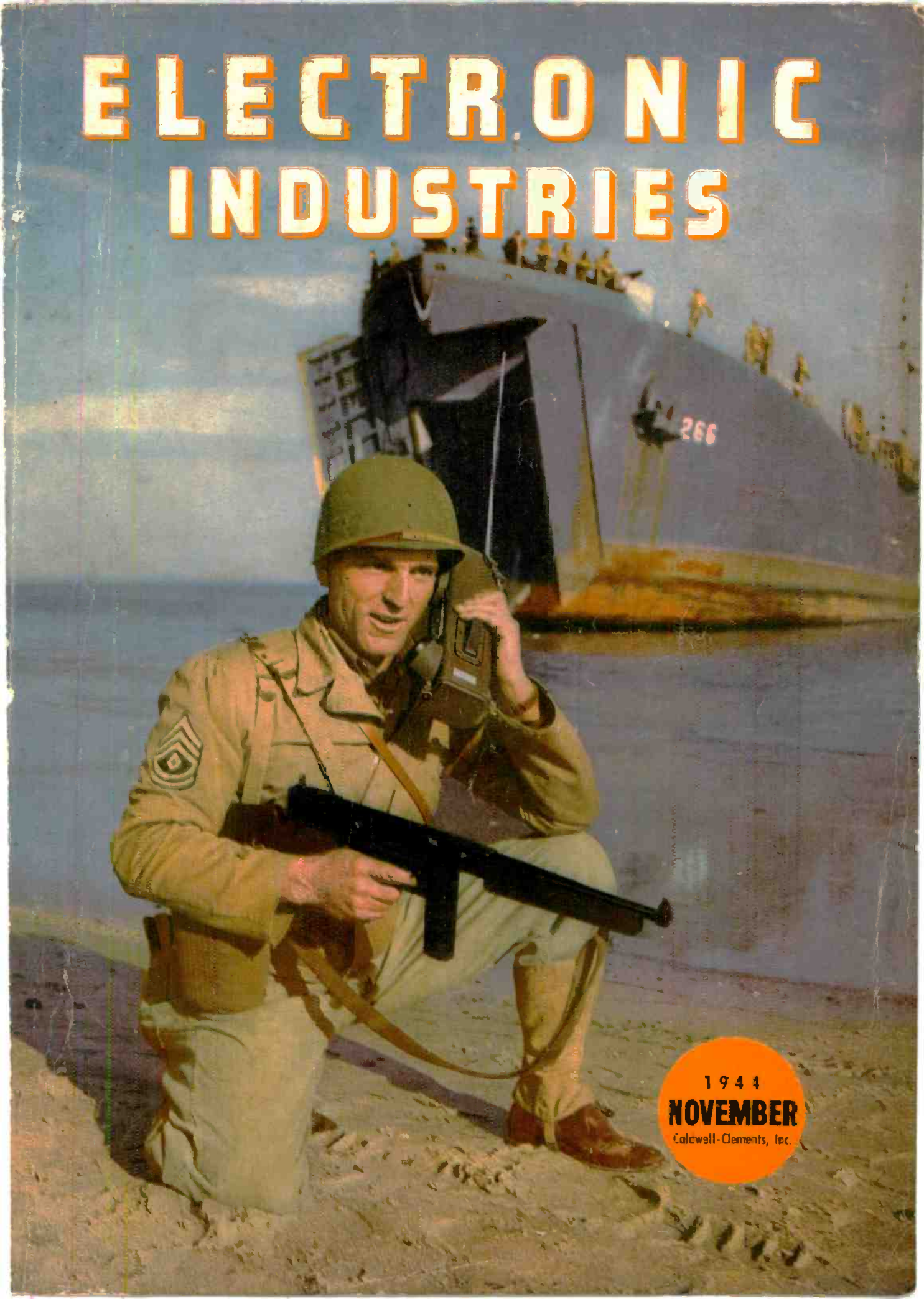
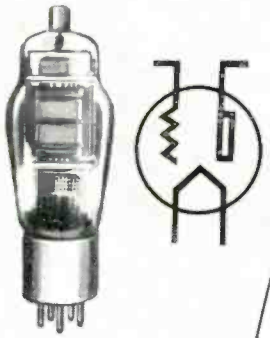
ELECTRONIC INDUSTRIES



1944
NOVEMBER
Caldwell-Clements, Inc.

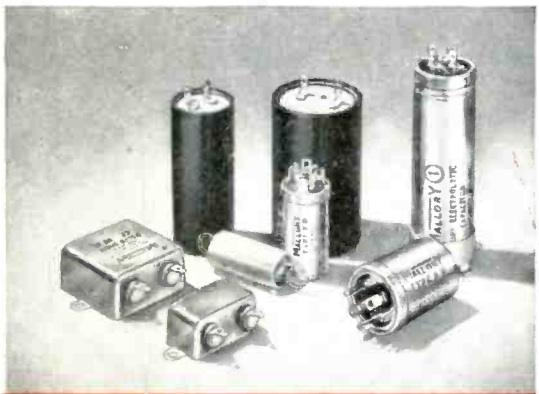
When You Use This



YOU NEED THIS

P.R. MALLORY & CO. Inc.
MALLORY
Type FP* Capacitor
*Trademark Registered

Your Country Needs Your Help:
Buy War Bonds



P.R. MALLORY & CO. Inc.
MALLORY
ELECTROLYTIC,
FILM AND PAPER
CAPACITORS

RADIO, television, movie apparatus, control devices—in these and hundreds of other applications, condensers are a vital necessity. With the majority of makers of such equipment, Mallory FP Capacitors are preferred.

For one thing, the patented "twisted ear" mounting feature found in Mallory FP Capacitors requires no other parts for mounting. This assures quick assembly and a rugged installation job.

For another, Mallory FP Capacitors have the advantage of being the smallest capacitors available for a given electrical rating.

Again, they are reasonable in price—improved production facilities have made them so.

But above all, of course, they are completely dependable. Long and gruelling life tests have proved *that* point again and again. Widespread acceptance after six years of use has dissipated the last shadow of doubt.

Do you have a problem involving electrolytics? Then let us show you how Mallory FP Capacitors can provide a ready answer. Free literature or engineering counsel are both available without charge. See your Mallory distributor, or write direct.

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

ELECTRONIC INDUSTRIES

Including INDUSTRIAL ELECTRONICS

★ IN THIS ISSUE NOVEMBER, 1944 ★

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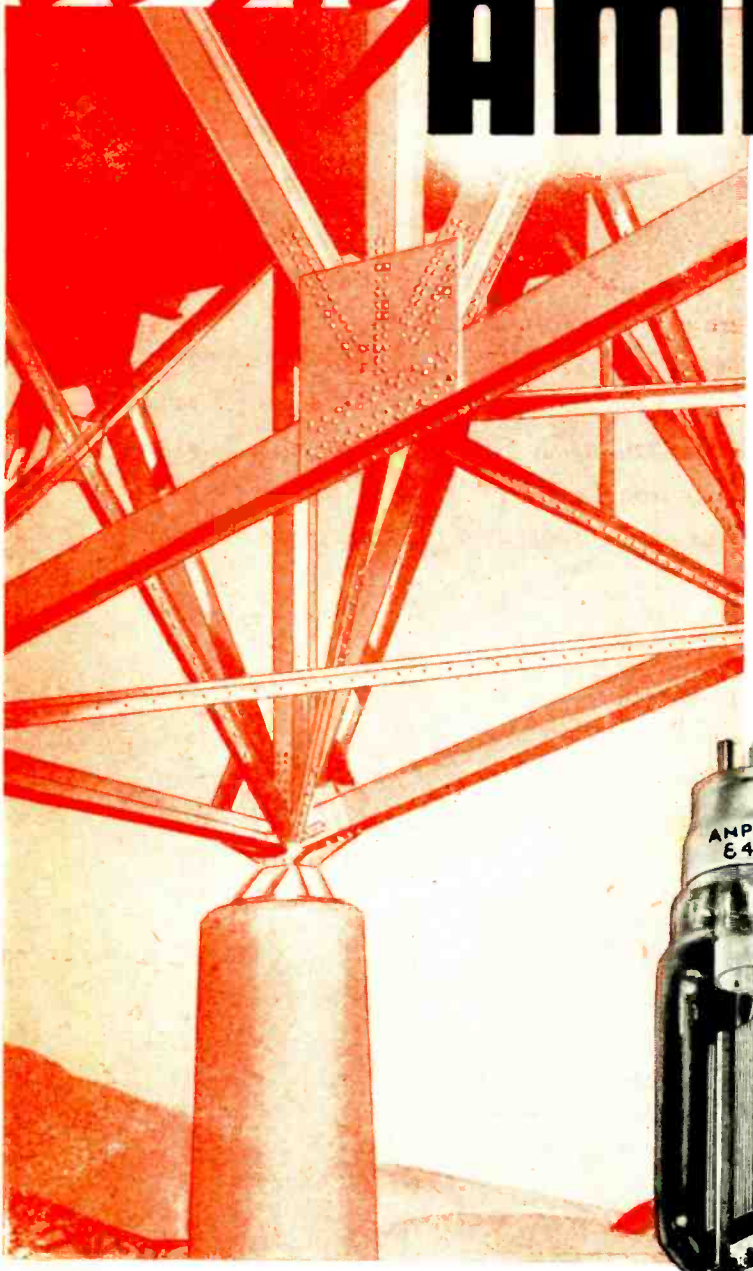
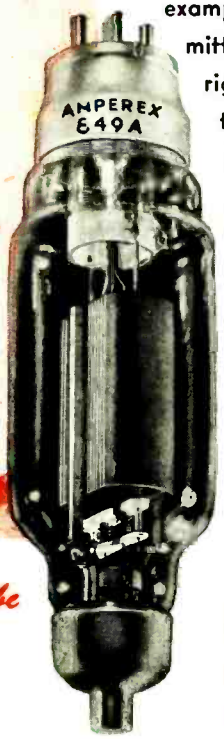
Printed in U. S. A.

CALDWELL-CLEMENTS, INC.—TEL. PLAZA 3-1340—480 LEXINGTON AVENUE, NEW YORK 17, N. Y.

Why AMPEREX

WATER and AIR COOLED TRANSMITTING and RECTIFYING TUBES





Of exclusive Amperex design! These four words, denoting an "Amperextra" reflected in better performance, have been used in a number of instances when describing our products. Of exclusive Amperex design, for example, is the channel support of our transmitting tubes. This feature results in more rigid support of tube elements. Exact inter-element alignment is assured. This, in turn, means absolute freedom from change in characteristics that might ordinarily arise from shock and vibration either in shipment or service.

There are more than 100 different types of ***Amperex*** tubes for broadcasting, industrial and electro-medical applications. An ***Amperex*** engineer will gladly assist you with your present or postwar problems.

AMPEREX *. . . the high performance tube*

Keep Buying . . .
Keep Holding . . .
More War Bonds

AMPEREX ELECTRONIC CORPORATION

79 WASHINGTON STREET . . . . . BROOKLYN 1, N. Y.
Export Division: 13 E. 40th St., New York 16, N. Y., Cables: "Arlab"

OLD FAITHFUL GEYSER, Yellowstone National Park. Geologists believe it began erupting before the last glaciation, about a million years ago. Within record, Old Faithful has erupted continuously at about 65-minute intervals, spouting a column of water 95—130 feet high for 4½ minutes.

STILL GOING STRONG

LONG, UNINTERRUPTED service under all operating conditions is the characteristic you want most in a capacitor. Tobe Capacitors serve so well and so long because every step in their manufacture is checked and cross-checked by rigid inspections. Constant improvement through constant research is the promise performed by Tobe engineers. An example is the Tobe TRS Capacitor, shown below, a skillfully designed transmitting condenser. Why not call on Tobe for prompt, specialized help on *all* your capacitor problems?

TRS 605,
5 mfd. 600 volts
SIZE—
Overall height 5"
CONTAINER—
1-3/16"x 2-1/2"x 4"
Dimensions of other TRS models on request.

SPECIFICATIONS FOR TRS CAPACITORS

CAPACITY . . . . .1 to 20 mfd.

WORKING VOLTAGE . . . 600 volts DC to 6,000 volts DC.

SHUNT RESISTANCE . . . 6,000 megohms per mfd.

RESISTANCE, Terminal to Case . . 10,000 megohms minimum.

POWER FACTOR . . . .002 to .005

VOLTAGE TEST Terminal to Case 2,500 VDC for 600 volt condenser.

Capacitor unit tested at 2 times rated voltage.

Universal (wrap around) L or foot type and screw Spade-lug mounting brackets can be supplied.

TOBE DEUTSCHMANN CORP. TOBE CANTON · MASSACHUSETTS

A small part in Victory today . . .

A BIG PART IN INDUSTRY TOMORROW

The Cover

U. S. Army's Signal Corps photographers have done a remarkable job in putting this war on film. Literally millions of photographs, black and white and color have come back from combat areas to show, among other things, the great role that is being played by radio, radar, wire communications and carrier. This view, taken somewhere in ETO (European Theater of Operations) shows one way in which the Army establishes immediate communications during amphibious operations. The sergeant, with the ubiquitous handi-talkie, brings naval and ground forces into contact.

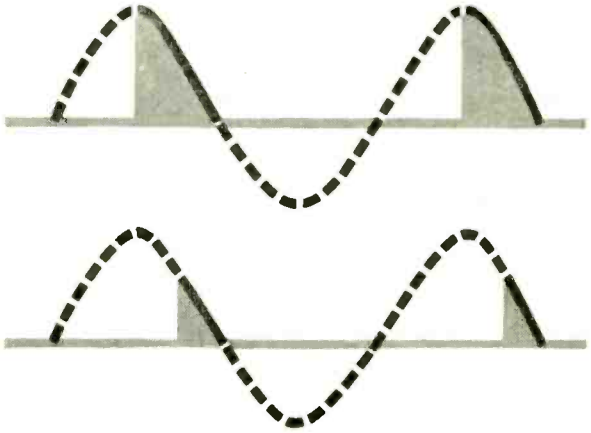
* * *

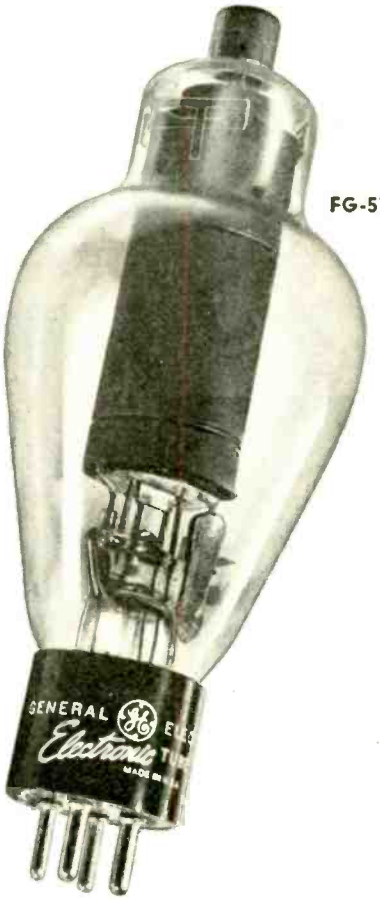
Electronic Gun Director Helps Lick the Robots

The Bell Telephone Laboratories' invention of the automatic electrical director of anti-aircraft guns played a major part in fighting the robot bomb menace in England. This was disclosed by Dr. Clarence A. Lovell, Bell Telephone Laboratories research engineer and one of the scientists who developed the electrical director, upon his return from an overseas mission to England and France to determine what improvements were needed in the directors which automatically calculate the height and forward speed of an approaching enemy bomber or robot bomb with set shell fuses to explode at given points. Only a few minor changes were necessary, Dr. Lovell reported. The electrical director for the ack-ack guns is manufactured by the Western Electric Co.

In revealing the role of the electrical directors, Dr. Lovell cited that on a typical day's robot bombing, 143 flying bombs reached the British coastline. Of these 65 were exploded by the anti-aircraft guns, 35 by the RAF and 17 by the barrage balloons. He cited that the went to England early in June when the British were in the process of strengthening and revising their anti-robot defenses and at that time the fastest pursuit planes were only bringing down about 35 per cent. The American batteries, equipped with the directors, knocked down 76 per cent of the buzz-bombs.

The American ack-ack batteries in France, equipped with these directors, in firing at night brought down enemy planes with 8 to 36 shots. One gun firing alone knocked down its Nazi in three shots. From D-Day to June 30 the American batteries in France cracked up 25 per cent of the enemy planes and from D-Day to Aug. 1 the score was 270 Nazi planes out of 1100 engaged (demonstrating the far greater efficiency of the anti-aircraft than in World War I).





FG-57

THYRATRON

the trigger tube that made precision control of industrial equipment possible

another G-E electronic FIRST!

DEVELOPED by General Electric, the thyratron is often credited with being "the most versatile electronic tube in industry."

It is the tube which triggers the current supplied through such other tubes as the ignitron.

It is the tube which, as a synchronous switch, times the shots with split-cycle precision in high-speed resistance welding. It offers control so accurate that it can be fired at any point in the a-c half-cycle (see examples above), time after time in predetermined and automatic sequence.

The thyratron can also act as a self-controlled power tube. It can run d-c motors directly from a-c lines, feeding current in exactly the right amount to maintain a constant preset speed in machine-tools regardless of load variations.

The thyratron executes the orders of the phototube, or electric eye, in sorting, grading, counting, detecting flaws in steel plates, operating doors, burglar alarms and safety devices.

General Electric is the manufacturer that can provide thyratrons, or any other electronic tubes, in quality that is unsurpassed for dependability, long life and economical operating.

OTHER G-E TUBES ARE WIDELY USED IN INDUSTRY, TOO!

The ignitron, for example—frequent teammate of the thyratron—is the rugged steel-jacketed water-cooled tube that is capable of handling the heavy shots of current in resistance welding. It is also used in place of rotating machinery for changing alternating current into direct current.

Write for Bulletin ET1-12, a convenient listing of all G-E electronic tubes for industrial applications. Address *Electronics Department, General Electric, Schenectady, N. Y.*

• *Tune in* "The World Today" *and hear the news direct from the men who see it happen, every evening except Sunday at 6:45 E.W.T. over CBS. On Sunday listen to the G-E* "All Girl Orchestra" *at 10 P.M. E.W.T. over NBC.*

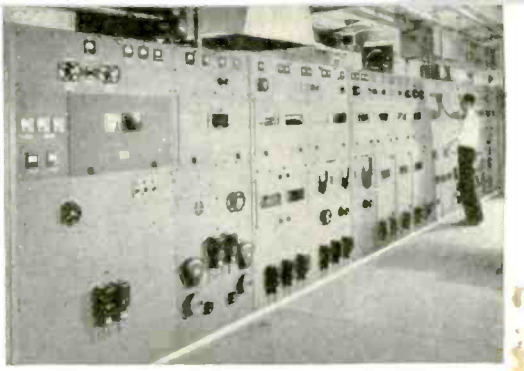
G. E. HAS MADE MORE BASIC ELECTRONIC-TUBE DEVELOPMENTS THAN ANY OTHER MANUFACTURER

GENERAL ELECTRIC

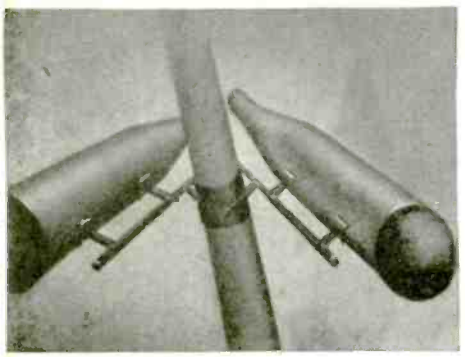
161-CB—8850

G-E control and monitoring consoles.

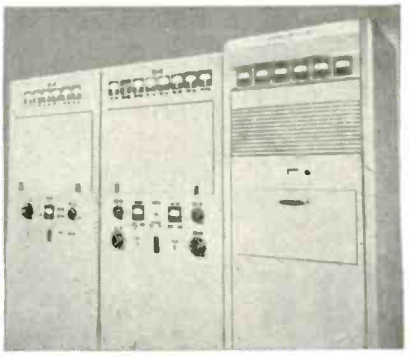
G-E transmitter monitor control board.



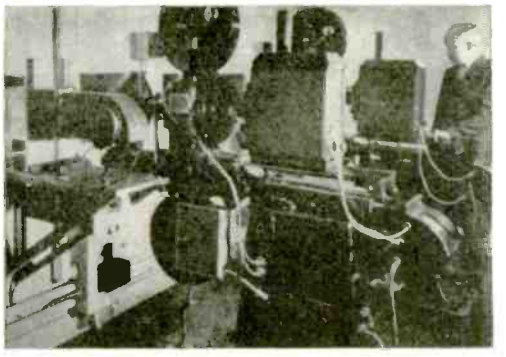
G-E transmitter (picture and sound units).



G-E "V" television broadcast antenna.



G-E S-T transmitters to relay signals from studio to transmitter.



G-E television projector for motion pictures.

G-E television studio cameras.

Other equipment (not illustrated): Transmitter tubes, studio spot lamps, heating and air-conditioning units, point-to-point relay equipment, portable pick-up units.

To you—the future television broadcaster—General Electric offers two important services:

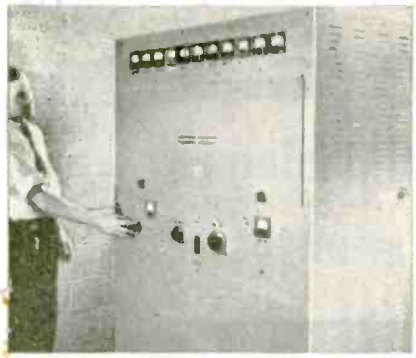
1. The complete television system—consisting of apparatus and accessories of coordinated design—to simplify the job of setting up your station.
2. The opportunity to see and study television equipment in action at the country's most powerful and best-equipped television station—WRGB in Schenectady.

At WRGB you can see the equipment required for a complete television station—the equipment shown on these pages. Here is the world's most powerful television transmitter. Here you can study the programming methods used in over 600 separate programs of all types, from Grand Opera to wrestling matches. Here you can see your future television station *in action*. Come to Schenectady . . . we invite you to see for yourself the work that is setting the pattern for tomorrow's television broadcasting. Thursdays and Fridays are "open-house" days at WRGB.

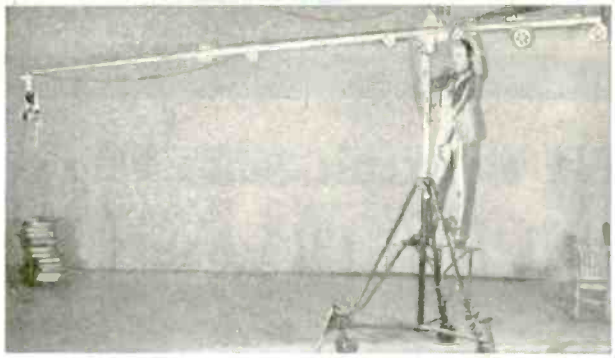
As shown on these pages, General Electric can provide all of the components you will need for a *complete television system for your station*. We welcome your inquiries. Write Electronics Department, General Electric, Schenectady, N. Y.

GENERAL ELECTRIC

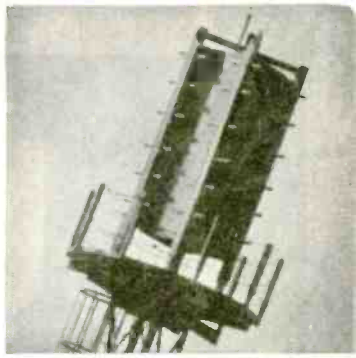
156-C4



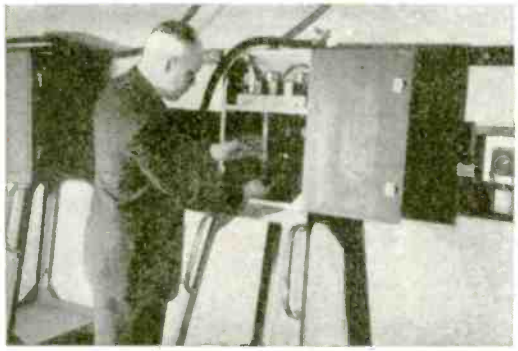
G-E visual relay receiver-converter.



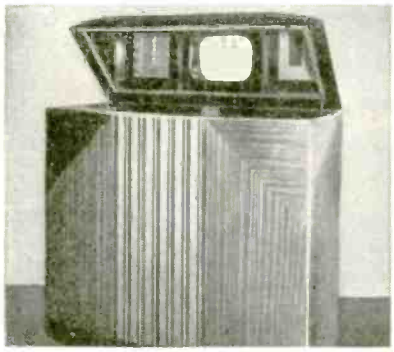
G-E motion-picture type studio microphone boom.



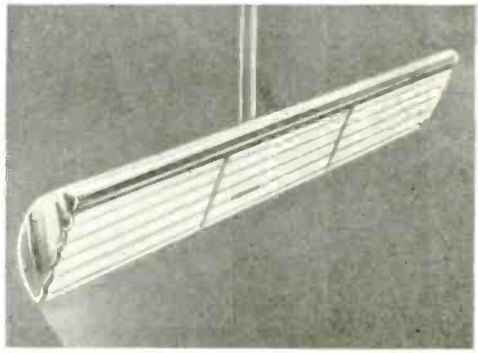
G-E ultra-high-frequency four-bay S-T antenna.



G-E film pick-up cameras.



G-E television home receiver.



G-E water-cooled mercury-vapor ceiling lamp (operated by remote control).

for Television . . .

Tune in General Electric's "The World Today" and hear the news from the men who see it happen, every evening except Sunday at 6:45 E.W.T. over CBS network. On Sunday evening listen to the G-E "All Girl Orchestra" at 10 E.W.T. over NBC.

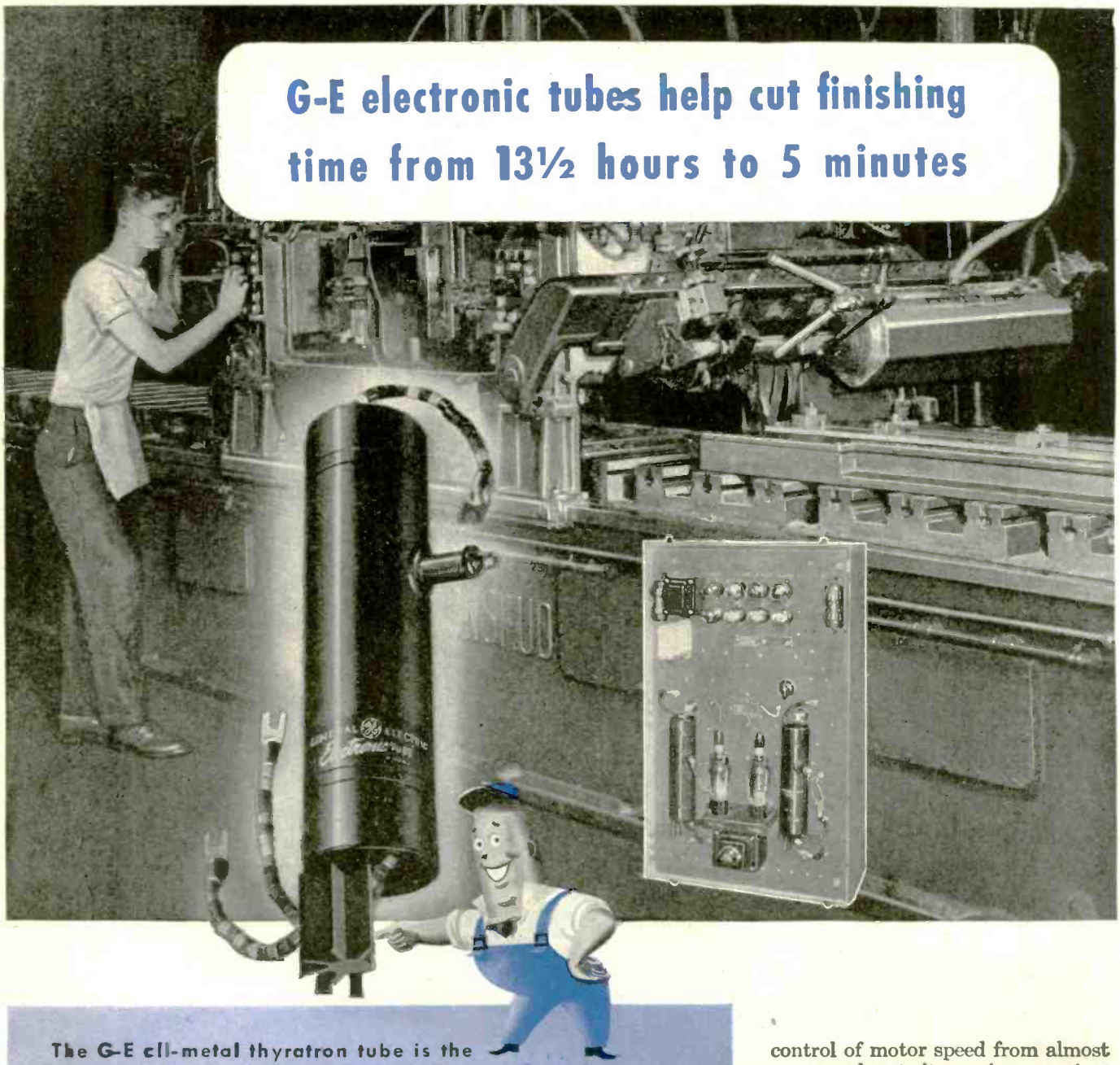
THE G-E EQUIPMENT RESERVATION PLAN and the brochure "Television Broadcasting Post-War" will be sent to anyone interested in television broadcasting. Write for this information. *Electronics Department, General Electric, Schenectady, New York.*

STUDIO AND STATION EQUIPMENT · TRANSMITTERS · ANTENNAS
ELECTRONIC TUBES · RECEIVERS

FM · Television · AM

See G.E. for all three!

G-E electronic tubes help cut finishing time from 13½ hours to 5 minutes



The G-E all-metal thyratron tube is the "heart" of the Thy-mo-trol unit that maintains correct machine speed for every load.

G-E electronic tubes in the G-E Thy-mo-trol Drive provide the multiple-timing control that has speeded up finish time on milling of aluminum spar beams for aircraft wings from one unit in 13½ hours to one unit in 5 minutes!

Onsrud Machine Works, Inc., met the requirements for increased production by designing its giant contour milling machine to include the G-E Thy-mo-trol Drive—the electronic-tube control unit that provides the smooth, stepless motor control for handling such complex factors as varying feed speeds for synchronizing with tool-cutting depths, controlling changing feeds, and high accelerations for fast "skips" when no cutting at all is required.

Electronic-tube control of d-c motors is applicable to drill presses, pump drives, lathes, boring mills, screw machines, and all other motor-driven machinery where a *right* speed is required for the job.

The heart of the electronic motor control, the G-E Thy-mo-trol Drive, is the G-E thyratron tube. This tube is a virtual stepless rheostat that controls with no moving parts the flow of current to give smooth, stepless control of motor speed from almost zero speed up to its maximum rating. The thyratron is but one of the complete line of G-E electronic tubes for industrial applications. Through its nation-wide distributing system, General Electric is prepared to supply users of electronic devices with replacement tubes. Ask your distributor for information on G-E thyratrons or any other type of industrial tube, or write *Electronics Department, General Electric Company, Schenectady, N. Y.*

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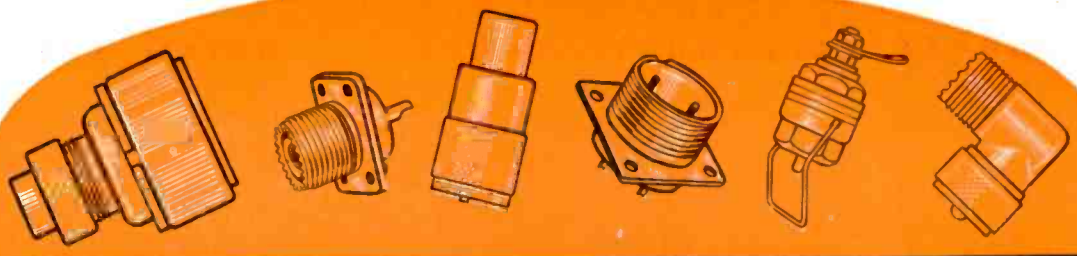
G.E. HAS MADE MORE BASIC ELECTRONIC-TUBE DEVELOPMENTS THAN ANY OTHER MANUFACTURER

GENERAL ELECTRIC

162-C12-6680



For Your Postwar Needs in Connectors and Related Units

Will coaxial cable connectors, cable plugs or special design parts in this general category, play roles in your postwar products? If so, we suggest you carefully consider both our offerings and exceptional facilities.

Connector Division, in addition to making a representative line of standard units, is uniquely staffed and equipped to serve your needs in this field on a mass production basis.

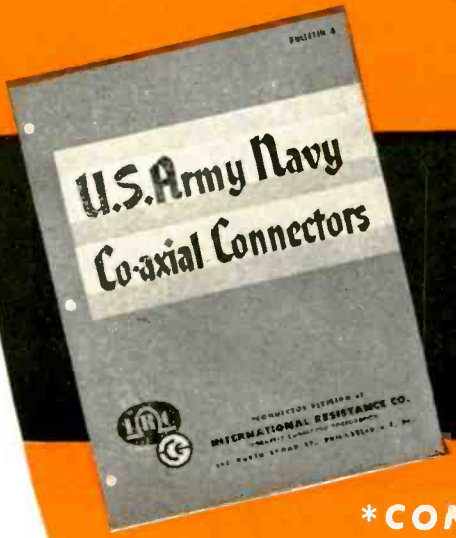
Our engineers will be happy to consult with you on specific problems or send you more detailed information.

