in the straight text, while there are fifteen letters and seven spaces between words in the abbreviated text. Also, quite elaborate code systems requiring code books have been set up for speeding up transmission effectively. On the European continent, telegraphy was carried on by means of the *continental code* which is well known to all radio men. This code does not permit as rapid a speed of signalling as the *American Morse* code because of the greater predominance of long pulses or dashes to transmit letters occurring with greatest frequency in the English language. Figure 1B shows a sample of the receiving tape used in automatic reception of radio signals.

With the expansion and growth of telegraphy, cable systems were developed to allow impulses to be transmitted over them. Some of these were relatively short and crossed rivers, canals and marshes. Still others were developed for deep-sea work. These were known as submarine cables. One of the first of these was laid between England and France in 1850. Not until 1866 was a completely successful cable laid between England and the United States. These cables had a central conductor of copper around which was placed a dielectric tube of gutta-percha insulation wrapped with jute coverings and protected overall by spirally-wound galvanized iron wires. The code used for transmission over these cables is effectively the Continental Morse in principle although not in reality. Signals are transmitted over submarine cables by using batteries of opposite poling. For example, if a battery of negative poling is used to transmit a dot pulse, then positive poling will be used for the transmission of a pulse in the opposite direction. Hence, if a letter *c* in Continental Morse were to be transmitted over a submarine cable, it would be sent by operating a double

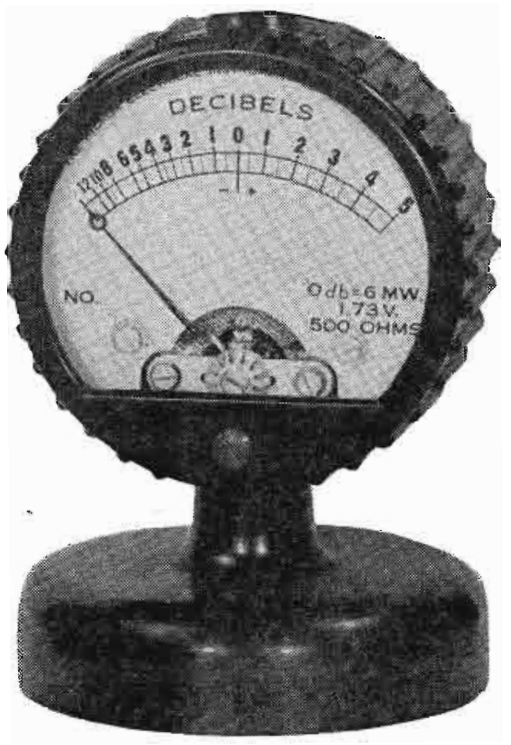


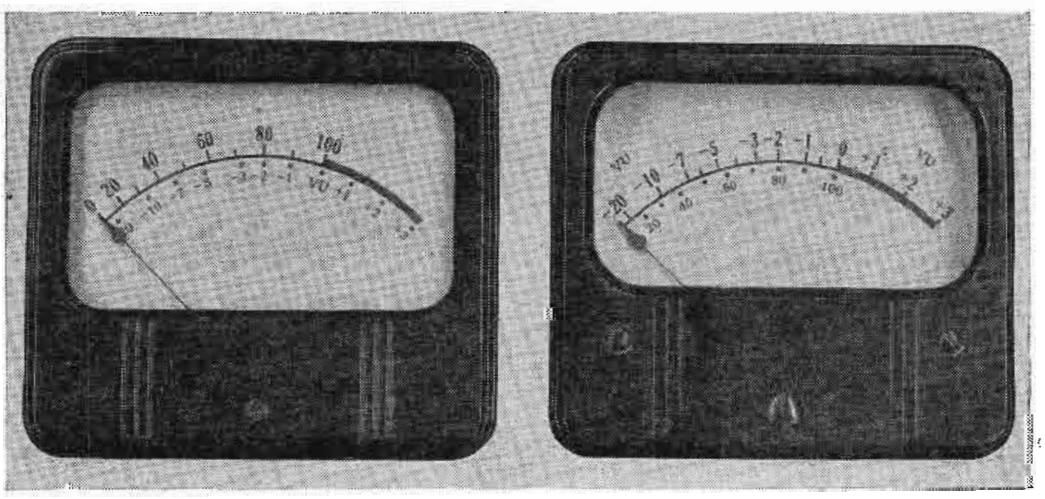
Figure 4
A custom-built type of db unit, popular with amateurs.
(Courtesy Hickok)

key sending first a positive pulse then negative, then positive and finally negative. The actual length of each pulse (both positive and negative) would be identical. Thus, as used for submarine-cable telegraphy, there is no actual differentiation in pulse length between the dot and dash of the continental code. The signals on these cables are received on tape recorders by a galvanometer. This is mechanically coupled to a suspension mechanism which inks the tape by means of a glass siphon fed from a small ink cup. When signals are received, the dots cause the ink siphon to move away from the operator while the dash signal causes the siphon recorded to move toward him. Figures 1A and 1C show samples of the transmitting and receiving tapes used for submarine-cable work when transmission and reception are entirely automatic.

Mechanical systems have been developed to speed up many of the processes used in telegraphy, until today they scarcely resemble any portion of the early day telegraph equipment. Duplex, quadruplex, and multiplex, as well as high frequency and voice frequency carrier systems have been developed throughout the years since the first line was built. The technique of telegraphy has grown in complexity to such an extent that the *old-time* telegraph operator has become a mere *babe in the woods* as far as operating is concerned. Today, but a very small proportion of telegraphy is carried on by manual means.

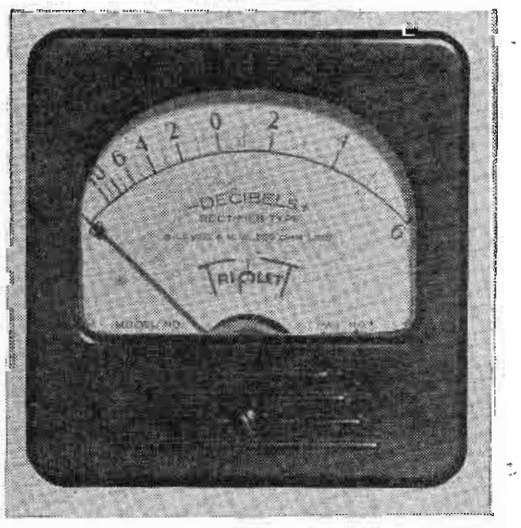
As lines and cables were built and placed in the telegraph service, numerous scientific men of England, the United States and European continental countries were busy devising and designing ways and means to improve the quality of signals because of distortion which placed a limit to the speed of signalling.

Kennelly, Heaviside, Malcolm and Lord Kelvin were among those who were most prominent in early researches made to determine the most efficient means of transmitting electrical telegraph impulses, and to find out what might be the most practicable system to use. Kennelly considered the effect of different types of signalling such as the dot-frequency and the reversal-frequency impulses, and ascertained the best resistance of receiving instruments to use on cables and the influence of terminal apparatus upon the signalling speed. Heaviside showed the importance of the relationships existing between the various portions of the line and equipment. His studies led him to the conclusion that to obtain the most efficient and distortionless system, the attenuation would have to be decreased. This could be accomplished by loading the line at frequent intervals with lumped inductances. However, he did not succeed in applying his theories in a success-



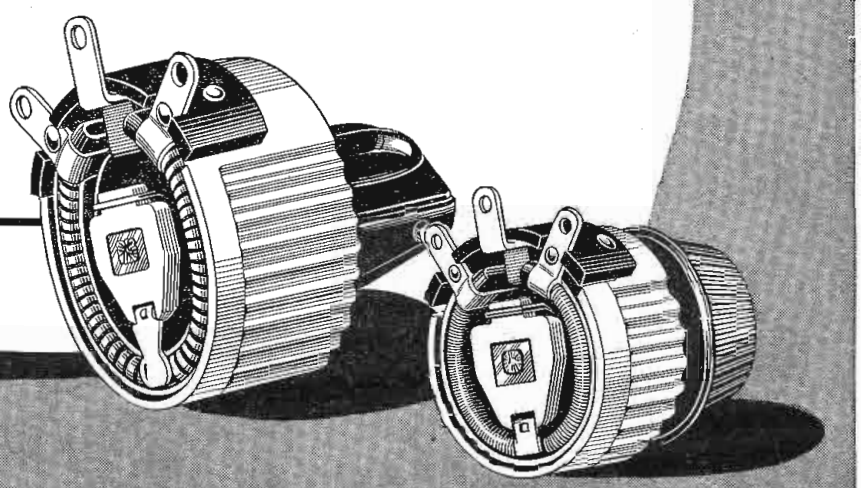
Figures 5 (left) and 6 (right)

Figure 5, two vu volume-level indicators; internally illuminated type at right, and non-illuminated type at left. *(Courtesy General Electric)*
Figure 6, a db type instrument.



IRC will be Ready

with RHEOSTATS



Once the grim business of war is concluded, you can count on IRC to deliver vast quantities of resistance devices of *all* types. Then, too, IRC's nation-wide network of Distributors will be prepared to render prompt service in supplying resistor requirements.

Built to surpass rigid Army-Navy "specs," IRC Resistors will offer greater values than ever because of modern mass production methods and greatly increased plant capacity.

INQUIRIES INVITED

It's none too soon for manufacturers of electronic equipment to survey their immediate post-war resistor needs. If you anticipate design or engineering problems involving resistances, we may be able to help in their solution. Feel free to call upon us and be assured your confidence will be respected.

QUALITY FEATURES OF IRC RHEOSTATS

1. All metal *shatter and vibration-proof construction.*

2. *Design provides almost 50% less temperature rise than other types for equal wattage rating and size.*

3. *Aluminum construction provides light weight.*

4. *Uniform spacing and tight winding of resistance element.*

5. *Enclosed construction as protection against dust, dirt and damage to the moving parts.*

6. *Clock spring between central terminal and slide eliminates one wiping contact and spring.*

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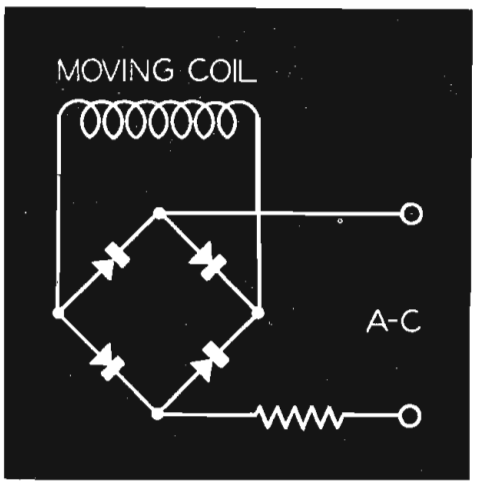
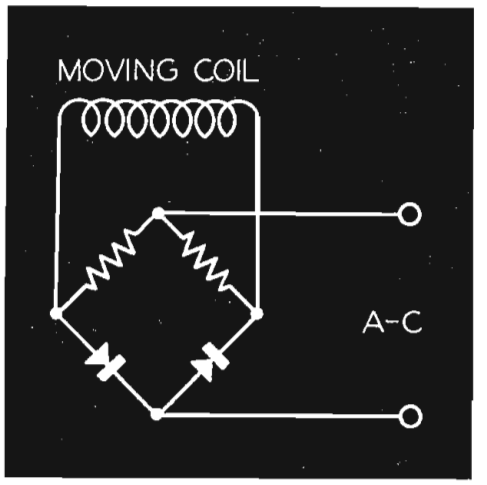
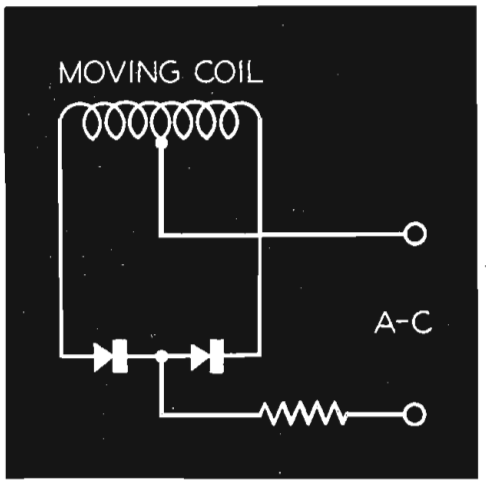






Figures 7 (left), 8 (top) and 9 (right) Circuits for db and vu instruments. Figure 7, a full-wave bridge rectifier. Figure 8, full-wave, using double half-wave rectifier. Figure 9, full-wave using center-tapped moving coil and double half-wave rectifier. (*Courtesy Hickok*)

ful manner to this problem. The principle of loading long lines with loading coils of inductance placed at frequent intervals along the line was invented by Pupin in 1900. Independently and nearly simultaneously, G. A. Campbell also showed the importance of loading to reduce the attenuation of a line and thus increase the possible lengths of line over those which had been possible before loading.

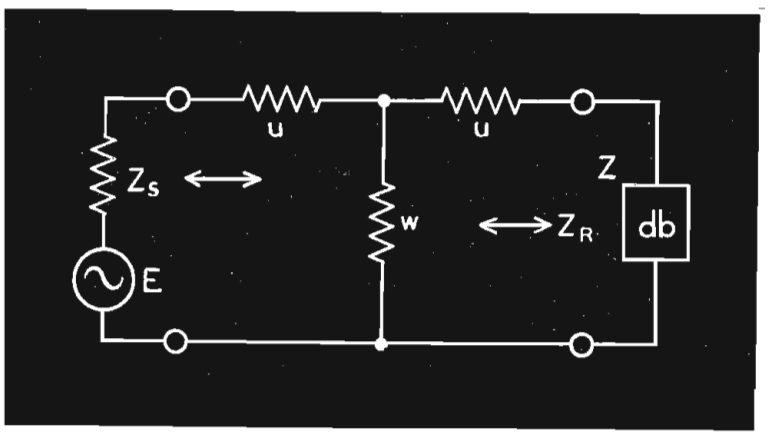
Lord Kelvin developed and designed cables and equipment for submarine cable telegraphy and announced the *CR* law which states that the speed of signalling varies inversely with the product of the total resistance and total capacity of a cable. The importance of this was that it gave a criterion of judgment upon which to base the performance of the cable from a practical standpoint. If two cables of equal lengths have the same time constant, then the same arrival curves of current will be received. If two cables have different lengths with different *CR* products so that the product *CR* and the square of the respective lengths are equal, they will also have the same arrival curves of current. This is strictly true for cables having negligible inductance and leakage. Further, this criterion assumed that the cable had no terminal equipment and was grounded at both ends. Malcolm extended these relations to include the effects of leakage and terminal equipment.

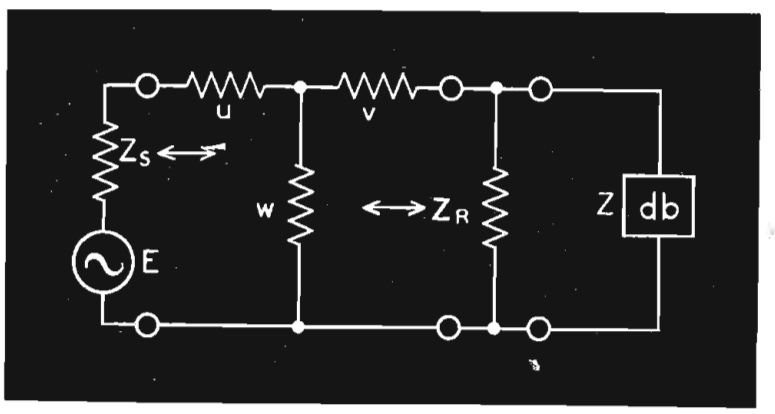
One of the earliest suggestions for a unit to indicate the electrical state or ability of a transmission line to conduct currents along it was made in 1887 by W. H. Preece, only two years after the invention of the telephone by Alexander Graham Bell. He suggested that the *CR* law advanced by Lord Kelvin be applied to telephonic measurements. However, with the development of long telephone transmission lines with wider frequency bands of transmission, more complex character of waves, and inductive plus conductive problems added to the capacitive and resistive problems of idealized cables, it was not tenable to consider applying the *CR* law, for it was not valid for such lines. When attempting to use the *CR* law to determine the intelligibility of transmission lines in advanced telephone practice, the order of magnitude of error as pointed out by Heaviside became as great as 1,000 per cent in error.

There are two main factors which determine the intelligibility of a broadcast or telephone system. (By intelligibility is meant the overall efficiency of transmission of the speech or musical sounds as ordinarily used for communication and broadcasting work.) These factors are the volume efficiency, and the articulation efficiency. Volume efficiency is determined by the ratio of the received acoustic power to the power sent through the transmission system, while articulation efficiency is determined by the quality of the received sounds in terms of comparison with the transmitted sound.