AVAILABLE ON PRIORITY ORDERS

(Actual Size)

U. S. ARMY-NAVY COAXIAL CONNECTORS

Built in accordance with U. S. Army-Navy designs and specifications, these precision units interlock firmly, when coupled, to assure positive, vibration-proof contact. The die cast, zinc housings and other metal parts are heavily silver plated. Contact parts (both pins and sockets) are made of specially tempered spring-brass. Cable plugs and receptacles alike are insulated with low-loss mica filled bakelite. Plugs may be had in either Signal Corps #PL-259, or Navy #C1-49195 models. Connector receptacle #50-392-1 is standard for each of these designs.



Write for Bulletin 4

IRC

*CONNECTOR DIVISION OF

INTERNATIONAL RESISTANCE CO.

401 N. BROAD ST., PHILADELPHIA 8, PA.

*FORMERLY CONNECTOR CORPORATION

COULDN'T BE MADE ...BUT IT WAS!

The Army came to Westinghouse for a very complex, completely new type of electronic tube. Our engineers didn't say it couldn't be made, but they thought just that. However, when the Army asks for it, you do the impossible. Our engineers sweated it out. They designed, built, tested and shipped the new tube. Then word came back: "It won't work." Instead of making the tube over, we got permission to redesign the apparatus in which the tube was to be used. Result: tube 100% perfect in new apparatus which the Army agreed did a better job than the original—and an order for 2000 tubes *exactly as supplied!*

The engineering resourcefulness and production expansion which made this possible have enabled Westinghouse to multiply tube output 30 times . . . so that today we're not only meeting time and quality "musts" on all Government contracts, but we're also continuing to meet the heavy needs of war industry. Your nearest Westinghouse office or Westinghouse Electronic Tube Distributor will be glad to receive your inquiries. Westinghouse Electric & Manufacturing Company, Bloomfield, N. J.

Westinghouse

PLANTS IN 25 CITIES OFFICES EVERYWHERE

Electronic Tubes at Work

Westinghouse Presents—John Charles Thomas, Sunday 2:30 E.W.T., NBC. Ted Malone, Monday, Wednesday, Friday 10:15 P.M., E.W.T., Blue Network.

Franklin's 39

RADIO SOCKET

The favorite yesterday, the favorite for tomorrow

MORE THAN 30 MILLION INSTALLED IN 1941

Positive Testimony to its POSTWAR VALUE

The story of Franklin's series 39 Radio Socket, with patented "U" shaped bow spring action contacts, is most remarkable ... developed and patented early in 1938 it received immediate acceptance and approval by practically all the radio set manufacturers and became standard equipment with most.

Series 39 sockets should be riveted to the chassis to become a permanent part of the set ... no replacement will be necessary as the socket will outlive the set.

Series 39 sockets were the favorite yesterday and will be the favorite tomorrow for standard broadcast receivers.

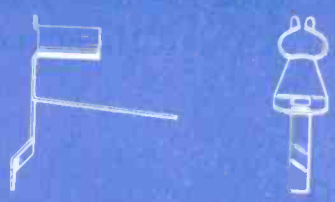
This series 39 socket has a 39G Contact with a soldering tab which eliminates wiring to ground.

Illustrating the "U" shaped bow spring action contacts...39H and 39G...used in Franklin's series 39 Sockets.

Bow spring action maintains resiliency even after installation of oversize pins

Direction of metal grain prevents breaking of soldering foil and permits rough handling in production

"U" shaped contact provides separate soldering foil which prevents solder from flowing into contact body



The 39G contact has a soldering tab to eliminate wiring to ground ... can be inserted in any position where grounding is desired.

For the details of the 39, Diheptal, Miniature, Lock-in, Battery and Sockets for other applications, moulded or ceramic...and a complete line of Radio Components...write for the New Franklin Catalog with which is included a complete Buyers Guide for the Electronic Industries.

A. W. FRANKLIN MANUFACTURING CORP.

SOCKETS • TERMINAL STRIPS • PLUGS • SWITCHES • PLASTIC FABRICATION • METAL STAMPINGS • ASSEMBLIES

175 VARICK ST., NEW YORK 14, N. Y.

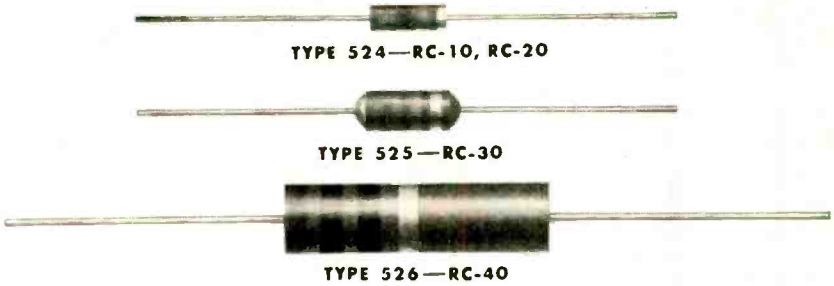
TWO *New* LINES OF

TYPE 504B—RC-21

TYPE 518B—RC-31

ACTUAL SIZE

ERIE RESISTORS



TYPE 524—RC-10, RC-20

TYPE 525—RC-30

TYPE 526—RC-40

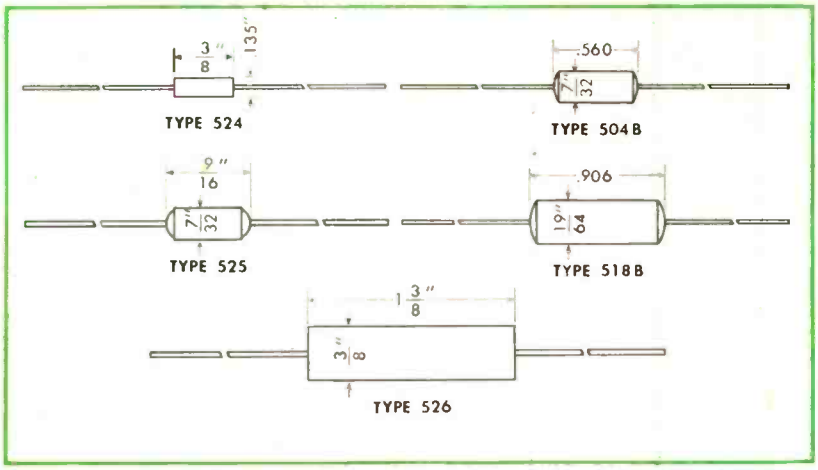
ACTUAL SIZE

ERIE Resistor announces two new lines of insulated carbon resistors, covering six different A.W.S. ratings, RC10, RC20, RC21, RC30, RC31, and RC40.

The well-known Types 504 and 518, ½ and 1 watt units with ceramic insulation, have been replaced with Types 504B and 518B. These new units are identical with the Types 504 and 518 with the exception that they have a one-piece, natural brown, molded phenolic case, instead of the ceramic insulation. The molded construction results in better protection against humidity and salt water immersion. Types 504B (RC21) and 518B (RC31) are available in resistance values from 0.5 ohm to 100 megohms.

In addition, Erie has a new line of compact, hot molded, insulated resistors in ¼, ½, 1, and 2 watt ratings. The resistance mix and insulation material are molded simultaneously as an integral unit. These resistors are manufactured only in RMA preferred values from 220 ohms up to and including 4.7 megohms. Type 524 (RC10 and RC20), and Type 525 (RC30) are now in production, and Type 526 (RC40) will be available shortly.

Nominal dimensions of these Erie Resistors are given above. Samples will be sent to interested engineers on request.



DO MORE THAN BEFORE—BUY EXTRA WAR BONDS

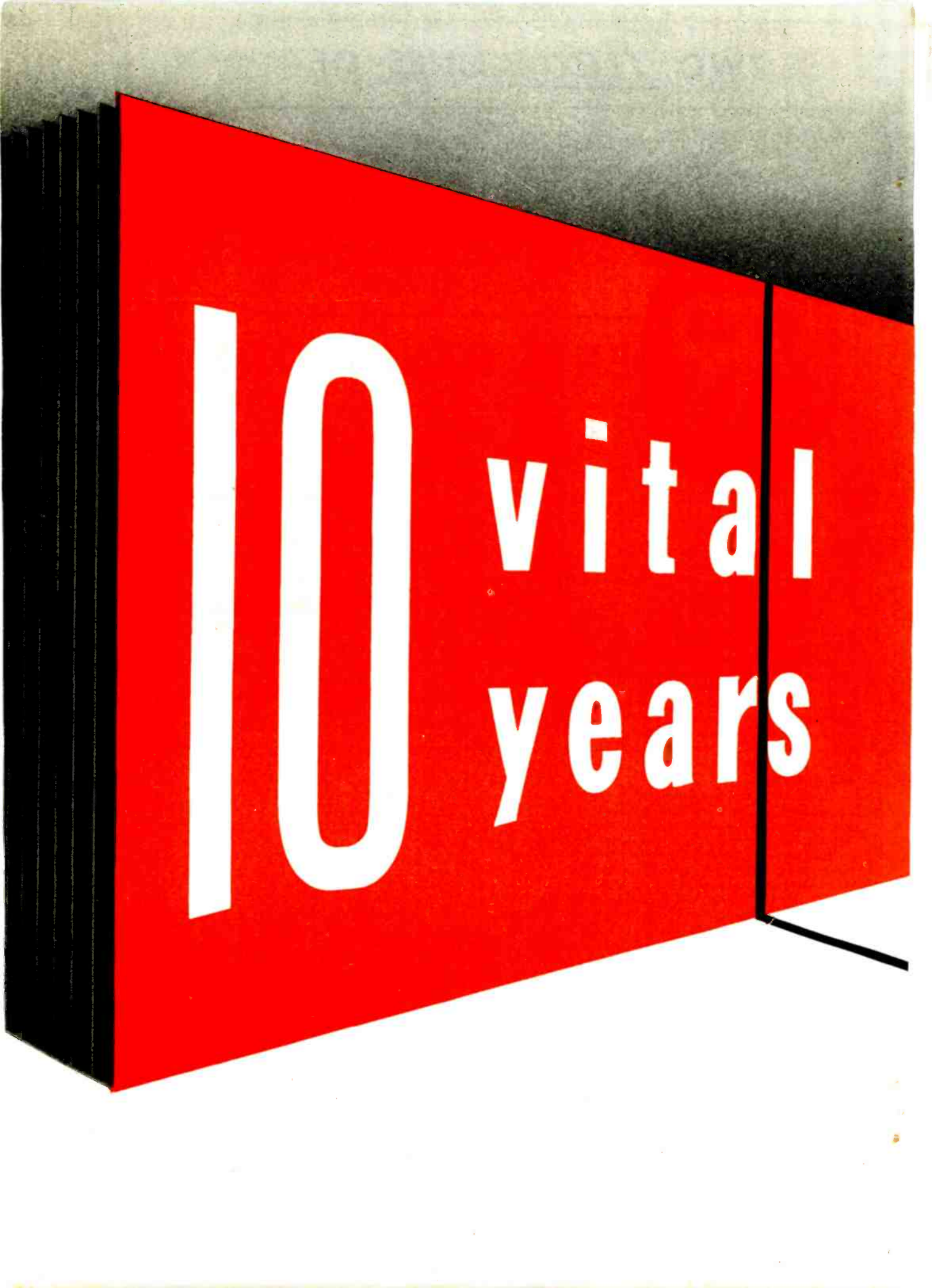
ARMY E NAVY

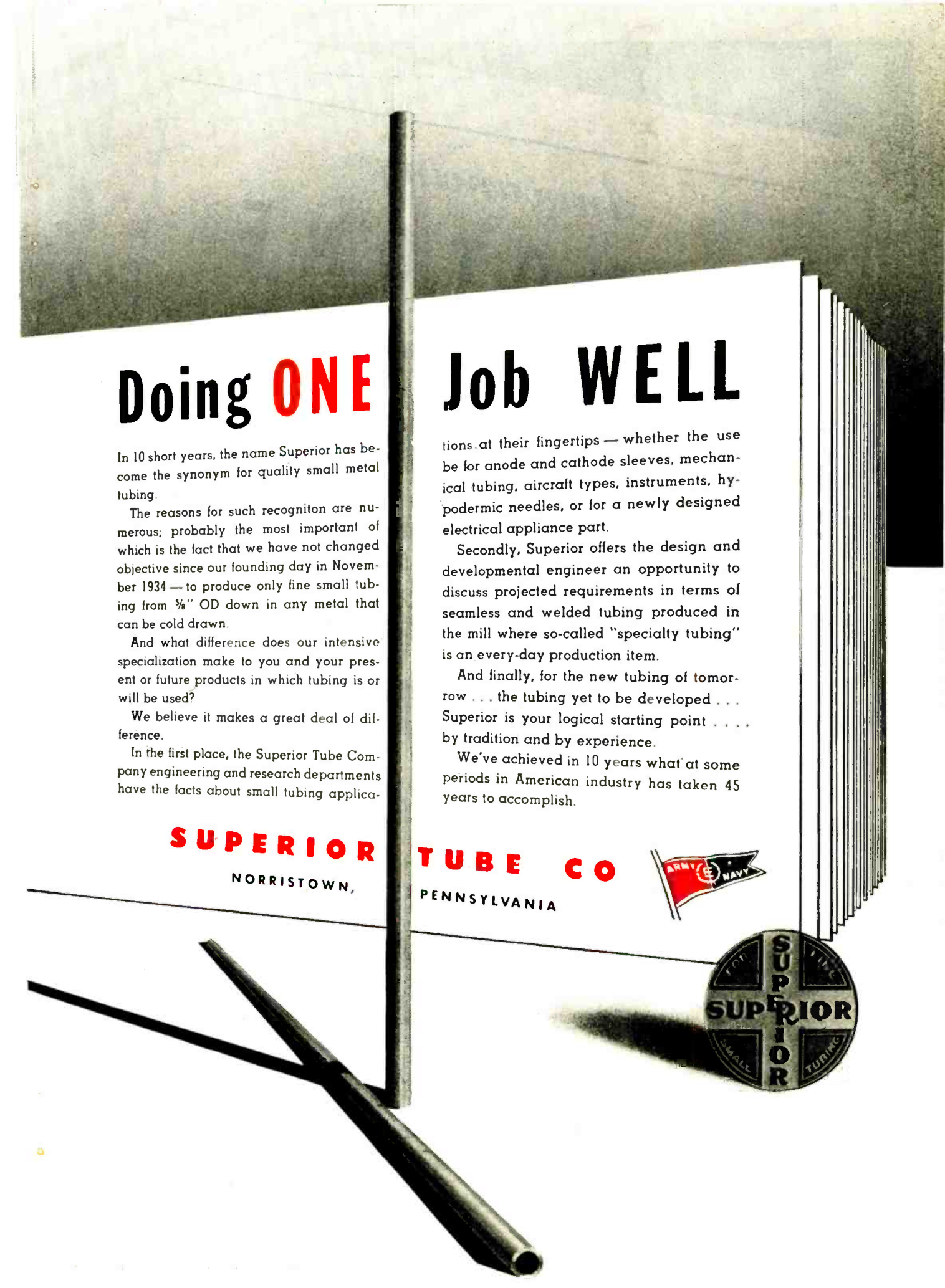
FOR HIGH ACHIEVEMENT IN WAR PRODUCTION

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND • • TORONTO, CANADA


10 vital years



Doing ONE Job WELL

In 10 short years, the name Superior has become the synonym for quality small metal tubing.

The reasons for such recogniton are numerous; probably the most important of which is the fact that we have not changed objective since our founding day in November 1934 — to produce only fine small tubing from ⅝" OD down in any metal that can be cold drawn.

And what difference does our intensive specialization make to you and your present or future products in which tubing is or will be used?

We believe it makes a great deal of difference.

In the first place, the Superior Tube Company engineering and research departments have the facts about small tubing applications at their fingertips — whether the use be for anode and cathode sleeves, mechanical tubing, aircraft types, instruments, hypodermic needles, or for a newly designed electrical appliance part.

Secondly, Superior offers the design and developmental engineer an opportunity to discuss projected requirements in terms of seamless and welded tubing produced in the mill where so-called "specialty tubing" is an every-day production item.

And finally, for the new tubing of tomorrow . . . the tubing yet to be developed . . . Superior is your logical starting point . . . . by tradition and by experience.

We've achieved in 10 years what at some periods in American industry has taken 45 years to accomplish.

SUPERIOR TUBE CO

NORRISTOWN, PENNSYLVANIA

ARMY E NAVY

SUPERIOR FOR SMALL TUBING

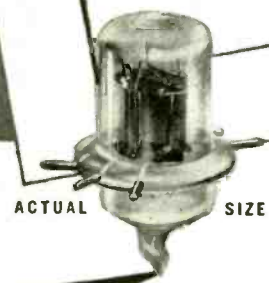
Announcing

SONOTONE

"Specification-Engineered"

ACORN TUBES

with a new LONG LIFE and STABILITY exceeding service specifications!



ACTUAL SIZE

ARMY E NAVY

WHITE PLAINS PLANT

★ now mass-produced!

For the first time, engineers can plan quantity peacetime production using acorn tubes whose life and stability exceed government service specifications. These improved acorn tubes are now being produced on mass-production schedule for widespread military uses, by revolutionary automatic technics and controls devised by the Sonotone Corporation.

In the important channels between 30 and 1,000 megacycles, in the fields of UHF broadcasting, television, communication, and in many commercial installations, Sonotone believes the new acorn tube will find many uses not previously anticipated. Long life, dependability, stability and uniformity, unobtainable before the war, now achieved by Sonotone methods, allow circuit engineers to specify these tubes for their sockets with full confidence of trouble-free performance.

If you have a problem where tubes of this character can be successfully applied, Sonotone's engineers will be glad to assist you in every way.

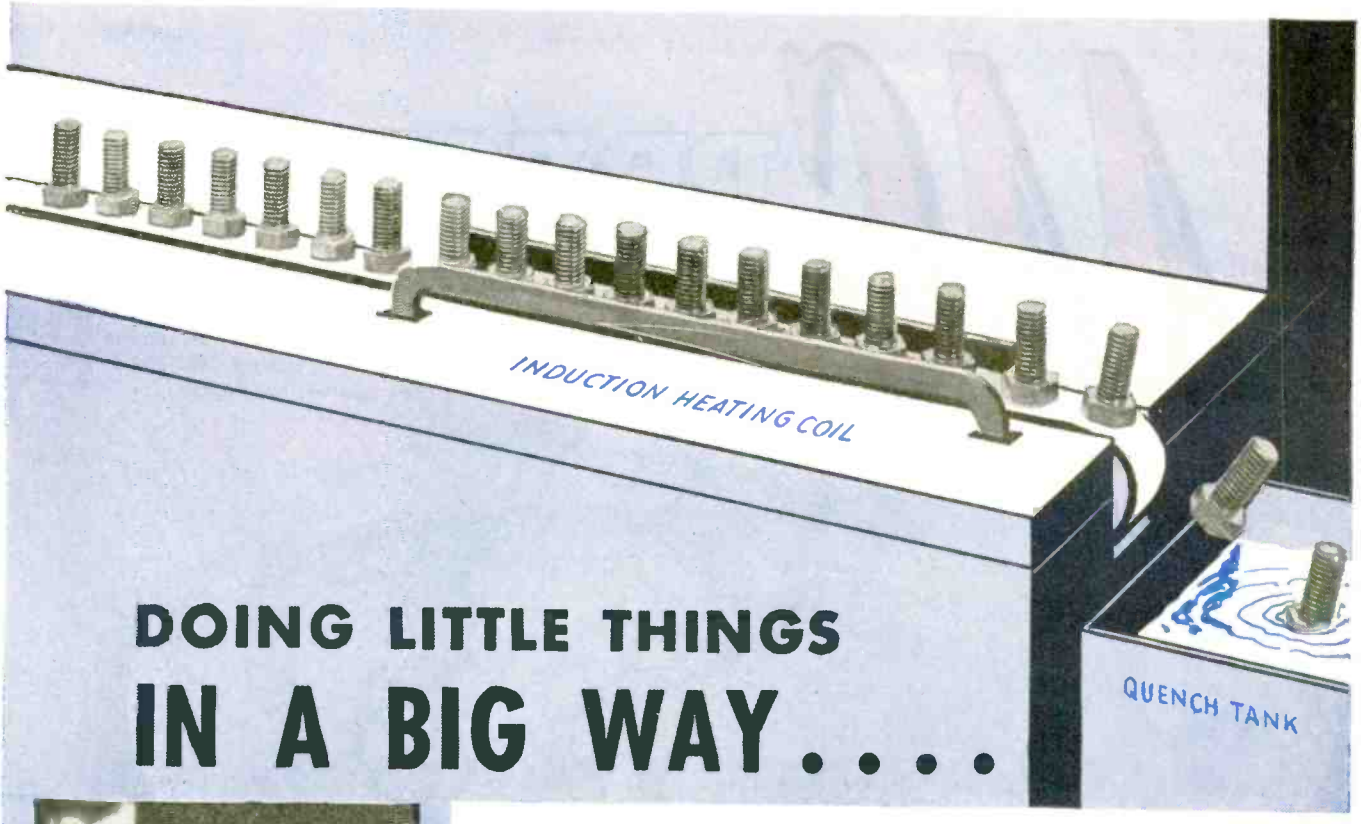
Technical Handbook No. 1 on Sonotone Acorn Tubes is on the press. Send for your copy.

WRITE NOW FOR THIS BOOKLET!

SONOTONE CORPORATION

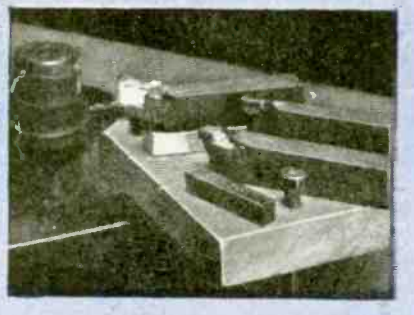
Elmsford, New York

HEARING AIDS • HEADSETS • THROAT MICROPHONES
"SPECIFICATION-ENGINEERED" ACORN TUBES



DOING LITTLE THINGS IN A BIG WAY....

Six clean, perfect, brazed joints per minute with this unit.



Carbide tool tips are brazed to shanks with better bond by high frequency heating.

WITH ELECTRONIC HEAT

Hardening the heads of screws as they pass on a conveyor through a heating coil is only one way Ajax-Northrup electronic heating can do the little things in a big way on your production lines.

For instance, Ajax-Northrup induction heating has hardened razor blades on the fly, brazed tin cans, and dried welding rod coatings. Big jobs too, such as heating bars for forging 20,000 shells per day.

Or if you work with small-production quantities, you'll need Ajax-Northrup's flexibility. By a simple change of jigs and coils, you can braze 1,000 parts one day, and harden 500 of another part the next day — with the same equipment. Conversion to post-war will be easy.

Call on us for suggestions. Our 25 years of experience and complete lines of carefully engineered high frequency equipment are available from no other source.

63

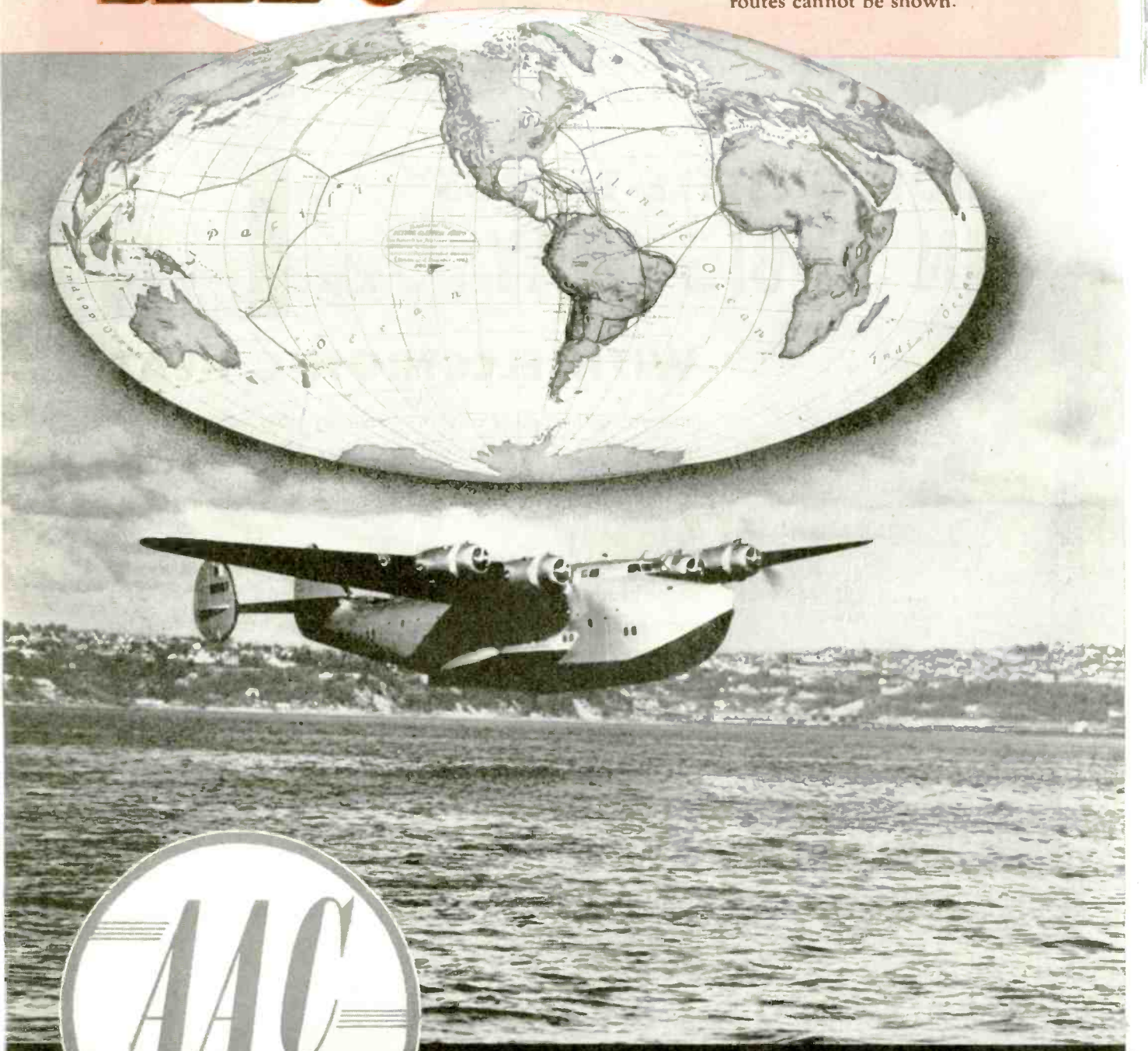
AJAX-NORTHRUP HIGH-FREQUENCY HEATING MELTING

AJAX ELECTROTHERMIC CORPORATION • Ajax Park TRENTON 5, N. J.

ASSOCIATE COMPANIES . . . THE AJAX METAL COMPANY. Non-Ferrous Ingot Metals.
AJAX ELECTRIC FURNACE CORPORATION. Ajax-Wyatt Induction Furnaces.
AJAX ELECTRIC COMPANY, INC. Ajax-Hultgren Salt Bath Furnaces.
AJAX ENGINEERING CORPORATION. Aluminum Melting Furnaces.

AAC PRECISION

* The Pan American World Airways routes shown below are those in existence on December 7th, 1941. Present routes cannot be shown.



AAC Products

AIRCRAFT PRECISION RADIO

Kansas City, Kans.

RADIO PRODUCTS

Serve PAA

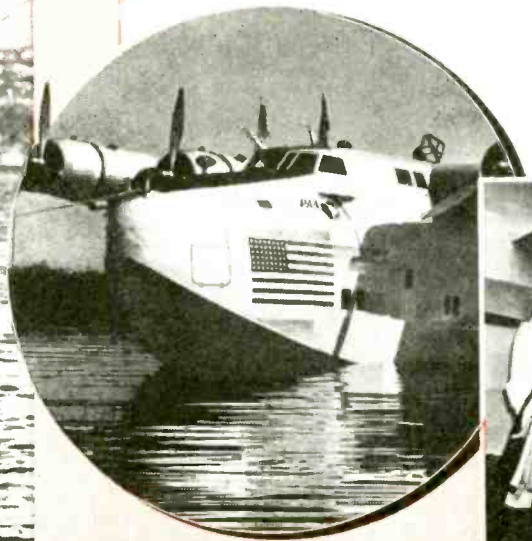
PAN AMERICAN WORLD AIRWAYS continues to perform a vital wartime service by speeding men and materials to every U.S. front and outpost . . . and AAC Precision Radio Products play an important part in this service.

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

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

ELECTRONICS DIVISION

KANSAS CITY, KANSAS



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

(E-54)

ACCESSORIES CORPORATION

and ELECTRONICS • ENGINEERED POWER CONTROLS

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

IT IS EASY to see that both these gentlemen are satisfied customers of General Industries. One acclaims our "know-how" in molded plastic parts —the other our velvety *Smooth Power* motors. Yes, we do both jobs under one roof and one management.

GENTLEMEN, *YOU'RE BOTH* RIGHT!

The plastic parts buyer has profited from the ingenious skill of our mold makers, who enable us to turn out tricky jobs economically and on time. Quite likely he has seen our up-to-date equipment for compression, transfer and injection molding of large or small parts in any quantities. Our engineers have made sensible and workable suggestions, by reading between his blueprint lines. He is typical of leading manufacturers in many fields who rely upon General Industries plastics division.

The speaker on *Smooth Power* motors might be a radio-phonograph builder who uses our turntables, record changers and recorders. Or he might be a designer who depends upon these fine low-torque drives to power electric, electronic or mechanical devices. In any case, he's well acquainted with the facilities of our *Smooth Power* motor division.

We want to emphasize the point that we're a thoroughly able producer of both these products. If your plans call for either or both, we'd like to work with you. In your request for details, please address the respective division . . . *small motors* or *plastics*.

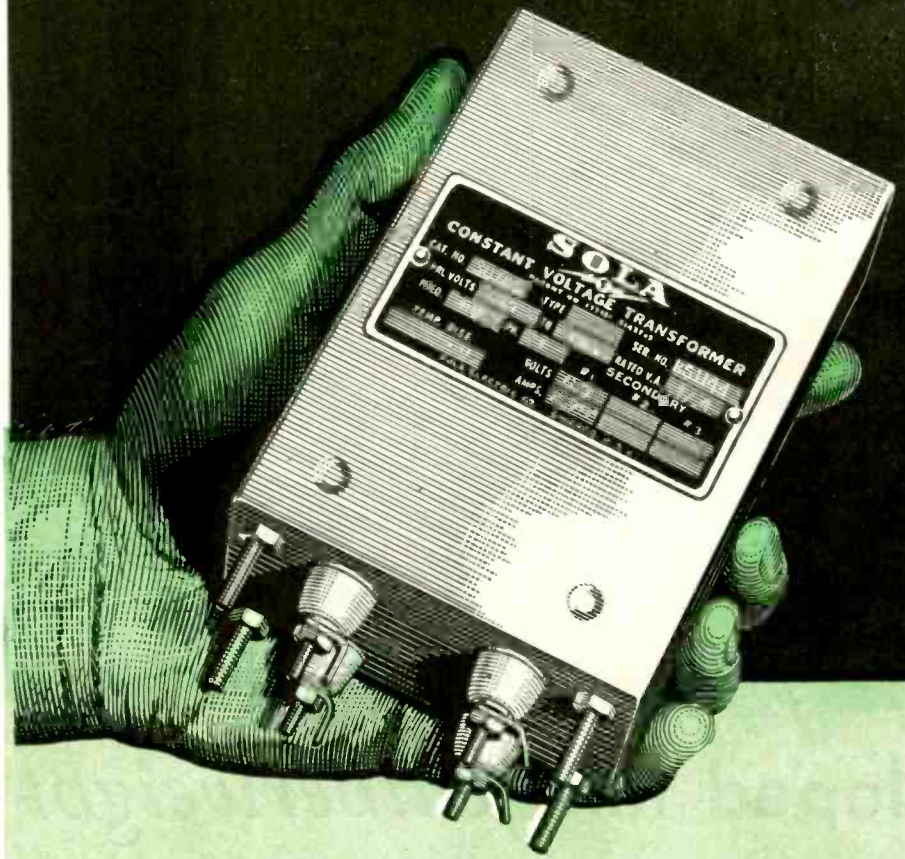
THE GENERAL INDUSTRIES COMPANY
ELYRIA, OHIO

ARMY E NAVY

This SOLA CONSTANT VOLTAGE TRANSFORMER

has an important postwar future in

YOUR



HEATING CONTROLS • REFRIGERATION CONTROLS • TELEVISION SETS • F-M RADIO • VACUUM TUBE VOLTMETERS • ELECTRONIC GAUGING AND INSPECTION EQUIPMENT • PHOTO-METRIC INSTRUMENTS... *there are other applications of course*

Here is a SOLA Constant Voltage Transformer that should be a built-in part of your equipment—

First: because it will stabilize output voltage at your rated requirements regardless of line voltage fluctuations as great as ±12 to 15 %.

Second: because its small, compact size is ideal for chassis mounting.

Third: because of its low, economical cost.

Fourth: because of the saving that can be made through the elimination of other components.

Fifth: because a majority of anticipated service calls can be eliminated from your cost calculations.

Sixth: because the users of your product will get greater satisfaction from trouble-free service.

This particular transformer is rated at 6.3 volts, 17VA output and is designed primarily for the stabilization of vacuum tube filament and heater voltages. Other voltages and capacities for chassis mounting can be supplied on the same low cost, economical basis to meet your exact requirements.