Still other factors enter into the final sounds heard after transmission over any given system. These also may be placed into two categories. These are the noise which may originate at the pickup point through direct sound wave conduction, circuit noise caused by corroded or loose connections, shot effect, microphonic noise, induction from power transmission lines, and from imperfect filtering in power supply equipment; and cross-talk, which may or may not be intelligible. In the cases involving many circuits, it will sound like babbling, while in the cases more frequently encountered in radio and broadcasting studios, it will sound like well articulated speech or program material but with very poor volume ef-

Figures 10 (left) and 11 (right) Figure 10, direct transmission measurement of loss (when $Z_s = Z_R$) with a db meter. Impedance of the meter $= Z_R = Z$, and the input power = 0 db normally. Otherwise the loss = the algebraic difference of the readings with and without the inserted loss. Figure 11, bridged transmission measurement by high impedance db meter. $Z >> Z_R$, and $Z_s \geq Z_R$. Input power $= N_s$db. Insertion loss $= (N_s$ — meter reading$) + 10 \log_{10} \frac{Z_s}{Z_R}$. Meter calibrated at Z_R reference. Input algebraically checked with Z_s termination. Where $Z_s > Z_R$ and $Z >> Z_R$, but the calibration of the meter is only correct for a value equal to Z_s and not for Z_R, meter will read too low by $10 \log_{10} \frac{Z}{Z_R}$. Input power at 0 db of the meter, when terminated with Z_s.





Over the whining bullets and the bursting shells . . . and in the dark silence of the night . . . he wants to hear the beat of your heart.

High up in his jungle roost, or down in the mud on his belly . . . waiting, watching, listening . . . he wants to know whether you're doing the things that will make his job easier, and the war shorter.

And if he were right here beside you, he might want to ask a few personal questions . . . like these:

Did you put some of this week's pay in war bonds?

Are you saving the scrap and fats and paper and other things we need to fight this war?

Have you given blood to the Red Cross to save the boys who are fighting to save you?

And . . . did you do your job today as if the outcome of the war depended on you alone?

These are the ways to show you're backing him up. These are the ways to let him hear the beat of your heart.

★ ★ ★

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

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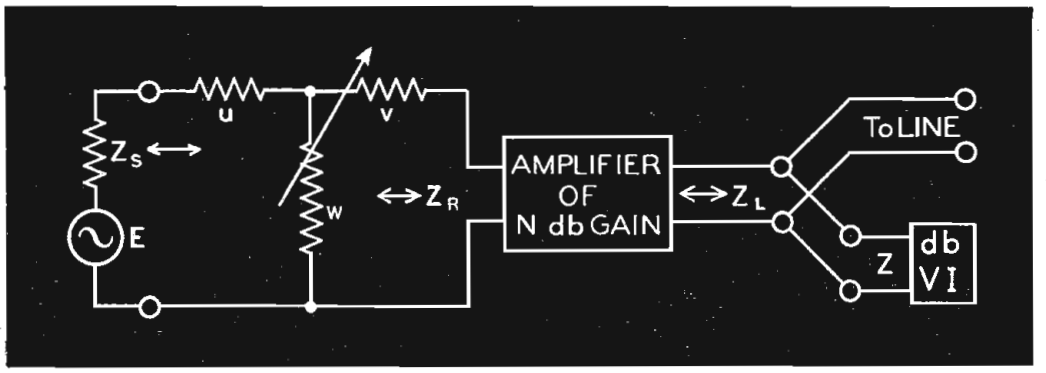
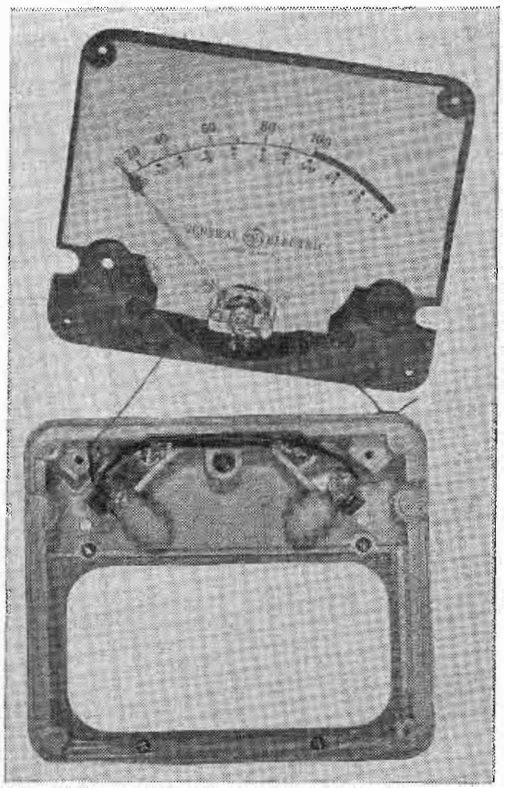




Figures 12 (left) and 13 (right)

Figure 12, with the line connections normal, and the db volume indicator bridged with a high impedance connection, the gain of the amplifier is given by the algebraic sum of the adjustable attenuator and the db meter reading. $Z_s = Z_L$; $Z >> Z_L$; $Z_s \geqq Z_R$.

Fig. 13, interior views of a vu volume-level indicator with an illuminated scale.

ficiency, because of the high attenuation experienced.

The earliest form of circuit which replaced the outmoded *CR* law for telephonic measurements of intelligibility was a *standard cable reference system.* This system was composed of an adjustable artificial line designed to simulate a number 19 AWG cable circuit having a capacity of 0.054 mfd per loop mile, a resistance of 88 ohms per loop mile, and with the inductance and conductance taken equal to zero; a standard common battery station set with battery and repeating coil at each end of the line. In England, a standard cable reference was also set up, and had in addition to the constants given, a conductance of 1 micromho per loop mile and an inductance of 1 millihenry per loop mile.

The early methods of measurement involved actually talking over a circuit to be measured, then switching to a reference circuit of standard cable which was connected to the receiver through the standard artificial line, repeating coil and standard common battery set. By adjustment of the artificial line, and by switching back and forth, a comparison of volume efficiency could be made with reasonable accuracy.

Other useful features of the artificial line for engineering purposes were placed to good use by comparing the volume of sound received for different adjustments of the network. This gave a direct comparison basis from which to judge to best advantage how long circuits might be made and still give reasonably good commercial service. It was found by these means that lengths up to twenty miles could be used satisfactorily for local exchange circuits and up to thirty miles for long distance or toll circuits. Losses of these magnitudes can not be tolerated today in good telephone practice.

The propagation function of a long uniform transmission line or cable terminated in its characteristic impedance is

$$P = a + jb = \sqrt{(R + pL)(G + pC)} \quad (1)$$

while the impedance function is

$$Z = \sqrt{(R + pL) \,/\, (G + pC)} \quad (2)$$

The real and imaginary parts of *1* give the attenuation and phase functions respectively and are

$$a = \sqrt{\tfrac{1}{2}[\sqrt{(R^2 - P^2L^2)(G^2 - P^2C^2)} + (GR + P^2LC)]} \quad (3)$$

$$b = \sqrt{\tfrac{1}{2}[\sqrt{(R^2 - P^2L^2)(G^2 - P^2C^2)} - (GR + P^2LC)]} \quad (4)$$

where $p = j\omega = j2\pi f$.

For the U S standard mile of cable with L and G equal to zero, these equations become for f=800 cycles per second

$$P = \sqrt{\omega RC} \cdot e^{-j45^\circ} = .00546\sqrt{f}\ /45^\circ \quad (5)$$

$$Z = \sqrt{R/\omega C} \cdot e^{-j45^\circ} = 16.1 \cdot 10^3 \sqrt{1/f}/45^\circ \quad (6)$$

$$a = \sqrt{\pi f RC} = 0.00386\sqrt{f} = 0.109 \text{ nepers} \quad (7)$$

$$b = \sqrt{\pi f RC} = 0.00386\sqrt{f} = 0.109 \text{ radian} \quad (8)$$

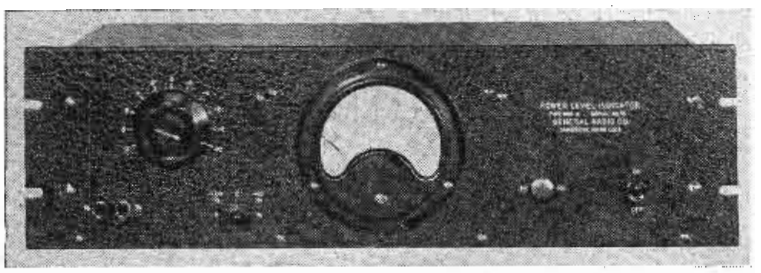


Figure 14
A power level indicator.

The British standard mile of cable includes the value of L of .001 henry and $G = 10^{-6}$ mho. These cause small changes in the above equations. For example, the order of magnitude of the changes may be appreciated from the value of attenuation obtained, which at 800 cycles per second is: a $=0.106$ neper.

It may be seen from *5* or *7* and *8* that the propagation, attenuation and phase functions are directly proportional to the square root of frequency, while from *6* the impedance function is inversely proportional to the square root of frequency.

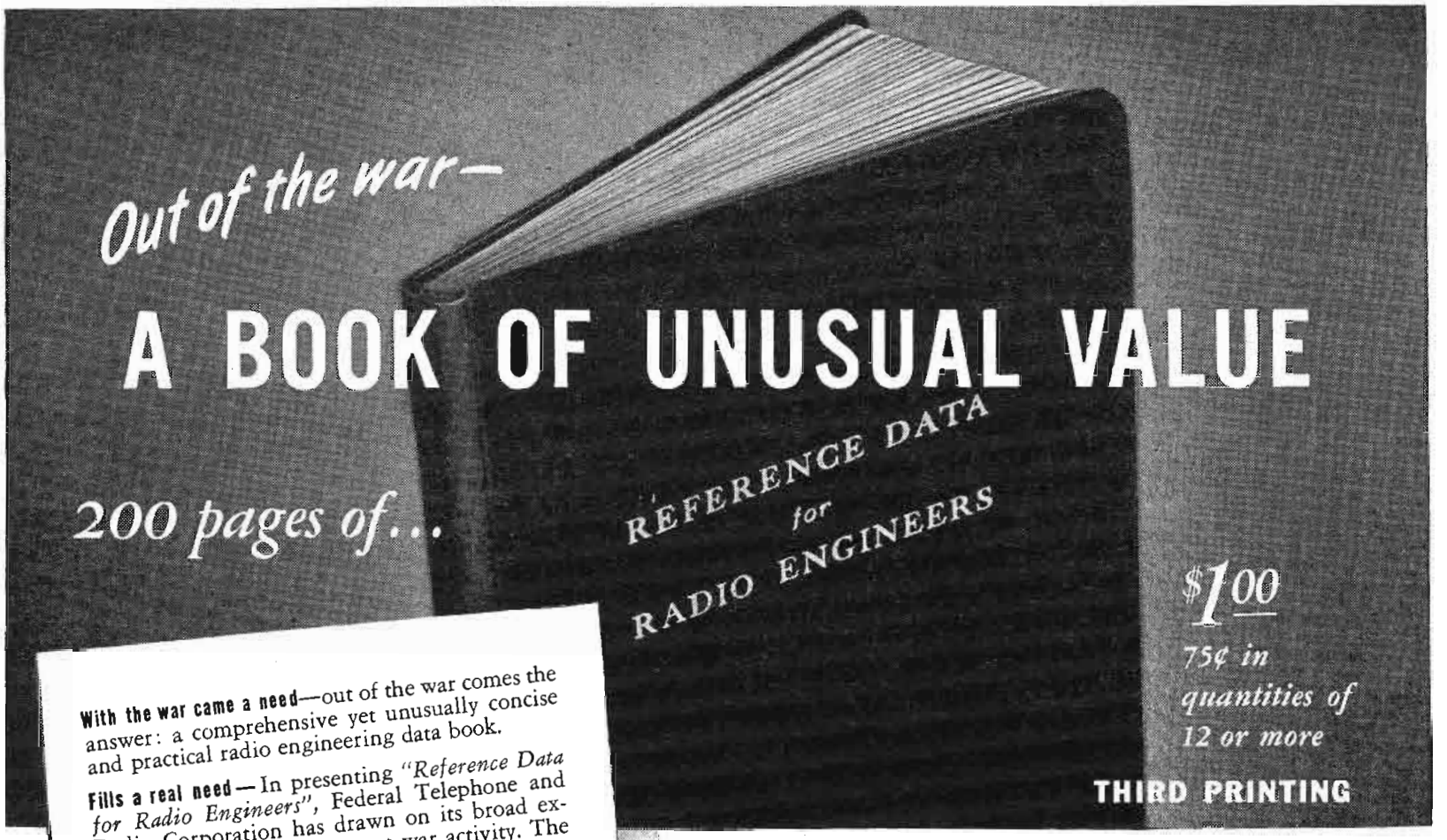
Oliver Heaviside has shown that in order for a line to be completely distortionless, the relationship between the parameters of the line is

$$RC = LG \quad (9)$$

This result is obtained by differentiating *a* with respect to L in *3* and placing equal to zero to find the condition giving minimum attenuation with a variation of the series inductance. It is evident that the standard cable did not meet this condition, nor in fact does any physical line attain this ideal objective.

As long as lines and circuit equipment were not capable of transmitting wide bands of frequencies without distortion and high attenuation, the standard cable gave very satisfactory performance as a standard of measurement, but with the increasing improvements in the quality of transmission of circuits, there became a wider and wider disparity between the quality of the new circuits and standard cable. It therefore became desirable to use a unit which could have universal application for transmission measure-

(*Continued on page* 85)



With the war came a need—out of the war comes the answer: a comprehensive yet unusually concise and practical radio engineering data book.

Fills a real need—In presenting *"Reference Data for Radio Engineers"*, Federal Telephone and Radio Corporation has drawn on its broad experience as well as its current war activity. The needs of both the engineer and the technician have been considered. Hence much fundamental data are included to bridge the gap between the concise handbook and the standard radio engineering text book.

Timely and essential data—such as those on Fourier Analyses of Non-Sinusoidal Waves, Relaxation Oscillators, Antenna Arrays, Transmission Lines, Wave Guides and Resonators have been included. Also much pertinent information *outside* the field of radio.

For quick, easy reference—a glance at the partial table of contents shows the wide range of useful theoretical and practical data included — charts, graphs and tables, plus numerous illustrations — all arranged for ready use.

Edited for today and tomorrow— The impetus of War production has shown the need for an absolute minimum time lag between research, production and utilization of equipment. This one compact volume places at your fingertips information that should be on the desk of every radio man or woman engaged in research, development, production or operation.

Order your copy today— In serviceable green cloth binding, $1.00 a copy; 75¢ a copy in quantities of 12 or more. The order form at the right is for your convenience.

Material for this Reference was compiled under the direction of the Federal Telephone and Radio Laboratories in collaboration with other associate companies of the International Telephone and Telegraph Corporation. This group of companies possesses experience gained throughout the world over a period of many years in the materialization of important radio projects.

PARTIAL TABLE OF CONTENTS

General Engineering Tables: Conversion, Fractions of Inch, Copper and Copperweld Wire, Machine Screw Data.

Engineering and Material Data: Insulating Materials, Plastics, Physical Constants of Metals, Spark Gap Voltages, Thermocouples, Water Pressure Data, Power Supplies in Foreign Countries, Weather Data, Audible and Ether Spectrums, RF Classifications.

Audio and Radio Design: Condenser and Resistor Color Codes, Inductance and Reactance Charts, Time Constants, Impedance and Electrical Circuit Formulas, Network Theorems, Attenuators, Filter Networks, Arrays, Frequency Tolerances.

Noise and Noise Measurement: Wire Telephony, Radio.

Non-Sinusoidal Waveforms: Relaxation Oscillators, Electronic Differentiation, Fourier Analysis of Recurrent Waveforms, Commonly Encountered Waveforms.

Mathematical Formulas and General Information: Miscellaneous, Mensuration, Complex Quantities, Algebraic and Trigonometric, Small Angles, Quadratics, Progression, Combinations and Permutations, Binomial and Maclaurin Theorems, Hyperbolic and Other Functions, Great Circle Calculations.

Mathematical Tables: Logarithms, Natural Trigonometric Functions, Logarithms of Trigonometric Functions, Exponentials, Natural Logarithms, Hyperbolics, Bessel Functions.

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C-4-'44

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NEWS BRIEFS OF THE MONTH ...—

WPB EXPANDS CRYSTAL USES

As a result of an easing in the crystal supply-demand situation, General Conservation Order M-146 has been amended, permitting additional uses. Heretofore quartz crystals could be used only in the manufacture of radio oscillators and filters for war purposes and a few other military items. They may now be used for: (*1*)—manufacture of radio oscillators and filters for governmental activities directly connected with defense, public health, welfare, or security. This will permit the police, forestry services, and similar activities to get the quartz radio parts they need; (*2*)—manufacture of radio oscillators and filters for commercial broadcasting stations and other commercial communication systems; and (*3*)—manufacture of optical or electrical parts for use in research or production instruments manufactured to fill orders rated AA-2X or better.

* * *

RIETZKE PRESIDENT OF NATIONAL COUNCIL OF TECHNICAL SCHOOLS

The National Council of Technical Schools, which was formed recently, will have as its first president E. H. Rietzke of the Capitol Radio Engineering Institute.

Membership in the Council is open to private schools, which have been established for at least five years, offering resident technical training on a level between that of the trade school and that of a purely academic institution. Besides officers and trustees of the association, five standing committees have been appointed for research and educational standards, business and ethics standards, membership, legislation, and publicity.

Executive director is Dr. J. S. Noffsinger. National Council of Technical Schools headquarters are at 839 Seventeenth Street, N. W., Washington, D. C.

* * *

POSTWAR TELEVISION DISCUSSED BY NBC WAR CLINIC

In a three-day schedule of meetings held recently in New York, Atlanta, Dallas, Chicago and Los Angeles, NBC's war clinic representatives discussed the postwar prospects of television, and the network of television stations planned by NBC. Niles Trammell, president of the National Broadcasting Company, revealed that A T & T planned to network the nation with coaxial cables.

* * *

WILSON APPOINTED WPB PRODUCTION SCHEDULING DIRECTOR

Arthur J. Wilson, former chief of the production control branch of WPB's radio and radar division, has been appointed director of the board's production scheduling division. Before joining the War Production Board in 1942, Mr. Wilson was vice president of the Audio Production Company, a subsidiary of Western Electric.

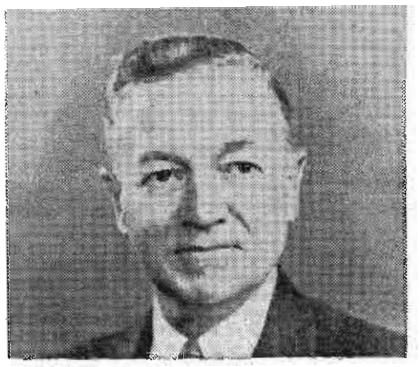
* * *

CHUNGKING REBROADCASTING OWI PROGRAMS

China has begun longwave rebroadcasts of American shortwave broadcasts to Chungking via the Overseas Branch of OWI in San Francisco, according to James L. Fly, chairman of the FCC. These rebroadcasts are over XGOA in Chungking.

CARDWELL APPOINTS FABEL

The Allen D. Cardwell Manufacturing Corporation, Brooklyn, New York, has appointed Joseph K. Fabel vice president in charge of sales. Mr. Fabel was formerly assistant district manager, New York section, of the Army-Navy Electronics Production Agency.



* * *

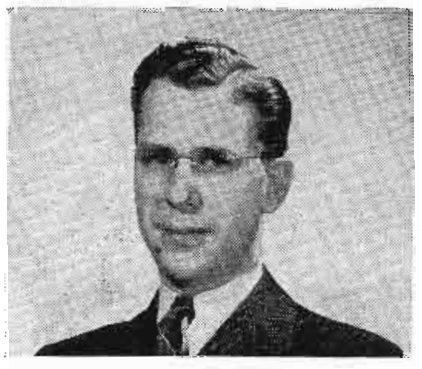
McKEY JOINS WKY-KLZ-KVOR AS TECHNICAL SUPERVISOR

Dixie B. McKey, for over twenty years with Graybar Electric, has joined the staff of the Oklahoma Publishing Company as technical supervisor of radio operations of stations WKY, KLZ and KVOR. In his new connection, Mr. McKey will deal chiefly with the technical and practical operational problems of f-m and television.

* * *

ELLMORE, WALKER, CARBONNEAU, DANISCH WIN UTAH PROMOTIONS

W. A. Ellmore has been named vice president in charge of engineering and sales of Utah Radio Products Company, Chicago, Illinois. Chester L. Walker, formerly chief engineer, has been appointed sales manager in charge of the manufacturing and equipment division. Marion S. Danisch becomes chief engineer, and Gordon S. Carbonneau has been promoted to engineer in charge of the quality control division.



W. A. Ellmore

CIVILIAN SHELLAC RESTRICTIONS TO BE EASED

Since increased imports of shellac now appear possible, the War Production Board announced recently that Allocation Order M-106 may be amended to make some of the higher grades of shellac available for civilian uses.

* * *

WGN CONTEST FOR NEW THEATRE DESIGN

A $10,000-prize contest for a design of an air *theatre of the future* has been announced by station WGN, Chicago. The projected theatre is expected to seat two thousand persons. Selection of winning designs will depend on beauty of design, visibility, and acoustics and utility.

* * *

WFIL HONORS MARK WOODS

Mark Woods, president of the Blue Network, was honored recently with a Citation of Merit by the Poor Richard Club, as a tribute in recognition of his leadership in radio network broadcasting. Station WFIL broadcast the ceremonies.

* * *

NATIONAL CARBON DEVELOPS IMPROVED CARBON FOR TELEVISION PROJECTION

A development in carbon technique by the National Carbon Company, subsidiary of Union Carbide Company, that is said to increase the brightness of theatre television projectors, has been announced by Scophony Corporation of America, 527 Fifth Avenue, New York City. The development, according to SCA, increases the carbon crater intensity of brilliance by seven times normal standards, a brilliance that is excellent for color television.

* * *

ELECTRICAL MANUFACTURERS OPEN PUBLIC INFORMATION CENTER

A public information center for the industry was opened recently in New York City by the National Electrical Manufacturers Association. Available at the center are a variety of facts about the electrical industry, including statistical data, historical and human interest details, photographs, library files and indices, for reference work.

John M. Moorhead, formerly of the *New York Herald Tribune* and the *Kansas City Journal,* is chief of the center.

* * *

GOLDER RESIGNS FROM ROLA COMPANY

Leon Golder has resigned as secretary and sales manager of the Rola Company, Inc., Cleveland, Ohio. Mr. Golder, who was with Rola since its establishment, was formerly with the Sonora Phonograph Company and Magnavox.

* * *

DU MONT "E" CEREMONIES TELECAST

The Army-Navy "E" was awarded recently to the DuMont Laboratories, Inc., Passaic, New Jersey. Paramount News cameramen filmed the ceremonies, which were later telecast over the DuMont Television station W2XWV and broadcast over WOR. Presentation of the award was made by Brig. Gen. G. L. VanDeu-

(*Continued on page* 69)

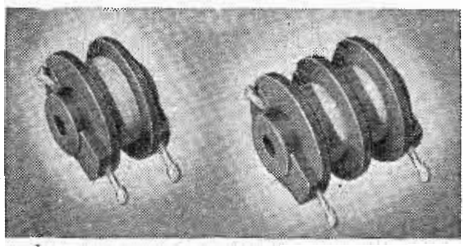
THE INDUSTRY OFFERS

KOOLOHM BOBBIN-TYPE RESISTORS

Bobbin-type resistors wound with flexible ceramic-insulated Koolohm resistance wire on molded high-temperature plastic forms, are now available from the Sprague Specialties Company, Resistor Division, North Adams, Mass.

Standard resistance tolerance for these resistors is said to be ± 5% for full wattage rating, although closer tolerances, as low as ± ½%, can be provided at lower wattage ratings. Maximum power rating is 2.5 watts and maximum resistance 250,000 ohms in a section ⅝" wide and having a diameter of 13/16". The maximum recommended operating temperature (ambient plus rise) is 150° C.

Recommended for use as meter multipliers, resistance standards in control instruments, resistanee elements of RC oscillators, power resistors of medium wattage ratings in values to ½ megohm, etc.



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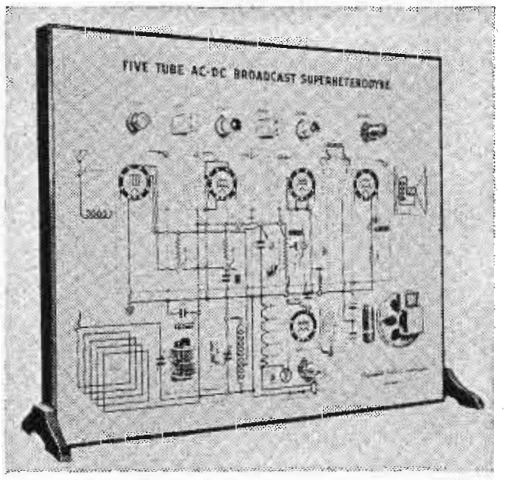
LAFAYETTE PANEL-TYPE DEMONSTRATOR

A 5-tube superheterodyne receiver, assembled on a 30" x 36" imprinted panel and mounted in a reinforced hardwood frame 3" deep, for instructional work, is now available from the Lafayette Radio Corporation, 901 West Jackson Boulevard, Chicago 7, Ill. It may be set up on a table, or blackboard, or wall.

Circuit is wired for 110-volt a-c/d-c operation. All parts except the loop are mounted in plain view adjacent to their schematic positions on the panel.

Demonstrator boards come with drilled panel in kit form or completely assembled and wired.

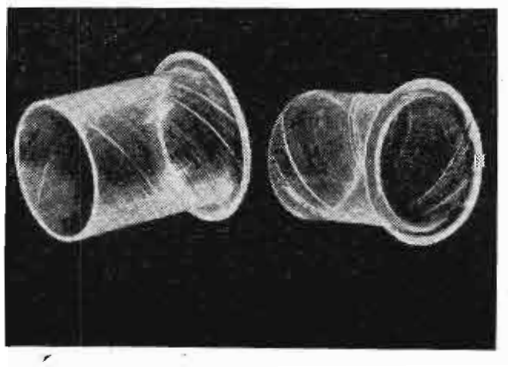


* * *

ACETATE GROMMETS

Spun acetate grommets have been announced by Precision Paper Tube Co., 2035 W. Charleston St., Chicago 47, Ill.

The grommets are made of acetate film, spirally wound and laminated. Supplied with one end spun, inserted in place, and subsequently spun over on standard drill press equipment with special tools supplied by Precision.



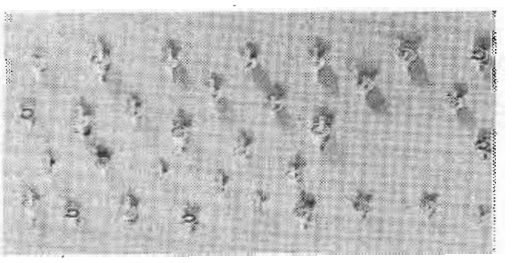
CENTRALAB SILVER MICAS

Silver mica capacitors with a range of 6 to 2,000 mmfd, measured at 1 mc, are now being manufactured by Centralab, division of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee, Wis.

Type 830 of this group has a metal cup holding the mica capacitor and is assembled to a tapped brass mounting with or without ground terminal. Capacitor is also available without tapped mounting, where it is preferable to solder the cup directly to another unit. Ranges are from 6 to 650 mmfd. Terminal types available include light right angle, heavy right angle, long tongue, U-shaped and post terminals. Another type, A831, 6 to 650 mmfd, is of *feed-thru* construction, with one or two terminals riveted to the center capacitor plate.

Type 832 similar to type 830, but with a deeper cup to accommodate more mica film, and available in 650 to 2,000 mmfd ranges, is available with light right angle, heavy right angle, long tongue and U-shaped terminals.

Power factor of all types is said to be .08% for resonant circuit application, 12% for bypass or blocking use. Leakage resistance is said to be 10,000 megohms.

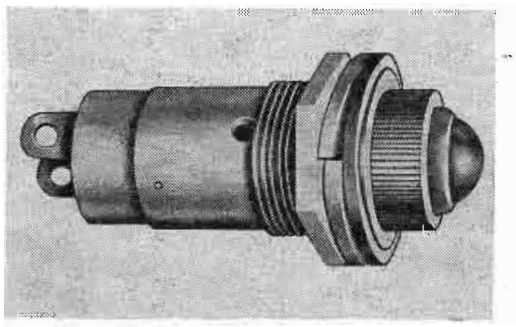


* * *

GOTHARD ENCLOSED PILOT LIGHT

Pilot lights primarily for ungrounded panels are now available from the Gothard Manufacturing Company, Springfield, Illinois. All variations of this new light are equipped with two solder terminals. Models 1110 (faceted jewel) and 1111 (plain jewel) use long bulbs; 1112 (faceted jewel) and 1113 (plain jewel) use round bulbs. The preceding models are available with bayonet sockets only.

Also available as a shutter type light, models 1114 and 1115; 90° turn of the shutter provides gradation from bright light, through intermediate glows to a dim glow, or total blackout. Can also be furnished with polarized lens. All models mount in an 11/16" hole and have ½" jewels. Lamps are removed from front of panel.

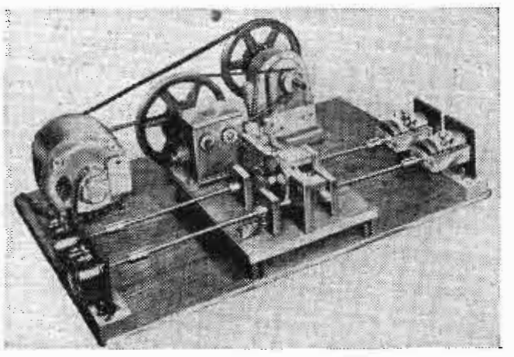


* * *

DEJUR RHEOSTAT LIFE TESTER

A continuous rotation testing machine has been designed by De Jur Amsco, Shelton, Conn., to subject rheostat-potentiometers to a lifetime's effective operation at a greatly accelerated rate.

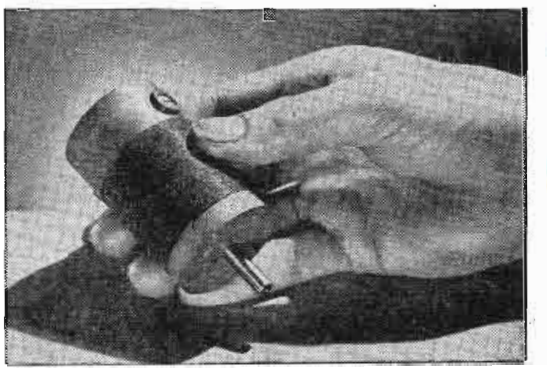
In operation, on one-half cycle, the wiper travels from minimum to maximum resistance and reverses in the next half cycle, simulating manual operations at a continuous high rate of speed.



FRACTIONAL H-P MOTORS

Completely enclosed small motors with aluminum ends, ball bearings, stainless steel shafts, running at speeds from 2,000 to 20,000 rpm on a-c or d-c, are now available from Small Motors, Inc., 1308-22 Elston Ave., Chicago 22, Illinois. They are reversible with high starting torque and low current draw. Can be wound for voltages from 6 to 230. Said to be corrosion proof to pass the 200-hour, 20% salt-spray tests.

Flange, clamp, base or integral mountings are furnished for operating in any required mounting position.



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AMP SOLDERLESS TUBE-CAP TERMINALS

Solderless tube-cap terminals for power tubes are being made by Aircraft-Marine Products Inc., 1591 F North Fourth Street, Harrisburg, Pa.

Hot-electro tinning is said to assure high corrosion resistanee. Diamond grip tube-cap units are available for use on insulated wire where an insulation-support type of terminal is required. Standard type *B* units may be used on either insulated or non-insulated wire.

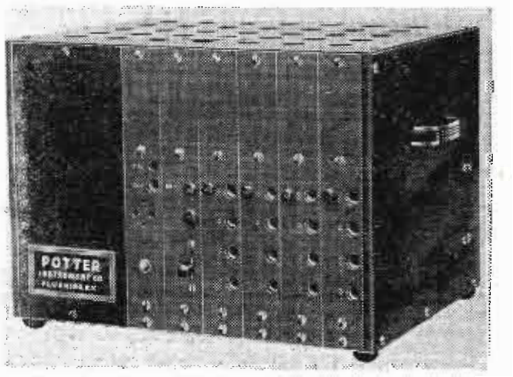
* * *

INTERVAL TIMER

A counter chronograph interval timer has been designed by the Potter Instrument Company, 136-56 Roosevelt Avenue, Flushing, N. Y.

Electronic counters are used, with a 100 kc crystal controlled oscillator to generate the initial counting rate. The 100-kc frequency is divided by four decades down to an output

(*Continued on page 76*)



Sound Ideas . . .

Sound ideas! On the drafting board . . . in practical engineering . . . in production "know-how". These form a strong union out of which come many Electro-Voice developments. And the latest of these is the Model T-45 "Lip Mike" . . . a noise-cancelling Differential Microphone.

The soundness of Electro-Voice design refinements will be even more effectively demonstrated in peacetime. We have grown up with the field. We know its needs and its possibilities. You may be sure that products born of Electro-Voice ideas will perform a sound function.

Electro-Voice distributors are giving greater understanding to your requirements than ever before. If your limited quantity needs can be filled by any of our Standard Model Microphones, with or without minor modifications, we suggest that you contact your nearest radio parts distributor.