Constant Voltage Transformers

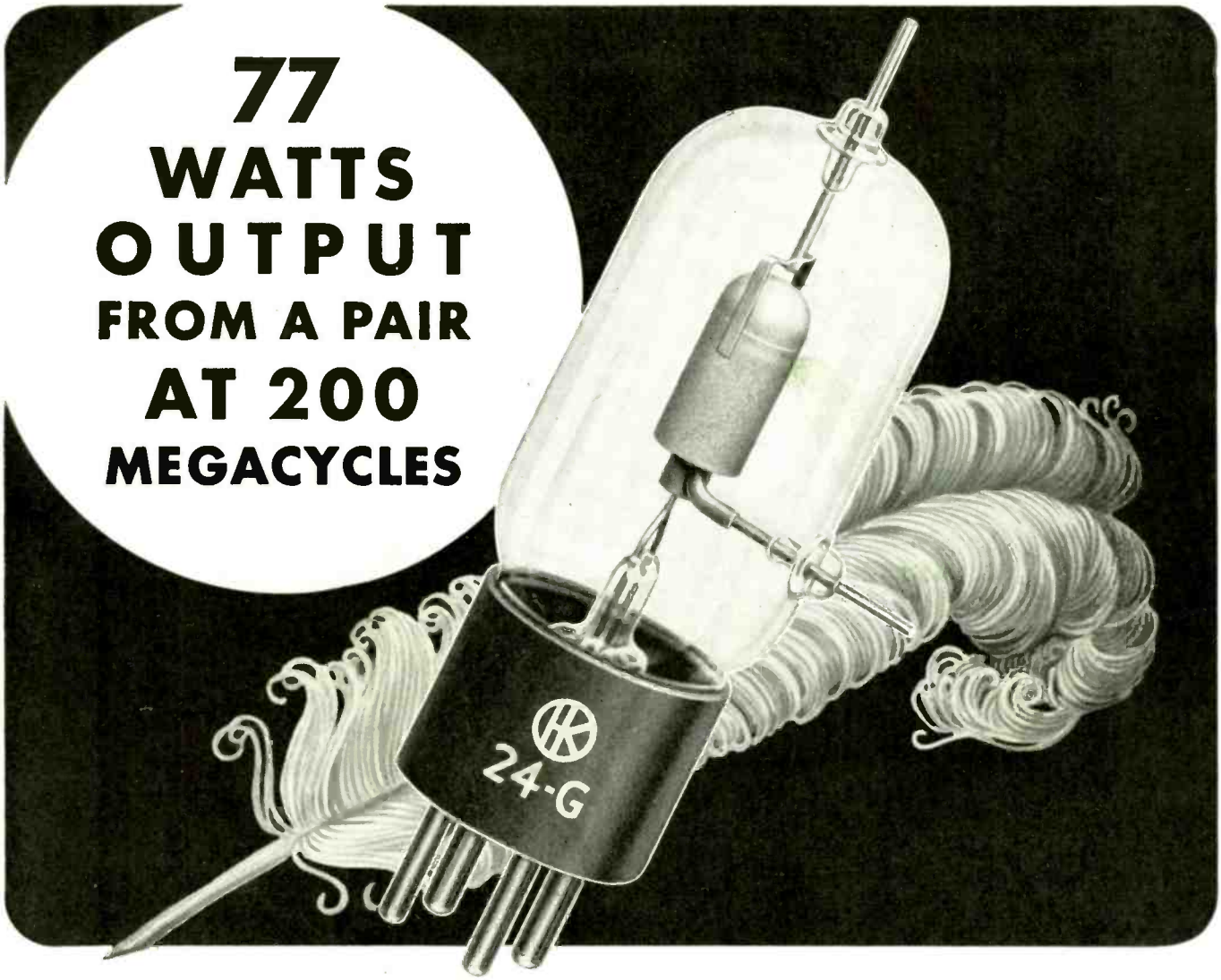
To Manufacturers:

Complete specification details covering this new Constant Voltage Transformer will be furnished at your request.

Ask for Spec. No. 10CV-103

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

77 WATTS OUTPUT FROM A PAIR AT 200 MEGACYCLES



H & K developed this *featherweight* to pack a wallop in the VHF region

The only thing that's small about this 4½-inch, 1½-ounce Gammatron is its size. Heintz and Kaufman engineers originated and perfected this powerful little tube to put out a 77 watt signal from a pair at 200 Mc. as a Class C unmodulated amplifier . . . 116 watts at 100 Mc. Even at peak frequency, 300 Mc., a pair of HK-24G Gammatrons develop a remarkable 44 watts.

The high efficiency of the HK-24G in the VHF region results from (1) the long, capped tantalum plate, typical of Gammatrons, which confines the entire electron stream for useful output, and (2) the fact that this grid is closely spaced to the filament for short electron time-flight.

The HK-24G triode is easy to neutralize, and parasitic oscillation is avoided, because the inter-electrode capacities are very low, and the grid and plate leads are short. For typical operating ratings of the HK-24G as an r. f. power amplifier, audio amplifier, crystal oscillator, doubler, or tripler, write today for data.

HK-24G MAXIMUM RATINGS

Power Output Class "C" R. F.	90 Watts
Plate Dissipation	25 Watts
Amplification Factor	25
Plate Voltage	2000 Volts
Plate Current	75 MA
Grid Current	25 MA
Frequency	300 MC

INTER-ELECTRODE CAPACITIES

C Grid-Plate	1.6 UUF
C Grid-Filament	1.8 UUF
C Plate-Filament	0.2 UUF

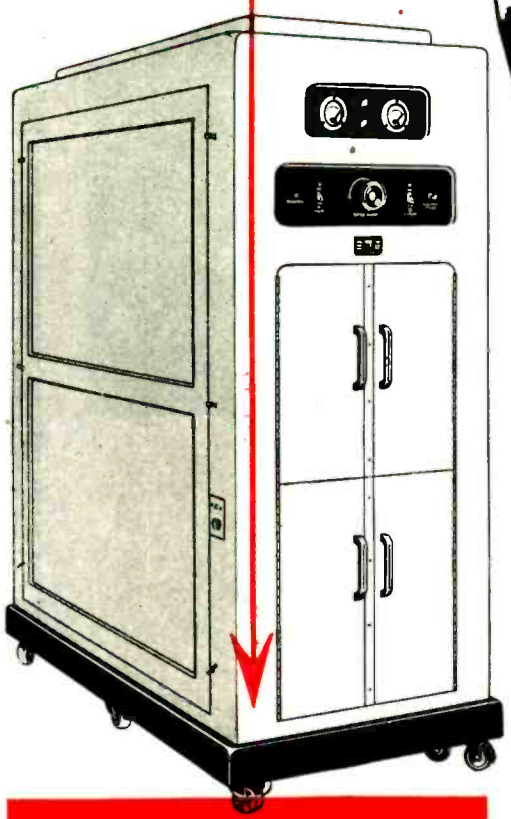
FILAMENT

Volts, 6.3 Amperes, 3

LOAN YOUR DOLLARS
DONATE YOUR BLOOD
FOR EARLY VICTORY

HEINTZ AND KAUFMAN LTD.
SOUTH SAN FRANCISCO • CALIFORNIA
Gammatron Tubes

There's no ONE-MAN-BAND in Electronic Heating



Although it is possible to construct an electronic heater that will generate a great range of high frequency currents, it will not perform *all* heating jobs efficiently and it would be very costly in use.

Virtually every application of electronic heating requires a specific FREQUENCY AND POWER combination. Therefore, to realize the maximum advantages of this improved heating method, *each installation should be designed and built for its particular application.* For example: when a heating operation can best be done at 5 kw and 22 megacycles it would be *wasteful* and *inefficient* to use a machine that delivers 20 kw at 500 kc.

Many first-time users of electronic heating are induced to buy "misfits" when they try to find an all-purpose machine. Our extensive line of equipment offers you the broadest range of power and frequency combinations at *prices lower* than other makes of comparable quality.

Investigate the production economies and advanced engineering designs offered by our greater variety of units . . . each one time-tested for high efficiency.

Before you buy write to us for detailed information

Our equipment offers you a selection of frequencies up to 300 megacycles — and the following power range, with stepless control from zero to full load:

- 3 Kw
- 5 Kw
- 7½ Kw
- 10 Kw
- 12½ Kw
- 15 Kw
- 18 Kw
- 25 Kw
- 40 Kw
- 100 Kw

Scientific Electric

DIVISION OF "S" CORRUGATED QUENCHED GAP COMPANY

119 Monroe Street Garfield, New Jersey

Manufacturers of Vacuum Tube and Spark Gap Converters since 1921

PAINSTAKING attention to details that are too often considered unimportant, is a sterling feature of HAINES production. HAINES windings, for example, are not only uniformly tight and evenly spaced, but the wire strands are kept absolutely clean during our unique winding process. This permits thorough bonding of the enamel coating with wire, terminals and cores. Just a trifle . . . but how tremendously important to you!

New Catalog Ready . . . In Writing Be Sure to Address Department 4

CABLE ADDRESS
HAINMANCO

HAINES
M. C.
FOR PRECISION

TELEPHONE
EVERGREEN 8-0036

HAINES MANUFACTURING CORP.

"Electronic Components"

248-274 McKIBBIN STREET

BROOKLYN 6, N.Y.

DESIGN + STATISTICS = QUALITY

Statistical Methods in Quality Control

Most of our advertisements have mentioned Quality Control of our products, using statistical methods—several have featured our use of this relatively new and powerful control technique.

Today we present our newest data book—"Statistical Methods in Quality Control." This book is the outgrowth of our own experience with statistical methods.

The 80 pages of this book are exact reproductions of data sheets selected from our own data book which is used by our own inspection department. It contains charts, graphs, sample calculations, formulas and includes actual analyses of test and production data by frequency distributions, correlation and control charts.

The data contained in this new book was written to be understood and used by our own personnel and is particularly suited for organizations interested in initiating or advancing their own quality control programs.

A limited number of copies have been printed and are available only to chief inspectors and engineers responsible for quality control—who request it on their company letterhead.

The original Hunter data book covering the design of mechanical springs is still available to engineers and designers. Over 5000 copies of this popular data book have already been issued.

No charge, of course, for either book.

HUNTER
Science in Springs

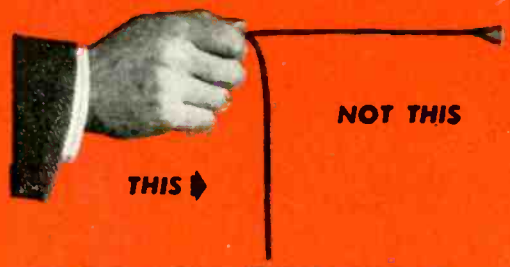
HUNTER PRESSED STEEL COMPANY, LANSDALE, PENNA.

BH NON-FRAYING FIBERGLAS SLEEVING

BH *EXTRA FLEXIBLE* FIBERGLAS SLEEVING

2 WAYS BETTER

NON-FRAYING



NON-STIFFENING

ASSEMBLERS and electricians don't have to be contortionists when working with non-fraying BH *Extra Flexible* Fiberglas Sleeving. Remarkably resistant to stiffening, this always supple insulation won't crack or rot with age. Whether in tough, active service or dead storage, it remains "fresh" and easy to work, retaining its full insulating efficiency *indefinitely*.

This special-processed sleeving won't burn and is non-crystallizing at low temperature. It offers all the natural advantages of Fiberglas—high dielectric and tensile strength—chemical and moisture resistance—and many more—in addition to its own unusual properties.

You'll want to see for yourself the cleaner cutting, non-fraying and non-stiffening features of the sleeving that simplifies assembly, lasts longer and cuts repair costs. BH *Extra Flexible* Fiberglas Sleeving is available in all standard colors. Sizes from No. 20 to ⅝", inclusive. Write for *your* samples today and compare!

BH SPECIAL TREATED FIBERGLAS SLEEVING FLEXIBLE AS STRING!

Here's another high quality BH Fiberglas Sleeving. Due to the BH exclusive process no saturant is used, yet it will not fray out when cut and will withstand heat up to 1200°F. Made in natural color only—all standard sizes. Test it and try it!

BH PRODUCTS

NON-BURNING IMPREGNATED MAGNETO TUBING • NON-BURNING FLEXIBLE VARNISHED TUBING • SATURATED AND NON-SATURATED SLEEVING

BENTLEY, HARRIS MANUFACTURING CO.

Dept. I, Conshohocken, Penna.

SANTAY CORPORATION

FORMERLY SINKO TOOL & MANUFACTURING CO.

351-359 NORTH CRAWFORD AVENUE • CHICAGO 24, ILLINOIS

REPRESENTATIVES: POTTER & DUGAN, INC., 29 WILKESON STREET, BUFFALO 2 • PAUL SEILER, 7779 CORTLAND AVENUE, DETROIT 4 • QUEISSER BROS., 108 E. NINTH STREET, INDIANAPOLIS 2

Santay Corporation introduces its new trademark–

"Symbol of Precision Craftsmanship!"

Whenever you see it associated with a thermoplastic product, metal stamping or electro-mechanical assembly, you'll know that Santay's specialized precision craftsmanship has been and always will be employed to give you the greatest possible satisfaction.

They wanted TOY-SIZE fastenings able to withstand BIG-GUN CONCUSSION

¾" long, .037" dia.
140 threads to inch

. . . and for these threaded "pin size" parts they chose a strong, corrosion-resistant INCO Nickel Alloy

The enemy isn't the only one to feel the shattering shock of a naval broadside. When the big guns thunder, everything aboard ship takes a beating.

Yet delicate vital instruments must function without a hitch. Every part . . . even the tiniest . . . must be able to withstand the tremendous concussion.

One such part in an essential instrument, is a fastening the size of a common pin . . . approximately ¾" long, .037" in diameter with 140 threads to the inch.

The metal chosen for this fastening needs:

corrosion-resistance, a necessity for sea-going equipment
strength and toughness, to hold up under shock.
machinability, to permit speedy, economical machine production.

All of these requirements add up to "R" Monel . . . the corrosion-resistant alloy for parts where extra machinability is important.

* * *

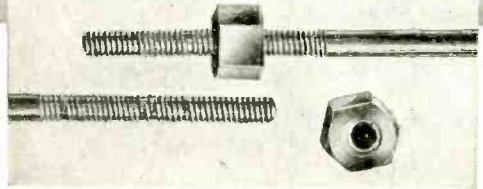
This use of "R" Monel is cited as an example of how INCO Nickel Alloys . . . such as "R" and "KR" Monel . . . often do the trick where a *unique combination* of properties is required.

If you have a problem involving metals . . . for equipment now in production, or planned for post-war . . . consult INCO Technical service. Write:

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York 5, N. Y.

Official U. S. Navy Photograph

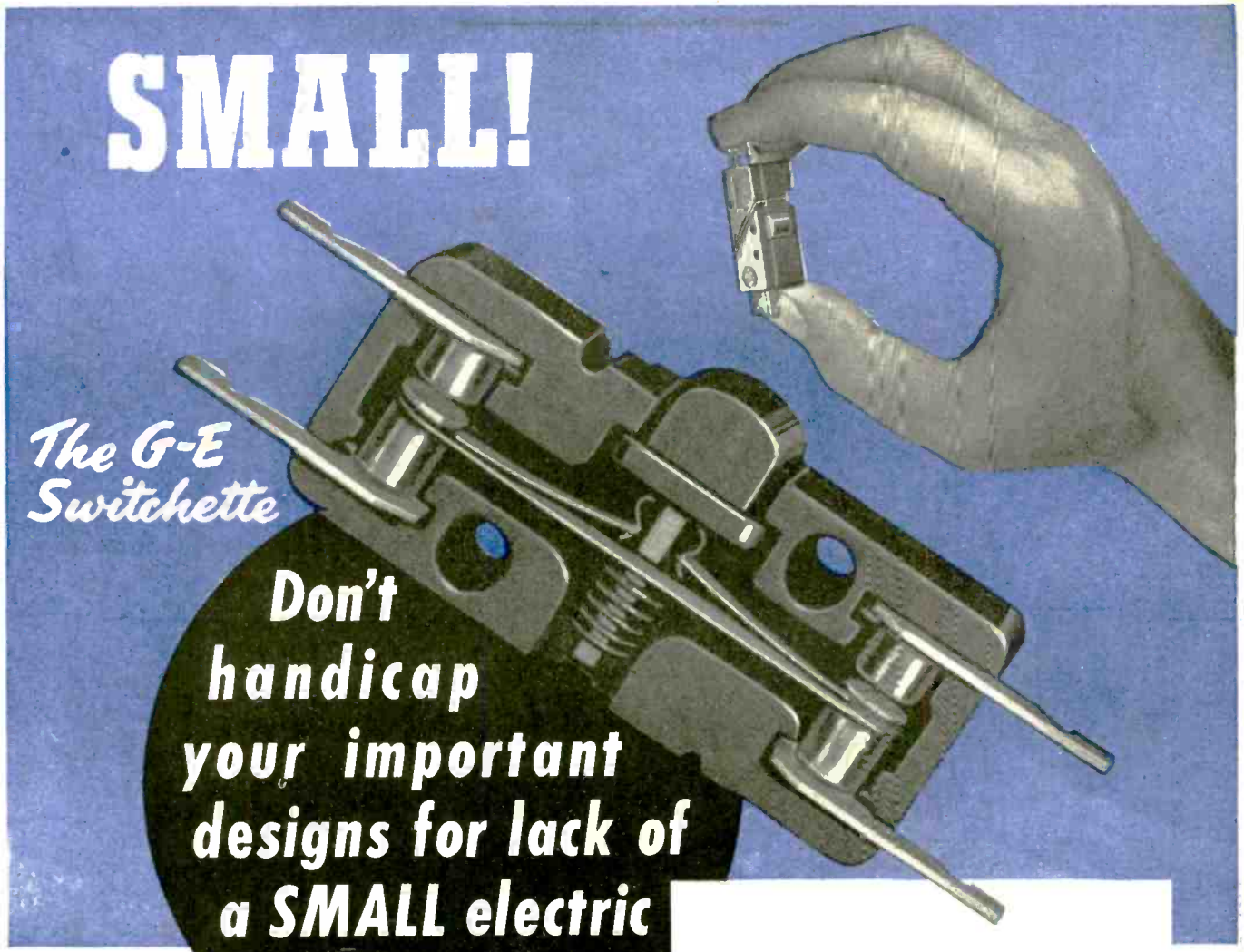
140 THREADS TO THE INCH, *shown in this enlarged photograph demonstrate the remarkable machinability of strong, corrosion-resistant "R" Monel. ("KR" Monel is suggested for applications where extra hardness is required.) The fastenings are machined from .037" diameter cold-drawn "R" Monel.*



INCO NICKEL ALLOYS

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • "Z" NICKEL • NICKEL
Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings

SMALL!



The G-E Switchette

Don't handicap your important designs for lack of a SMALL electric switch

● Here's an inside view of the tiny, versatile G-E Switchette, enlarged to show you the double-break contact construction, which makes possible many ingenious wiring arrangements to solve tricky circuit problems. This is a standard form for controlling one normally open and one normally closed circuit. Variations of this arrangement are available to provide control of a single circuit, either normally open or normally closed. Other modifications include a form for simultaneously opening two circuits and closing one, or vice versa; also single-break forms for more sensitive operation.

BECAUSE of its unusually small size and light weight, its lightning-fast snap action, and its long life, the G-E Switchette is becoming more and more popular with designers for circuit control where space is at a premium.

Switchettes are available in ratings up to 10 amperes at 24 volts d-c (230 volts a-c), are provided with solder-lug terminals for wiring. They meet government specifications covering corrosion and vibration resistance, and operate at altitudes up to 50,000 feet and in ambient temperatures from 200 F to −70 F.

More than 200 modifications have already been developed to meet special circuit requirements and to fit into special mechanical arrangements. Dimensions, operating characteristics, and ordering directions for standard Switchettes and many typical modifications are given in our new catalog, No. GEA-3818C. For your copy, mail the coupon. If you don't find the forms you need in the catalog, our engineers will be glad to work with you in adapting Switchettes to meet your requirements.

GENERAL ELECTRIC

SWITCHETTES

GENERAL ELECTRIC COMPANY, SECTION 8676-141
SCHENECTADY 5, NEW YORK

Please send me Bulletin GEA-3818C giving dimensions, ratings, and operating characteristics of Switchettes

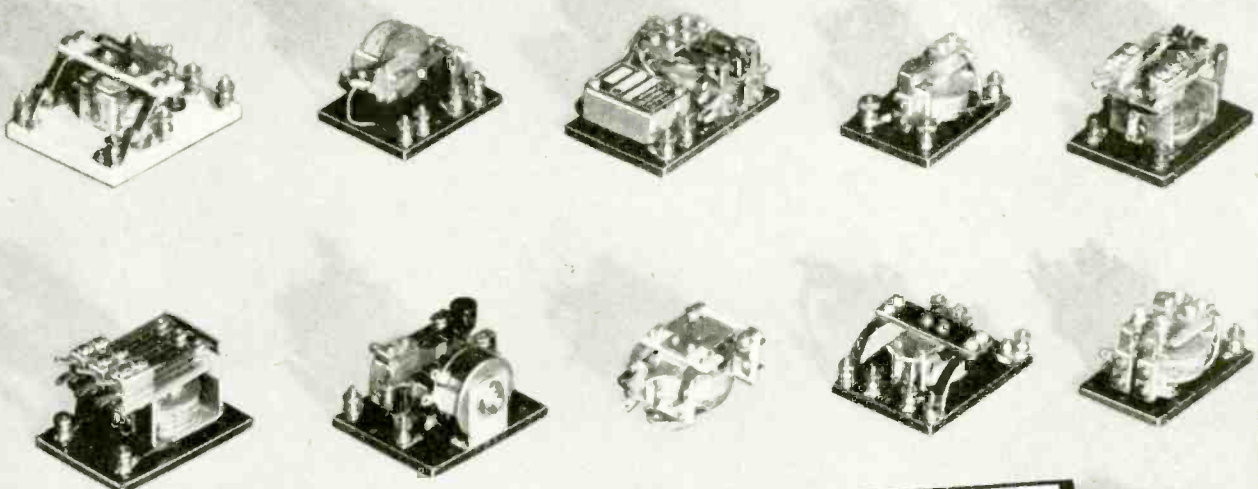
NAME .....

COMPANY .....

ADDRESS .....

CITY ..... STATE .....

Buy all the BONDS you can — *and keep all you buy*



CO-OPERATIVE ENGINEERING FOR NEW RELAY APPLICATIONS

SIMPLIFY your product development and manufacturing problems by calling on Advance Engineers for the close co-operation they are prepared to give you *immediately*. This service not only applies to adaption of one or more of the forty basic types of Advance Relays, which are usually directly applicable to most modern electrical control requirements, but may be utilized for the development of special test models. In any event, you will have the best of relays, exactly as you want them. Write today.

In every branch of the Army and Navy, Advance Relays are dependable components of many types of electrical equipment. Factory production is still all-out for War, but Engineering Service for Post-War products is available *now*.

Advance Relays

ADVANCE ELECTRIC & RELAY CO.

1260 WEST SECOND STREET • LOS ANGELES 26, CALIFORNIA

File This For Reference...

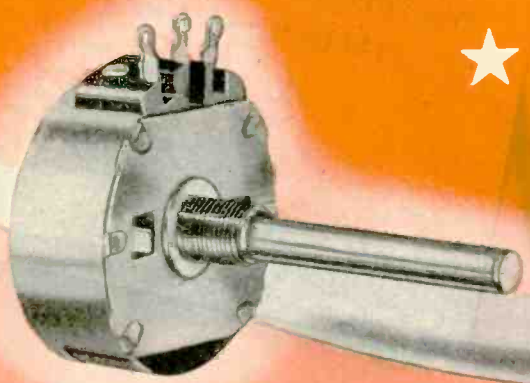
USEFUL INFORMATION ABOUT PRESENT-DAY AND FUTURE APPLICATIONS OF QUARTZ OSCILLATOR PLATES

Here is common-sense, understandable data about the characteristics, production, and adaptation of quartz crystals. Graphically illustrated, these papers are combined in a convenient file for instant accessability. Write for your copy today.

Crystal
PRODUCTS COMPANY
1519 McGEE STREET, KANSAS CITY, MO.

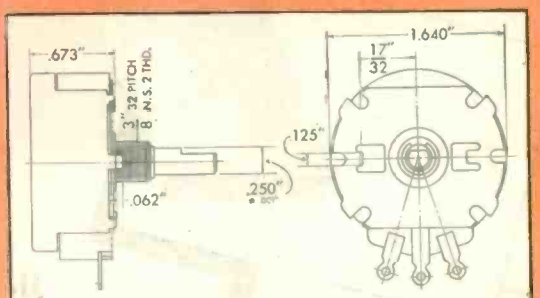
Producers of Approved Precision Crystals for Radio Frequency Control

New VARIABLE RESISTOR



★ Chicago Telephone Supply Company now offers a new 1⅝" diameter, wire wound variable resistor, 352 Series, with resistance value up to 20,000 ohms linear and with the same bakelite housing and grounded metal construction as the popular 1¼" 252 Series. This potentiometer may be used with switches attached and in tandem construction.

This new resistor is another expression of the many years of intensive research and development behind Chicago Telephone Supply Company, a scientific manufacturing organization devoted to high standards in the mass production of variable resistors, both wire wound and carbon types.



NO. 352 SERIES VARIABLE WIRE WOUND RESISTOR

Manufacturers of Quality Electro Mechanical Components Since 1896

VARIABLE RESISTORS, PLUGS AND JACKS

SWITCHES, TELEPHONE GENERATORS, RINGERS

REPRESENTATIVES
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Kansas City 8, Missouri
Phone: Victory 3070

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CTS

CHICAGO TELEPHONE SUPPLY
Company

ELKHART ★ INDIANA

BRANCH OFFICES
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Philadelphia 8, Pennsylvania
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IN CANADA
C. C. Meredith & Co.
Streetsville, Ontario

Extensive

STOCKS OF FIBERGLAS TAPES

are available at M-R

"Electrical Insulation Headquarters"

for IMMEDIATE DELIVERY

and

Complete Protection

of your

Electrical Equipment

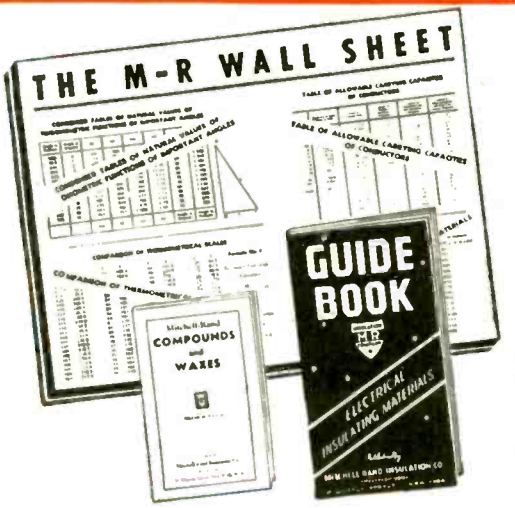
MITCHELL-RAND *for* 55 YEARS THE ELECTRICAL INSULATION HEADQUARTERS

Overloading . . high or low temperatures . . moisture . . corrosive acids, vapors or fumes . . oils . . greases . . dust or dirt, the destructive elements of ordinary electrical insulations WON'T AFFECT M-R FIBERGLAS INSULATION.

The success story of Fiberglas Insulation abounds with fewer breakdowns, less maintenance, elimination of waste, savings in labor and materials and proves its value as the optimum in electrical insulation protection.

Widths range from ⅜ to 1½ inches; Thicknesses: .003"–.005"–.007" and .010".

Tensile Strength: extraordinary — example — tape ½" wide and .003 thick — 80 pounds.



FREE FOR THE ASKING

A Sample Card of Varnished Tubings; samples to fit sizes from B&S wire #20 (.032") to #0 (.325") . . . a Wall Chart with quick easy to read reference tables of electrical symbols, capacity of conductors, dielectric averages of insulating materials, mathematical tables, tap drill sizes, standards of varnished tubing sizes . . . Wax and Compound Guide Book and the M-R Book of Electrical Insulations . . . all are Free for your asking . . . *write for them on your letterhead.*

Obtain your Fiberglas Electrical Insulation from

MITCHELL-RAND

ELECTRICAL INSULATION HEADQUARTERS FOR 55 YEARS

Write for booklet describing Fiberglas and its electrical insulation uses and properties.

MITCHELL-RAND INSULATION COMPANY, INC.

51 MURRAY STREET COrtlandt 7-9264 NEW YORK 7, N. Y.

A PARTIAL LIST OF M-R PRODUCTS

Fiberglas Varnished Tape and Cloth
Insulating Papers and Twines
Cable Filling and Pothead Compounds
Friction Tape and Splice
Transformer Compounds

Fiberglas Braided Sleeving
Cotton Tapes, Webbings and Sleevings
Impregnated Varnish Tubing
Insulating Varnishes of all types

Fiberglas Saturated Sleeving and Varnished Tubing
Asbestos Sleeving and Tape
Extruded Plastic Tubing
Varnished Cambric Cloth and Tape
Mica Plate, Tape, Paper, Cloth and Tubing

Would You Pay A WHOLE DOLLAR for your daily paper?

THAT man is here again! The guy who used to say "I can get it for you wholesale" now whispers: "I can get it for you WITHOUT RATION COUPONS . . ." The sad thing is that—he CAN. But, oh, what a price you pay!

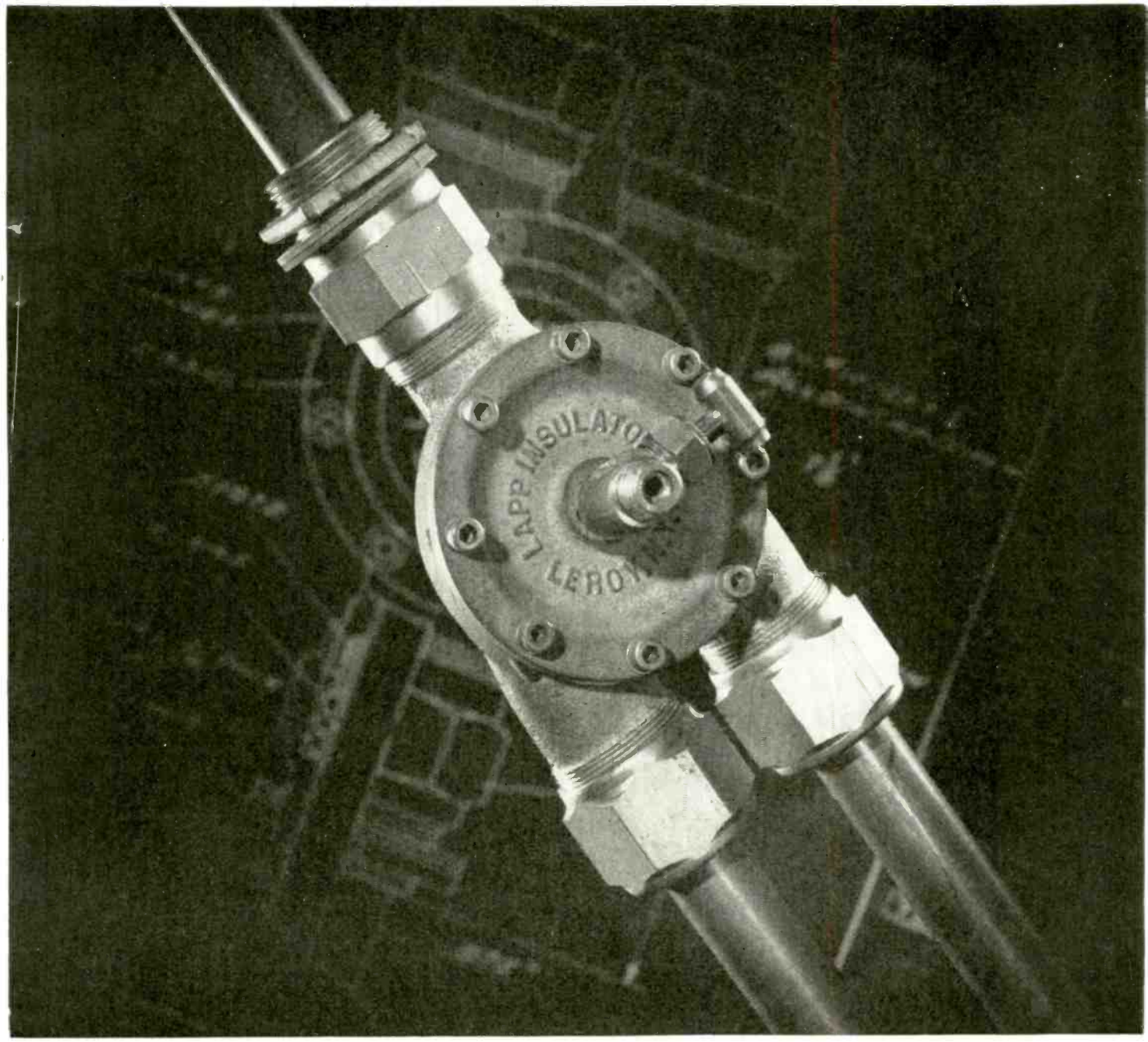
You can't beat arithmetic. If there are ten refrigerators for sale and a hundred eager bidders for them, the seller is going to nick those ten buyers for *all the traffic will bear!* Then prices soar . . . the dollars that buy those refrigerators drop in value. Too few goods, too much money on the loose, connive to breed the worst of all national dangers: INFLATION. A 100-cent dollar sinks to 5c—or less—in buying power! Uncontrolled prices . . . *less* for your hard-earned money! A drop in the value of your savings account, of your insurance, of everything you own. Would you like to pay a whole dollar for your daily paper?