DON'T WASTE WASTEPAPER . . . TURN IT IN TO FIGHT FOR OUR SIDE

Electro-Voice MICROPHONES

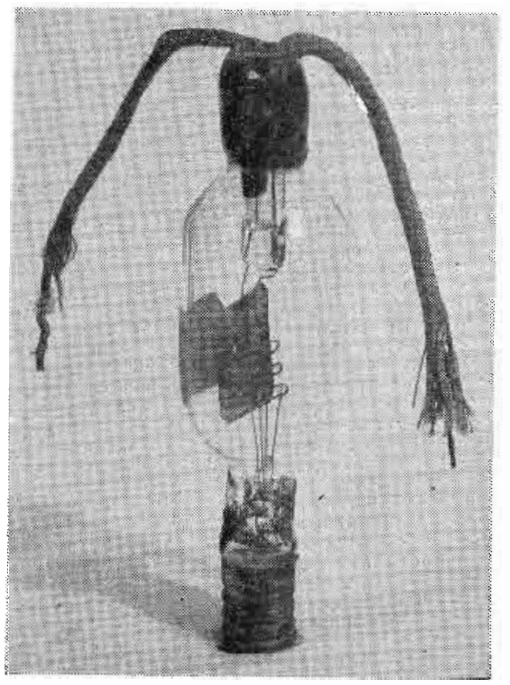
ELECTRO-VOICE MANUFACTURING CO., INC.
1239 South Bend Ave. • South Bend 24, Indiana
EXPORT DIVISION: 13 EAST 40th ST., NEW YORK 16, N. Y. — U. S. A. CABLES: ARLAB

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

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

Personals

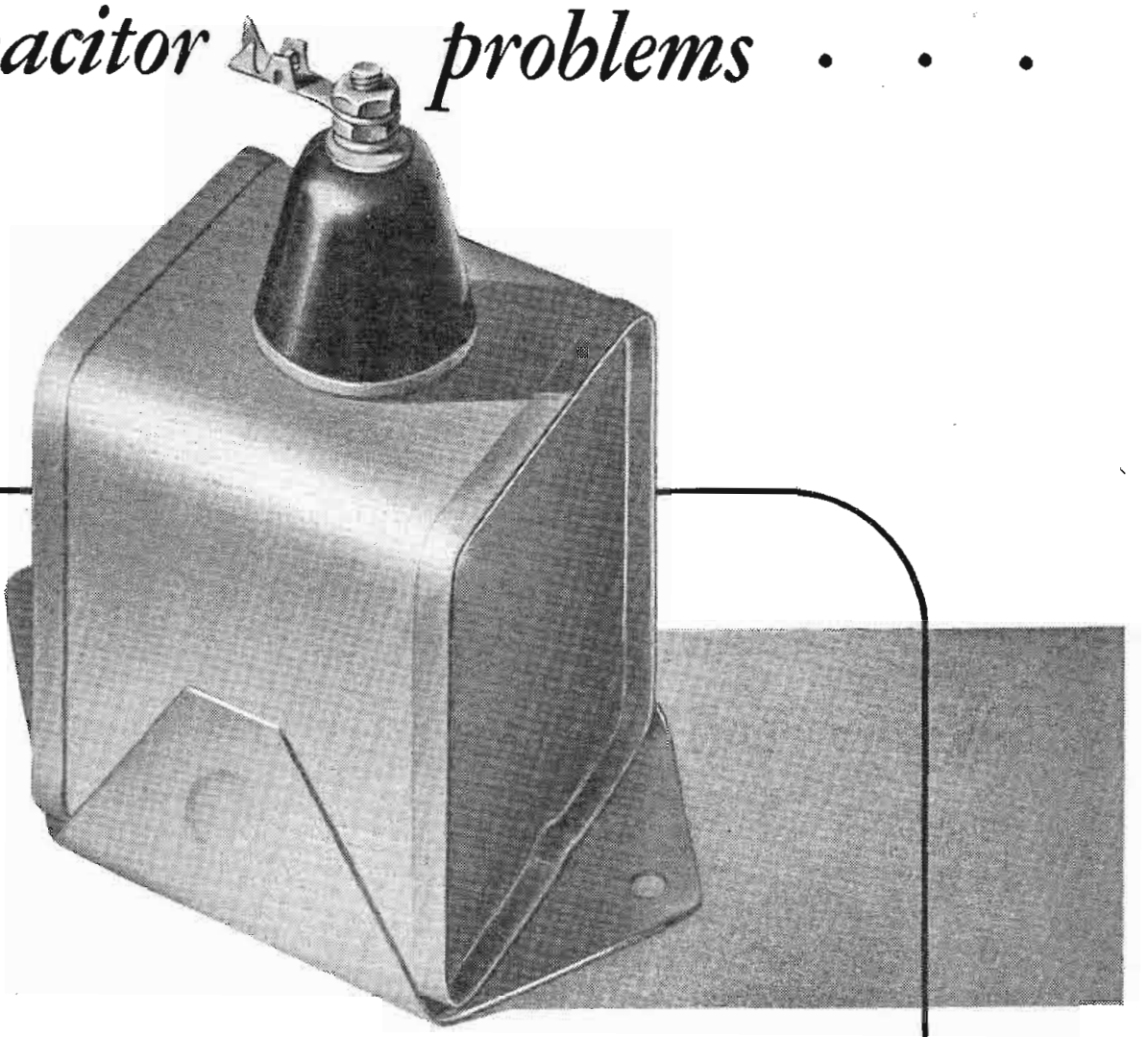
THE VWOA board of directors tendered a testimonial dinner to Commander Fred Muller, chairman of the board, upon the eve of his departure to a new and more important assignment. We are sure all our members join with us in wishing Fred, Godspeed and all success in the new job. . . . Our sincere and heartfelt congratulations to Kenneth B. Warner upon his silver anniversary as general manager of the ARRL. Ken was given an honorary VWOA membership in 1943, as an outstanding member of the radio communications fraternity. May we all be here to wish him luck on his golden anniversary. . . . All good wishes to Neville Miller, honorary member of our Association, who recently resigned from the presidency of the National Association of Broadcasters after the longest tenure in that office of any president. Mr. Miller received on behalf of NAB our Association's first Marconi Memorial Plaque in 1940. . . . Yes, veteran wirelessmen do get the job done. . . . Another oldtimer in the wireless operating profession, Allen B. Du Mont, president of the Allen B. Du Mont Laboratories, recently accepted the Army-Navy "E" flag on behalf of himself and his associates from our good friend General Van Deusen, Commanding General of Fort Monmouth. This award places Mr. Du Mont on our Honor Roll and makes him eligible for a Marconi Memorial Medal of Achievement. . . . Lacking details we cannot give you a complete report of the Los Angeles-Hollywood chapter dinner held in Los Angeles on the evening of February 24. What say, LA, let us in on the news. . . . Lt. Commander V. H. C. Eberlin, a former VWOA treasurer and more recently chairman of our Miami chapter, is now Communications Officer of one of our newest aircraft carriers. Let's hear from you, Ebby. . . . Did you know that Ludwig Arnson, who received a Marconi Medal of Achievement, was the first operator aboard an American ship to use the original signal of distress,



A 1908 de Forest 3-element tube with a candelebra base.
(From the Clark Radio Library)

"CQD," way, way back? As you probably remember Teddy Haubner was the first American operator to use the SOS signal. And, of course, Jack Binns was one of the first ever to use the CQD signal resulting in the saving of hundreds of lives in the Republic-Florida disaster. As a matter of fact your president was the first to introduce the skippers of the Republic and Florida, thirty years after the collision between the two vessels. . . . Let us have more of this type of information from some of you real pioneers. . . . An appreciative note came in from General McClelland, Air Communications Officer of the Army Air Force. General McClelland represented General Arnold at our nineteenth anniversary dinner-cruise. . . . Our relations with Canada have been always of the best, and the note we received from the Consul-General of Canada, the Hon. H. D. Scully, is further evidence of why this shall always be. Mr. Scully, writing to your president, said: "I wish to thank you heartily for including me in your list of guests to the annual dinner of the Veteran Wireless Operators Association at the Astor Hotel. I am afraid I came away without saying goodnight or thanking you in person at the conclusion of the meeting, so I am taking this more formal method of expressing my appreciation of your courtesy and hospitality." . . . Please don't forget the informal spring dinner at the 77th Division Club on April 27, 28 East 39th Street. These meetings are arranged primarily for our members but you are welcome to bring along a friend. . . . Here's an important message to oldtimers, especially those who have licenses or who can easily obtain one. The War Shipping Administration is in urgent need of radio officers to man our Victory ships. So urgent is the need that WSA is sending telegrams to all licensed operators. For further information address Recruitment and Manning Organizations, War Shipping Administration, 37 Broadway, New York, N. Y. . . . Because of an overseas assignment, Major William S. Marks, Jr., was unable to be with us at the Astor. He is expected back in time for the 27th at the 77th. . . . Hermann Florez, formerly of the staff of WOR and more recently engaged in a consulting radio engineering practice in Washington, was unable to attend the dinner, since he was in London on an important government assignment. . . . We welcome H. B. Black of the Crocker Wheeler Electric Manufacturing Company into our Association as a veteran member. HBB is a real pioneer in this business and we hope he will send in some oldtime tales. . . . Peter R. Cuda, now an instructor in the Army Air Forces School at Madison, Wis., was a member of VWOA back in '31 and '32 and is back with us again. . . . Bill Simon, our treasurer, has also taken over the duties of executive secretary. . . . A. F. "Steve" Wallis, recently resigned from the Maritime Service where he had served for several years as Lt. Commander, to return to the Marine Department of Mackay Radio. . . . Our sincere thanks to George W. Bailey, assistant to the president and special Washington VWOA representative, for his splendid cooperation during the past year. . . . Keep the news notes coming. . . . 73, MC.

Here's How Micamold Helps Project-Engineers *with capacitor problems . . .*



Several thousand transmitting mica capacitors were needed for an imperative wartime function

***Micamold* engineers analyzed the specifications of the mica condenser. They found that a similar type could be built—*without using strategic and costly mica*. This *Micamold* Paper Capacitor is the result.**

The Micamold-created Paper Transmitting Capacitor is mechanically interchangeable with its mica counterpart . . . and serves its purpose in the particular application for which it was designed. Thousands of pounds of precious mica were saved and production costs were greatly lowered.

IF YOU HAVE A CONDENSER DESIGN PROBLEM, CALL ON MICAMOLD

Micamold is equipped to help you with your capacitor problems and to manufacture a wide variety of standard or special types to suit your requirements. Collaboration between project engineers and our own staff has broken many a "bottleneck" We would like to work with you on present or postwar projects.

MICAMOLD RADIO CORPORATION
1087 FLUSHING AVENUE BROOKLYN 6, N. Y.

NO LET UP and NO LET DOWN • *KEEP BUYING MORE WAR BONDS*

Are you properly emphasizing the SAVINGS FEATURE OF YOUR PLANT'S PAYROLL SAVINGS PLAN?

WITH the war swinging into its tensest phase, now's the time to emphasize over and over again the *savings* feature of your Payroll Savings Plan. To press home to all your people the need of building up their savings—the need of building up their savings not only in wartime but also in the years directly after the war. To point out that a bond cashed before its full maturity is a bond killed before it has given its fullest service to its owner—*or to his country!*

Buying War Bonds, holding War Bonds, and keeping wartime savings mounting—all are absolutely vital. But no one of these is enough by itself. The *savings habit* must be carried over into the years of reconstruction which will follow the war. For if, at war's end, we have 'flash-in-the-pan' spending, *everybody loses.* The spender loses, you lose, and the country loses! While a working public, convinced of the value of continued, planned saving, is the soundest possible foundation for private enterprise of every sort.

We call these bonds War Bonds—and with their aid we will win this war at the earliest possible moment! But they're Peace Bonds, too—and, rightly used, they will win for their holders, *and for all of us,* a happy and prosperous place in the years of peace to come.

WAR BONDS to Have and to Hold.

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

COMMUNICATIONS

★ Let's All Back
★ the Attack...
★ with War Bonds!

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

NEWS BRIEFS

(*Continued from page 62*)

sen, Commanding General, Fort Monmouth, and Cmdr. A. S. Kibbee, USNR, Office of Inspector of Naval Materiel, New York.

* * *

CLAYTON RETURNS TO GENERAL RADIO

John M. Clayton, on leave of absence with the Navy for the past two years, has returned to his desk at the General Radio Company, Cambridge, Massachusetts. He will resume direction of all technical and trade advertising.

* * *

LIP MIKE DEMONSTRATION

The first public demonstration of the lip mike was heard recently over CBS in an unusual two-point hookup. The program featured a conversation between workers of the Electric Boat Company's submarine building plant at Groton, Connecticut, and workers at ELCO's PT boat plant at Bayonne, New Jersey.

The lip mike was developed by the Electro-Voice Manufacturing Company, South Bend, Indiana, in collaboration with the Fort Monmouth Signal Corps unit.

* * *

ARCO ISSUES NEWS MONTHLY

The *Allied Radio and Electronic News,* a monthly bulletin of developments in the electronics field, is being distributed by Allied Radio Corporation, 833 West Jackson Boulevard, Chicago 7, Illinois.

* * *

ARPIN ADVANCES LYNCH AND BLOEMEKE

Walter H. Lynch has been elected vice president in charge of engineering of Arpin Manufacturing Company, 422 Alden Street, Philadelphia. Mr. Lynch is chief engineer, and will also serve as general manager and a director of the company.

Richard H. Bloemeke, formerly chief production engineer, has also been elected a director of Arpin, as well as general plant manager. Both Mr. Bloemeke and Mr. Lynch were with National Union Radio Corporation before coming to Arpin.

* * *

CALLITE THERMOSTATIC BI-METALS BULLETIN

A 4-page bulletin discussing *Calliflex*

(*Continued on page 70*)

●

EXPERTS DISCUSS TELEVISION

Thomas F. Joyce, manager of the radio, phonograph and television department of RCA Victor, discussed postwar television before the Sales Executive Club at a Television Day meeting, in New York City. At Mr. Joyce's left, Allen B. DuMont, president of DuMont Labs., who also presented an analysis of postwar television problems.

NEWS BRIEFS

(*Continued from page 69*)

Bi-Metal, has been published by Callite Tungsten Corporation, 540 Thirty-Ninth Street, Union City, New Jersey. The bulletin, No. 155, gives technical data on the deflection and power of the five types of thermostatic bi-metal in strip and coil, thicknesses, sizes, etc.

* * *

MECK INDUSTRIES TO PRODUCE POSTWAR RECEIVERS

The John Meck Industries of Plymouth, Indiana, received RCA and Hazeltine licenses recently to manufacture postwar radio receivers.

* * *

SYLVANIA OPENS SAN FRANCISCO OFFICE

A new office, which will serve as west coast headquarters, was opened recently at 111 Sutter Street, San Francisco, by Sylvania Electric Products, Inc. B. K. Wickstrum, Pacific Coast sales manager for the company's lighting products, is in charge.

* * *

PHILCO ELECTRONIC MASTER MIND

An electronic *master mind* developed by Philco to calibrate equipment automatically is reported to have saved 144,000 manhours, and over a million dollars for the government.

* * *

BELL SYSTEM SALVAGES COPPER

Twelve-thousand tons of copper, enough for more than a billion machine gun cartridges or a million miles of telephone wire, was returned to the national stockpile from the telephone plant of the Bell System during 1943, according to Western Electric Company.

* * *

NEW HYTRON PLANT

The Hytron Corporation has opened another plant at Beverly, Massachusetts. Hytron now has five plants in operation.

* * *

NEW QUARTERS FOR PHILHARMONIC RADIO

Removal of their entire plant from 216 William Street to expanded quarters at

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MUSIC FOR THE ILL

Lucille Ingebretson, pharmacist second class, at the control panel of a Stromberg-Carlson receiver-sound system that supplies entertainment to patients at St. Albans Naval Hospital, St. Albans, New York.

528 East 72 Street, New York City, has been announced by Phil-American, Inc., prewar manufacturers of Philharmonic radios. The company is a subsidiary of American Type Founders, Inc.

* * *

HAGER REELECTED NAB DISTRICT DIRECTOR

Kolin Hager, general manager of WGY, Schenectady, was reelected director of the second NAB District at a recent meeting in New York City.

* * *

RCP TESTING INSTRUMENTS CATALOG

An illustrated catalog, No. 128, has been issued by Radio City Products, 127 West 26 Street, New York 1, New York. Among the instruments described are various types of multitesters, vacuum tube testers, insulation testers, electronic voltmeters, limit bridges for precision resistance testing, etc.

* * *

CORDAGE, INCORPORATED, FORMED

A new company, Cordage, Incorporated, devoted primarily to the manufacture of rubber-jacketed and retractable electrical cords, was recently announced. Headquarters are in Chicago, Illinois. The company is an outgrowth of the research and development conducted by R. D. Collins of Santa Monica, California, during the past several years. Mr. Collins, who is commercial superintendent of the Associated Telephone Co., Ltd., in Santa Monica, originated the retractable handset telephone cord.

Officers of the new organization are C. D. Manning, president, R. D. Collins and H. D. Hurlbut, vice presidents and E. Johnson, secretary-treasurer. P. C. Geraty, for many years head of the insulating department of Kellogg Switchboard and Supply Company, has been appointed manager. All orders will be handled through Kellogg.

* * *

JESTER GOES TO MEISSNER

Oden F. Jester, formerly vice president of Utah Radio Products, has joined

(*Continued on page 72*)

COPPER-OXIDE RECTIFIER TESTS

William H. Sutton of Westinghouse making final adjustments on Rectox units before submitting them to heat tests. Resistor units furnish heat to the test chamber while thermostatic control keeps the temperature level constant. These rectifiers are said to be capable of standing high ambient temperatures.

NEWS BRIEFS

(*Continued from page 71*)

Meisner Manufacturing Company as a vice president.

* * *

HARDWICK JOINS IRC

A. H. Hardwick, former president of Hardwick, Hindle, Inc., has joined the executive staff of International Resistance Company, Philadelphia, Pennsylvania. Mr. Hardwick will manage the New York City sales and customers' service offices of IRC and Connector Corporation at 165 Broadway, New York 6, N. Y.

* * *

REVIEW DATA IN RCA SERVICE MONTHLY

The latest issue of RCA's monthly, *Radio Service News,* reports a review of wartime radio in '43 and an outline of radio's future by the company's president, David Sarnoff. Among other items of interest in this paper are a new allocation plan for receiving tube distributors, an improved cathode-ray oscilloscope, and a transformer reference chart.

* * *

LA MARQUE GRAYBAR SALES MANAGER

J. W. LaMarque, formerly manager of the Graybar radio broadcasting department, has become radio sales manager of Graybar Electric Company, Inc., 420 Lexington Avenue, New York 17, New York.

* * *

IRVINGTON PLASTIC TUBING CATALOG

A 20-page illustrated catalog, *Facts About Plastic Tubing,* has been issued by the Irvington Varnish & Insulator Company, Irvington, New Jersey. Included in the catalog, which describes Irvington fibronized extruded plastic tubing, are a number of product data sheets detailing the characteristics and applications of Irvo-lite types XTE-30, XTE-130, and Iviflex extruded tubing, transflex transparent plastic tubing, Hyflex plastic tubing, and Irvington plastic marker insulators.

* * *

CAP PROCEDURE MANUAL

A 16-page booklet titled *Procedure Manual for Aircraft Radiotelephone Communication* has been released for distribution to members of all CAP wings, groups, squadrons and flights, by Electronic Specialty Company, 3456 Glendale Boulevard, Los Angeles 26, California. The booklet is a reproduction of the Civil Air Patrol training directive on the use of two-way radio equipment.

* * *

WESTINGHOUSE WARTIME ENGINEERING ANNUAL

The annual Westinghouse publication describing the technical contributions of

the company's engineering staffs throughout the year has just been released. Among the developments reported on in the magazine, called *Wartime Engineering,* are radio sets which operate after being in water, roving power trains which feed electricity to bomb-torn cities, and a camera *gun.*

* * *

SPEED CONTROL DATA IN G. R. EXPERIMENTER

The current issue of the *General Radio Experimenter* contains an article, with charts, on *Motor Speed Control* with the Variac, as well as three additional methods of continuous interpolation which was featured last month.

* * *

DEAKINS HEADS RCA VICTOR CANADA

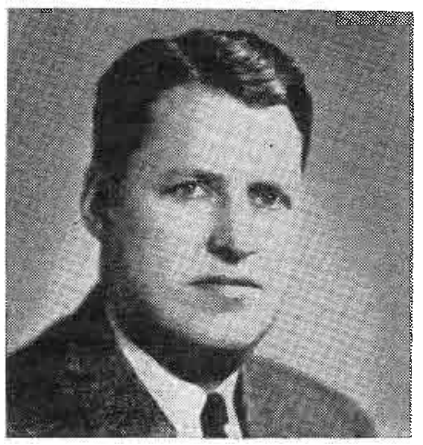
Frank R. Deakins has been named president of RCA Victor Company, Ltd., of Canada, a subsidiary of Radio Corporation of America.

* * *

LAWRANCE AERONAUTICAL ORGANIZATIONAL CHANGES

Lawrance Engineering & Research Corporation, Linden, New Jersey, will hereafter be known as the Lawrance Aeronautical Corporation. The development and manufacture of electronic aeronautical accessories for commercial aviation is planned, to supplement Lawrance's regular production of auxiliary electric power supply for aircraft and surface craft.

Dr. Rowland Burnstan, executive vice president and general manager of the company, has been elected president, to succeed Charles L. Lawrance, who becomes chairman of the board.



Dr. Rowland Burnstan

* * *

ACRO PROMOTES LYNN AND ROBINSON

Fred R. Lynn has been appointed vice president in charge of manufacturing of the Acro Electric Company, Cleveland, Ohio. C. A. Robinson was promoted vice president in charge of sales. Mr. Lynn was formerly associated with the Cannon-Kocka Company and the P. A. Geier Company.

* * *

ELECTRICAL APPARATUS COMPANY MOVES OFFICES

The Electrical Apparatus Company has moved its offices from 1018 Commonwealth Avenue to 1200 Soldiers Field Road, Boston, Massachusetts.

* * *

IDEAL MACHINE TOOL ACCESSORIES CATALOG

A 12-page catalog covering machine tool accessories has been issued by Ideal

(*Continued on page* 74)

NEWS BRIEFS

(*Continued from page* 73)

Commutator Dresser Company, 1290 Park Avenue, Sycamore, Illinois. Described are the a-c magnetic chuck, etcher-demagnetizer, and electric tachometer, as well as triple-duty live centers, machine shop metal etcher, portable demagnetizer, grinding wheel dresser, balancing ways, and electric cleaners.

* * *

WESTINGHOUSE BOOKLET ON POWER CENTERS

A 25-page booklet describing coordinated unit substations available in all standard ratings, has been issued by Westinghouse. The booklet contains a time-saving guide to the selection and specification of indoor and outdoor transformer installations, including disconnect and protective equipment.

* * *

CHERRY RIVET COMPANY MANUAL

A 36-page manual, *Cherry Blind Rivets No. B-44,* has been issued by the Cherry Rivet Company, 231 Winston Street, Los Angeles 13, California, for distribution to field repairmen, inspectors and other users of rivets. The manual, illustrated with color sketches, diagrams and tabular material, covers descriptions of the blind rivet, drilling of the hole, selecting the rivet and pulling head, operation, installation procedure, tools, and inspection technique.

* * *

BENEDICT NAMED WESTINGHOUSE ANALYSIS SECTION MANAGER

Frank R. Benedict has been named manager of the product performance analysis section of Westinghouse, East Pittsburgh, Pennsylvania.

* * *

FEDERAL TEL. & RADIO APPOINTS JAMMER

J. S. Jammer, assistant vice president of Federal Telephone and Radio Corporation, has been appointed general commercial director, in charge of sales and advertising.

* * *

HOPP PLASTICS BULLETIN

An 8-page bulletin describing the properties and uses of lumarith, vinylite, and ethyl cellulose plastics has been released by the Hopp Press, Inc., 460 West 34 Street, New York 1, New York.

* * *

RCA TUBE SUBSTITUTIONS BOOKLET

A 16-page booklet, *Tube Substitution Directory,* covering over two-thousand substitutions, has been issued by the commercial engineering section of Radio Corporation of America, 596 South Fifth

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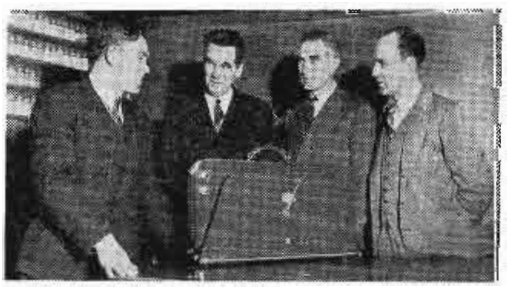
SUITCASE ELECTRON MICROSCOPE



Left to right: Igor Bensen, G.E. development engineer; F. A. Klingenschmitt, Radio Club of America president; Frank King, and Dr. C. H. Bachman, of G.E., with the compact electron micrscope described before a recent meeting of the Radio Club of America in New York City.

Street, Harrison, New Jersey. Included in the directory are sample calculations of series and shunt resistors in heater strings, and a listing of 304 RCA receiving tube types with one or more substitution types which may be used as replacements. The directory, which costs ten cents, is available through RCA distributors or through RCA at Harrison.

* * *

COMMERCIAL ULTRAHIGH SPEED MOTION PICTURE SERVICE

The research division of McLarty Business Films, 986 Ellicott Street, Buffalo 8, New York, has announced an ultrahigh speed motion picture service for high speed research.

* * *

G. E. F-M LISTENER REACTION SURVEY

General Electric Company has released a booklet covering the findings of its recent survey of f-m receiver owners in four of the thirty cities now having f-m stations: New York, Philadelphia, Detroit and Milwaukee. Purpose of the survey was to determine f-m listeners' reactions to f-m reception as compared with a-m, their attitude towards f-m, and the reasons for their present opinions on f-m. The survey showed that 77.2% favored f-m.

* * *

THOMSON OF WESTERN ELECTRIC RETIRES

Philip L. Thomson, director of public relations of Western Electric Company for the past thirty-three years, has retired after forty-one years of service with the company. Fred B. Wright, of the company's distributing organization, assumes Mr. Thompson's post.

* * *

G. E. NEW PARTS DATA ON ELECTRIC INSTRUMENTS

Nine loose-leaf pages covering the 2½" d-c and r-f ammeters and voltmeters of the new internal-pivot design have been released by G. E. The parts are illustrated in sizes proportional to each other.

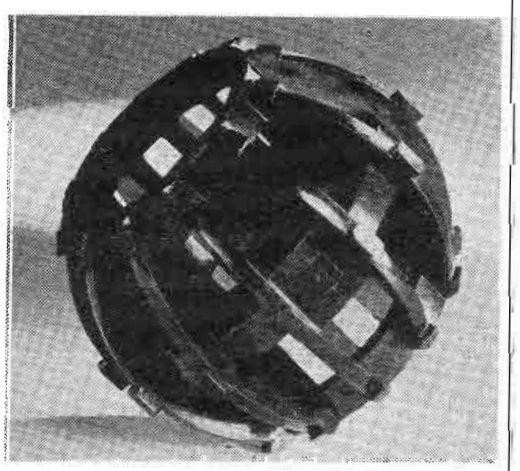
* * *

AUDIO DEVELOPMENT COMPANY CATALOG

A 16-page catalog, containing specification data and product illustrations, has been issued by the Audio Development Company, 2833 Thirteenth Avenue South, Minneapolis 7, Minnesota. Described are impedance, audio, input, bridging and power-transformers, reactors, aircraft and industrial transformers, filters and equalizers, plugs, patch cords, jacks and jack panels, and key switches.

(*Continued on page* 91)

HUGE COIL FORM



Ribbed spheroid coil form, approximately 4" x 5" and weighing about one pound, recently molded from a mold weighing seven hundred pounds.

(*Courtesy Bakelite*)

THE INDUSTRY OFFERS . . .

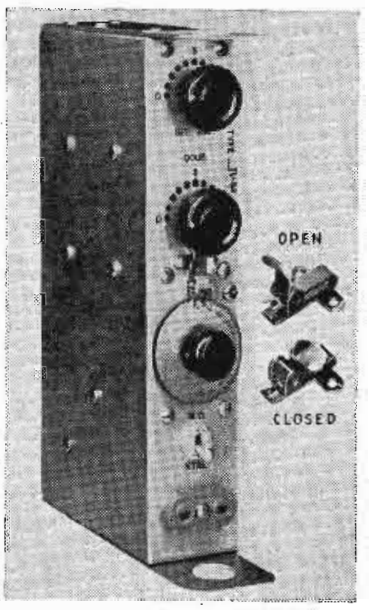
(*Continued from page 64*)

of 0.1 second. Answers are indicated for each decade on four neon lamps designated 1-2-4-8. Size is 15" x 10" x 10"; weight is approximately 30 pounds.

* * *

DIAL LOCK AND TUNING INDICATOR

A tuning control with a lock that will accommodate a wide range of dial thicknesses and a tuning indicator that maintains a fixed position on the dial simply by snapping the lock is now available from the Radio Craftsmen, 1341 S. Michigan Ave., Chicago 5, Illinois. The unit was originally designed for the frequency tuning unit of the Hallicrafters SCR-299 mobile set.



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G. E. FLAMENOL BUILDING WIRE FOR WET LOCATIONS

A small-diameter, type SNW, flamenol building wire for wet locations has been announced by G. E.

The wire has a special thermoplastic insulation with low moisture absorption. It is designed for use in accordance with section 3035 of the National Electrical Code, and is approved by the Underwriters' Laboratories in sizes 14 to 4/0 inclusive.

The insulation is said to be superaging, high in dielectric strength and resistant to oils, acids and alkalies. It is flame resistant and will not support combustion. Its temperature rating is 50° C.

Wire is also said to be self-protecting and requires no braid; finish is hard, smooth and glossy, striped for grade identification. Small size permits more conductors to be used in one conduit or duct, or smaller conduits or ducts to be used.

* * *

MONITOR CIRCULAR SLIDE RULE

A circular white vinylite slide rule with scales on a disc 6" in diameter, has been produced by the Tavella Sales Company, 27 W. Broadway, New York 7, New York.

The rule solves multiplication, division, square root, problems involving the use of logarithms and functions of angles. The front side of the rule has four scales, log, C, D, and CI or C inverted scale. The reverse side has sine and tangent scales and A and D scale for finding squares and square roots.

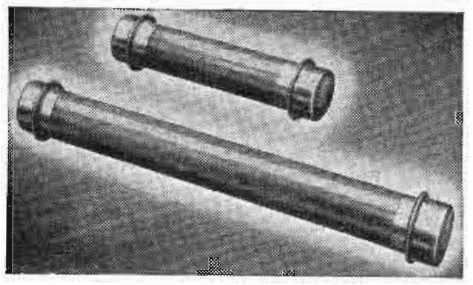
* * *

SPRAGUE HIGH-VOLTAGE MEG-O-MAX RESISTORS

Resistors with a minimum of critical materials, and formed of a series of pressed and sintered ring-shaped segments electrically so joined that the units are non-inductive, are announced by the Sprague Specialties Company, Resistor Division, North Adams, Massachusetts. Finished units are encased in a hermetically sealed glass envelope provided with ferrule terminals.

The resistors known as Meg-O-Max are employed as high voltage bleeders, and as coarse accuracy meter multipliers for voltage indicators. Other present applications include use in high-voltage networks, measuring equipment, rectifier systems, high-voltage voltage dividers,

and as broad accuracy meter multipliers. Available in two types; (1), 5 9/32" long with a range of from 3,600 ohms to 100 megohms; and (2), 9 25/32" long, with a range from 6,800 ohms to 100 megohms.



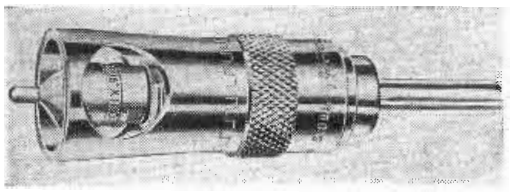
* * *

AIRCRAFT TOOLS COUNTERSINK

A micro-set stop countersink has been announced by Aircraft Tools, Inc., Los Angeles, California.

This new model is said to offer many features such as split collet type shaft which allows the use of various cutters and pilots, full ball thrust bearing that eliminates heat and friction, simplified positive sight adjustment in increments of .002", lock spring in sight adjusting sleeve that holds locking teeth in set position, and pin that locks stop collar to shaft.

A spring loaded spindle retracts cutter back into stop cage for safety to operator and materials, thus protecting cutting edge of tool. Concentricity of the shaft, pilot and cutter limits are held to .002" indicated reading. All parts are interchangeable.



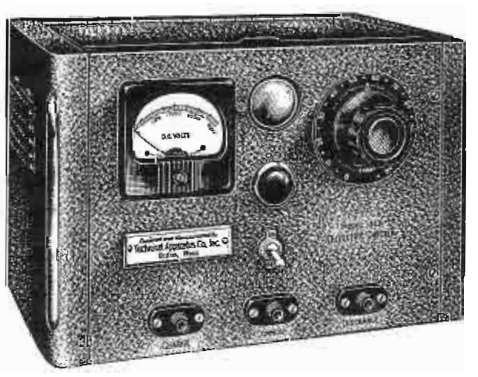
* * *

DIELECTRIC TEST SET

Voltage breakdown tests up to 4000 volts are provided for with the 1031-B dielectric test set manufactured by the Technical Apparatus Company, Boston. Its half-wave rectifier circuit, utilizing a 2x2 tube, delivers up to 18 ma. High voltage output is delivered at safety connectors to which 24" flexible cables, insulated and terminated in high voltage test prods, may be connected.

Charge and discharge of capacitive test specimens, as well as breakdown of insulation under test, are indicated by a neon glow lamp. An output indicating meter shows voltage being applied to the specimen and a primary Variac provides continuous control of output voltage. No extended warm-up period is said to be required.

Housed in steel cabinet 8" x 10" x 8".



* * *

RCP V-T VOLT OHMEGGOR INSULATION TESTER

Insulation testing at 500 volts up to 10,000 megohms is available with the vacuum tube volt ohmeggor insulation tester, model 665, announced by Radio City Products Company, Inc., 127 West 26th Street, New York 1, New York. Instrument is also said to provide capacity tests, as low as 2.5 micromicrofarads and up to 2,000 microfarads.

There are 13 a-c and d-c voltage scales, measuring from a fraction of a volt to 6,000 volts. Input resistance 16 megohms maximum. The vacuum tube ohmmeter has 7 ranges to 1,000 megohms.

* * *

DU PONT CONDUCTIVE COATING

A ceramic type composition that produces elec-

(*Continued on page 78*)

THE INDUSTRY OFFERS . . .

(*Continued from page 77*)

trically conductive coatings for glass, plastics, porcelain, soapstone, wood, cloth and paper has been developed by the electrochemicals department of E. I. du Pont de Nemours & Company, Wilmington, Delaware.