"Ration coupons?" Oh, nuts! "Ceiling prices?" "Listen, fella, I can get you what you want—for only a few dollars more . . ." Don't you believe him. He can't, *really!* You may not give up ration coupons THIS time, but you may have to give up MUCH more in the long run. The unhappy spiral of inflation can put every thing you want and need 'way beyond your price-reach! Don't let this happen to *you*—your neighbors, your entire nation. Instead, for a FAIR share at a FAIR price, take the Consumers' Pledge of Fair Play, and LIVE UP TO IT: "I will pay no more than ceiling prices; I will take no rationed goods without giving up ration coupons." DEFEAT the scourge of Inflation!

THE MARK OF EXCELLENCE

Here at Kenyon, we're proud to play our small role on the stage of a BIG war. That's why EVERY Kenyon transformer used by our fighting forces throughout the world reflects only the highest precision craftsmanship. Kenyon workers are doing their share — bringing Victory closer by turning out top quality transformers *uninterruptedly*—and as fast as possible!

KENYON TRANSFORMER CO., Inc. 840 BARRY STREET NEW YORK, U. S. A.



Electronic Parts: ENGINEERING AND PRODUCTION

The gadget above is a junction box for a co-axial gas-filled transmission line. It is one of a series of coupling units, end seals and other fittings for high-frequency transmission—designed and built by Lapp.

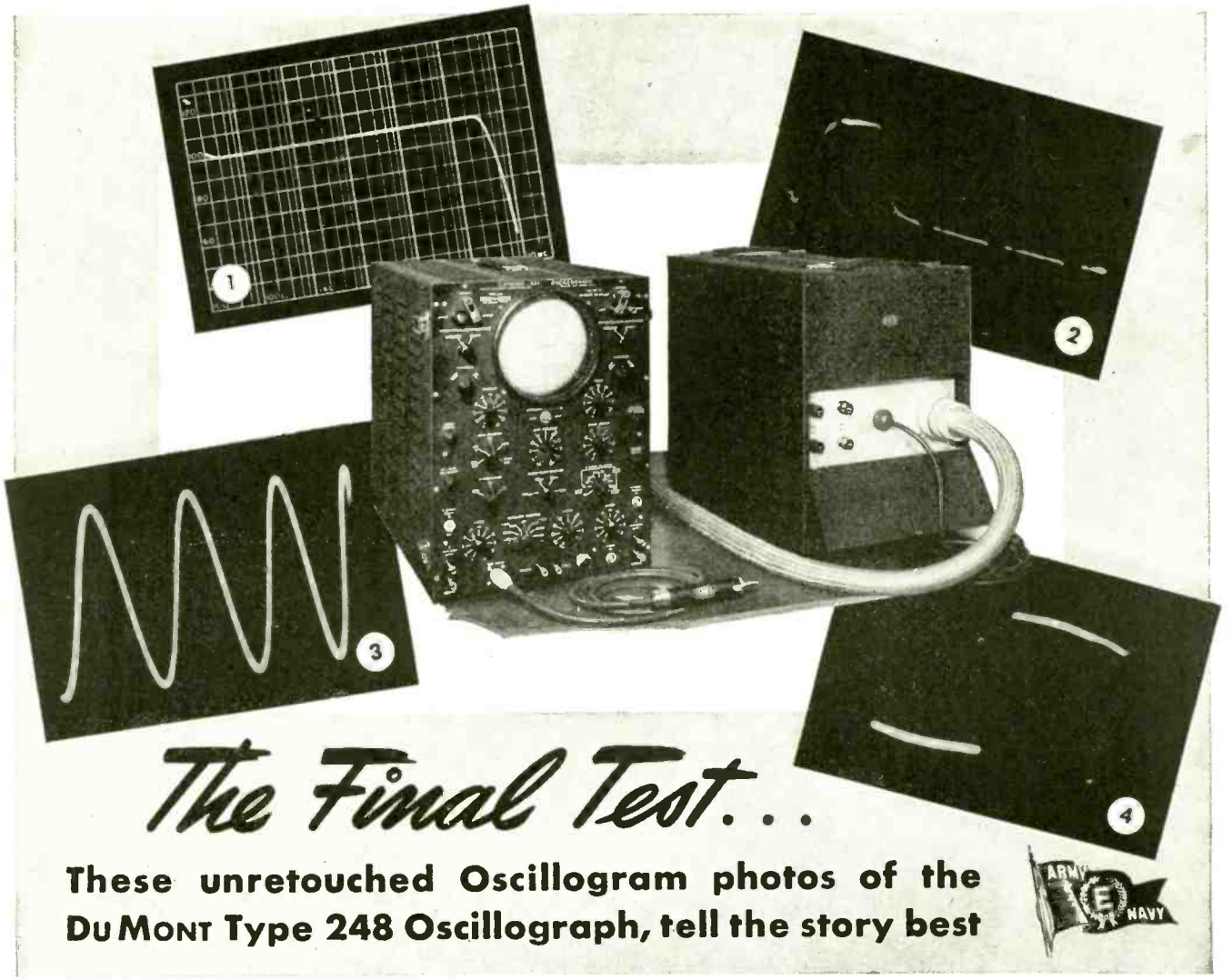
To this type of construction, Lapp brings several innovations and improvements. For example, such a line from Lapp parts is genuinely leak-proof. Every gasket is under spring loading, so there's no leakage created by vibration or thermal change.

Whether or not you're interested in gas-filled transmission lines, you ought to know about Lapp. Here is an organization of engineers and manufacturers with broad basic knowledge of ceramics and their application. With experience in hundreds upon hundreds of special-purpose electronic parts, we have been able countless times to improve performance, or reduce costs, or cut production time through the application of our specialized skills to design and manufacture of parts involving porcelain or steatite and associated metal parts.

For quick and efficient assistance on a war production subcontract—or for the competitive advantage Lapp-designed and Lapp-built parts will give to you in the postwar battle—an inquiry to Lapp now may pay you dividends. *Lapp Insulator Co., Inc., LeRoy, N. Y.*

Lapp

ARMY E ** NAVY



The Final Test...

These unretouched Oscillogram photos of the DU MONT Type 248 Oscillograph, tell the story best

ARMY E NAVY

This is the DuMont Type 248 Oscillograph. As is true of all other precision instruments, it must stand or fall by its performance. Because written specifications often give little indication of how well an oscillograph meets today's critical requirements, we believe the accompanying *unretouched* photos cover points of particular interest to those who work with modern electronic circuits. To wit:

(1) Sinusoidal frequency response curve of the vertical amplifier. Free from irregularities. No rise caused by over-compensation at high end. Fall-off is gradual.

(2) The excellent transient response of this instrument is shown by absence of overshoot or other distortion in this pulse having a rise time of about 1/10th microsecond. Here the driven (or "slave") sweep is triggered by the pulse itself, which is then delayed by a self-contained distortionless network so that the leading edge is not obliterated. The one microsecond markers (or others at intervals of 10 or 100 microseconds) are blanked into the trace by an internal marker oscillator. A beam-control circuit eliminates the bright spot of the beam rest position.

(3) Continuous sweep circuit has a range when free-running of from 15 c.p.s. to 150 kc. When moderately synchronized with a signal of higher frequency, however, it will operate at much faster rates. This oscillograph shows a one megacycle sine wave at a sweep frequency of approximately 300 kc. Return trace is normally completely blanked but may be seen if necessary by fully advancing the intensity control. Notice the good linearity of this time-base as well as that of the driven sweep in (2).

(4) Correct compensation at the low end of the frequency range is illustrated by almost distortionless transmission of a 30 cycle square wave through the vertical amplifier. Compensating circuits for both low and high frequencies are carefully adjusted for optimum phase characteristics.

• • •

All of which, together with other equally convincing characteristics, boils down to this: The DuMont Type 248 Oscillograph, used on the bench or mounted on its matching streamlined truck, is an instrument without equal for laboratory, shop or production line.

Write for Literature . . .

DUMONT *Precision Electronics & Television*

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

Casting the International Meter Rods in Paris 1874. The degree of accuracy attained 1/10,000,000 of a quadrant of a terrestrial meridian.

WHO SETS THE *Quality Standard* FOR TRANSMITTING TUBES

UNITED

TRANSMITTING TUBES

IN every art or craft, the work of some acknowledged master sets the standard.

Since 1934 UNITED has won recognition by specializing exclusively in the engineering, design and building of transmitting tubes which are unchallenged for excellence. UNITED tubes excel in every electronic application . . . including radio communication, physiotherapy, industrial control and electronic heating. In these and other applications, tubes by UNITED continue to win top honors for uniformly dependable performance.

In communication equipment for airlines, commercial broadcasting, police radio stations and other vital civilian services, UNITED transmitting tubes set the standard. Accept nothing less than UNITED quality tubes for your requirements.

Order direct or from your electronic parts jobber.

UNITED ELECTRONICS COMPANY

NEWARK, 2 New Jersey

Transmitting Tubes EXCLUSIVELY Since 1934

BUILT TO WITHSTAND WHIP AND VIBRATION

Electronic Tubes used in the communications equipment of planes and ships, industrial controls, car radios and even in home sets are all subjected to vibration in varying degrees. Long life and maintained efficiency is therefore very dependent on a firmly supported mount.

The demands of war have emphasized the importance of rugged construction. To impart a new sturdiness to the mounts of miniature tubes TUNG-SOL Engineers have designed a plate construction for the 6AK5 that greatly strengthens the mount . . . in fact, it makes it virtually impossible to tilt it after the plate has been placed in position. This feature assures straight, sturdy mounts and the maintenance of close tolerances.

The many dependability features that have been designed into TUNG-SOL tubes before and during the war will be invaluable to manufacturers and users of electronic devices afterward. When you are ready to plan your post-war electronic products, have a TUNG-SOL Engineer sit in with you. His knowledge of tubes and their application will greatly simplify your job.

NEW TUNG-SOL PLATE CONSTRUCTION

The former two-piece plate in the 6AK5 tube was supported only at four points in the center. In the new TUNG-SOL one-piece plate, there are four corner supports, top and bottom. This construction provides a firm support between micas, assuring straight, sturdy mounts.

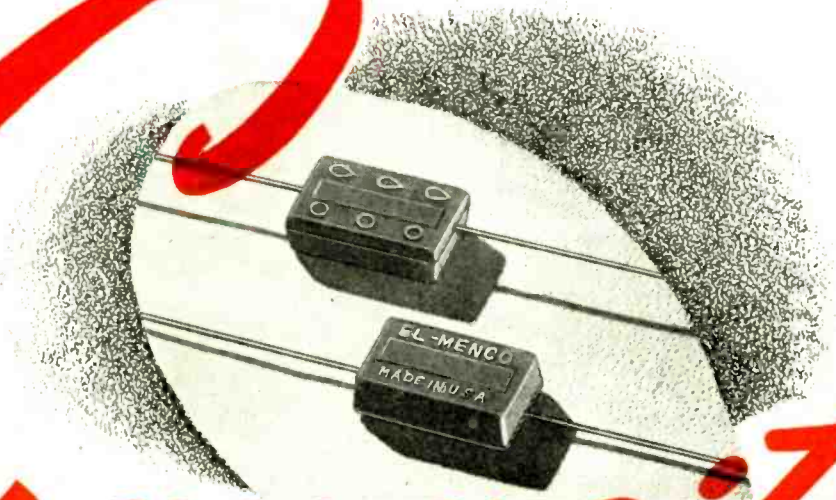
TUNG-SOL
vibration-tested
ELECTRONIC TUBES

ARMY E NAVY

TUNG-SOL LAMP WORKS INC., NEWARK 4, NEW JERSEY

ALSO MANUFACTURERS OF MINIATURE INCANDESCENT LAMPS, ALL-GLASS SEALED BEAM HEADLIGHT LAMPS AND CURRENT INTERMITTORS

Capacitors

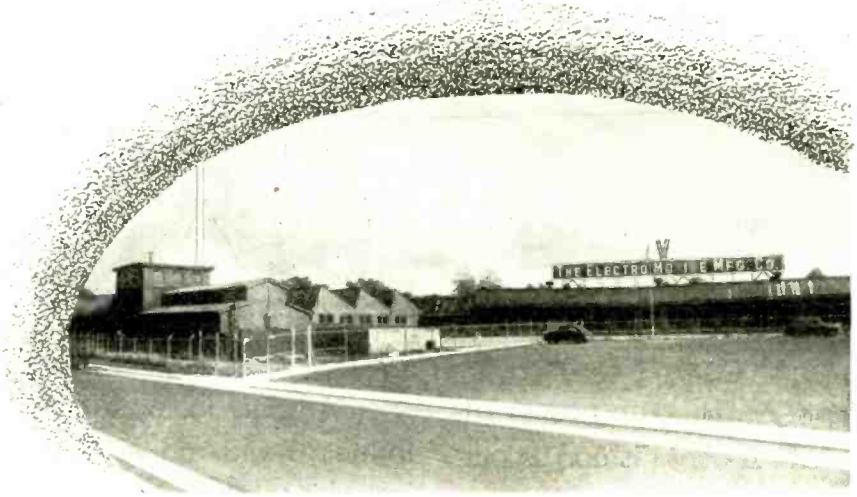


MOLDED MICA—MICA TRIMMER

Units to fit any requirement.

MADE BY

El-Menco



HONORED BY

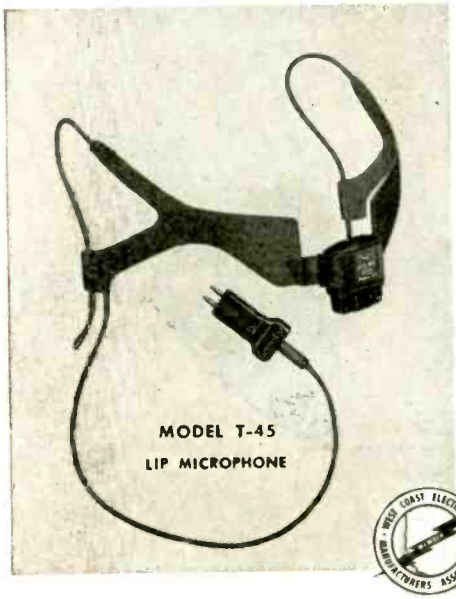
El-Menco

At countless vital points in army and navy communications equipment, El-Menco Capacitors serve unobtrusively, but with efficiency that has become a recognized standard. Electronic Equipment Manufacturers: Send today—on firm letterhead—for new El-Menco catalog.

THE ELECTRO MOTIVE MFG. CO. WILLIMANTIC, CONN., U. S. A.

History of Communications, Number Nine of a Series

MILITARY COMMUNICATIONS BY TELEPHONE



During the Spanish-American War the telephone as a means of electronic voice communication met with favor and played a vital part in military action for the first time. Replacing men and horses, a telephone message could cross and recross enemy territory by wire without delay and cost of life.

Today, telephones in the office and home life of the average American have been an instrumental force in our higher standard of living.

Universal, manufacturing microphones and other voice communication components for the allied forces, will again after Victory is ours, stock dealers' shelves with the Universal components you have been waiting for. Until then — *Buy War Bonds.*

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

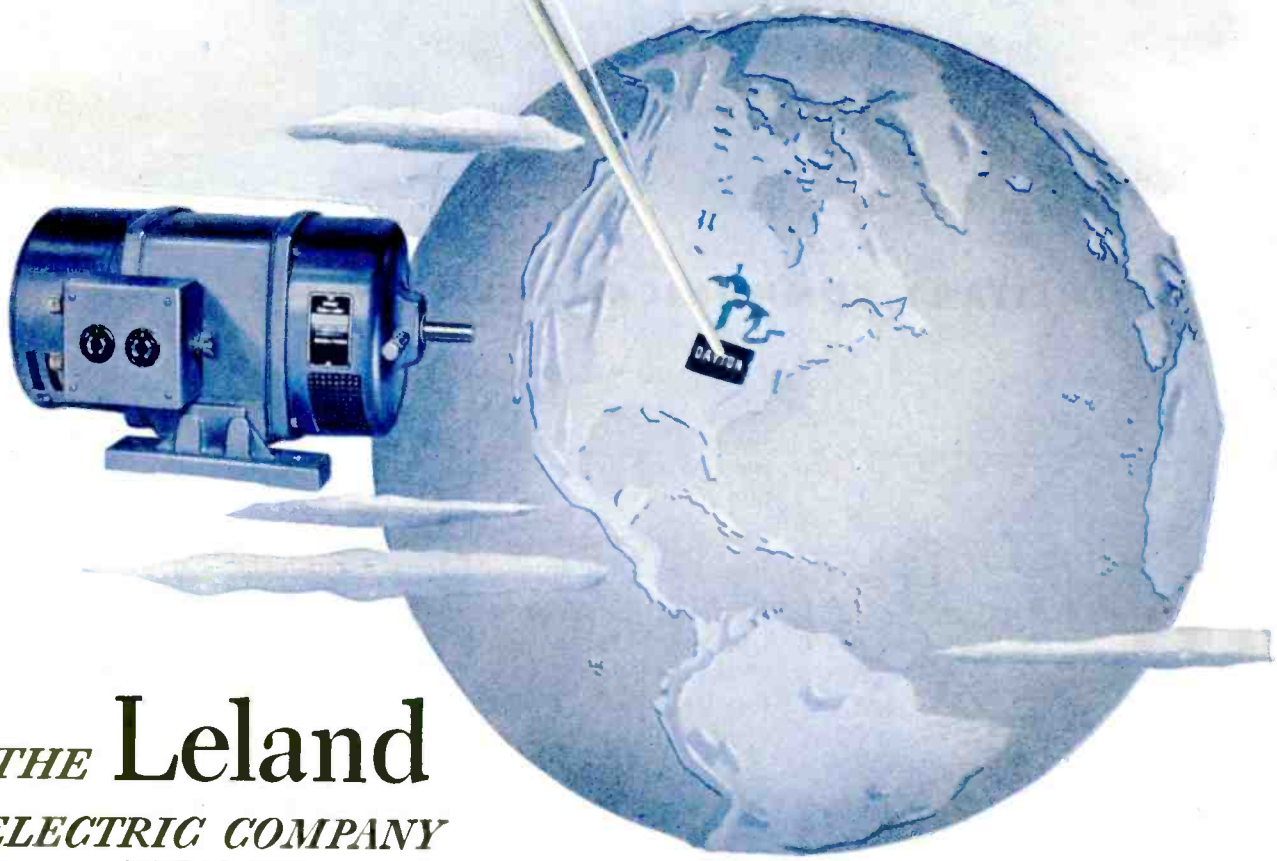
FOREIGN DIVISION: 301 CLAY STREET, SAN FRANCISCO 11, CALIFORNIA ·· CANADIAN DIVISION: 560 KING STREET WEST, TORONTO 1, ONTARIO, CANADA

CREATIVE ELECTRICAL ENGINEERING

There are few industries in which post-war planning does not involve *Creative Electrical Engineering* ability of the highest order. The exacting competitive situation developing demands topnotch skill.

On its record, LELAND Electric has earned your consideration. Our experience and ingenuity in solving tough electrical problems may prove immensely valuable to you.

We invite you to consult with us.



THE Leland
ELECTRIC COMPANY

DAYTON 1, OHIO

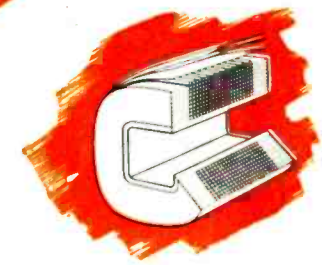
In Canada: Leland Electric Canada Ltd., Guelph, Ontario

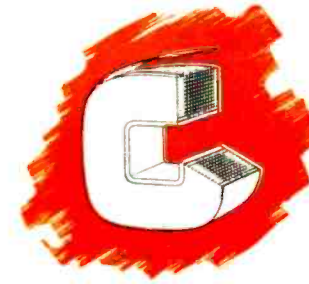
Alternator

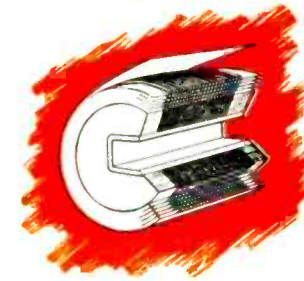
Self-excited, can be used with electric motor or gasoline drive, up to 2½ KW output, general purpose electric power supply.

Anaconda Paper Section Coils

...all standard and special types







THE PAPER SECTION construction used by Anaconda is exceedingly flexible and a wide variety of coils can be made by this method. Standard Paper Section Coils may be wound on round, square or rectangular cores. The thickness of the inner layer of the paper is especially selected to suit the size of wire used for the winding.

In addition, special types of Paper Section Coils are designed for high voltages, ranging up to 85,000 volts or more, such as in the case of X-ray transformers.

Anaconda High Voltage Paper Section Coils are made with special methods of insulation and construction to accommodate high potentials. For example, the paper margin is substantially larger; the number of inter-layer paper wraps is graded throughout the coil; the inner and outer layers of wire are usually wound with increased pitch to separate the individual turns; the type of paper used is carefully selected to meet specific conditions.

Paper Section Coils are one of the many fine *engineered* products of Anaconda. Any of our sales offices will be glad to refer inquiries to our coil engineering staff. 44238

Magnet wire and coils

ANACONDA

ANACONDA WIRE & CABLE COMPANY

GENERAL OFFICES: 25 Broadway, New York 4 — *Subsidiary of Anaconda Copper Mining Company*

CHICAGO OFFICE: 20 North Wacker Drive 6 • Sales Offices in Principal Cities

. . . in Directional Microphones

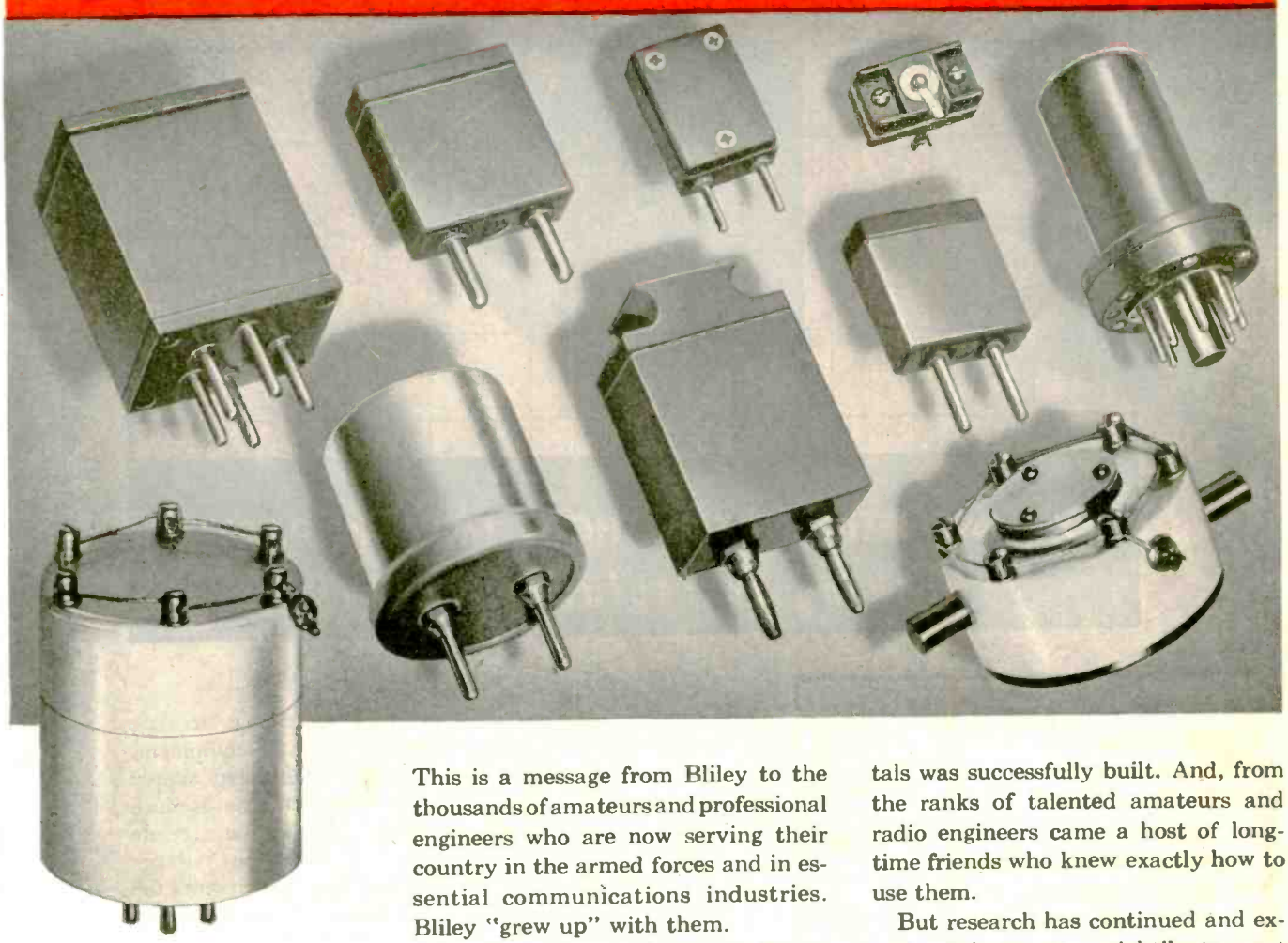
It is not enough to design a Microphone that merely converts sound waves into electrical impulses. A Microphone, to be truly useful in modern broadcasting, should be discriminating enough to accept wanted sounds —and reject unwanted sounds. Shure Research was the first to develop a single unit uni-directional Microphone, both crystal and dynamic.

Shure Research is the reason why practically every major broadcasting station uses the Shure 556 Unidyne. Shure Research is your assurance of postwar microphone superiority.

SHURE BROTHERS, 225 West Huron Street, Chicago
Designers and Manufacturers of Microphones and Acoustic Devices

SHURE MICROPHONES

In QUARTZ CRYSTALS, the most significant advancements have been introduced by Bliley



This is a message from Bliley to the thousands of amateurs and professional engineers who are now serving their country in the armed forces and in essential communications industries. Bliley "grew up" with them.

To these men and women Bliley crystals are still a familiar sight. They recognize, in the military crystal units used by our armed forces, many basic features that were pioneered by Bliley for application in peacetime services.

When tremendous production was demanded by our armed forces Bliley had the engineering background, the facilities and the production experience to provide a firm corner stone on which this volume production of radio crystals was successfully built. And, from the ranks of talented amateurs and radio engineers came a host of long-time friends who knew exactly how to use them.

But research has continued and experience has grown mightily to meet the challenge of war requirements. With the return to peace, and relaxation of wartime restrictions there will be better Bliley crystals for every application as well as new Bliley crystals for the new services that loom on the horizon. That's a promise.

To our old friends, amateurs and professional engineers, we say, "Look to Bliley for crystal units that embody every advanced development."

Bliley CRYSTALS

Do more than before . . .

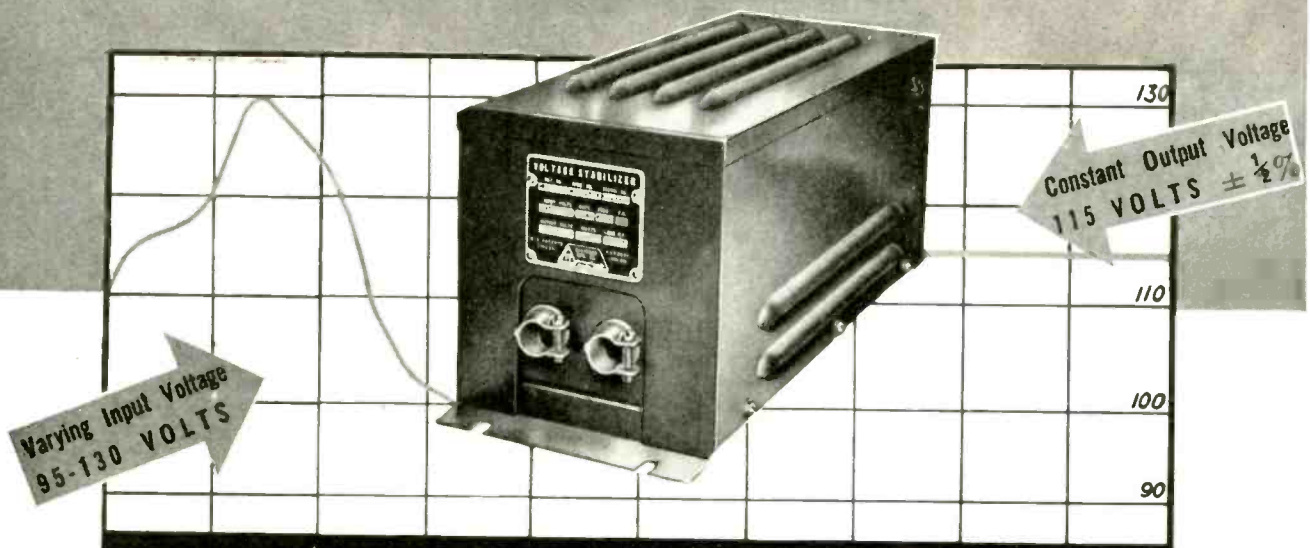
buy extra War Bonds

BLILEY ELECTRIC COMPANY

UNION STATION BUILDING · ERIE, PENN.

RAYTHEON VOLTAGE STABILIZERS

CONTROL FLUCTUATING VOLTAGE TO ± ½%



A MAGNETIC UNIT WITHOUT MOVING PARTS

Nothing to replace or adjust

FOR

- Television
- Colorimeters
- Radar & Radio
- Signal Systems
- X-Ray Machines
- Sound Recording
- Electronic Devices
- Testing Equipment
- Photo-Cell Devices
- Production Machinery
- Constant Speed Motors
- Motion Picture Equipment
- Communications Apparatus
- Precision Laboratory Apparatus
- Other Applications Requiring Regulated Voltages

New Stabilizer bulletin DL48-537. Contains operating characteristics, graphs and complete specifications. Write for your copy, today.

Constant AC voltage is essential for reliable, accurate operation of a wide variety of electrical equipment. When these devices are connected to ordinary supply mains, the unstabilized input voltage often varies as much as from 95 to 130 volts thus impairing the accurate operation of the equipment. A Raytheon Voltage Stabilizer, incorporated into the product, overcomes the disadvantages of fluctuating line voltages by providing an accurately controlled source of power held to ± ½%.

Entirely automatic in operation, the Raytheon Voltage Stabilizer has no moving parts . . . nothing to wear out, consequently requires no maintenance. Simply connect it to line and from there on it will take care of itself.

Raytheon Voltage Stabilizers built-in new equipment or offered as an accessory not only improve the performance but also increase the salability of the product.

Users of many types of electrical equipment not having voltage stabilization will find that Raytheon Voltage Stabilizers improve the performance and reliability of their equipment.

Raytheon Voltage Stabilizers are equally suitable for use in equipment for the laboratory, production or unattended locations.

RAYTHEON
MANUFACTURING COMPANY
190 WILLOW STREET, WALTHAM, MASS.

MANUFACTURERS OF VOLTAGE STABILIZERS, RECEIVING AND TRANSMITTING TUBES AND COMPLETE ELECTRONIC EQUIPMENT

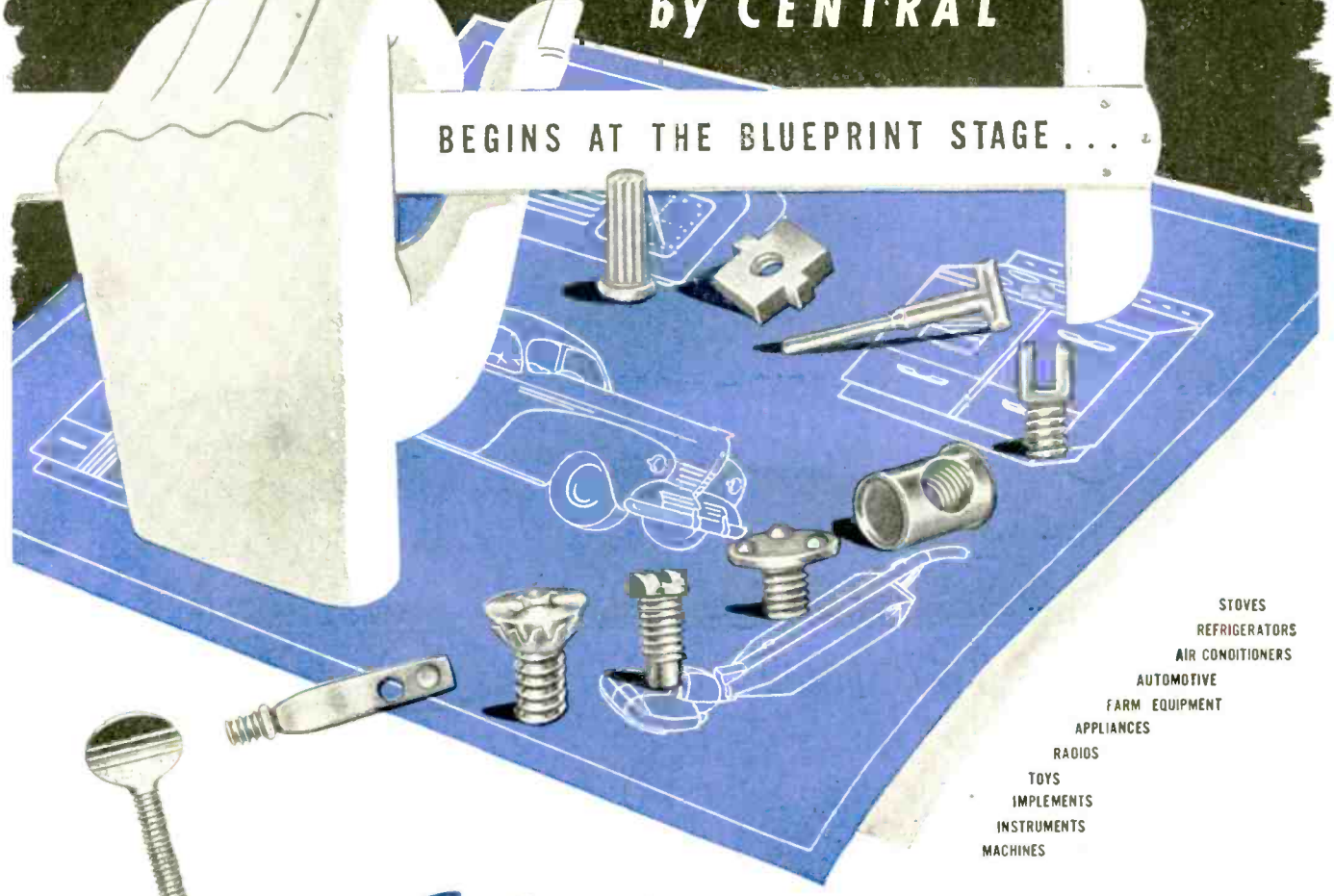
The coveted Army-Navy "E", for Excellence in the manufacture of war equipment and tubes, flies over all four Raytheon Plants where over 15,000 men and women are producing for VICTORY.

Fasteneering

TRADEMARK REG. U. S. PAT. OFF.

by CENTRAL

BEGINS AT THE BLUEPRINT STAGE . . .



STOVES
REFRIGERATORS
AIR CONDITIONERS
AUTOMOTIVE
FARM EQUIPMENT
APPLIANCES
RADIOS
TOYS
IMPLEMENTS
INSTRUMENTS
MACHINES

Fasteneering — make note of the name . . . Fasteneering by Central Screw Company. When peacetime products appear on the postwar market, Fasteneering shall be associated with the successful development and sale of many well-known items of everyday use.

WHAT IS FASTENEERING? It is a technique developed through years of experience at Central Screw Company, a method that simplifies your complex assembly at the blueprint stage, that creates parts designed especially for your assembly and produces them in large quantities by the cold forged process at remarkably low costs.

Examine the items shown on this page. They are typical Fasteneered units made by the "cold upset" method. Although they resemble machined parts, they are brighter in appearance—stronger under torsion—cost much less. Send today for New 8-Page Booklet illustrating a wide variety of special operations and parts that will enable you to visualize "Fasteneering" as applied to your product. No obligation. Write

STANDARD PRODUCTS:

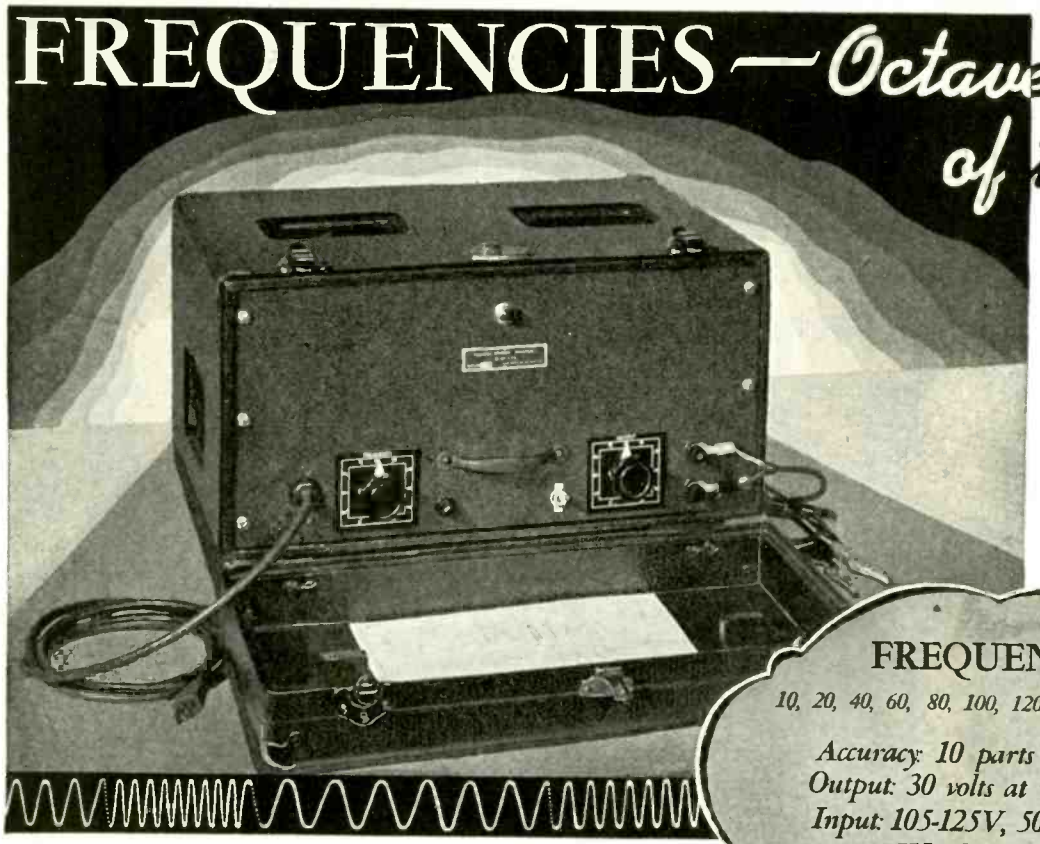
MACHINE SCREWS
STOVE BOLTS
LOCKWASHER SCREWS
SELF-TAPPING SCREWS
MACHINE SCREW NUTS · WING NUTS · THUMB SCREWS · CARRIAGE BOLTS · MACHINE BOLTS · RIVETS · STUDS · RODS

You can depend on Central

CENTRAL SCREW COMPANY

3523 SHIELDS AVENUE • CHICAGO 9, ILLINOIS

STANDARD FREQUENCIES—Octaves of them



FREQUENCIES

10, 20, 40, 60, 80, 100, 120, 140, 160, 180, 190

Accuracy: 10 parts in 1,000,000
Output: 30 volts at 500,000 ohms
Input: 105-125V, 50-60c., 40 watts
Weight: 50 pounds

Impossible? Well, here it is—

This Multi-frequency generator furnishes the frequencies shown above at the turn of a switch. All frequencies are obtained from a temperature-compensated tuning fork and voltage-stabilized circuit.

With this unit it is possible to calibrate oscillators at many selected points without encountering complex oscilloscope patterns. One of the uncertainties involved in development work on tuned circuits, filters, reeds—and in time measurement can be minimized with the aid of this instrument.

Developed primarily to check frequency meters for precision war work, this Multi-frequency generator possesses a rugged durability and dependability in service that will prove an extra value to many laboratories.

Additional information available on request.

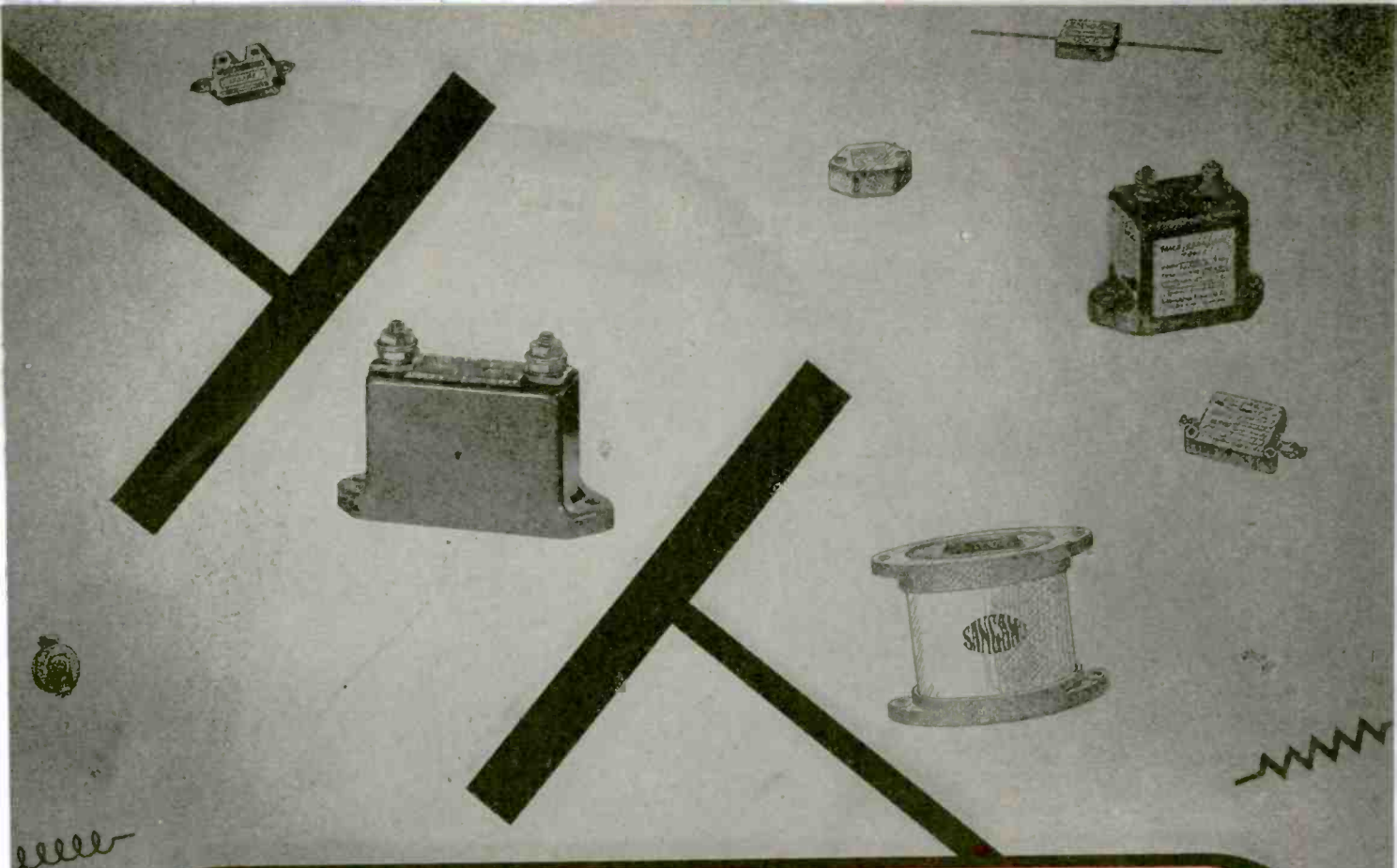
Manufacturer of the

Watch Master

and distributor of
Western Electric
Watch-rate Recorders

American Time Products, INC.

580 Fifth Avenue New York 19, N. Y.

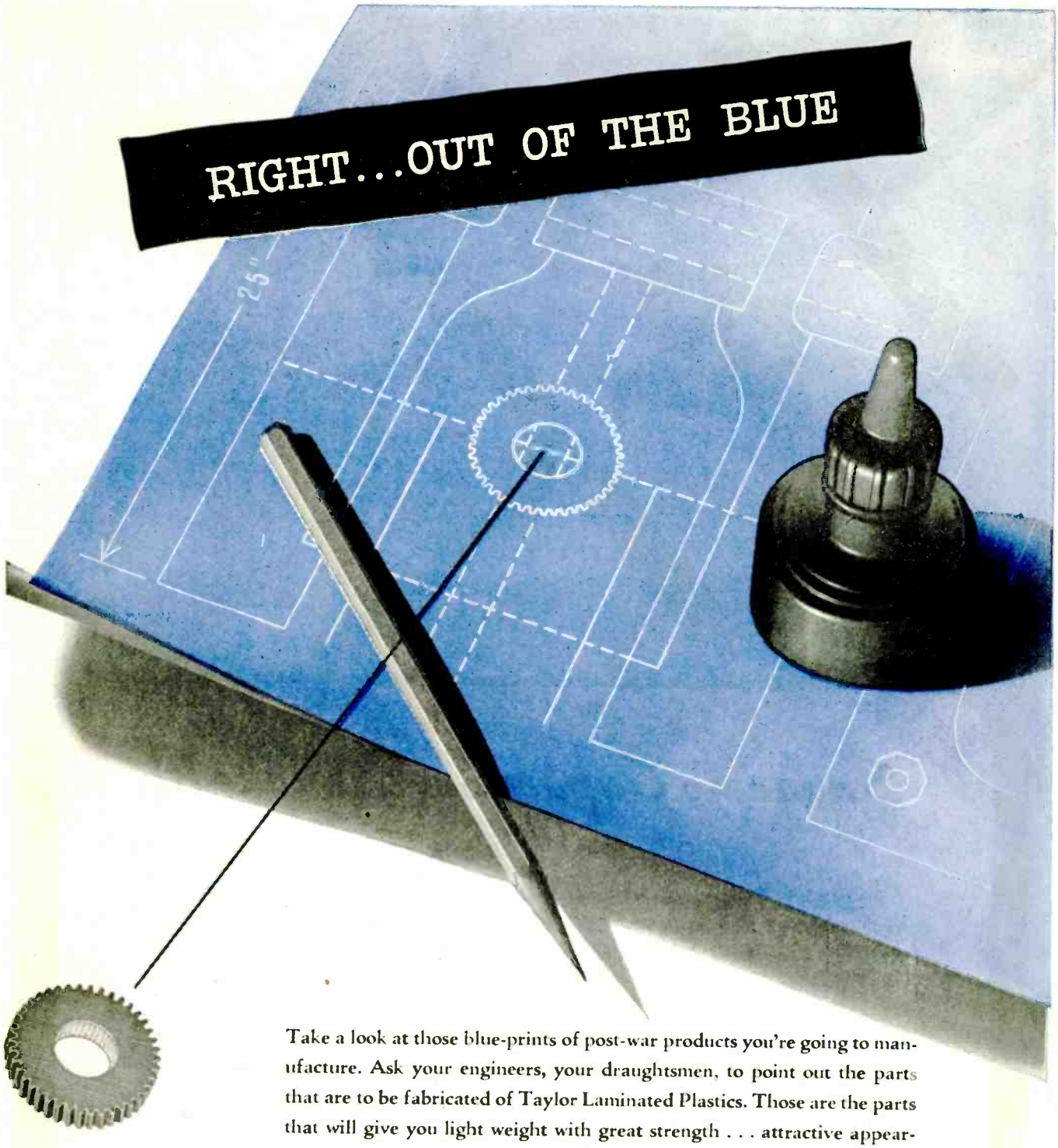


Sangamo Capacitors Can Take It!

Sangamo Type FI capacitors were designed particularly to meet the critical capacitor requirements of medium and low-powered transmitters. Close tolerances, low losses, accurate retrace, and definite temperature characteristics are attributes of this type unit. They are manufactured in accordance with American War Standard specifications, which include a requirement that the capacitors be subjected to at least five temperature cycles through a temperature range of from minus 55° C. to plus 85° C. —then immersed for two cycles of 15 minutes' duration in water at 65° C. and 20° C. respectively, and still have an insulation resistance of greater than 3000 megohms.

Such requirements necessitate the most comprehensive engineering design and manufacturing procedure. The many hundreds of thousands of Sangamo units of this type, now giving satisfactory service under climatic conditions which are as severe as the prescribed tests, are the best proof of the quality that Sangamo has built into these units.

SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS



Take a look at those blue-prints of post-war products you're going to manufacture. Ask your engineers, your draughtsmen, to point out the parts that are to be fabricated of Taylor Laminated Plastics. Those are the parts that will give you light weight with great strength . . . attractive appearance . . . unsurpassed insulating qualities . . . the characteristics required for extreme machining at high speeds . . . the necessary resistance to moisture and solvents . . . the economy of speedy mass-production that will be vital in meeting post-war competition.

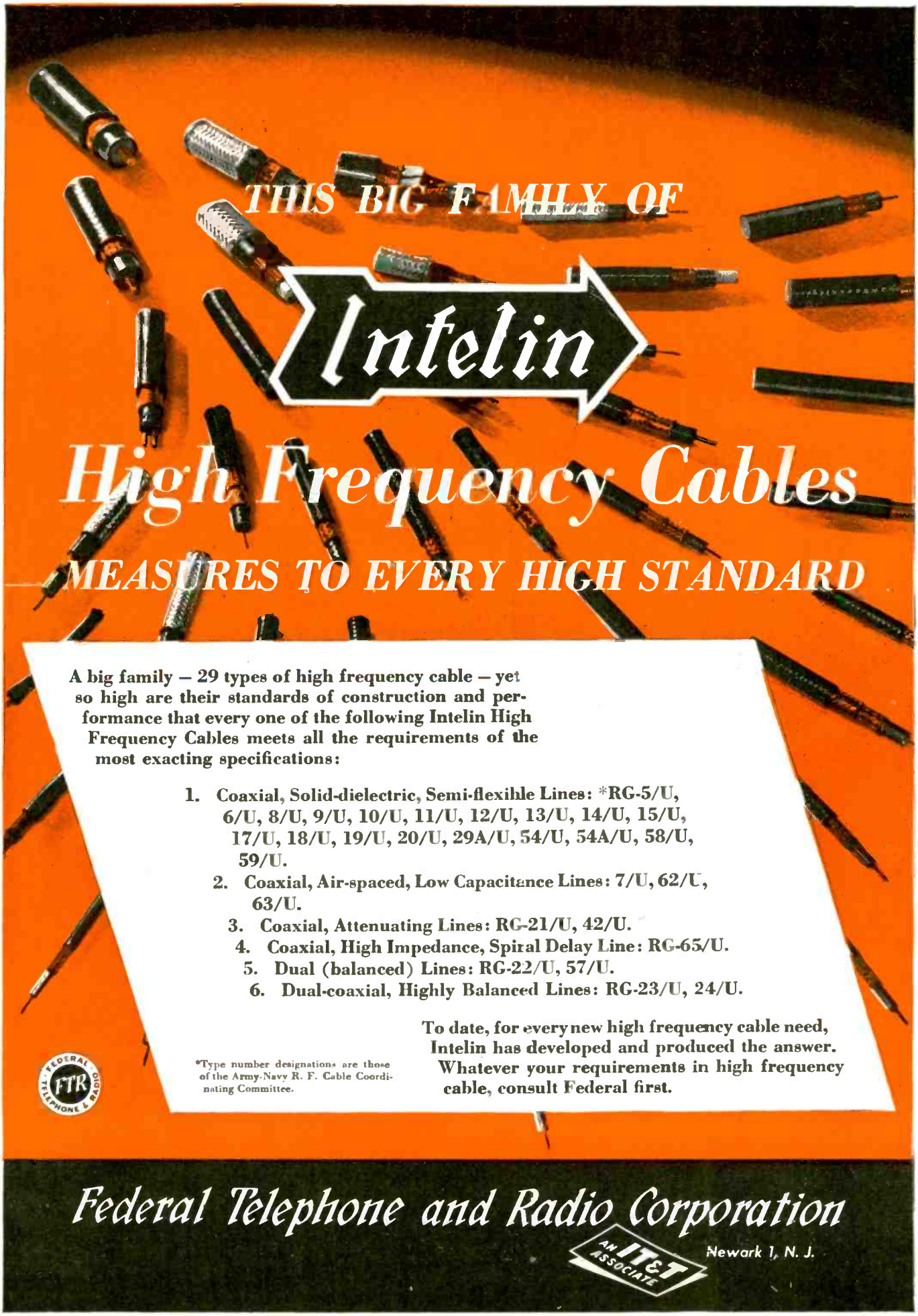
Submit your blue-prints to Taylor with the confident knowledge that Taylor's recommendations will be right . . . out of the "blue." Do it now.

POST-WAR-PLANNING DEPARTMENT OF

TAYLOR FIBRE COMPANY

LAMINATED PLASTICS: PHENOL FIBRE · VULCANIZED FIBRE · Sheets, Rods, Tubes, and Fabricated Parts

NORRISTOWN, PENNSYLVANIA . OFFICES IN PRINCIPAL CITIES . PACIFIC COAST HEADQUARTERS: 544 S. SAN PEDRO ST., LOS ANGELES



A big family — 29 types of high frequency cable — yet so high are their standards of construction and performance that every one of the following Intelin High Frequency Cables meets all the requirements of the most exacting specifications:

1. **Coaxial, Solid-dielectric, Semi-flexible Lines: *RG-5/U, 6/U, 8/U, 9/U, 10/U, 11/U, 12/U, 13/U, 14/U, 15/U, 17/U, 18/U, 19/U, 20/U, 29A/U, 54/U, 54A/U, 58/U, 59/U.**
2. **Coaxial, Air-spaced, Low Capacitance Lines: 7/U, 62/U, 63/U.**
3. **Coaxial, Attenuating Lines: RG-21/U, 42/U.**
4. **Coaxial, High Impedance, Spiral Delay Line: RG-65/U.**
5. **Dual (balanced) Lines: RG-22/U, 57/U.**
6. **Dual-coaxial, Highly Balanced Lines: RG-23/U, 24/U.**

*Type number designations are those of the Army-Navy R. F. Cable Coordinating Committee.

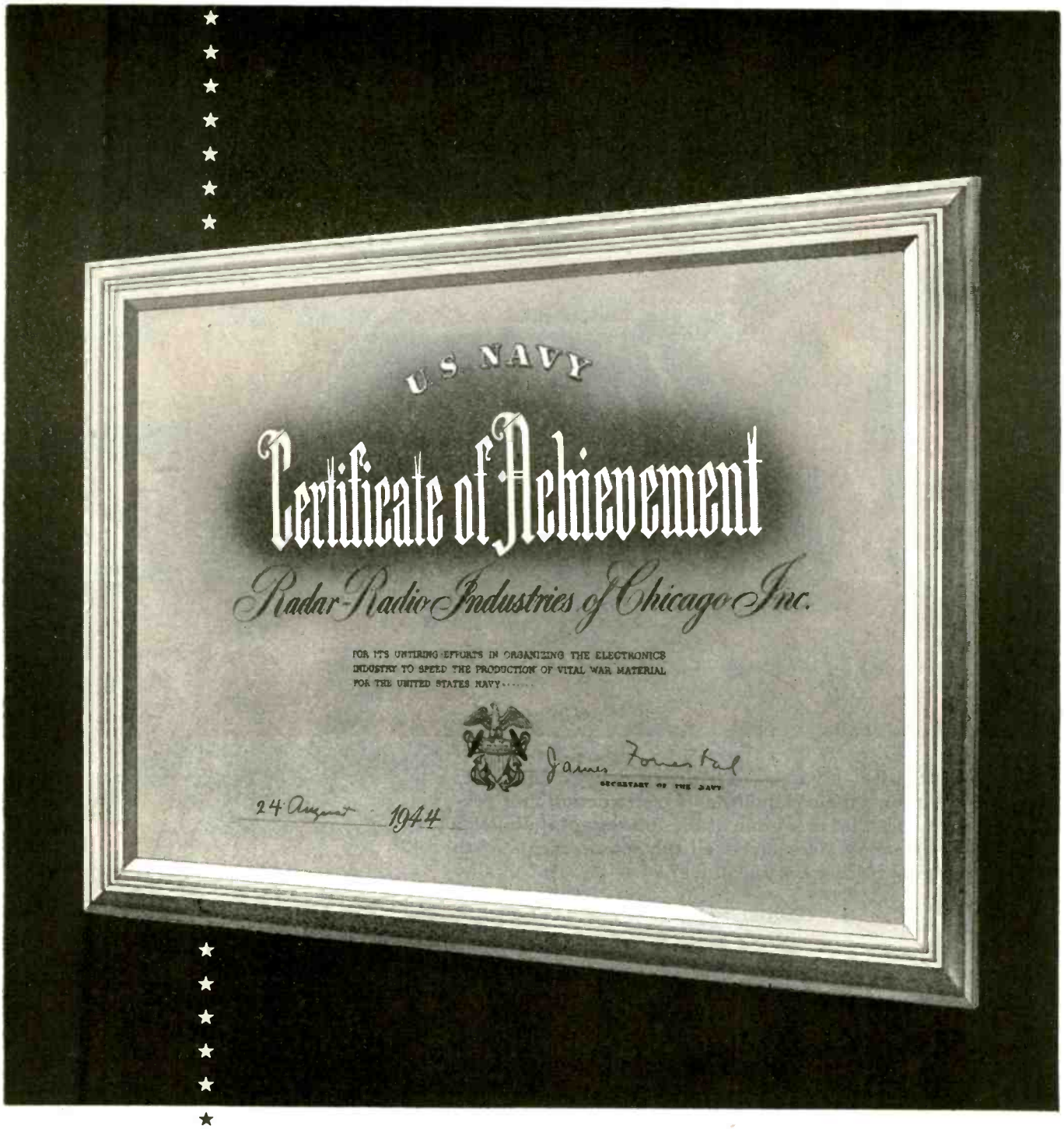
To date, for every new high frequency cable need, Intelin has developed and produced the answer. Whatever your requirements in high frequency cable, consult Federal first.

FEDERAL TELEPHONE & RADIO FTR

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark 1, N. J.



The United States Navy has awarded the men and women of Hallicrafters a special "Certificate of Achievement"... first award of its kind... for outstanding service with the radar-radio industries of Chicago in speeding vital war material to the Navy. Added to the four Army-Navy "E" awards, this makes five times Hallicrafters workers have been cited for distinguished service. They promise that this kind of service will be continued until total victory is ours.

★ *BUY A WAR BOND TODAY*

hallicrafters RADIO

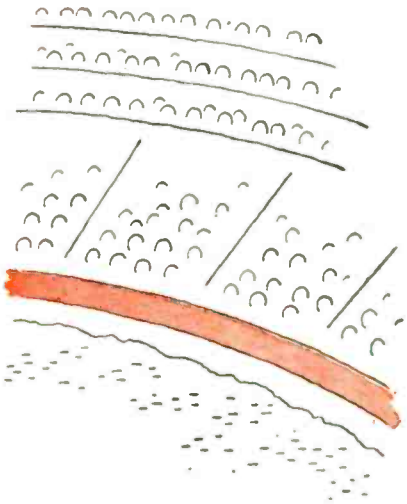
THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT, CHICAGO 16, U. S. A.

It's all in the TIMING, Mister!

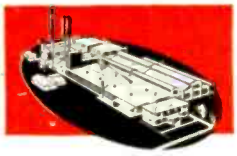
IF YOU'VE GOT PLASTICS for your post-war products on your mind—believe us, the time is right now. We mean the time for some planning. And that goes double if you haven't used plastics before!

Our production capacity is still completely devoted to war orders. But as of today, our engineering department can give you an expert "yes" or "no" on new applications—can help with development work, and engineer blueprints into final form. And as of some day soon, those blueprints will take an early priority when mold-making opens up again.

Then—when we can mold for peacetime production again—those early plans and waiting molds will be ready for the quick production you're going to want. *That is, if we get together and work things out now!* Just ask.



Why Kurz-Kasch for Plastics? Kurz-Kasch offers a 28-year-old reputation for thoroughly engineered, quality production. • One of the largest, best-equipped exclusive custom molding plants in the country—75,000 square feet of floor space with 125 compression and transfer presses of all sizes.



Complete mold-making and finishing facilities • Extensive production sequences of radio-frequency preheating equipment, with full experience in their use. Completely equipped shop for production of inserts • For satisfaction in plastics, key these facilities into your production line.

BUY BONDS! ALL YOU CAN — WHENEVER YOU CAN

KURZ-KASCH

For over 25 years Planners and Molders in Plastics

Kurz-Kasch, Inc., 1427 South Broadway, Dayton 1, Ohio

Branch Sales Offices: New York • Chicago • Detroit • Indianapolis • Los Angeles • Dallas
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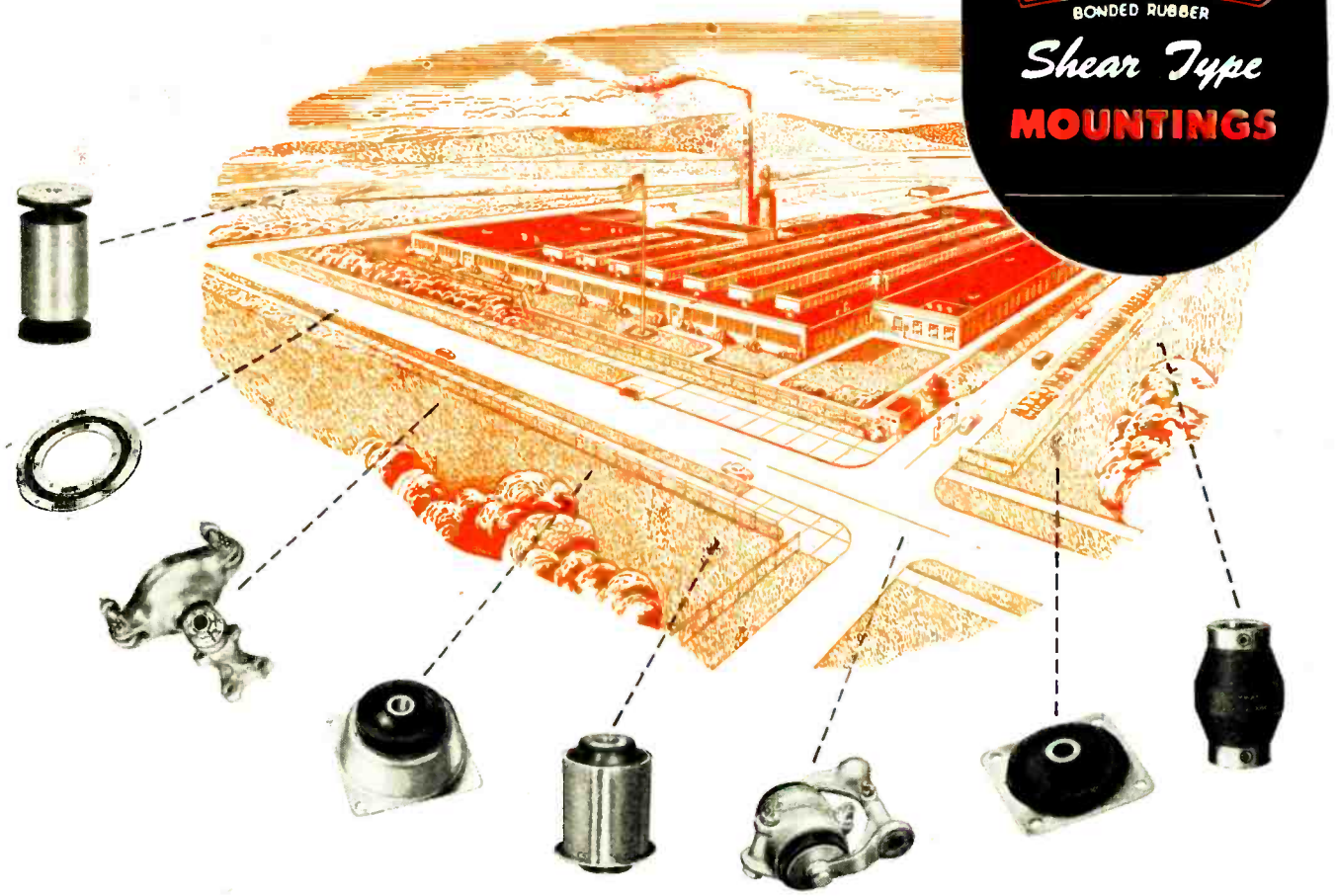
The Plant Behind The Product . . .



AN idea that was born over twenty years ago; an idea that was painstakingly developed on reams of paper covered with engineering formulas, drawings and mathematical computations; an idea that was proven in countless laboratory tests. That idea accounts for the fact that Lord has had to make three additions in as many years, to take care of the war-time demand for the best in vibration control mountings for airplanes, ships, tanks, and a hundred other tools of war.

The idea was that a Shear Type Mounting, properly designed, is vastly superior in vibration control to compression or tension type mountings. The work on paper and in the laboratory has continued; it has included designs for thousands of different jobs; it has included methods of bonding rubber to practically every industrial metal; it has included exhaustive tests of *natural rubber and synthetic rubber* of varying compositions and degrees of stiffness.

It has all resulted in Lord being the authority on vibration control and isolation. When a tough vibration problem comes up, the typical expression heard from the designer, the engineer, the shop superintendent is, "Send it to Lord".

Because Lord knows, there is a solution to your vibration problem. Perhaps it's in our free literature; perhaps you would do well to call in a Lord Vibration Engineer. No obligation attached to either service.