These coatings which contain silver powder can be applied by spraying, dipping or brushing, followed by air drying and, in some cases, baking.

Several different formulations of the new material are being produced. A thermoplastic conductive cement is one form. Others include a conductive coated cloth and a flexible conductive film.

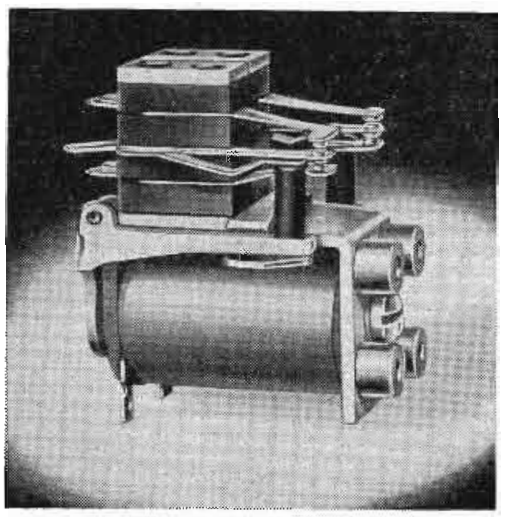
* * *

ALLIED TELEPHONE TYPE RELAY

A small telephone type relay, TKL, using mycalex and specifically designed for high frequency use is now being made by Allied Control Company, Inc., 2 East End Avenue, New York 21, N. Y.

The coil is cellulose acetate sealed. Contacts are of palladium. Fine silver or special alloy contacts are available on request. Double pile-ups of contacts can be supplied from a single *A* (spstno), *B* (spstnc) or *C* (spdt) arrangement to a maximum of four *C* combinations.

Weight and dimensions, less contact pile-ups, are 1½ ounces and 1 7/16" long x 15/16" wide x 1 1/16" high.



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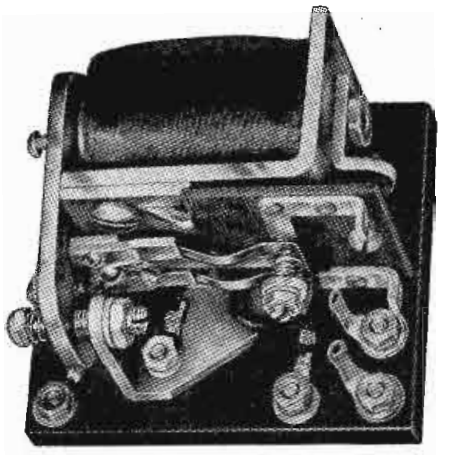
STRUTHERS-DUNN REDESIGNED SNAP-ACTION RELAY

The 79XAX sensitive, snap-action relay first introduced as an overload unit for protecting an electron microscope, has been redesigned to extend its applications by Struthers-Dunn, Inc., 1321 Arch Street, Pbiladelphia 7, Pennsylvania.

The relay is designed so that its armature practically completes its travel before the contacts snap with a positive action to the corresponding position. Applications now include overcurrent protection, particularly in the range of 1 to 100 milliamperes; overcurrent protection in connection with shunts furnishing potentials in the range of 1 to 100 millivolts; pulsing circuits, sensitive vacuum tube circuits, etc.

Normal sensitivity is 0.01 watt; contact rating 10 amperes. For 110 volt a-c, and 10 amperes, 24 volts, a-c. Coil resistance available from ¼ to approximately 30,000 ohms. Weigbt is 10 ounces; size 2¼" x 3" x 1¾"; spdt.



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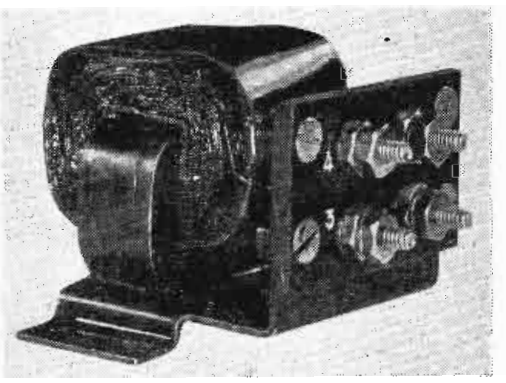
NYT AIRCRAFT TRANSFORMER

An 8-ounce transformer with a temperature rise of 30° C which is said to permit operation over all ambient temperatures from minus 60° C to plus 70° C and altitudes up to 50,000 feet has been developed by the New York Transformer Company.



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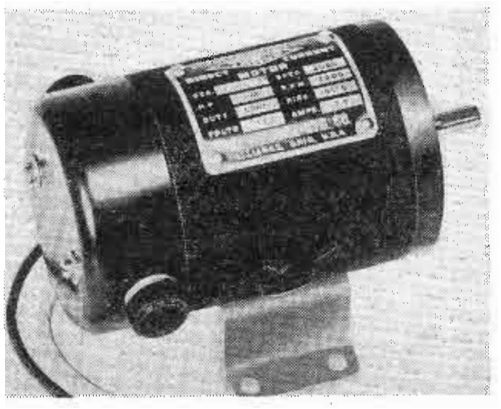
ALLIANCE AIRCRAFT DC MOTOR

A d-c series motor primarily designed for use

in airbourne equipment, operating continuous duty on a 13-volt d-c source at 7.4 amperes delivering 1/12 h-p at 7,500 rpm has been produced by the Alliance Mfg. Company, Lake Park Boulevard, Alliance, Ohio. It measures overall less the ¼" diameter shaft extension, 4 5/16" in length x 2¾" diameter. Weighs 3½ pounds. Said to have low temperature rise, permitting operation under high ambient temperature.



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AMBIENT COMPENSATED TIME DELAY SWITCH

An ambient compensated time delay switch, with contact capacity of 1,500 watts, 115/230 volts a-c is announced by George Ulanet Company, 88 East Kinney Street, Newark 5. New Jersey. Heater windings are wound for 6 to 230 volts. Heavy duty electrolytic silver contacts, available normally open or normally closed. Weighs ¾ ounces; overall dimensions 2¾" x ¾" x ⅝".

* * *

VAN EPS-DUOTONE CUTTING HEAD

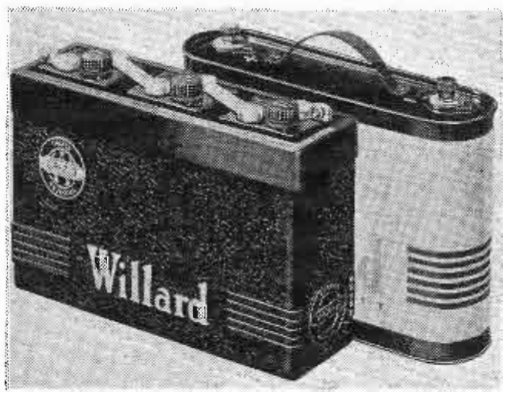
A cutting head with a reed armature has been announced by Duotone Company, 799 Broadway, New York 3, N. Y.

Its measured distortion is said to be 1.8% at 400 cps. The impedance of the cutter is 500 ohms at 400 cps. It is said to require plus 20 db level (6 milliwatts in 500 ohms) for normal amplitude. The head comes equipped with an extra mounting plate for instant mounting and is interchanged with other heads. Available in 15- and 500-ohm impedances and designed for 9/16" stylus.

* * *

WILLARD CHARGE-RETAINING BATTERY

A 6-volt charge-retaining storage battery designed to replace 6-volt dry batteries in applications requiring low current drain at sustained



voltage over long periods of time, is now being offered by the Willard Storage Battery Company, Cleveland, Ohio.

It is said that this new charge-retaining battery CR-2-3, will deliver service equivalent to the life of a 6-volt dry battery on just one charge.

* * *

DUO-DIRECTIONAL SOUND REPRODUCER

A duo-directional reproducer with an 8" p-m speaker is now available from Executone, Inc., 415 Lexington Ave., New York.

An opening at front and back provides the duo-directional transmission.

Baffle is equipped with a mounting for transformer which matches the impedance of the reproducer unit to the wiring line and amplifier. Has two suspension rings fastened on top for hanging. Unit is 17" wide x 10½" deep x 23" high.

FILE IN YOUR NOTEBOOK

TECHNICAL NOTES

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

The Iconoscope

Regardless of whether or not television is being employed in the present war, it undoubtedly will be one of the most important post-war enterprises. CREI has been fully aware of this and has prepared a specialized course on the subject. We borrow from this course, our material for the technical article appearing in the May issue of the CREI NEWS.

The subject is The Iconoscope, and Part I, presented in the May issue of the CREI NEWS deals with the general aspects of photoelectric and secondary emission phenomena as a preparation for Parts II and III, in which the action of the iconoscope itself will be analyzed.

The approach is mainly from the physical viewpoint, since to the average engineer, a good qualitative understanding of the action of the iconoscope will stand him in better stead than a theoretical mathematical presentation, which is not of much use practically because of the difficulty in measuring the various quantities involved.

THE CREI NEWS is offered free for the asking to anybody sufficiently interested to write us for it. ***Write today for the May issue, and the article, "The Iconoscope."*** *You incur no obligation in requesting to be put on our mailing list.*

★ ★ ★

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

PUNCH IN HOLES INDICATED

CAPITOL RADIO ENGINEERING INSTITUTE

E. H. RIETZKE, President

Home Study Courses in Practical Radio-Electronics Engineering for Professional Self-Improvement

Dept. CO-4, 3224—16th St., N. W.
WASHINGTON 10, D. C.

Contractors to the U. S. Navy—U. S. Coast Guard — Canadian Broadcasting Corp. — Producers of Well-trained Technical Radiomen for Industry.

THE Q-LAP

(*Continued from page 42*)

flow down to filter tank inside base.

The Q Lap for Angle Correction

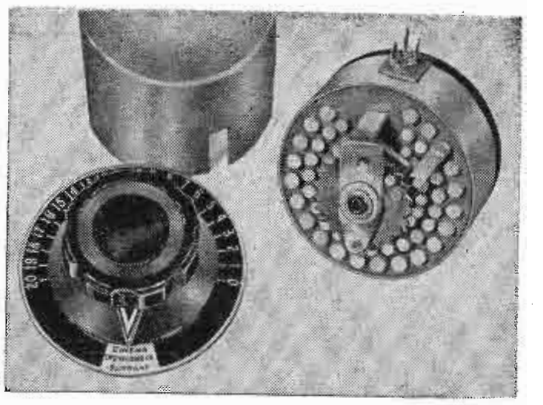
Although the cutting technique of quartz has been considerably improved, off-angle crystals are found in runs, particularly with first cuts. To eliminate this deficiency, an angle correction unit was developed for the *Q-lap*.

Ten or fifteen seconds are required to correct two blanks simultaneously. The principle is the same as that described before, except that the rocker arm is provided with a special head, and the crystal holder does not rotate.

In Figure 7 appears this correction device. The shaft is provided with the normal suction head, and on the end of this shaft there are two adjustable screws, *2*, which lock the shaft with respect to the bearing screws, *3*. On support *4*, is mounted a dial gauge reading in .001 minutes. The relation between bearing screw *3* and pointer of dial gauge is such that when the hand of the dial gauge is on zero, the suction head is perfectly aligned with the diamond wheel. The readings are directly in minutes.

Once the angle has been determined on the x-ray machine, the blank is marked, the dial gauge is adjusted, and the crystals can be ground to a predetermined thickness. The angle setting at the moment Figure 7 was taken was 58 minutes.

In Figures 8, 9 and 10 appear photomicrographs of crystals lapped on the *Q-lap* and drill-press lap. The finish of a rough-lapped *Q-lap* crystal blank where the diamond wheel has been used is shown in Figure 8. A finished *Q-lap* crystal lapped with 303½ abrasive mixture appears in Figure 9. And in Figure 10 appears the surface of a rough lapped blank using 180 carborundum abrasive mixture, taken from a drill-press lap.



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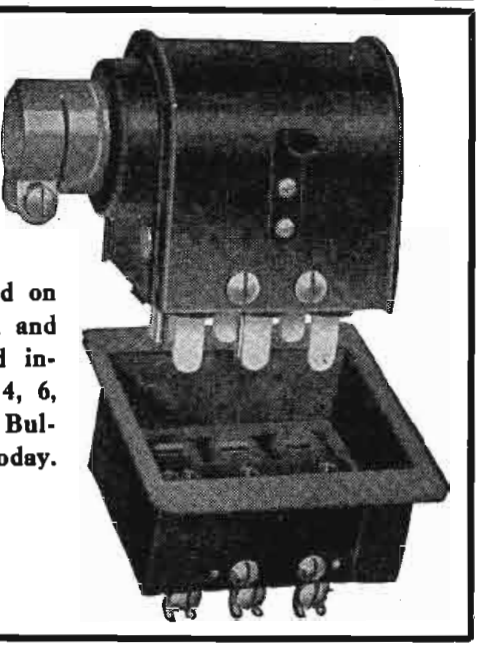


HOWARD B. JONES
2460 W. GEORGE STREET
CHICAGO 18, ILL.

TELEVISION PICKUPS

(*Continued from page 38*)

lution, the object being to obtain optimum picture resolution for a given frequency band. It was pointed out that, as long as the horizontal plus vertical resolution was fixed, it was not necessary that they be equal; that this held over fairly wide limits. It was formerly thought that the two should be equal for optimum performance.

In discussing scanning systems, Mr. Shelby pointed out that 525 lines at 30 frames per second equals 15,750 lines per second. Thus if we had a picture one foot wide, the cathode-ray beam would be traveling at the rate of 15,750 feet per second, which is equal to 3 miles per second.

An analysis of picture-time factors was also presented by Mr. Shelby. In this analysis, Mr. Shelby showed that approximately 7½% of vertical time is lost in returning the spot from right to left for the next line, and similarly, 17% is lost in horizontal time. Thus approximately 76% of the time is available for the picture. The *lost* time is lost only to the picture, but is not wasted for synchronizing, explained Mr. Shelby, as equalizing data is transmitted in these intervals. The synchronizing signal occurs off the screen at the right and is therefore not seen. It is not possible to superimpose some sort of separate sine wave on the carrier for synchronizing, he said, because of the full frequency range demanded by the picture transmission, 30 cycles to 4.5 mc. In scanning at the pickup device and at the reproducer, it is necessary to synchronize the 15,750-cycle line frequency and the 60-cycle field frequency. The tie-in between various power stations and networks provides sufficient synchronization, Mr. Shelby pointed out.

To isolate the synchronizing pulses from the picture they are given a value which corresponds to blacker than black, said Mr. Shelby. Figure 8 shows the FCC standard waveform with two fields, *A* and *B*. The pulses in field *B* are offset 1/60 second from those in *A*, which causes interlacing to take place automatically. The picture is shown occupying a bias level of maximum white to black whereas the control pulses are above the black or blacker than black.

Mr. Shelby next described various television pickup devices and cameras beginning with the Iconoscope. The heart of this tube is a photosensitive mosaic consisting of hundreds of thou-

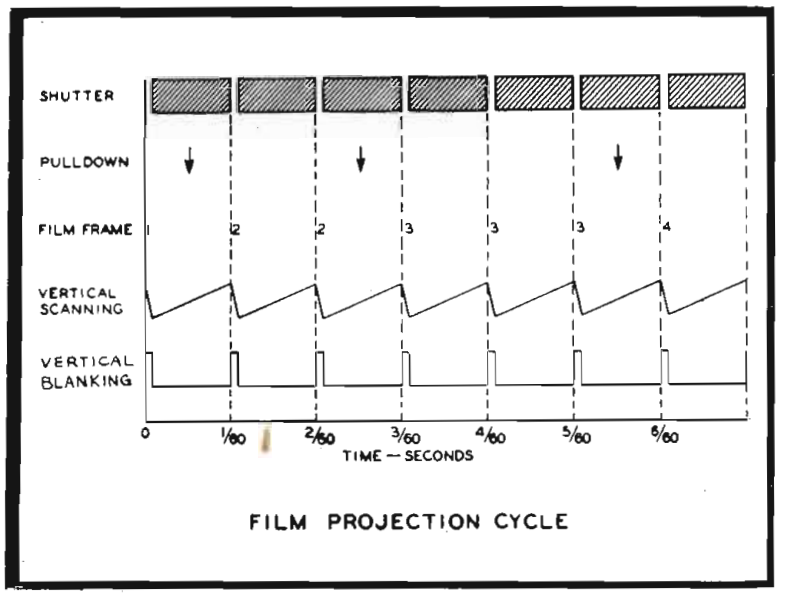


Figure 13
Method of transmitting standard motion picture film with the Iconoscope, based upon the tube's storage property. With this method 30 television frames match the 24 frames of motion pictures.

sands of individual silver globules, separated from a common back plate, or signal plate, by a very thin mica sheet so as to form individual, isolated capacitors, explained Mr. Shelby. These are scanned electronically by an electron beam coming from an electron gun at an angle of 30° from the normal to the mosaic. This angular arrangement is unavoidable because the gun must not interfere with the optical pickup, he said. The scanning is accomplished by magnetic deflecting coils, and the beam, in striking the elements, strikes off a number of secondary electrons which increases the sensitivity, but gives some spurious signals. The potential of the elements varies from +2 or 3 volts to —1.5 volts, he explained, the latter value occurring just ahead of the scanning beam. Being capacitors, the elements can store energy during the scanning cycle, which accounts for the high sensitivity of the Iconoscope, pointed out Mr. Shelby.