IT TAKES RUBBER *In Shear* TO ABSORB VIBRATION

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ERIE, PENNSYLVANIA

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RAILWAY & POWER ENGINEERING CORP. LTD.
TORONTO, CANADA

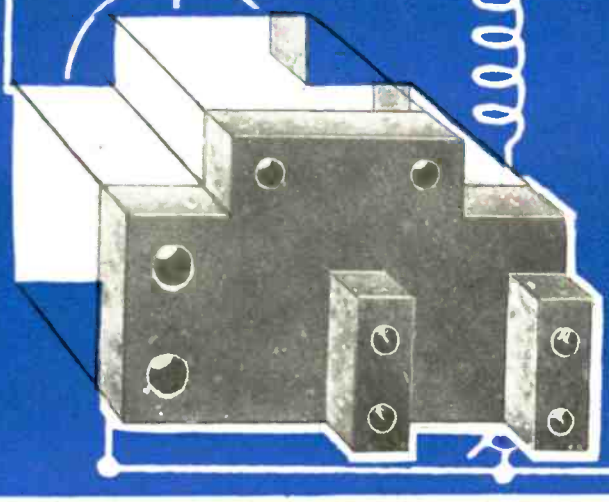
Originators of Shear Type Bonded Rubber Mountings

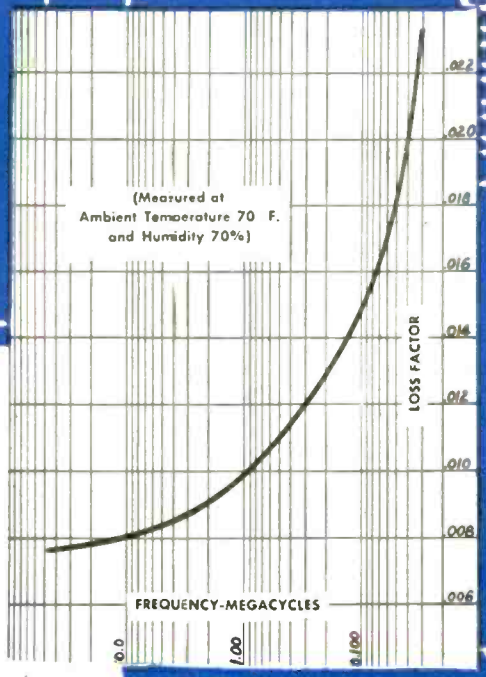
Do More Than Before—
Buy EXTRA War Bonds

MYCALEX 400

(PATENT PENDING)

The 'Last Word' in Low-Loss Insulation—Perfected after 25 years of Research Leadership





FITS PERFECTLY *Into High Frequency Design*

AT LAST designers of tomorrow's high frequency apparatus have an improved type of glass-bonded mica insulation to specify where new advancements in low-loss characteristics are desired, as in ultra high frequency applications.

Behind this new product is a history of 25 years of research leadership. Just as the original MYCALEX, developed by the MYCALEX (Parent) Company of Great Britain 25 years ago, was a vast improvement over other ceramics, so the new MYCALEX 400, developed exclusively by the MYCALEX Corporation of America, is a comparable advancement over all early forms of glass-bonded mica.

MYCALEX 400 meets government specifications for L-4 characteristics, by virtue of its pronounced low-loss factor of 0.013 at 1 megacycle. Its surface resistivity is 300,000 megohms. Its power factor is 0.0018 at 1 megacycle, in accordance with American War Standard C-75.1—1943 (Jan. 1-10). Its dielectric constant is unchanged from 50 kilocycles to 10 megacycles. MYCALEX 400 can be machined with greater precision . . . drilled, tapped, milled, sawed, turned and threaded.

Improved postwar h-f equipment deserves this newly refined and perfected electronic insulation. Let us supply your stock requirements in sheets and rods; or have us fabricate component parts to your specifications. White for full details and samples.

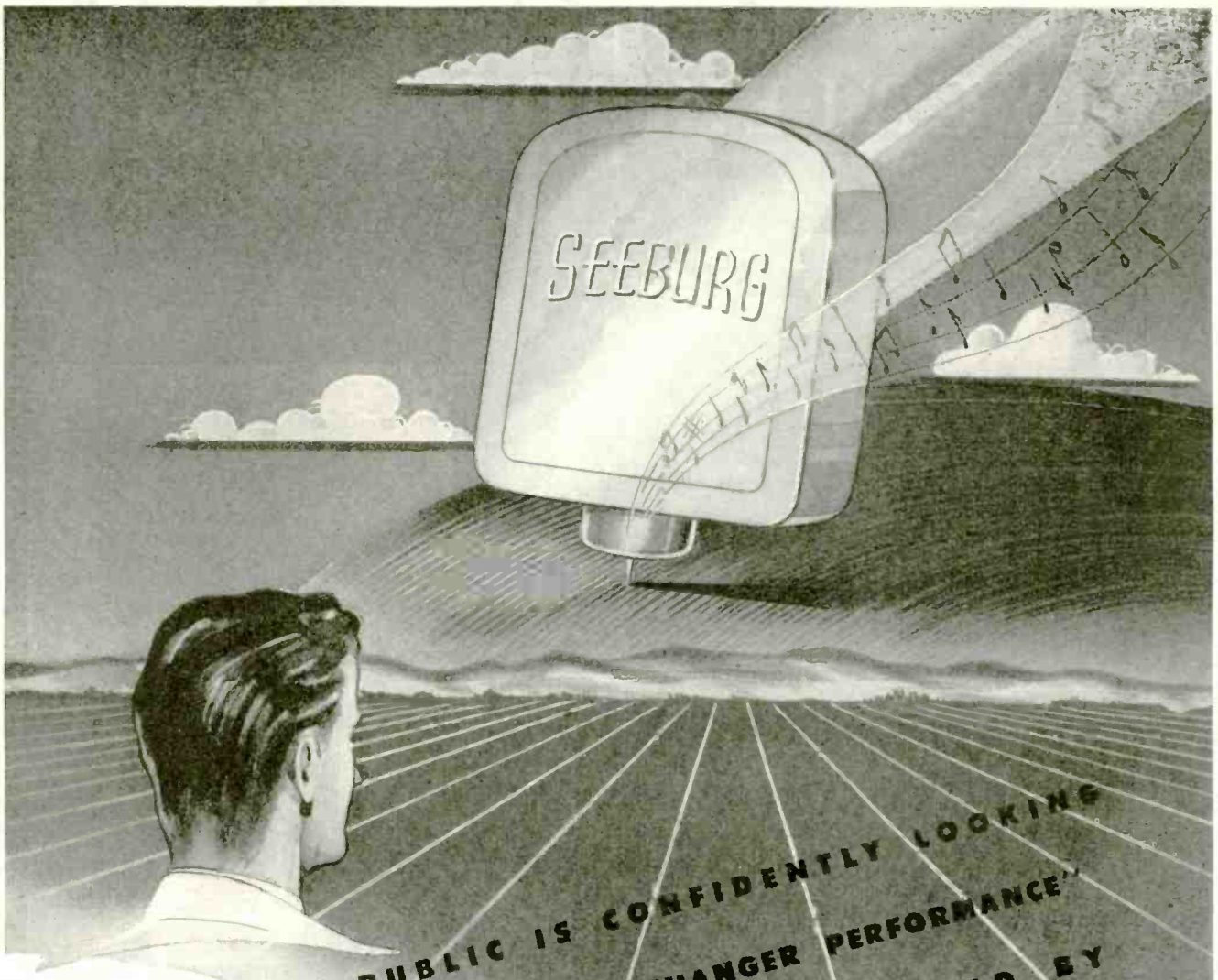
MYCALEX
THE INSULATOR
TRADE MARK REG. U. S. PAT. OFF.

MYCALEX CORPORATION OF AMERICA

"OWNERS OF 'MYCALEX' PATENTS"

CLIFTON, NEW JERSEY

Executive Offices: 30 ROCKEFELLER PLAZA NEW YORK 20, N. Y.



THE AMERICAN PUBLIC IS CONFIDENTLY LOOKING AHEAD TO IMPROVED "RECORD CHANGER PERFORMANCE" THIS CONFIDENCE WILL BE JUSTIFIED BY THE NEW

SEEBURG RECORD CHANGERS

YOU SAVE LIVES
WHEN YOU SUPPORT
ALL WAR LOAN DRIVES!

ARMY E NAVY

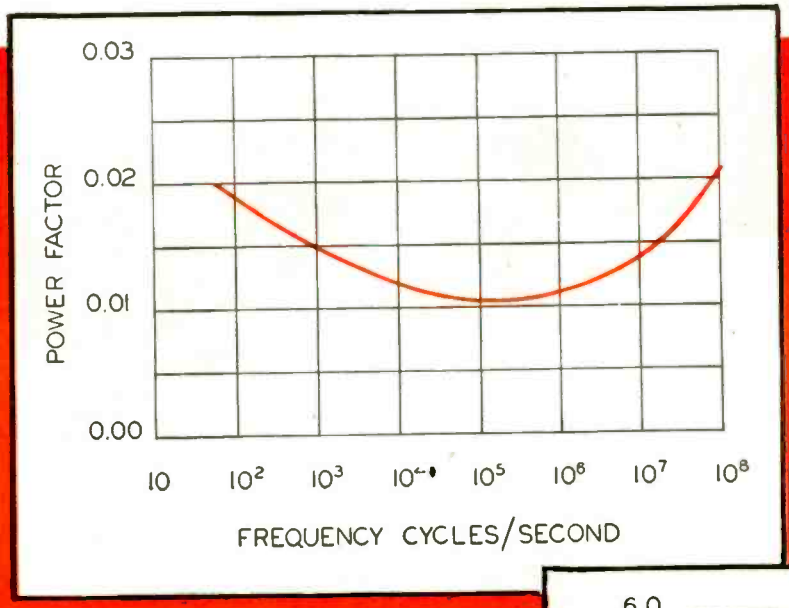
Awarded to the J. P. Seeburg Corporation for outstanding production of war materials in each of its four plants

Seeburg

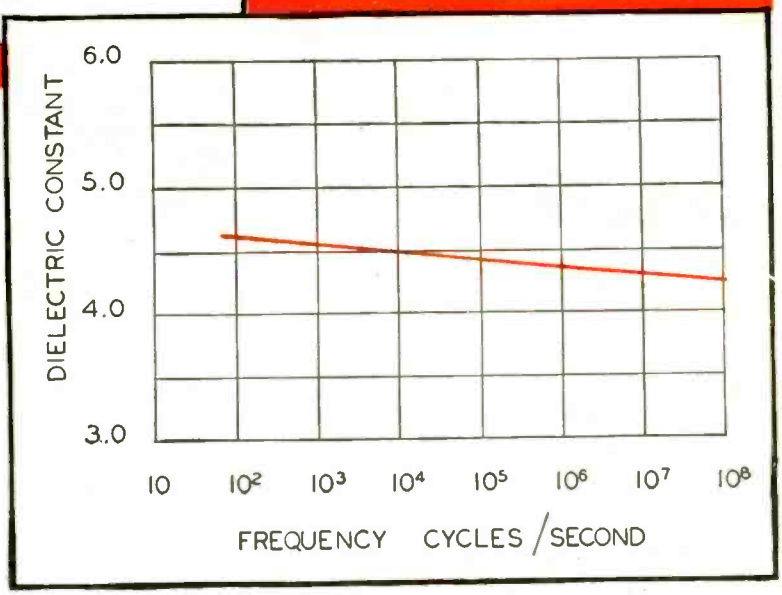
FINE MUSICAL INSTRUMENTS SINCE 1902

J. P. SEEBURG CORPORATION • CHICAGO

How's this for POWER FACTOR and DIELECTRIC CONSTANT



In a Machinable, Easily Worked Material?



THESE curves show how closely Formica MF-66, glass mat base laminated phenolic insulating material, approaches ceramics and other high quality insulators at high frequencies. It can perform many of the functions for which these materials were once thought necessary.

At the same time it has the mechanical strength to withstand sharp blows and the vibration that is so often present where airborne, ship, and ground installations must be used. Dimensions are stable under changes in temperature and humidity. MF-66 resists the growth of fungi and may be used in the tropics.

It has the usual Formica characteristics of machinability and workability — speeding production and reducing labor costs.

This combination of qualities opens a wide field for the application of the material which as yet has scarcely been scratched.

Test samples are available on request.

● *These data represent average values measured at normal laboratory conditions of temperature and humidity on specimens not previously conditioned.*

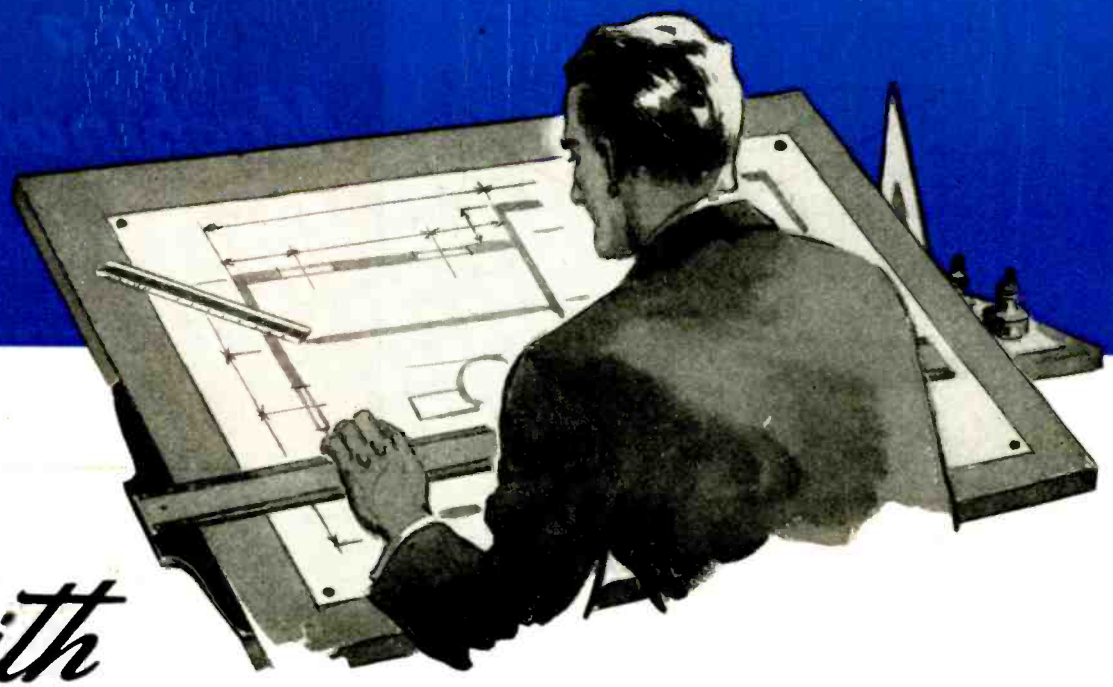
FORMICA

THE FORMICA INSULATION COMPANY
4647 Spring Grove Avenue, Cincinnati 32, Ohio

Plan Now For

DEPENDABILITY

in your Postwar Radio-Phono Combinations



with

WEBSTER RECORD CHANGERS

LOOK TO WEBSTER PRODUCTS

TODAY

Dynamotors and Voltage Regulators

TOMORROW

World Acclaimed Record Changers

WAR BONDS
are Top Value for TODAY and TOMORROW

In the selection of component parts for your models, you will be interested in the dependability of the unit and the ability of its manufacturer to carry through on any program undertaken. You will find satisfaction on both scores at Webster Products.

Webster Record Changers will have *all* the features you would expect from the pioneer manufacturer of record changers—with remarkable economies of space.

We will be glad to discuss with manufacturers now the ways we may serve you today and tomorrow.

WEBSTER PRODUCTS

3825 W. ARMITAGE AVE. CHICAGO 47, ILLINOIS

"AFTER TURNING HIMSELF INSIDE OUT FOR TWO MONTHS TRYING TO GET SOME COILS, THE BOSS JUST LEARNED THAT ALL HE HAD TO DO WAS CALL ALBION..."

SUPER-QUALITY COILS AT REASONABLE PRICES

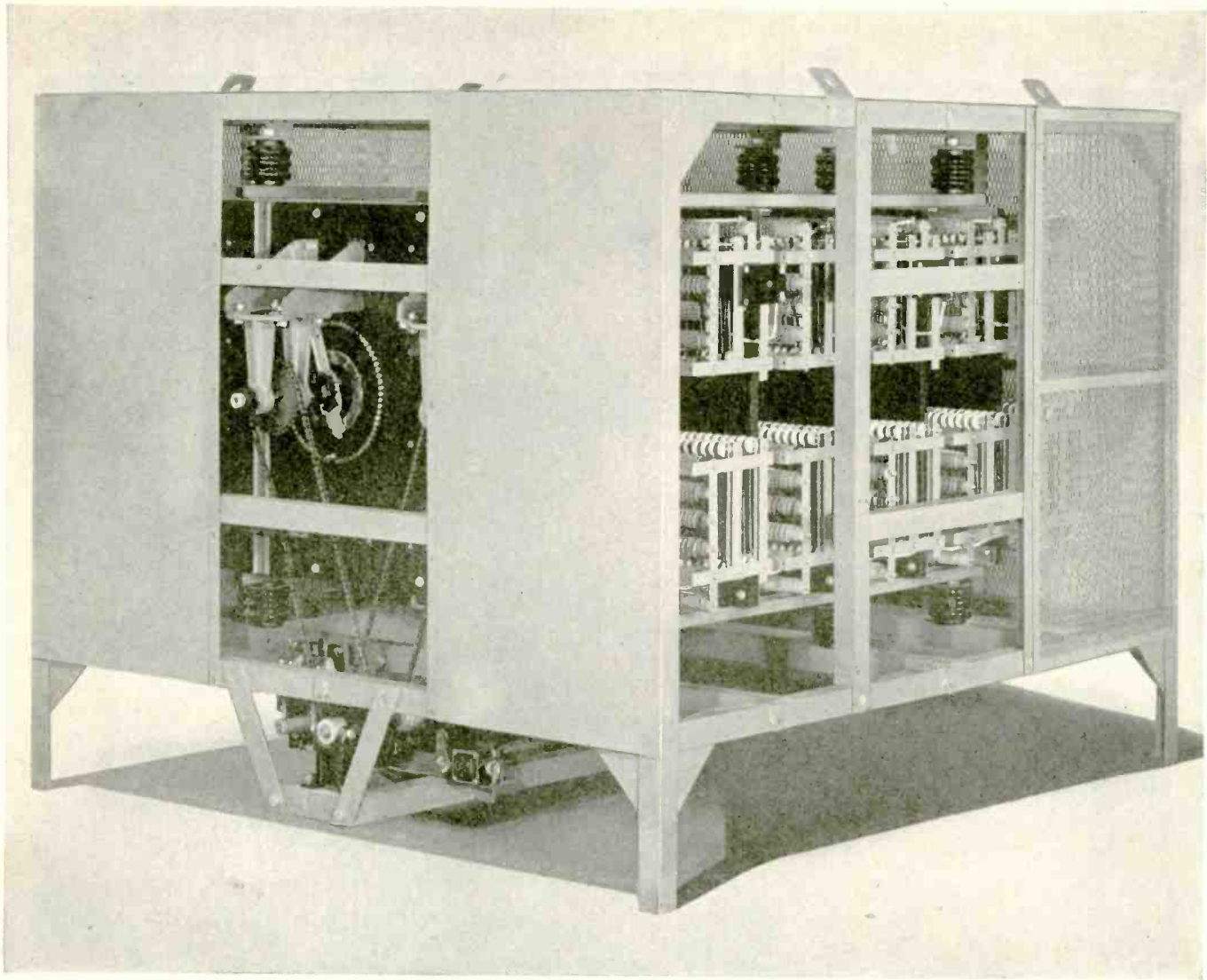
More and more every day, the industry is turning to Albion for fast, quality and quantity production of coils, chokes, and transformers. That's because here you benefit from the unbeatable combination of management "know how," skilled workmanship, streamlined facilities, and central location. Your requirements will be given prompt and thoughtful attention.

ALBION

COIL COMPANY

ALBION, ILLINOIS

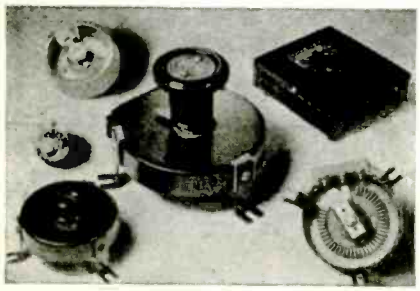
R. F. AND TRANSMITTING COILS AND CHOKES;
I. F. TRANSFORMERS



ASSEMBLED RHEOSTATS

Here is a Ward Leonard assembled rheostat designed for production testing of grid-controlled rectifier tubes. It consists of five face plates with each face plate composed of two rheostats. Each rheostat will drop from 0 to 375 volts at any current between 15 and 0.15 amperes. The rheostats are mechanically connected but electrically independent. They may be connected in series to give a maximum drop of 3750 volts or in parallel to give a maximum current of 150 amperes. The assembly is tested at 10,000 volts to ground and 2,000 volts between rheostats. Whenever you have an electric control problem, Ward Leonard engineers are at your service.

Send for rheostat bulletins of interest to you.



The Ward Leonard line of rheostats includes steel plate types, porcelain ring types and ribohm face plate types. These rheostats provide control for the minute current requirements of the laboratory and the heaviest current demands in industrial applications.

ARMY E NAVY

WARD LEONARD

RELAYS • RESISTORS • RHEOSTATS

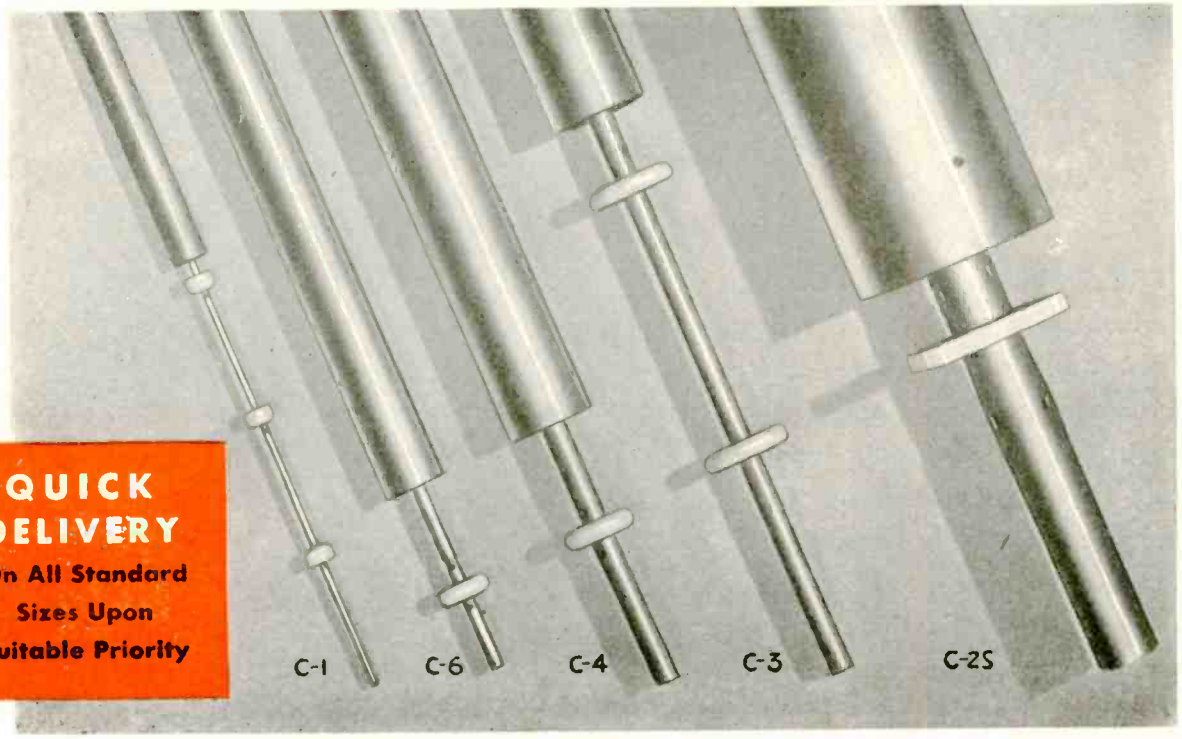
Electric control (WL) devices since 1892.

WARD LEONARD ELECTRIC COMPANY, 61 SOUTH STREET, MOUNT VERNON, N. Y.

Concentric Transmission Line

by Doolittle

A Standard Product Since 1934



QUICK DELIVERY
On All Standard Sizes Upon Suitable Priority

Ten years of experience in building concentric transmission line and associated impedance matching equipment assures you highest quality and workmanship.

Seven standard sizes of Doolittle Lines are listed below. Each line uses seamless copper tubing for the outer and inner conductor, except Types C-1 and C-6 which use solid inner conductors. The insulating heads are made of low loss ceramic—impervious to moisture—spaced and fastened securely for maintaining proper electrical and mechanical characteristics. Carefully designed fittings and accessories for any requirement are also available.

Special sizes are made to order. For engineering information concerning installation and use, feel free to consult our engineering staff.

WRITE FOR CATALOG AND PRICES

Type of line	C-1	C-2	C-2S	C-3	C-4	C-5	C-6
Diameter of outer conductor	⅜ in.	2 in.	2 in.	1 in.	⅞ in.	3 in.	⅜ in.
Diameter of inner conductor	.081 in.	⅜ in.	½ in.	¼ in.	¼ in.	¾ in.	.144 in.
*Standard section length, feet	50	20	20	20	20	14	50
Net weight per ft.	2 oz.	10 oz.	1 lb. 1 oz.	8 oz.	8 oz.	1 lb. 10 oz.	4 oz.
Power rating-kilowatts	1	50	50	10	10	100	5
Surge impedance-ohms	70	100	82	75	66	80	73
Loss per 1000 ft. at 1 mc. decibels	.94	.156	.083	.31	.33	.095	.55
Capacity per ft. mmfds.	19.8	10.5	12.5	14.1	16.0	12.8	14.8

*A set of couplings for the inner and outer conductors is furnished with each length.

Doolittle RADIO INC.
Builders of Precision Communications Equipment
7421 SOUTH LOOMIS BLVD.
CHICAGO 36, ILLINOIS

G I Phone Booth .. Model 44

THERE are few comforts for the man out in the forward observation post, but of one thing he can be sure—he has the best Communications Equipment in the world. For the Electronic Industry has gone all out to provide our G.I.'s with the finest . . . the best performing and the most dependable . . . Communications Systems that scientific discovery and manufacturing genius can produce.

The oldest and most respected names in audio communications are to be found on the components that make up these Systems and so it is that many of the Transformers, Coils, Headsets and other electronic parts are marked "Rola". It's a mark that meant much before the war . . . that will mean more in the Electronic Age now just beginning.

ROLA

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

Let's do more *in forty-four!*

MAKERS OF THE FINEST IN SOUND REPRODUCING AND ELECTRONIC EQUIPMENT

OVER 8,500 AMPHENOL PRODUCTS FOR ELECTRICAL TRANSMISSION

Save this— For future reference. For information you need now— Use the Coupon.

If in your products you use electrical transmission equipment, there is in these Data Sheets information that you can use to advantage, if not today then on postwar products.

Amphenol equipment is used where the requirements are tough. There are Amphenol products for current of low or high frequency Wherever you use electricity you need the best of equipment—Amphenol.

Use the coupon to send for the information you want

AN and 97 CONNECTORS
Where electrical connections must be positive and secure, where they must be made or broken quickly—as on aircraft, tanks or ships—these connectors are used. Made with from one to forty-eight contacts. On the coupon check **Section A.**

SPECIAL CONNECTORS
These are the special service connectors—explosion proof, moisture proof, thermo-coupling, grounding, instrument, special mounting, etc. Mark the coupon **Section A1.**

CONDUIT FITTINGS
Conduit couplings—straight, 45° and 90°, coupling nuts, ferrules, clamps, etc. Designed for secure connections. Properly finished to avoid abrasion of wire insulation. On coupon check **Section B.**

AIRCRAFT ELECTRICAL CONDUIT and CABLE ASSEMBLIES
Flexible metal and plastic conduit, cable assemblies, wiring harnesses, etc. Ample facilities for quantity production. On coupon check **Section B1.**

SPECIAL TOOLS
Conduit ferrule crimping machines, saw vises for cutting conduit and cable. Special tools for good work on this type of electrical equipment. Mark on the coupon **Section C.**

U. H. F. CABLES AND CONNECTORS
For ultra high frequency transmission—Amphenol low-loss cables and connectors—a complete line. This includes the full list of RG type cables. On coupon check **Section D.**

BRITISH CONNECTORS
In quality, type, range of size and application these are similar to Amphenol AN and 97—but built to specifications of the British Air Ministry. Mark the coupon **Section E.**

RADIO PARTS AND ACCESSORIES
For Radio, FM, Television, Electronic and Sound equipment—connectors, sockets, plugs, etc. Also special tools for wiring. On the coupon check **Section F.**

SYNTHETICS FOR ELECTRONICS AND INDUSTRY
The story of Amphenol's facilities for making plastic parts or products by compression or injection molding, extrusion or machining On the coupon check **Section G.**

AMERICAN PHENOLIC CORPORATION
1830 S. 54th Avenue, Chicago 50, Illinois

Please send me information and Data Sheets as checked below—without obligation.

☐ Section A	☐ Section B1	☐ Section E
☐ Section A1	☐ Section C	☐ Section F
☐ Section B	☐ Section D	☐ Section G

Signed _____

Company _____

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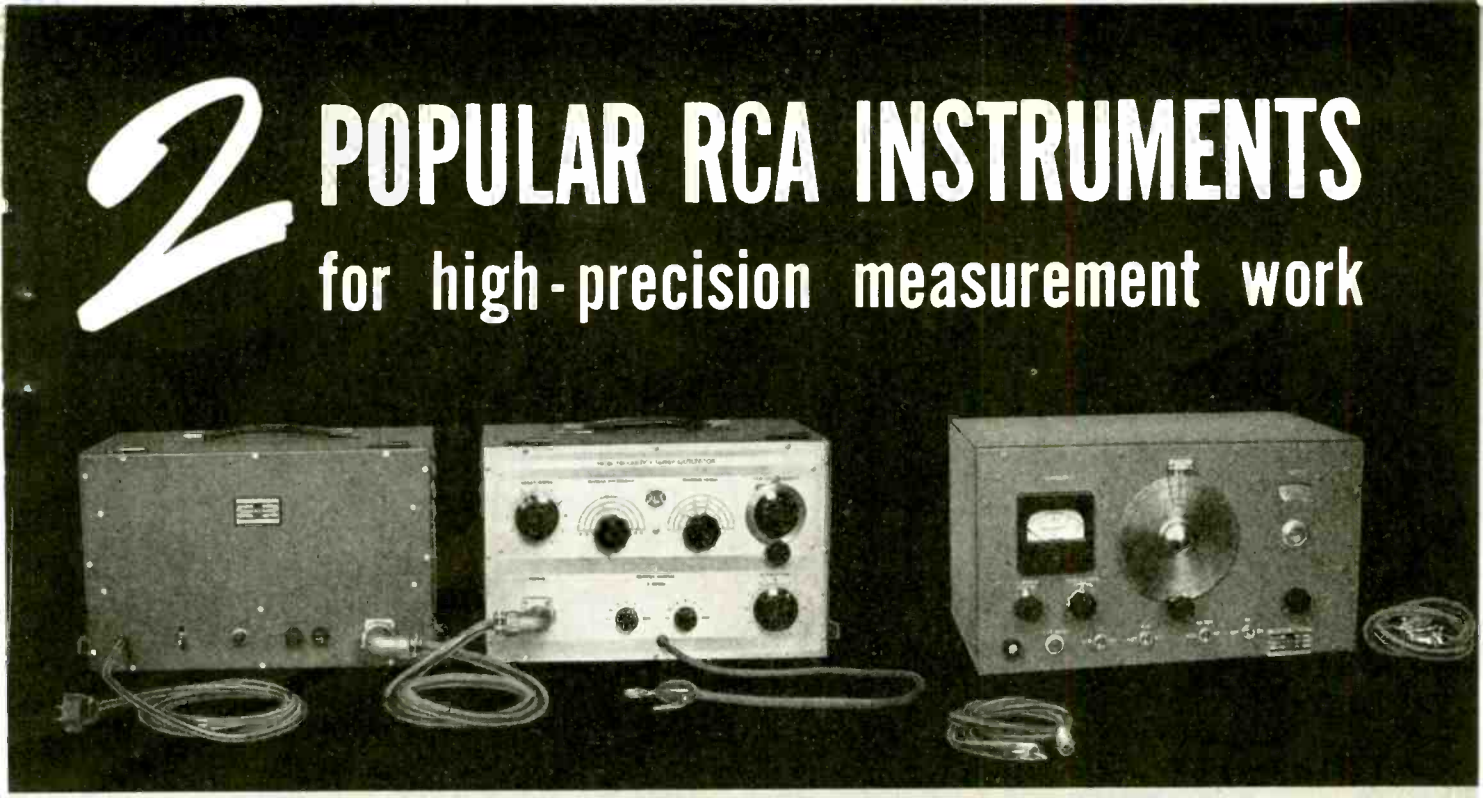
City and State _____

2 POPULAR RCA INSTRUMENTS
for high-precision measurement work



RCA High-Frequency Wide-Band Sweep Generator *Type 709 B*

RCA Ultra-High Frequency Signal Generator *Type 710 A*

THE big job is done—valuable development, production and field test experience are combined in two quality products—the 709 B Sweep Generator and the 710 A Signal Generator. Here are two instruments every Television, FM and H.F. Laboratory can rely on for postwar design applications.

The 709 B Sweep Generator covers the frequency band of 5 to 65 megacycles (center frequency). It is ideal for high frequency I. F. curve response study. Its calibration marker permits constant checking of band width characteristics.

The 710 A Signal Generator, with a frequency range of 370 to 560 megacycles, is widely used for checking high frequency devices. This instrument provides smooth and complete attenuation throughout its range, plus precision frequency control.

Planning your postwar activity means planning your laboratory facilities as well. Now is the time to investigate the characteristics of these reliable RCA instruments.

RCA bulletins containing complete descriptions and specifications of the 709 B Sweep Generator and the 710 A Signal Generator will be sent promptly on request.

Please note that deliveries of these instruments are subject to regulations of WPB General Scheduling Order M-293.

Buy More War Bonds

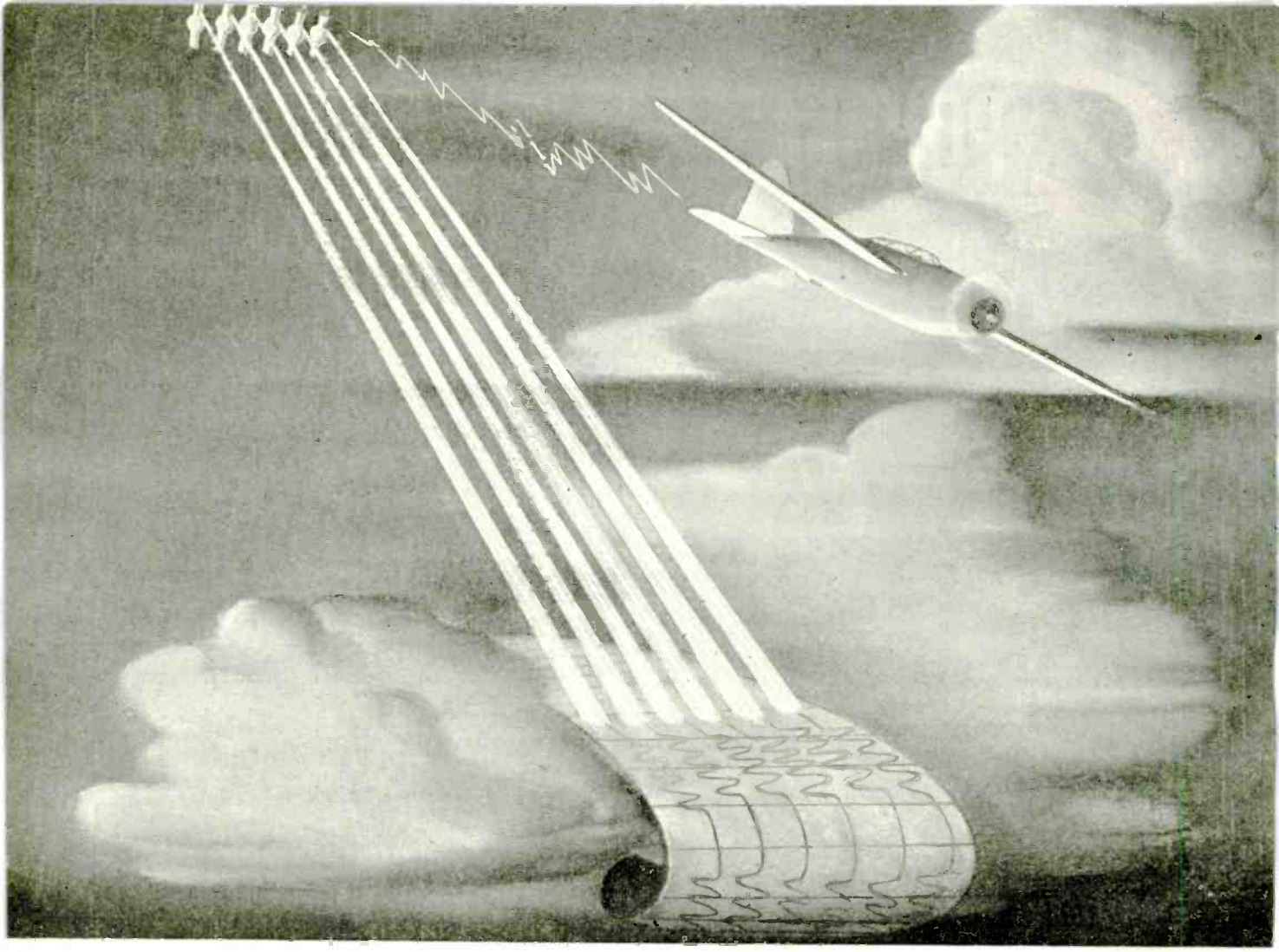
RCA

RADIO CORPORATION OF AMERICA

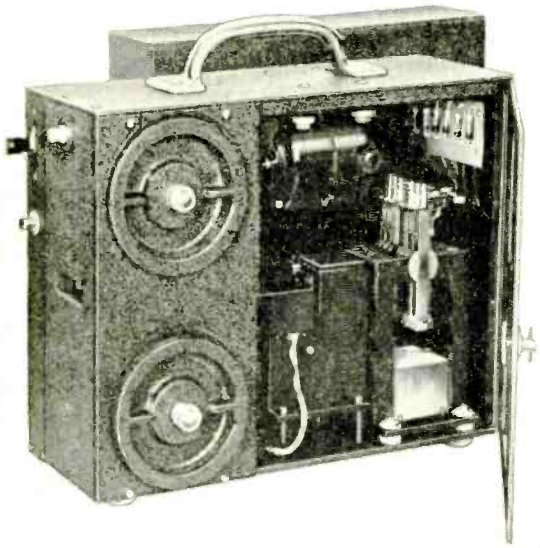
RCA VICTOR DIVISION • CAMDEN, N. J.

In Canada:

RCA VICTOR COMPANY LTD., MONTREAL



WRITES WITH BEAMS OF LIGHT



For recording dynamic strains and vibrations of *aircraft in flight*, we offer an extremely sensitive and accurate six channel Oscillograph, weighing less than 20 lbs., exclusive of battery, occupying less than ⅔ of a cubic foot of space and selling for only $1500. Operates from its own or the plane battery. Sensitivity is such that many dynamic strains and vibrations can be recorded directly without amplification. Takes hundred foot roll of paper 2" wide operating at 3, 6 or 12 inches per second. Write for further details.

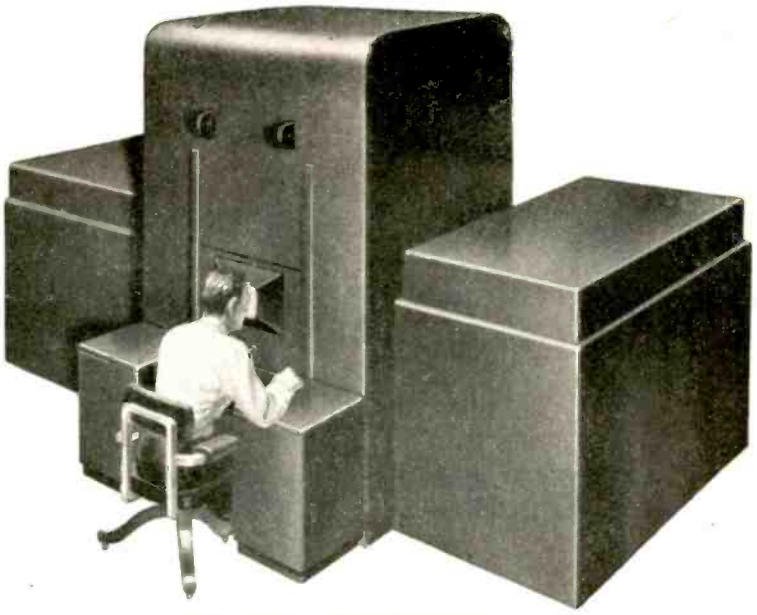
Write for rental list and service manual on your business letterhead.

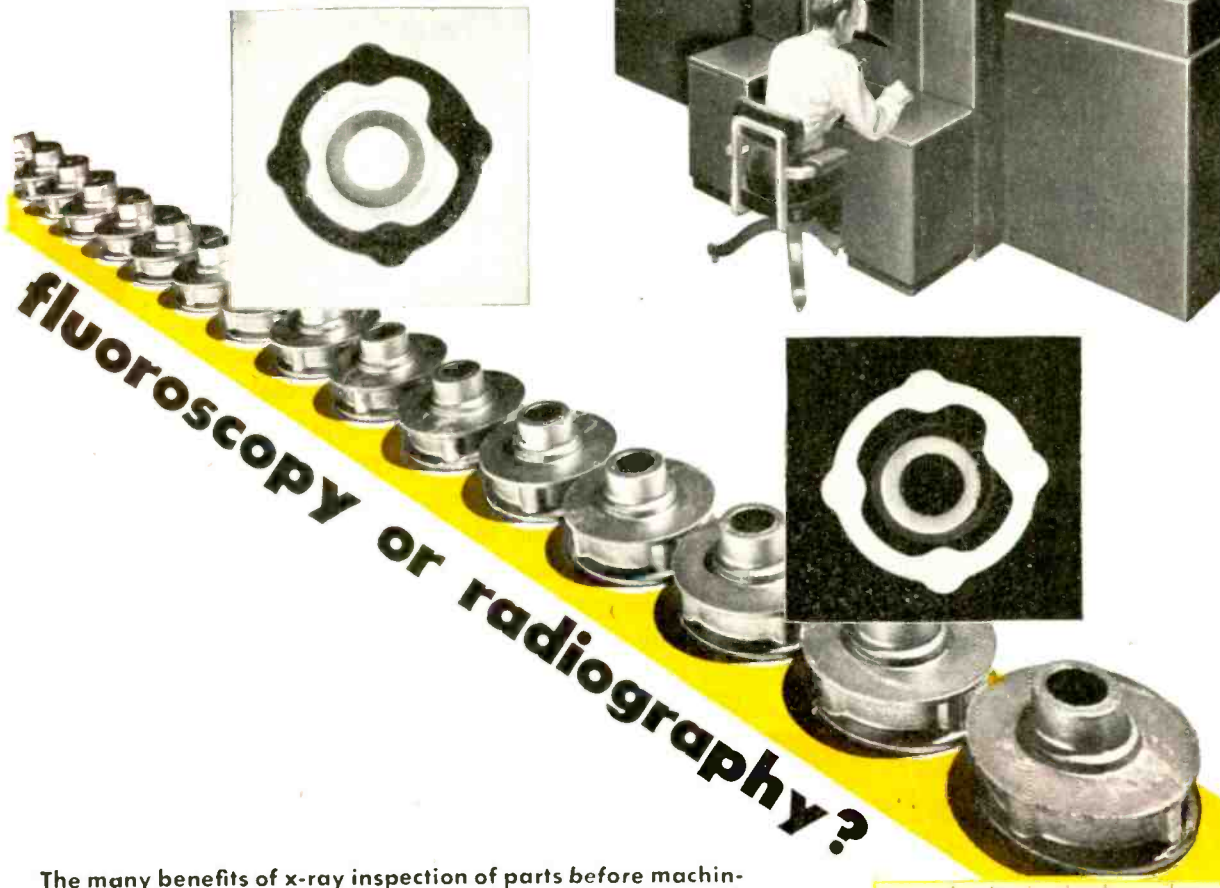
A complete line of indicating and recording instruments available.

WAUGH *Laboratories*

Pacific Coast Branch: 180 East California St., Pasadena 5, California ○ 420 LEXINGTON AVE., NEW YORK 17, N. Y.

The inspector is seated comfortably before the fluoroscopic window of the Picker Ray-Proof Combination X-Ray Inspection Unit. The Unit requires no manual unloading, since ejection of defective parts is automatic.





fluoroscopy or radiography?

The many benefits of x-ray inspection of parts *before* machining have been amply demonstrated in hundreds of case histories where lower costs and higher quality are the end results. The question then resolves itself in one of *method*. Within its limitations, x-ray fluoroscopy is the ideal answer in some cases; radiography is indicated in others. The determining factors are density and section thickness of the material to be examined.

This Picker Combination Conveyor Production Inspection Unit is designed to perform both fluoroscopy and radiography with equal facility. This single Combination Unit obviates the previous need for a separate apparatus for either function.

A Picker engineer will be glad to survey your own inspection problems and recommend a practical procedure, based on your individual requirements. The Picker line of industrial x-ray inspection units embraces types designed not only for large quantity production inspection requirements, but also for small-scale examination where major investment is neither necessary or desirable.

Industrial PICKER X-ray

PICKER X-RAY CORPORATION
300 FOURTH AVENUE • NEW YORK 10, N. Y.
WAITE MF'G DIVISION • CLEVELAND, OHIO

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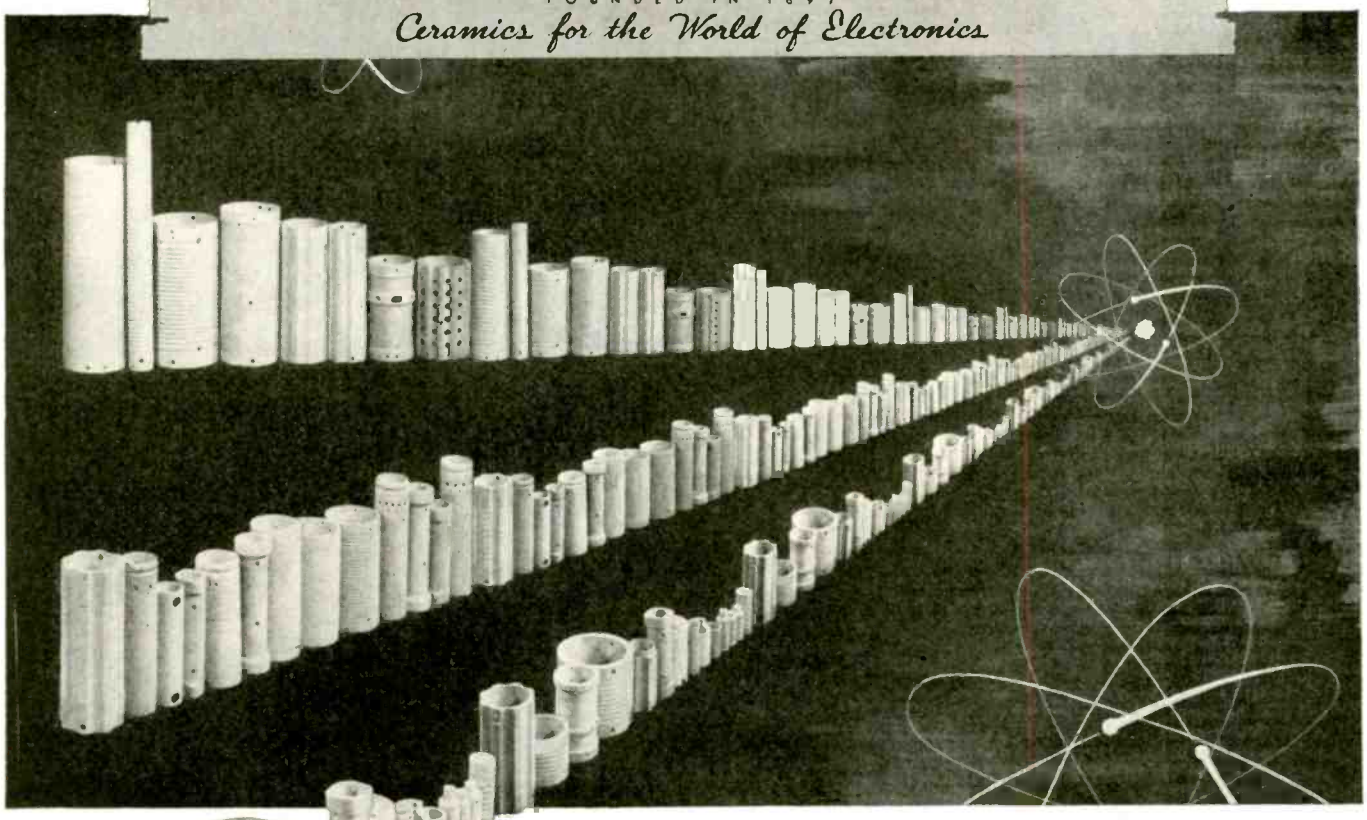

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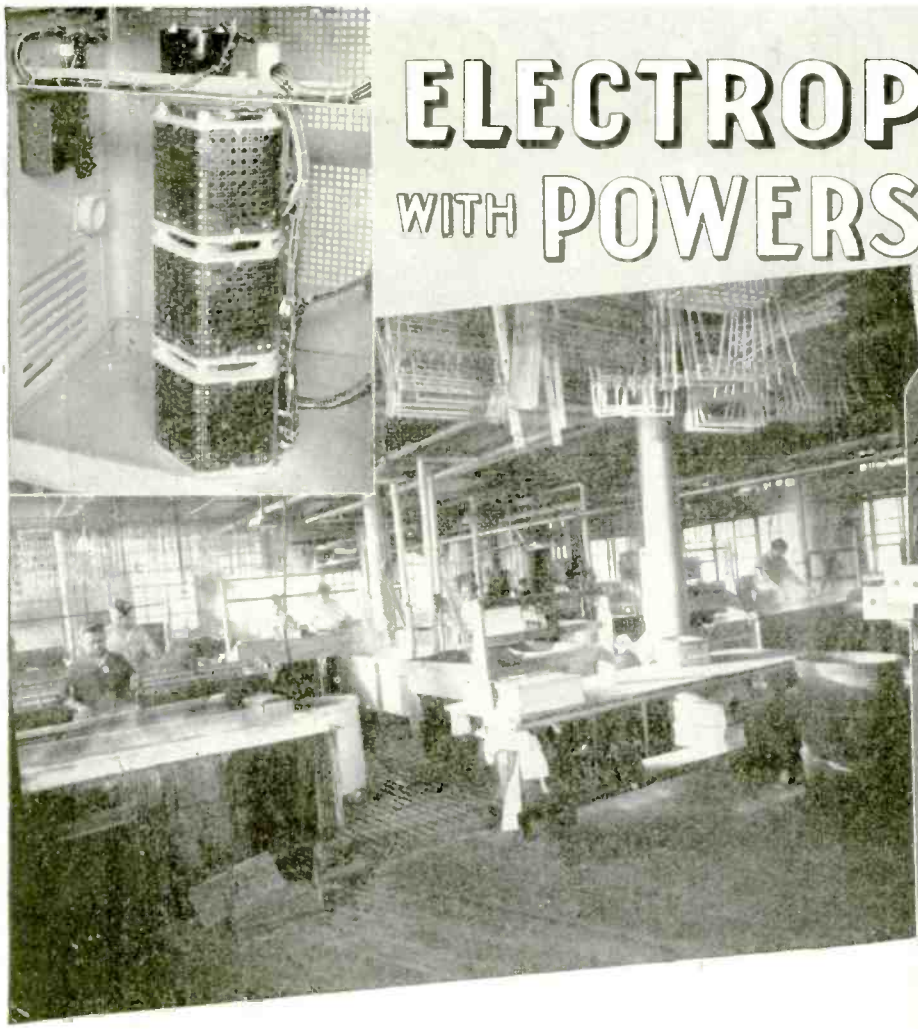

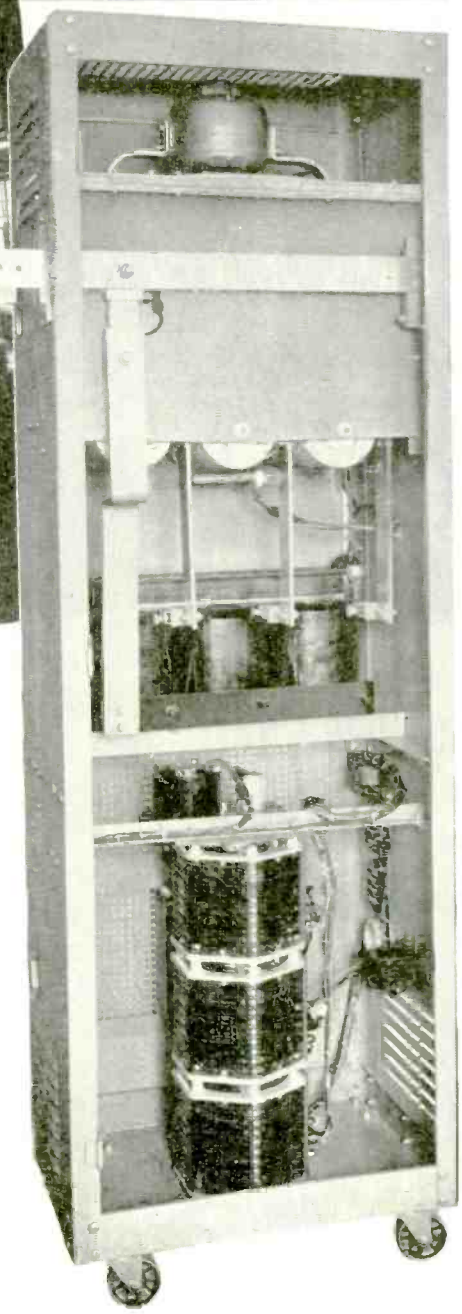

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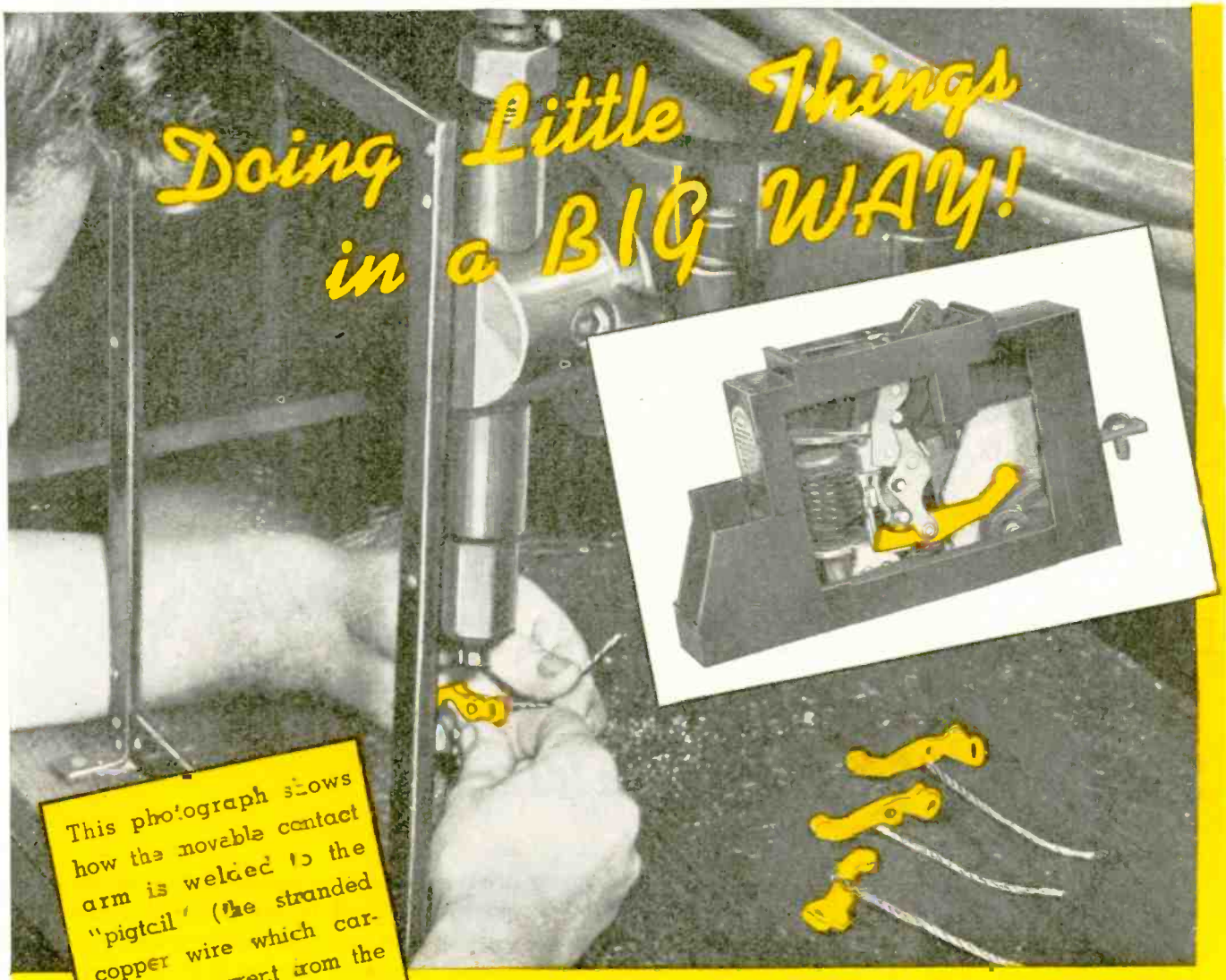

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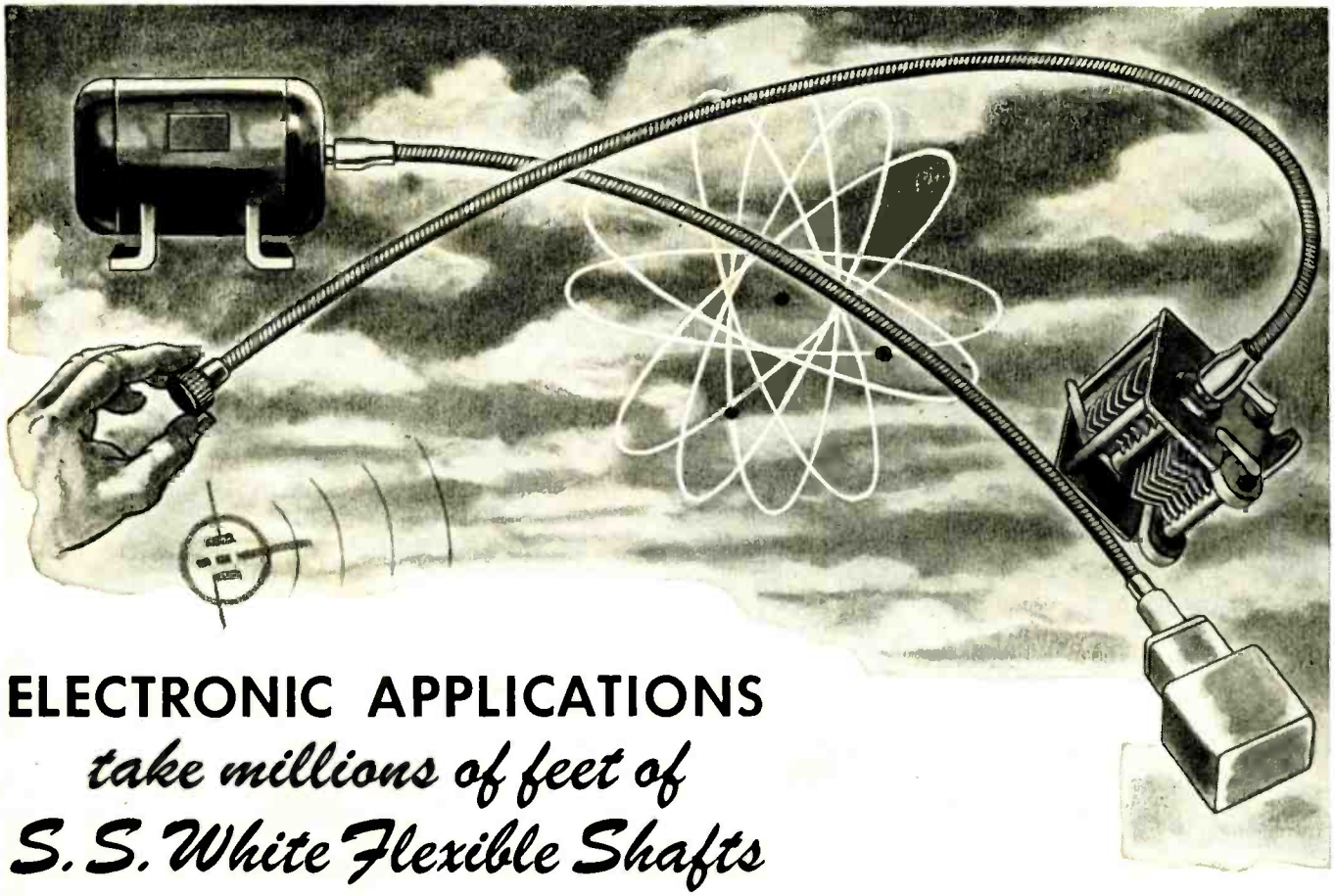

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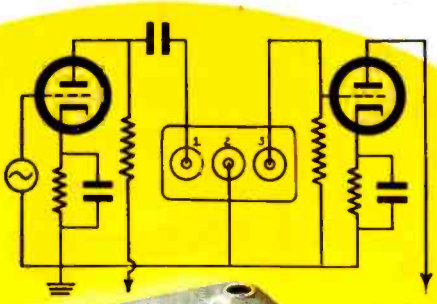

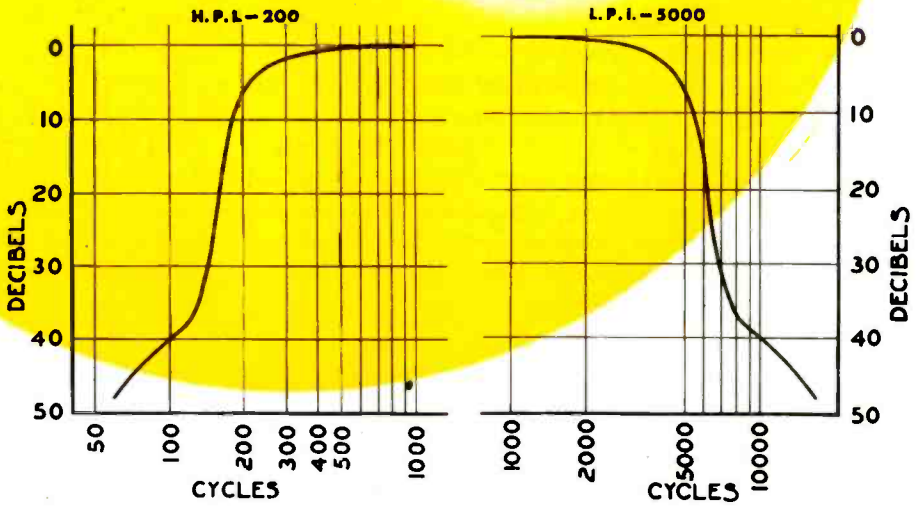

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These units employ a dual alloy magnetic shield which reduces inductive pickup to 150 Mv. per gauss. The dimensions in hermetically sealed cases are 1½" x 2½" x 2½". Filters of the HPI and LPI type can be supplied for any cutoff frequency from 200 to 10,000 cycles. Specify by type followed by frequency, as: LPI-2500.

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TELEVISION IS READY, NOW!

Television is ready!

Television is ready to form the foundation for a postwar billion-dollar industry that will serve millions with visual information and entertainment.

Television is ready to provide employment for half a million people in factories, stations, distribution houses, retail stores and service.

Television is ready to provide acceptable pictures right off,—and to continue the pioneering and improvement which every other new art has experienced as it got underway.

"*Television is ready*" is the united verdict of engineers and manufacturers,—of both the "monopolies" and the independents,—who have provided 90% of the capital invested in the new industry, and who are eager to get it started immediately postwar. (Even FM will be stimulated as the new television sets become widely distributed, capable of receiving FM programs during non-television hours.)

* * *

BUT there are those who would now hold television back, by relegating it to the Siberia of new ultra-high frequency channels,—there to start all over again, working out a new and questionable existence!

These critics declare unctuously "for television's good" that "television needs more lines and wider bands",—ignoring the testimony of television engineers that the present 525-line raster is not yet 70% utilized, or that present video channels are best for the purpose.

And who are those who would delay television another five years by banishing it to the upper frequencies? Each critic, it may be found, has some present lucrative activity which the early coming of television would hamper. Yet these enemies of television are listened to,—instead of heeding the men who have poured engineering genius and venture capital into developing television. (What would have happened to the young automobile industry a generation ago, if the carriage and bicycle makers' objections had been heeded, and the Fords, Duryeas and Chryslers not even given a chance to demonstrate what they could do?)

* * *

NO, as V-day nears, it is time for the government and public to listen to the men who created television and know that it is ready.

Already these patient untiring workers have been held up five years since television's 1939 launching (which government ukase and war later cancelled). If, postwar, television men are again required to begin all over again, on the ultra high channels where there is yet little experience in producing sufficient power or setting up adequate circuits, another five years will elapse before television can even get started! And so on, interminably!

And this will mean a five-year (or longer) delay in employment of hundreds of thousands,—a five-year delay in an invaluable new public service and enrichment of American home life.

Television is ready now. Chairman Fly has said that "a steady green light" is all set for television progress. Let no critics or enemies of television who will stand to profit from its postponement, get the power to introduce new obstacles to television jobs or public enjoyment.