A mock-up camera with two lens systems, one for the Iconoscope and the other for viewing and focusing, was also shown (Figure 9). The camera has push-button controls and requires only 250 foot-candles at f4.5 for average subjects and a good depth of focus, said Mr. Shelby. Due to the 30° angle of the gun, the top of the mosaic is further away from the deflecting coils than the bottom. This would produce angular distortion of the picture if not corrected. The correction is made by modulating the horizontal signal with a small part of the vertical signal, he said.

Mr. Shelby also discussed Farnsworth's image dissector tube which has the advantage of freedom from secondary emission with the consequent spurious signals, but does not provide for the storage of energy during scanning. It therefore has a low sensitivity, he said, but is excellent for reproducing motion pictures.

The image Iconoscope with an electronic lens system and a photoelectric cathode was described briefly. This tube (Figure 10) is much more sensitive than the original design, said Mr. Shelby, since secondary emission is more effective than photo emission in charging the minute condensers. This

(*Continued on page* 84)

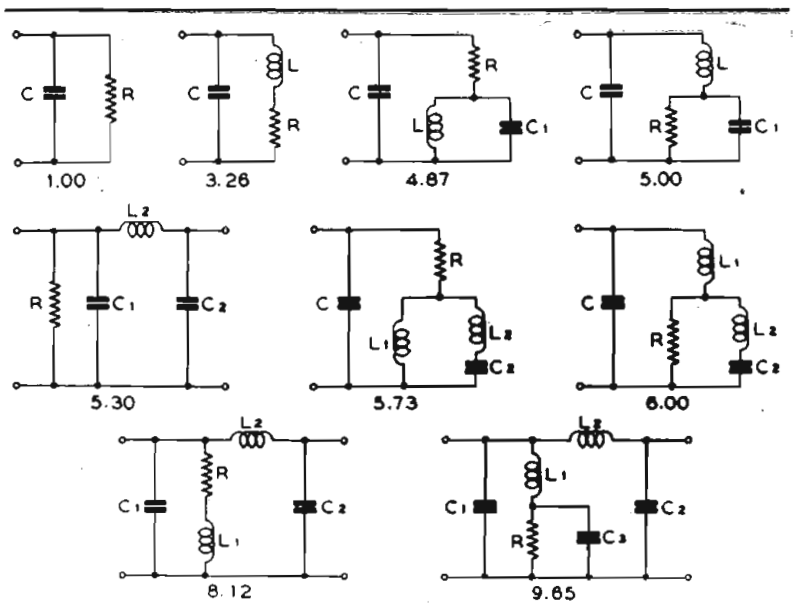


Figure 14
Filter and equalizer circuits used to obtain wide-band response.

TELEVISION PICKUPS

(*Continued from page 82*)

tube also allows short focal length lenses.

Another variety of pickup tube with very high sensitivity obtained without a high velocity beam, the Orthicon, was also discussed. This tube (Figure 11) uses magnetic deflection for the vertical, electrostatic deflection for horizontal, and a beam perpendicular to the mosaic. It may be operated as low as 10 foot-candles but does not have as high resolution as other types, though adequate for many purposes, explained Mr. Shelby. Another disadvantage mentioned is the complete blocking, caused by an excessive charge such as that caused by a photoflash lamp in the vicinity.

The Monoscope

The last tube described was the Monoscope (Figure 12), the fixed picture type used for testing and station identification. This tube has a pattern etched or printed on the mosaic and depends upon secondary emission for its performance. All television tubes and optics have one-quarter wavelength fluoride coatings to reduce reflection and increase light transmission which reduces the required light level, explained Mr. Shelby.

Matching Frames

An ingenious method of transmitting standard motion picture film with the Iconoscope, based upon the storage property in which the charge remains until neutralized, was described by Mr. Shelby. A sawtooth-controlling waveform is used with the shutter open only 7% of the time, the shutter being closed 93% of the time. The shutter opens 60 times per second, he said, but the frames remain for either 2 or 3 openings in alternate series: 2, 3, 2, 3, 2 . . . film projection cycle. This scheme matches the 24 motion picture frames to the 30 television frames (Figure 13.)

Radio City Studio

In the concluding portion of his paper, Mr. Shelby discussed the Radio City studio which contains 68 kw of light in ceiling and wall fixtures, although not all of it is used simultaneously. Mention was also made of the studio and transmitter amplifiers which are required to raise the microwatt level of the pickup tube to the kilowatt level of the transmitter while passing the video band without amplitude or phase distortion. This is a power gain of 10^{12}. A simple amplifier contains 20 stages, he said. There are 1,300 tubes used in the two studios, which equals that of 29 sound studios, Mr. Shelby said. In Figure 14 appears some of the filter and equalizer circuits used to obtain wide-band response, with figures of merit compared to a standard RC coupled amplifier.

THE DB AND VU

(*Continued from page* 60)

ments of lines, cables, amplifiers, radio systems, public address work, etc. This would require a distortionless unit which would be wholly dependent upon the ratio of the power sent into the input of a circuit and the power received at any portion of it, and would be independent of frequency. The need for such a unit was met by the suggestion that a new unit, to be temporarily called a *TU,* be adopted. This term was an abbreviation for the words *Transmission Unit.* The magnitude of the unit was so chosen as to give approximately the same amount of loss that was given by the standard mile of cable at 800 cycles. The actual frequency which would be required to produce the same loss as the new unit was 886 cycles, or expressed differently, the loss of the standard mile at 800 cycles was about five per cent higher than one of the new units. The power ratio of the new unit was defined by the statement that two amounts of power differ by one transmission unit when they are in the ratio of $10^{0.1}$, and any two amounts of power differ by N transmission units when they are in the ratio of $10^{0.1N}$. This may be written as

$$\frac{P_s}{P_R} = 10^{-0.1N} = \frac{E_s^2/Z_s}{E_r^2/Z_R} = \frac{E_s I_s}{E_r I_R} = \frac{I_s^2 Z_s}{I_r^2 Z_R} \qquad (10)$$

For the special case of equal terminating impedances, these become

$$\frac{P_s}{P_r} = 10^{0.1N} = \frac{E_s^2}{E_r} = \frac{E_s}{E_r}\frac{I_s}{I_r} = \frac{I_s^2}{I_r} \qquad (11)$$

By the use of common logarithms on each side of the equations, the number of transmission units may be written

$$N = 10 \log_{10} \frac{P_s}{P_r} = 20 \log_{10} \frac{E_s}{E_r}$$

$$= 10 \log_{10} \frac{E_s I_s}{E_R I_r} = 20 \log_{10} \frac{I_s}{I_r} \text{ db} \qquad (12)$$

In the Naperian or natural logarithm form, a standard unit was one which gave

$$\frac{P_s}{P_r} = e^2 \qquad (13)$$

while n units gave

$$\frac{P_s}{P_r} = e^{2n} \qquad (14)$$

Using logs to the base e,

(*Continued on page* 86)

(*Continued from page* 85)

$$n = \tfrac{1}{2} \log \frac{P_s}{P_r} \text{ nepers} \qquad (15)$$

The three units of the standard mile, the transmission unit and the neper, were in general use and something had to be done to relieve the confusion resulting from their mixed usage. Accordingly, in 1924 an International Advisory Committee on Long Distance Telephony in Europe was organized. Representatives from the various European telephone administrations composed the committee, and representatives from the United States were invited to attend some of their meetings. The suggestion was made that the fundamental unit on the decimal basis be defined to be equal to that of ten transmission units. This would make the basic power ratio 10^1. Two units were suggested for use in the final deliberations, one based upon a power ratio of 10^1 and the other on a power ratio of e^2. Provision was made for the use of decimal submultiples of either unit by customary prefix designations. It was further suggested that the naperian unit be called the *neper,* in honor of Napier, the inventor of natural logarithms, and that the fundamental decimal unit be called the *bel,* in honor of Alexander Graham Bell, the inventor of the telephone.

In addition to the organized efforts of the above mentioned committee, lively and interesting discussions of the advantages and disadvantages of the three units then in use were carried on through the medium of several of the leading technical journals devoted to the communication art.

The committee's work and the discussions in the journals resulted in the adoption of the decibel by the Bell System, England and Belgium. The remainder of continental Europe adopted the neper. The decibel is based on a power ratio of $10^{0.1}$ and is a tenth-part of the bel, while the neper is based on a power ratio of e^2. The standard mile of cable, or the 800-cycle mile, was completely abandoned as a transmission reference upon the adoption of the decibel.

With the adoption of the decibel by the telephone companies, it was inevitable that this unit should come into use in the fields of public address, phonograph recording, general radio service work, radio broadcasting, program network distribution on local loops in urban areas, and later in the field of motion picture sound recording and technique, and in national program networks.

Since the decibel is simply a numeric which is the logarithm of a power

ratio, or in the case of equal terminating impedances, of either a voltage or current ratio, it became a matter of great importance to decide upon what power should be used for a reference. To complicate and confuse the issue, several different values of terminating impedances were gradually injected into the picture. Some of these *standard* impedances were 50, 100, 250, 500, 600 and 1,000 ohms. Therefore, it would not apparently matter too much what value of power was selected as the reference from which to measure in terms of decibels, as long as the power selected was consistent with the actual power required for that system. As a result, a number of different reference powers came into existence for various purposes. Some of these were chosen with respect to a definite need and others were purely arbitrary values. Some of these references were chosen at 1, 6, 10, 12.5, or 50 milliwatts in 500 or 600 ohms. Measurements made at other impedances required correction factors to be used to interpret the readings obtained. It is not surprising therefore that a rather chaotic condition should have existed whenever engineers of various organizations attempted to correlate and interpret the readings of the db indicators, especially when the indicators used at reading points were widely different in their dynamic characteristics. As long as cooperation and correlation of readings were not necessary, the exact reference power and the impedance used caused no difficulty, for all readings were on the same relative basis. Perhaps one of the most fundamental stumbling blocks in the way of proper interpretation of readings between cooperative groups using different reference powers and impedances was the type of indicator used for each specific application.

Necessarily, the adoption of the decibel as the transmission unit required that some particular type of instrument be decided upon for indication of the true power level above or below the reference point. Accordingly different instruments for the express purpose of indicating their usage in the measurement of power outputs and decibels above or below reference were developed. These were identified as the db meter, volume indicator, power level indicator, decibel meter, volume level indicator, etc. Variations included level indicator, V.I. and power output meter, and others.

The type of scale that is used with each type of indicator meter largely

(*Continued on page* 91)

CONDENSER CHARGING

Continued from page 52)

the open end, as illustrated in Figure 5. The power dissipation rate there is $(I_x)^2 R dx$. The total energy dissipated at that point is

$$W = \int_0^\infty (I_x)^2 R dx\, dt$$

The total energy dissipated in I^2R loss in the entire line is

$$\int_0^L \int_0^\infty (I_x)^2 R\, dx\, dt$$

To square *1* would be an elaborate task. However, this is not necessary. Integrating with respect to t does not alter the manner in which the functions of x appear in the equations. When the integration with respect to x is performed, since the functions of x are orthogonal between the limits of integration, all the cross-product terms will each reduce to zero. Therefore, it is necessary to retain only the squared terms in the series, and no cross-products, even when performing the first integration, with respect to t.

Accordingly,

$$W = R \int_0^L \int_0^\infty (I_x)^2\, dt\, dx$$

$$= \frac{4E^2R}{R^2L^2} \int_0^L \int_0^\infty \sum_{n=1}^{\infty} \left[\sin^2 (2n-1) \frac{\pi x}{2L} \right] e^{-(2n-1)^2\pi^2/4L^2\ 2t/RC}\, dt\, dx$$

Again we may integrate term by term; the proof of the validity of the step will be omitted. Integrating with respect to *t yields*

$$W = \frac{4E^2}{RL^2} \int_0^L \left\{ \sum_{n=1}^{\infty} \sin^2 \left\{ \frac{(2n-1)\pi x}{2L} \right\} \frac{2L^2RC}{(2n-1)^2\pi^2} \right\} dx$$

$$= \frac{8E^2C}{\pi^2} \int_0^L \left\{ \sum_{n=1}^{\infty} \frac{\sin^2 (2n-1)\pi x/2L}{(2n-1)^2} \right\} dx$$

If this last expression is integrated term by term (again, a valid process) the final result is obtained.

$$W = \frac{8E^2C}{\pi^2} \sum_{n=1}^{\infty} \left\{ \frac{1}{(2n-1)^2} \int_0^L \sin^2 \left[\frac{(2n-1)\pi x}{2L} \right] dx \right\}$$

$$= \frac{8\,E^2\,C}{\pi^2} \sum_{n=1}^{3} \frac{1}{(2n-1)^2} \frac{L}{2}$$

$$= \frac{4\,E^2\,CL}{\pi^2} \sum_{n=1}^{\infty} \frac{1}{(2n-1)^2}$$

As mentioned previously, this final series sums to $\frac{\pi^2}{8}$. Accordingly, the final expression for energy dissipated in the resistance is

$$W = \frac{4\,E^2\,CL}{\pi^2} \cdot \frac{\pi^2}{8} = \frac{E^2\,CL}{2}$$

Thus, it is seen that the complicated analysis of the open-circuited *RC* cable yields the result anticipated; i.e., an amount of energy, equal to that finally stored in the capacitance of the cable, is dissipated during the charging process.

General Theory Application to Non-Linear System

A full appreciation of the general theory is best acquired if it is used in a non-linear circuit problem. According to the general theory, no matter how the resistance in an *RC* circuit may vary with current, as long as it always remains finite, and not zero or negative, the total I^2R loss will be equal to the final energy on the condenser, when the condenser is charged from a source of constant emf. If the above were not appreciated, many complications would ensue in an attempt to solve a relatively simple non-linear problem.

Let a condenser be charged in series with a resistance whose value varies linearly with current; i.e., $R = R_o + \alpha I$

$$\text{Then } E = (R_o + \alpha I)\, I + \frac{1}{C} \int_o^T I\, dt$$

$$= R_o I + \alpha I^2 + \frac{1}{C} \int_o^T I\, dt$$

or in a more convenient form,

$$R_o \frac{dI}{dt} + 2\alpha I \frac{dI}{dt} + \frac{I}{C} \doteq 0$$

This readily integrates into (*2*)

$$C\,R_o \ln I + 2\,\alpha\,C\,I = -t + \text{constant}$$

To evaluate the constant, use the boundary condition that at $t = 0$, $E = I\,[R_o + \alpha I]$

(*Continued on page* 90)

CONDENSER CHARGING

(Continued from page 89)

This yields, at $t = 0$,

$$I = -\frac{R_o}{2\alpha} \pm \frac{\sqrt{R_o^2 + 4\alpha E}}{2\alpha}$$

Only the + value may be used, to yield a positive current at $t = 0$.

Putting this value of i into *2*, and setting $t = 0$, would yield the constant of integration. However, at this point it would be impossible to progress further with simple functions. The current could not be expressed simply as an explicit function of time, and an integration could not be performed to determine the exact way the charge varies with time. Also squaring the current and integrating that with respect to time, between the limits zero and infinity, is a hopeless task.

Thus, a straightforward attack on the problem would yield no exact result. Numerical integration of *2*, after the current had been plotted following tedious computations, would give an approximate result. From the curve of current versus time, a graph of I^2R versus time could be made, and the total heat energy expended thus determined.

However, all this is unnecessary in light of the general theorem. The energy expended in the resistance has to be equal to $(\frac{1}{2})E^2C$.

Two Condensers Sharing a Charge

Let condenser C_1, Figure 7, have an initial charge Q, and let C_2 be unchanged initially. Closing the switch through resistance R yields a current governed by

$$R\,I + \frac{I}{C_1}\int_0^T \pm\, dt + \frac{I}{C_2}\int_0^T I\, dt = 0 \quad \text{and}$$

$$I\,\frac{Q}{R\,C_1}\,e^{-t[C_1+C_2]/R\,C_1C_2} \qquad (3)$$

Going through an analysis as before will yield the familiar result that the final charge on C_1 is given by

$$Q_1 = \frac{QC_1}{C_1 + C_2}, \quad \text{and} \quad Q_2 = \frac{QC_2}{C_1 + C_2}$$

The final energy in the system

$$= \tfrac{1}{2}\frac{Q_1^2}{C_1} + \tfrac{1}{2}\frac{Q_2^2}{C_2}$$

$$= \tfrac{1}{2}\left[\frac{Q^2C_1}{(C_1 + C_2)^2} + \frac{Q^2C_2}{(C_1 + C_2)^2}\right]$$

$$= \tfrac{1}{2}\frac{Q^2}{C_1 + C_2}$$

Which is to be expected, since the original charge has been conserved in the sharing process, but the capacitance of the system has been increased, by putting the two condensers in parallel. Thus, an amount of energy equal to

$$\tfrac{1}{2}\left[\frac{Q^2}{C_1} - \frac{Q^2}{C_1 + C_2}\right] = \tfrac{1}{2}\,\frac{Q^2\,C_2}{C_1[C_1 + C_2]}$$

has somehow been wasted.

A simple integration of I^2R, as given by *3*, will show that this energy, $\frac{1}{2}\,\frac{Q^2\,C_2}{C_1[C_1 + C_2]}$ is consumed in I^2R loss.

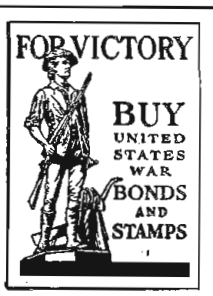
Thus, when two insulated objects share a charge, only a fraction of the energy, in general, is expended in a spark.

In conclusion, it must be emphasized that all these analyses apply only to cases where a constant source of emf is used to charge the condenser. It is this invariance with time that permitted the derivation of equation (b) from (a), during the discussion of Figure 1, and thus yielded the general theorem, proved for several specific cases in this paper. If the voltage source varies in magnitude with time, such a simple equivalence of stored and dissipated energy, in general, does not exist.

THE DB AND VU

(*Continued from page 87*)

depends upon the manner of its usage with other components. Some volume indicators of the early type used a specially marked scale which had no direct relationship to the number of db involved, but were calibrated on an arbitrary basis. With the adoption of the db as a measuring unit, these meters were marked with additional markings above and below midscale to indicate the number of db above or below this arbitrary scale reading. The input circuit of the meter connections was adjusted so that mid-scale was obtained with 6 milliwatts of power into 600 ohms. Following these early models, other types of scales marked in per cent modulation and different ranges of db were provided for the various specialized branches of the communication art.



NEWS BRIEFS

(*Continued from page 75*)

UNIVERSAL MICROPHONE PROMOTES RAMSEY

Robert Ramsey has been promoted to the post of field expediter of the Universal Microphone Company, Inglewood, California.

* * *

HYDRAULIC PRESSURE PROCESSING FOLDER

A 4-page folder on hydraulic pressure processing has been issued by the Hydraulic Press Manufacturing Company, Mount Gilead, Ohio. The folder contains a description of the press used in sheet metal forming and drawing, coining, die casting, powder metallurgy, and other high pressure operations.

* * *

GANTT NOW I. T. & T. VICE PRESIDENT

Robert A. Gantt, formerly vice president in charge of communications of the U. S. Commercial Corporation, has been appointed a vice president of International Telephone and Telegraph Corporation.

* * *

HALLICRAFTERS SALUTE TO THE SIGNAL CORPS BULLETIN

A 48-page bulletin, *Salute to the Signal Corps, United States Army,* is being distributed by The Hallicrafters Company, Chicago 16, Illinois. The bulletin contains reprints of advertisements of Hallicrafters and other manufacturers who contributed to the production of Army SCR communications units.

STIEFEL PROMOTED BY WESTINGHOUSE

Ira B. Stiefel has been appointed assistant to the vice president in charge of industrial relations at Westinghouse, in East Pittsburgh. Mr. Stiefel has been with Westinghouse since 1912, and was formerly manager of industrial relations.

* * *

STEATITE TALC RESTRICTIONS RELAXED

Inventory restrictions on steatite talc have been relaxed because of the better supply-demand position. In effecting these changes, WPB amended Conservation Order M-239.

The amended order provides that all consumers of steatite talc for products and processes in List A of the order may maintain a 12-month supply, as heretofore, and for other products and processes, a six-month supply. Formerly, those in the second category were allowed only a two- or three-month supply.

Dealers or distributors of steatite talc are limited to a three-month supply based upon average monthly sales during the first nine months of 1942.

Consumers who have customarily bought in carload lots will be permitted to continue this practice provided inventories do not exceed 60 tons.

* * *

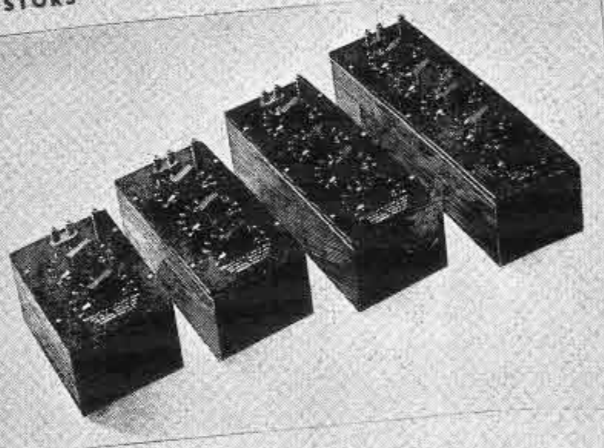
W. L. FLAT RESISTOR CATALOG

A catalog, describing strip type resistors, has been issued by Ward Leonard Electric Co., 75 South St., Mount Vernon, N. Y.

ADVERTISERS IN THIS ISSUE*

COMMUNICATIONS—APRIL, 1944

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



TYPE 602 DECADE-RESISTANCE BOX

USES. Accurate resistance boxes are extremely valuable wherever electrical measurements are made. Such boxes are constantly used in circuits where a wide range of resistance values is required or where variable dummy generator and load resistances are needed. The accuracy of TYPE 602 Decade-Resistance Boxes also permits them to be used as laboratory standards and as ratio arms for direct- and alternating-current bridges.

Although designed primarily for direct-current and audio-frequency work, they are useful well into the radio-frequency range for many applications.

DESCRIPTION. The TYPE 602 Decade-Resistance Box is an assembly of two or more TYPE 510 Decade-Resistance Units in a single cabinet. Mechanical and electrical protection of the units is provided by the shielded walnut cabinet and aluminum panel, which completely enclose both the resistance units and switch contacts. The resistance elements have no electrical connection to the shield, which is brought out to a separate terminal connected to the panel.

Two-, three-, four-, and five-dial decade assemblies are available. Each decade has eleven contact studs and ten resistance units, so that the dials overlap. A positive detent mechanism assists in setting squarely on the contacts and so permits adjustments to be made without looking at the dials.

FEATURES. By careful mechanical design the zero resistance of the TYPE 602 Decade-Resistance Boxes has been kept below 0.003 ohm per decade. In applications where a minimum zero resistance is desired, this feature is very valuable. On the other hand, there are many types of measurement, such as substitution measurements, in which the difference between two settings of a resistance box is the significant value. This difference is given correctly only when the individual resistors have been adjusted independently of switch and wiring resistance. Accordingly, the resistance units in the TYPE 602 Decade-Resistance Boxes are adjusted to have their specified values at their own terminals, rather than at the terminals of the box.

All resistors except the 10,000-ohm cards are wound with manganin wire; consequently no difficulty due to thermal emf is encountered in direct-current measurements, except when using the high-resistance decades of the TYPES 602-M and 602-L. With these decades, some attention should be given to temperature differences, if maximum accuracy is desired.

At radio frequencies, the residual inductances

and capacitances cause the effective series resistance at the terminals to depart from the low-frequency value.* In addition, the reactance component, which is negligible at audio frequencies, may become significant. The 100-, 10-, and 1-ohm-per-step decades of the TYPE 602 Decade-Resistance Boxes are the most satisfactory for use at high frequencies. In no case, however, is the frequency error serious below 50 kc. The magnitudes of the residual impedances are given in the specifications below.

The maximum allowable current for each decade, based on a 40° Centigrade temperature rise, is engraved just above each decade switch knob.

*See "Radio Frequency Characteristics of Decade Resistors," General Radio Experimenter, Vol. XV, No. 8.

SPECIFICATIONS

Frequency Characteristics.* A TYPE 602 Decade-Resistance Box can be represented quite closely by the equivalent circuit below, which represents one decade of a box, with the remaining decades set to zero. R_0 and L_0 are the zero resistance and inductance of the box, due to the wiring and switches. These values are proportional to the number of decades in the box. ΔL is the inductance associated with each increment of resistance, ΔR. The effective capacitance C depends, in general, upon the dial setting, the variation being approximately linear with setting (the higher value is for the lowest setting). The values of the constants are tabulated below:

L_0 = 0.10 μh per dial
R_0 (d-c) = .002 to .003 ohm per dial; proportional to the
R_0 (1 Mc) = 0.04 ohm per dial; square root of frequency at all frequencies above 100 kc.

Type of Decade	1-Ohm Step	10-Ohm Step	100-Ohm Step	1000-Ohm Step	10,000-Ohm Step
ΔR in ohms	0.1	1.0	10	100	1000	10,000
ΔL (μh)	.014	.05	0.11	0.29	3.3	9.5
C (μμf)	—	27	26-23	21-13	—	—

Zero Resistance. The direct-current zero resistance of the various boxes depends on the number of dials, as follows:

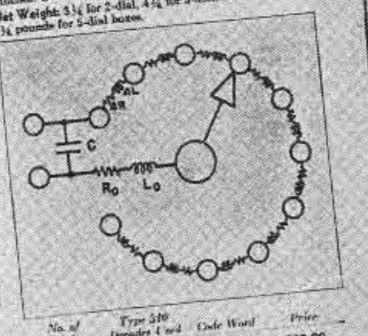
No. of Dials	Zero Resistance
2	0.004–0.006 ohm
3	0.006–0.009 ohm
4	0.008–0.012 ohm
5	0.010–0.015 ohm

Temperature Coefficient. Less than ±0.002% per degree Centigrade at room temperatures, except for the 0.1Ω decade, where the box wiring will affect the over-all temperature coefficient.

*See "Radio Frequency Characteristics of Decade Resistors," General Radio Experimenter, Vol. XV, No. 6.

[The value of the capacitance shunting a single decade in a box depends upon the location of the decade in the box, as well as on the resistance of the decade. The values given here are for a TYPE 602-G and may be taken as representative.

If several decades of a box are in circuit at the same time, the incremental inductances of the several decades may be added directly, and the capacitance may be taken to be approximately that of the highest decade in use.



Type	Resistance		No. of Dials	Type 510 Decades Used	Code Word	Price
602-D	11 ohms, total, in steps of	0.1 ohm	2	A, B	DIGIT	$25.00
602-E	110 ohms, total, in steps of	1 ohm	2	B, C	DECAY	35.00
602-F	111 ohms, total, in steps of	0.1 ohm	3	A, B, C	DELTA	35.00
602-G	1110 ohms, total, in steps of	1 ohm	3	B, C, D	DIGIT	45.00
602-K	1111 ohms, total, in steps of	0.1 ohm	4	A, B, C, D	DEPTH	50.00
602-J	11,110 ohms, total, in steps of	1 ohm	4	B, C, D, E	DEBIT	60.00
602-N	11,111 ohms, total, in steps of	0.1 ohm	5	A, B, C, D, E	DEMON	70.00
602-M	111,110 ohms, total, in steps of	1 ohm	5	B, C, D, E, F	DIGIT	80.00
602-L	111,100 ohms, total, in steps of	10 ohms	4	C, D, E, F	DECAY	

Type of Winding. See specifications for TYPE 510 Decade-Resistance Units, page 24.

Accuracy of Adjustment. All cards are adjusted within 0.1% of the stated value between card terminals, except the 1-ohm cards which are adjusted within 0.2%, and the 0.1-ohm units which are adjusted within 1%.

Maximum Current. See specifications for TYPE 510 Decade-Resistance Units, page 24. Values for 40° Centigrade rise are engraved on panels directly above switch knobs.

Switches. Quadruplo-leaf, phosphor-bronze switches bear on contact studs ¾ inch in diameter. Switch brushes are bent so as not to be tangent to the arc of travel, thus avoiding cutting. A cam-type detent is provided. There are eleven contact points (0 to 10 inclusive).

Terminals. Jack-top binding posts set on General Radio standard ½-inch spacing for resistance connections. There is an extra post at the corner of the panel for connections to the shield.

Mounting. A copper-lined walnut cabinet, with aluminum panel, completely encloses switches and resistance units. The panel finish is black crackle lacquer.

Dimensions. Panel length depends on the number of dials (see price list), being 7¾ for 2-dial, 10¼ for 3-dial, 13 for 4-dial, and 15¾ inches for 5-dial boxes. Panel width, 5 inches. Over-all height, 5 inches.

Net Weight. 3¼ for 2-dial, 4¼ for 3-dial, 5 for 4-dial, and 6¼ pounds for 5-dial boxes.

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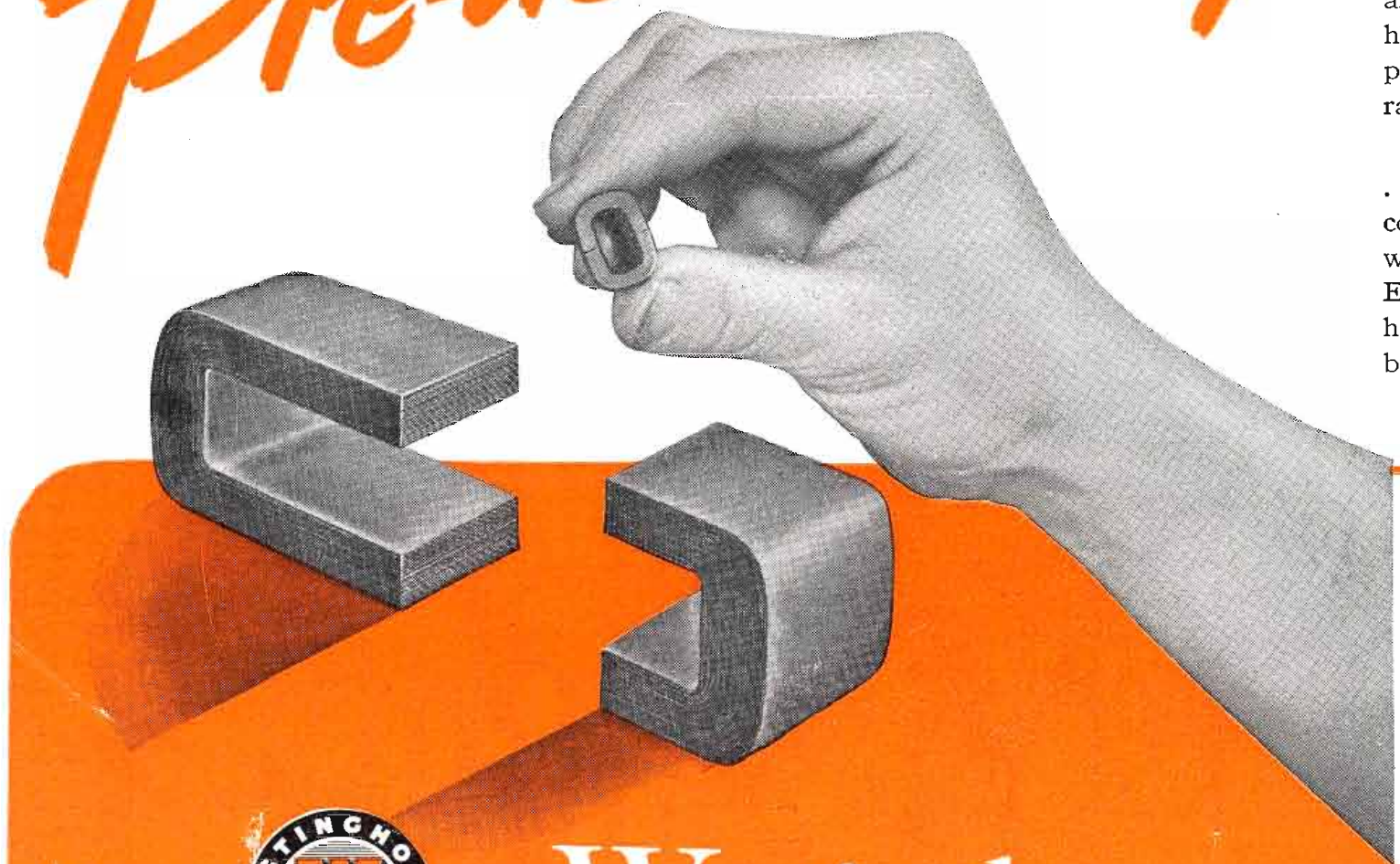

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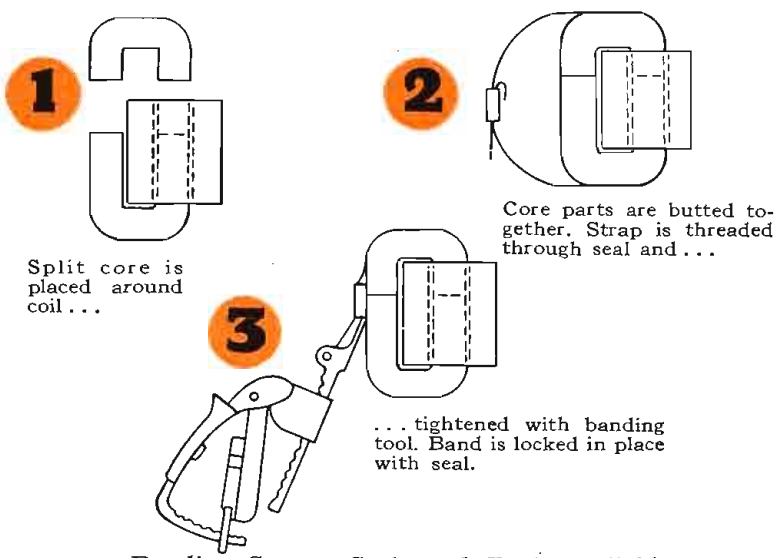

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