The present television channels are ample. The present television art is adequate for a flying start, with progress to be made as we go ahead. *Television is ready, now!*

★ **National Electronic Conference Paper**

RCA SUPER-FM USES

by G. L. BEERS,
RCA Victor Div., Radio Corp. of America

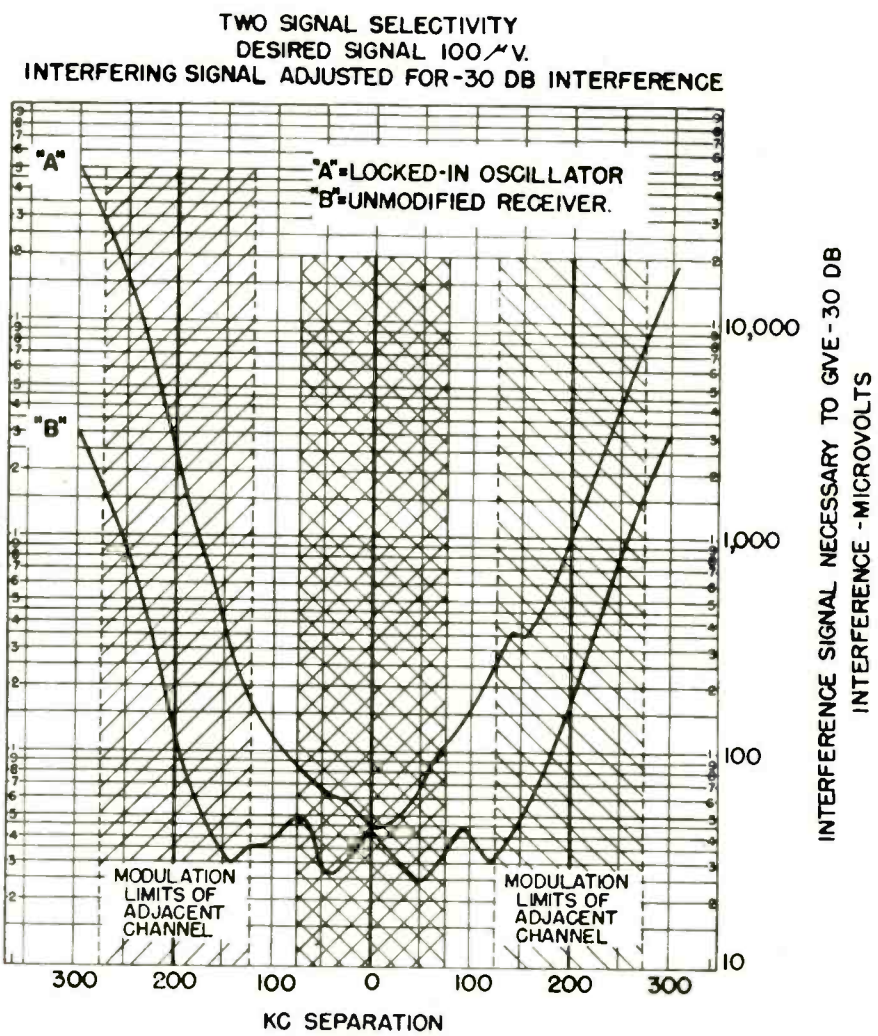
Continuously operating local oscillator functions at one-fifth IF frequency giving greatly improved selectivity

● Super FM, as revealed by G. L. Beers represents a new circuit intended to produce results superior to anything heretofore possible with conventional circuits. The difficulty has been to achieve a high degree of selectivity, and in this case the problem has been attacked by building around a continuously operating local oscillator which is locked-in with the received signal but only with frequency variations which occur within a desired signal channel. Mr. Beers explained:

Basically the operation of the system* depends on producing, in the receiver, a local signal which is frequency modulated by the received signal. The local signal is provided by a continuously operating oscillator. The received signal, after it has been amplified by conventional RF and IF amplifiers, is applied to the oscillator in such a way as to cause its frequency to change in accordance with the frequency variations of the received signal.

The oscillator is locked-in with the received signal at one-fifth the intermediate frequency. With this 5:1 relationship between the intermediate frequency and the oscillator frequency, an equivalent reduction in the frequency variations of the local oscillator is obtained. Received signal frequency variations of ±75 kc are reproduced as ±15 kc variations in the oscillator frequency. It should be noted that the locked-in oscillator operating at one-fifth the intermediate frequency reduces the frequency deviation corresponding to any modulation frequency but does not change the modulation frequency. The frequency-modulated signal derived from the oscillator is applied to a discriminator which is designed for this reduced range of frequencies.

The output voltage of the oscillator is independent of the strength of a received signal. In fact, the same voltage is applied to the discriminator when no signal is being received as when the receiver is tuned to a nearby transmitter. This feature makes it unnecessary to employ the conventional arrangements for minimizing amplitude variations in the received signal. In the new receiving system a novel principle is used to provide additional adjacent channel selectivity. The oscillator is designed to "lock-in" only with frequency variations which occur within the desired signal channel. The oscillator is therefore prevented from following the frequency variations of a signal on an adjacent channel. A substantial improvement in selectivity is thus obtained by electronic means.



This chart, comparing signals received on an unmodified FM receiver and on one of the new type super FM circuits shows the greatly improved, single peak selectivity given by the latter

* U. S. Patent No. 2,356,201 filed February 12, 1942.

LOCKED-IN OSCILLATOR

The "locked-in" oscillator arrangement provides, under weak signal conditions, a voltage step up of approximately 20. In other words, the voltage required to lock in the oscillator with a weak signal is approximately one-twentieth of the voltage applied to the discriminator. Since this voltage gain is obtained at a lower frequency than the IF, the stability of the receiver from the standpoint of overall feedback is materially improved.

A block diagram of one receiver arrangement is shown in Fig. 1. In this diagram the units which are heavily outlined are those which are peculiar to the new system.

The locked-in oscillator circuit diagram is shown as a part of Fig. 2. The tube generally used in this circuit has been an A-5581, an experimental converter tube, which is similar to the 6SA7 but has a higher mutual conductance. The oscillator tuned circuit is connected to the plate of the tube and the feedback tuned circuit is connected to the No. 3 grid. The received signal is applied to the No. 1 grid of the tube through a 4300 kc IF transformer. The No. 1 grid is operated with grid-leak bias.

One type of discriminator that can be used with the locked-in oscillator is shown connected to the oscillator in Fig. 2. This circuit has a pair of diodes connected with their load resistors in opposition so the discriminator is balanced at the center frequency. One diode has a tuned circuit in series with it and the other has a tuned circuit across it. The discriminator is connected across the tank circuit of the locked-in oscillator through the coupling capacitor shown in the diagram. The audio frequency output from the discriminator is fed through a deemphasis network to the audio amplifier.

As previously stated the oscillator is designed to lock in at one-fifth the intermediate frequency. With an IF of 4300 kc the oscillator plate circuit tank circuit is tuned to 860 kc. When no signal is being received the tube will function as a normal oscilator. The amplitude of the oscillation in a feedback oscillator is determined by the curvature of the $E_g - I_p$ characteristic and is usually so great that the grid voltage swings well into the curved parts of the tube characteristic during the cycle. This means that a distorted output current is produced in the plate circuit, having component frequencies 2ω, 3ω, 4ω, . . . where ω is the natural frequency of the tuned plate circuit. These harmonics are applied to the No. 3 grid because of the regenerative coupling. Furthermore the No. 3 grid operates with self bias and draws grid current during the positive swings of voltage. The grid current pulses also contain the harmonics of ω.

Suppose now that the signal voltage of frequency 5ω (4300 kc) is applied to the No. 1 grid. Since the tube is a nonlinear device and operates as a converter, combination frequencies will be produced equal to $\pm 5r\omega \pm s\omega$ where r, s = 0, 1, 2, 3 . . . Since the plate circuit is tuned to a frequency ω (860 kc), the only frequencies which will be amplified are those of frequency ω; the others will be effectively bypassed. If r = 1, then s = 4 or 6 will give the frequency ω. This means that either the fourth or the sixth harmonics of the oscillator will beat with the incoming signal, having a frequency of 5ω, to give the output frequency ω.

This added 860 kc component of the plate current caused by the harmonics of the oscillator beating with the incoming signal is in phase with the 860 kc current in the oscillating plate circuit. The circuit becomes stable in this condition and the injected current will "lock in" the incoming 4300 kc signal with the 860 kc current in the plate circuit. Since the injected current has the same phase and frequency as the normal cur-

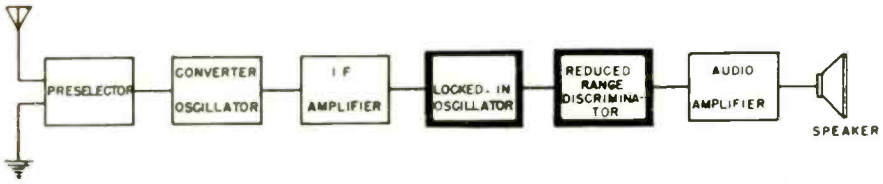


Fig. 1—Block diagram showing the arrangement of locked-in oscillator and discriminator units

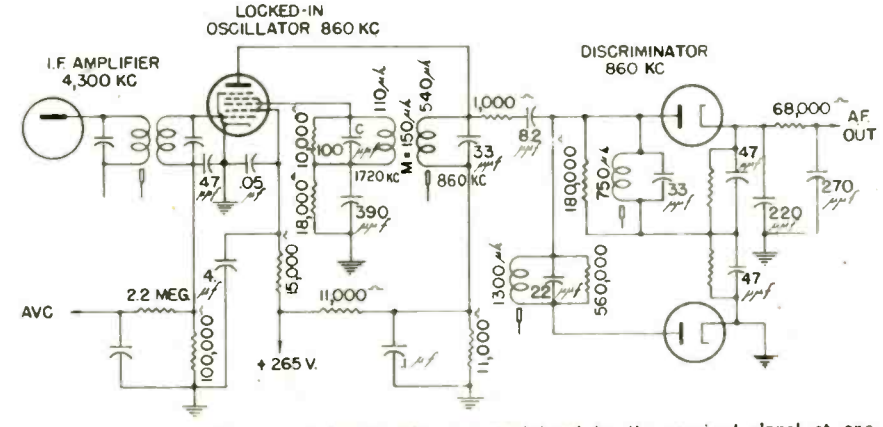


Fig. 2—The local oscillator is locked-in with and modulated by the received signal at one-fifth the intermediate frequency. The discriminator is designed for the reduced frequency

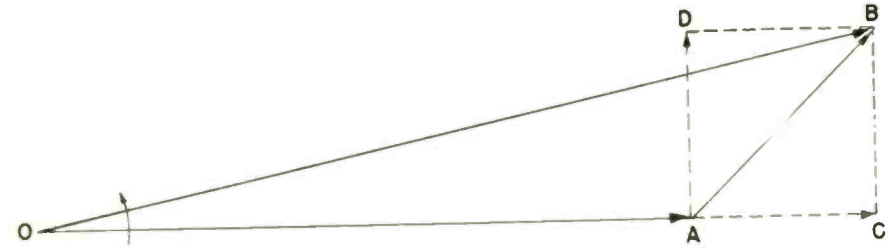


Fig. 3—Vector diagram showing phase relationship when the oscillator locks in with the incoming signal; vector AB then makes a constant angle CAB with OA

rent, it is merely equivalent to an increased output from the tube.

Now suppose that the frequency of the incoming signal is increased somewhat. The effect of the fourth harmonic will be to inject a current of slightly greater frequency than 860 kc into the tank circuit. The sixth harmonic will also cause an injected current of slightly less than 860 kc; this will be considered later. Assume for the moment that the oscillator is not locked in. In Fig. 3, OA is a vector rotating 860,000 times per second and represents the normal current in the oscillating tank circuit. Let AB be the injected current of frequency slightly greater than 860 kc, from the fourth harmonic of the oscillator voltage beating with the incoming signal voltage. This vector will rotate slightly faster than 860,000 times per second and thus will have an angular velocity relative to OA equal to the difference of the two angular velocities.

The injected current AB has a component AC in phase with OA and another component AD, 90 deg. out of phase with respect to OA. This resultant current OB is applied to a tuned circuit tuned to 860 kc, which is at resonance with respect to the current OC (860 kc) and equals $i_a + i_b$. The quadrature current AD is a leading current at the instant shown by Fig. 3, and the result is the same as though an additional condenser C′ is in the circuit. The effect is to decrease the natural frequency of the tuned circuit. An instant later, the vector AB rotates and produces a lagging component to reduce the apparent capacitance and increase the resonant frequency.

It is now evident that the oscillator circuit in Fig. 2 behaves like a reactance tube and swings the frequency of the tuned plate circuit back and forth. It is easy to see that if the frequency of the incoming signal is approximately five times that of the tuned circuit, a point will be reached when the frequency of the tuned circuit becomes exactly one-fifth of the incoming signal frequency. When this happens the oscillator will "lock in" with the incoming signal. This means that the amplitude and phase of the plate current now remain fixed with respect to the incoming signal; vector AB now makes a constant angle CAB with OA.

When the sixth and fourth harmonics are both present simultaneously, it can be shown that the result is a single injected current of variable amplitude and phase. This causes the frequency of the tuned circuit to swing back and forth in accordance with these variations; the process is very similar to that already explained when the fourth harmonic only is present. Usually, the fourth and sixth harmonics will be of unequal amplitude and the effect of the weaker one is to produce relatively small variations in the other.

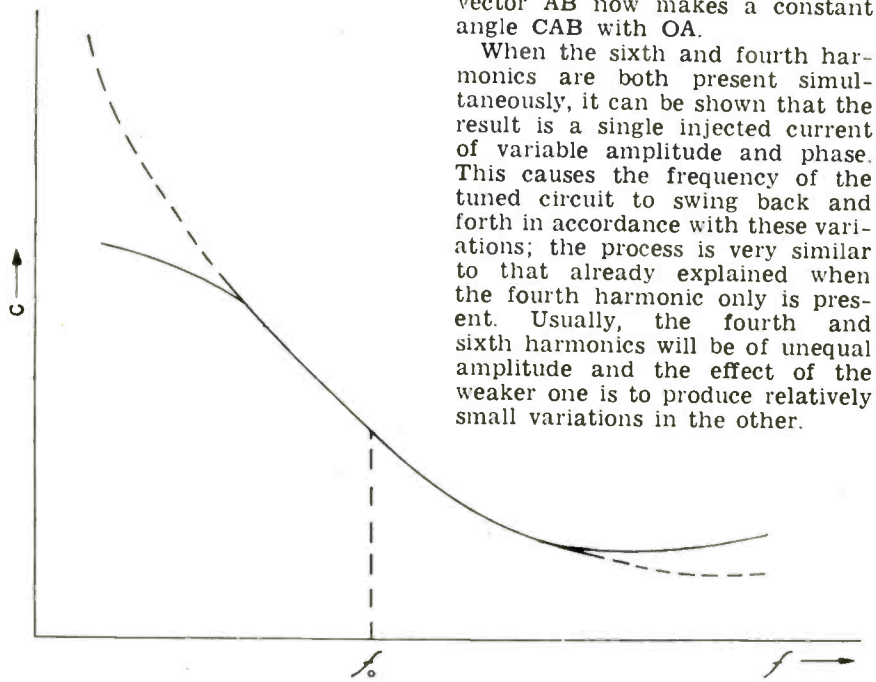


Fig. 4—Solid line is falling input capacitance of discriminator; dashed line is variation of capacitance needed to keep the oscillator in tune as the frequency is varied

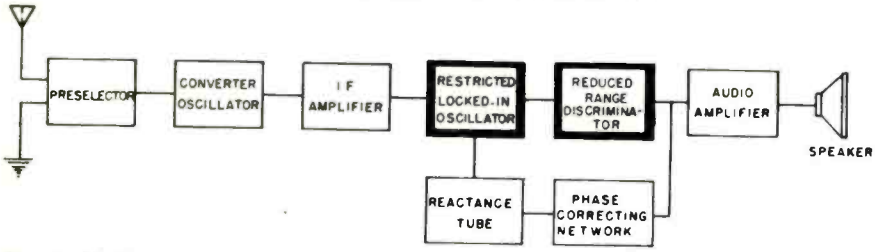


Fig. 5—Modification of a receiver to include the locked-in oscillator and reduced range discriminator as well as a reactance tube and phase correcting network indicated that such an arrangement provided superior noise reducing and adjacent channel selectivity

As previously stated, by restricting the lock-in range of the oscillator to frequency variations in the desired channel a material improvement in selectivity can be obtained. It is necessary that the lock-in range be adequate to follow the frequency variations of the received signal and in addition provide for receiver mistuning and frequency drift in the transmitter and receiver.

The amount of fourth and sixth harmonics on the No. 3 grid of the oscillator is limited and this limits the lock-in range. When the deviation exceeds the lock-in range the oscillator breaks out and starts back toward the center frequency since it is no longer controlled. The oscillator may then suddenly jump to a series of different frequency ratios such as, . . . 36/7, 41/8, 46/9 . . . 5/1, . . . 44/9, 39/8, 34/7, . . . for short intervals. The lock-in range for each of these ratios is very small, and the oscillator breaks out between them. The result can be distorted output.

Lock-in range

When a discriminator is connected to the oscillator, it changes the impedance relations of the tank circuit and increases the lock-in range. The equivalent input capacitance of the discriminator circuit shown in Fig. 2 decreases rapidly with frequency near the center frequency of the oscillator. If the oscillator tank circuit is to be kept in tune over the operating frequency range, the tank circuit capacitance should decrease with increasing frequency.

The discriminator input capacity characteristic can be designed to provide an apparent capacitance change with frequency to nearly match the requirements for tuning the oscillator.

In Fig. 4 the solid line represents the falling input capacitance of the discriminator and the dashed line is the variation of capacitance required to keep the oscillator in tune as the frequency is varied. If the two curves have approximately the same slope at the center frequency f_0, the lock-in range will be greatly increased since only a small amount of reactive current will shift the oscillator frequency a considerable amount.

For small applied voltages the lock-in range increases rapidly from zero with increasing signal voltage until it reaches a maximum, and it then decreases slowly with further increase in voltage. In practice, the screen and plate resistors can be chosen to correct this falling off of the lock-in range with increased input. This com-

(*Continued on page* 228)

2-MILLION VOLT X-RAY TUBE

Accelerating column used to speed electrons in new sealed-off unit having focal spot of but .010 inch

● The development of a two-million volt sealed-off X-ray tube by the Machlett Laboratories, Springdale, Conn., for the first time makes it practical to radiograph thick metal sections by reducing the exposure time, for example, from a week with a million volt X-ray system to less than an hour with the new two-million volt tube.

The new tube shown in the accompanying photograph and diagram is compact in spite of its high operating voltage. It has a tungsten cathode approximately 0.020 in. in diameter located at the upper end of the tube. This cathode is centrally located at the end of a column formed by 182 metal accelerating anodes. The anode rings are separated from each other by glass insulation rings, the whole unit being sealed to produce a vacuum tight system. The voltage between adjacent rings is 12 kv. The accelerating column produces the necessary velocity for the electron stream.

Ultra fine focus

One of the requirements for this tube, as established by the high voltage laboratory at M.I.T., was the production of a focal spot only a few thousandths of an inch in diameter, which can be compared with other high voltage X-ray tubes having focal spots approximately ¼ in. in diameter. This was necessary to prevent the concentrated beam energy from bringing the target up to the melting point. However, such a large focal spot produces poor radiographic images, particularly where pictures of thick sections are made and when the fault lies near the surface of the object at the maximum distance from the film. A point source of X-rays is, of course, the ideal solution to this problem.

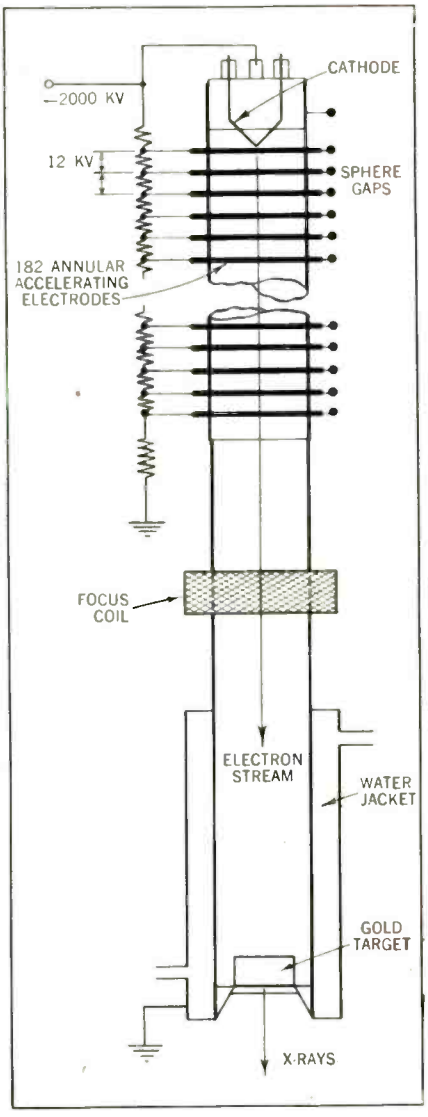
To achieve this extremely small focal point a focusing coil is used, giving a high intensity magnetic field parallel to the motion of the electrons. This produces a focusing effect similar to that used in certain cathode ray tubes. The focused spot achieved in this tube is only 0.010 in. in diameter.

The anode, or target, of the tube is a block of gold approximately one-half inch thick located at the bottom of the column and perpendicular to the beam of electrons. This target is a transmission type, rather than the more conventional reflection target, and the X-rays are emitted in the same line taken by the electron path. The penetrating power of the two-million volt X-rays is sufficiently great to render unimportant the filtering action of the dense gold. The water jacket surrounding the target end keeps the temperature at a safe value.

The focusing point in this tube is sufficiently small to indicate a 0.014 in. thickness variation in a 16-in. section.

In operation the tube is mounted in a metal tank into which air is pumped at from 200 to 400 lb. per sq. in., the high pressure air acting as the insulating medium. The high voltage generator for operating this tube is of the Van de Graf moving belt type. The target end is operated at ground potential while the cathode is at minus 2000 kv. The

(Continued on page 226)



At left, R. R. Machlett, president of Machlett Labs., holds new 2000 kv X-ray tube. Cathode end is at top and water jacketed target at bottom. At right is outline of accelerating column, focus coil, target and water jacket. X-rays are transmitted directly through target

★ **National Electronic Conference Paper**

TRANSIENT RESPONSE OF

by **DR. W. W. HANSEN**

Sperry Gyroscope Co.

Defining and evaluating transient bandwidth, and coupling schemes for one to one hundred stages

• The performance of an amplifier might, in principle, be completely described in either of two ways—one might specify the amplitude and phase as a function of frequency or, alternatively, one might describe the transient response to a delta function input. (A delta function has infinite amplitude and infinitesimal time duration, the infinity and the infinitesimal being so related that the area under the curve is unity. Otherwise said, it is the derivative of a unit step.) Either of the above gives a complete description and from each the other can be found—in principle.

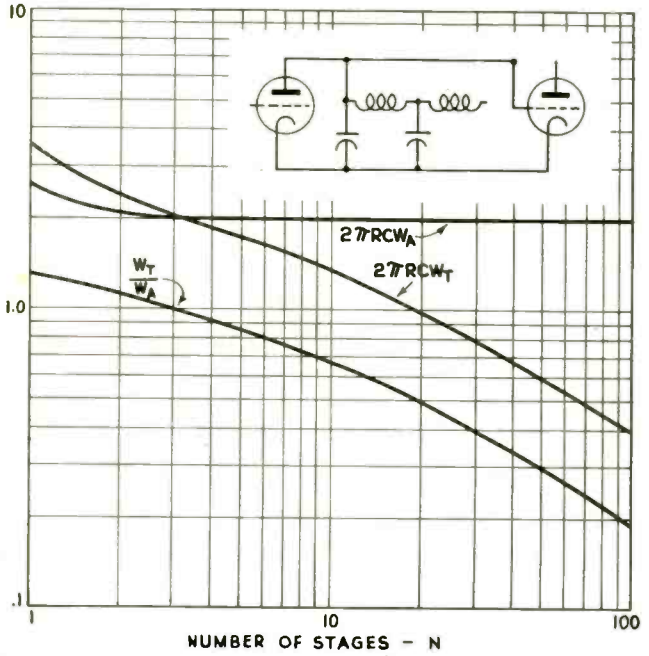
When the circuits involved are of the minimum phase type, as they usually are, one can, in principle, specify even less. For it is then possible to specify the amplitude, the phase or the delta function response, any one determining the other two. To this we add two statements. First, the determination of the remaining two responses from the given one is likely to be difficult. Second, very slight changes in one characteristic may produce large changes in the other two. Thus one can have amplifiers with almost identical amplitude responses which have very different phase responses, etc. Thus from a "practical" point of view it may appear that the three responses are almost independent whereas from a mathematical point of view they are completely interdependent.

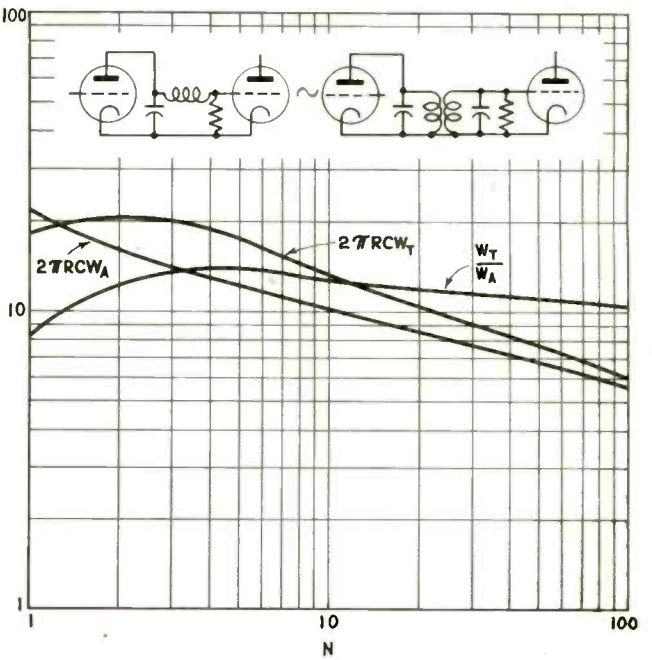
Which of the three is important depends on the application. One can find applications in which knowledge, to moderate accuracy, of any single one of the three suffices. For example, in the reproduction of speech and music, it is commonly considered that the amplitude response only is important, almost any phase and transient response will do. As a further example, we may consider a receiver whose band is made wide, not because the transmitter spectrum is wide, but because the mean transmitter frequency may vary and it it desired that this should not cause the output to vary.

An example in which the phase response is of dominant importance occurs when, as above, the transmitter frequency can vary and it is desired that the time delay of the amplifier should remain unchanged. An example in which the transient response is the important one occurs in television where the receiver output should be an accurate duplicate of the input (time delay being allowed), but what the amplitude and phase responses are is of no direct importance.

Moreover, the distinction between the three responses is not academic for it is possible to construct amplifiers with good amplitude but poor phase and transient response and ones with good phase but poor amplitude and transient responses. In the third case, that of making an amplifier with good transient re-

Shown here and on page 82 are the final results for a series of coupling schemes believed to include most of those likely to be used in practice W_T and W_T/W_A as a function of the number of





WIDE BAND AMPLIFIERS

sponse but which is poor otherwise, not so very much can be done, but even here variations of two or even four to one in amplitude response for the same transient response are possible.

Until fairly recently most applications have made requirements only on amplitude response. Fortunately, both the computation and measurement of amplitude response are rather easy so that curves of amplitude response versus frequency are usually available when desired. Moreover, it has been found that it is usually possible to condense the most important information obtainable from such a curve into a single number called the bandwidth.

Applications in which the phase response alone is important are not common and will not be discussed further.

Transit response

Lately, applications in which the transient response is the one of real interest have become frequent. Here difficulties have arisen. The transient response is usually quite difficult to compute and not too easy to measure. As a result, the transient response of amplifiers used for transient response is often, or even usually, not known. Also, no single number, like the bandwidth, has been suggested which can be used as a measure of the excellence of the transient response. Usually the amplitude bandwidth has been used. This has some justification for it can easily be shown that a wide amplitude band is necessary for good transient response. But, while necessary, it is not sufficient.

The reason for the continued use of the amplitude bandwidth, in cases where transient response is the thing of primary interest, is not that the logical mistake has not been appreciated, but rather that the amplitude response had something to do with the matter and no other practically usable criterion existed. So, lacking anything better, the amplitude response has been used.

It is the object of the present work to improve this situation by defining two numbers called transient bandwidths. Each is precisely and simply defined and gives, in a single number, a measure of the excellence of the transient response of the amplifier. Although the numbers measure different things in detail, it seems likely that for most purposes only one need be known. Should this prove true this number may perhaps come to be accepted as the transient bandwidth. In any case, for lack of time, the discussion today will be confined to what is believed to be the more useful of the two.

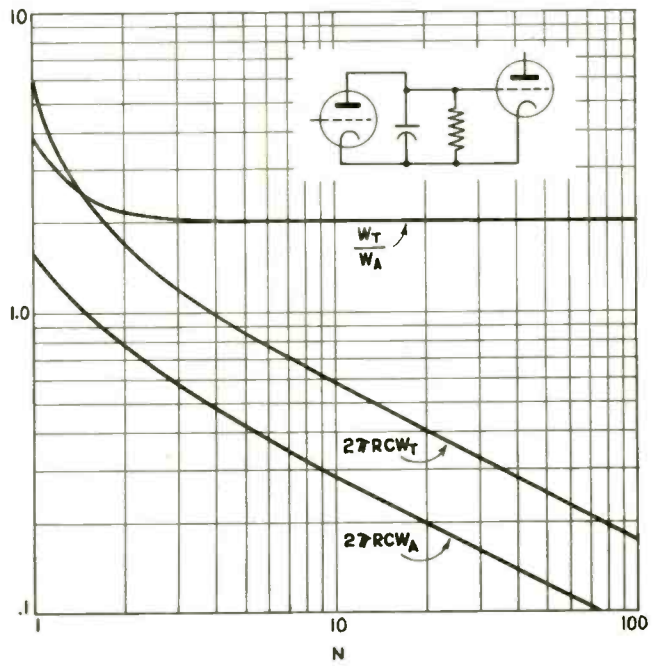
In the succeeding sections of this paper, then, the following will be done. As a preliminary, a precise definition of amplitude bandwidth will be given, along with some background discussion. Next, the transient bandwidth will be defined, the reasons for the definition given, and various general conclusions drawn. Third, methods of evaluating the bandwidth will be discussed. Finally, evaluations will be given for a variety of coupling circuits believed to include almost all those likely to be used and for numbers of stages running from one to one hundred.

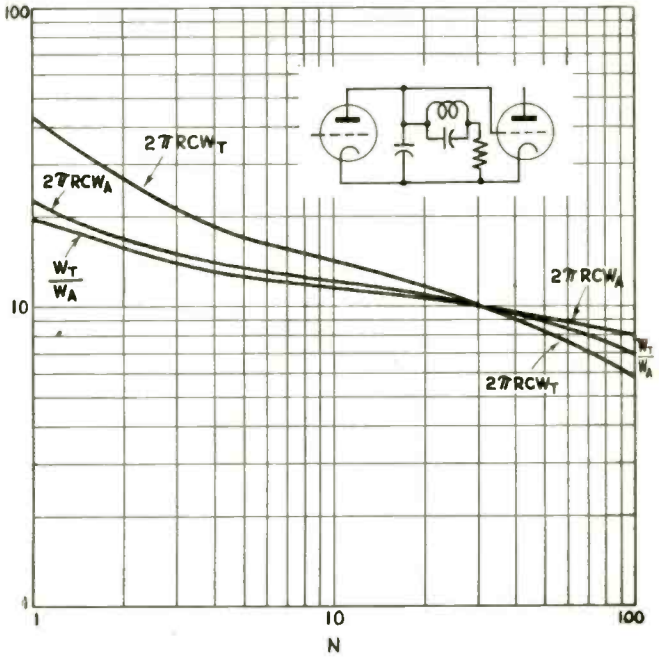
Amplitude bandwidth

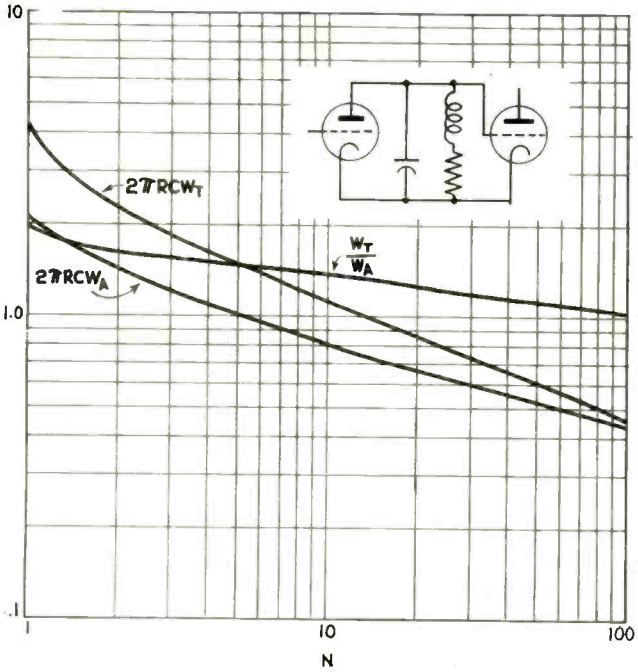
Before touching the main subject of this paper, we need to make a few remarks relative to amplitude bandwidth. These are needed for precision and will also serve a useful purpose as an introduction to certain points of view needed later.

Let the amplifier response be specified in the usual way by a complex function $G(\omega)$ which gives the output for unit input of radian frequency ω. A certain frequency is now chosen as the band center of the amplifier. In what follows we will, for brevity, take this frequency to be zero. That is, we consider only low pass amplifiers—the changes required to take in band pass amplifiers are regarded as

and for numbers of stages running from one to one hundred. These results are in the form of graphs which show each coupling scheme, W_A, stages. In all cases, N equals number of stages







needing no added discussion. Then we define the amplitude bandwidth as

$$W_A = \frac{1}{2\pi |G(o)|^2} \int_0^\infty |G(\omega)|^2 \, d\omega \quad (1)$$

Often it is convenient to introduce a function $g(\omega) = G(\omega)/G(o)$ which is the gain normalized to unity at band center. Then

$$W_A = \frac{1}{2\pi} \int_0^\infty |g|^2 \, d\omega \quad (2)$$

The bandwidth so defined is a number such that the area under the curve $|G|^2$ is the same as the area under a rectangle having the same height at band center and a width W_A. This definition is independent of gain and is otherwise a perfectly reasonable definition. Other reasonable suggestions might be made, but this one seems singled out because it also has fundamental importance in determining the noise output of the amplifier. In fact, the above definition is equivalent to saying that the bandwidth is a number such that an amplifier with uniform gain, equal to G(o), out to W_A and zero thereafter would have the same noise power output as the actual amplifier.

It is interesting to note that if the output F(t), resulting from the application of a delta function to the input, is known, then W_A can be found as

$$W_A = \frac{1}{2} \int_{-\infty}^{+\infty} |f|^2 \, dt \quad (3)$$

where $f(t) = F(t)/G(o)$. That is, W_A is a measure of the output energy resulting from excitation by a delta function.

While there can be no doubt that W_A, as defined above, is the most useful single number measuring the amplitude response other definitions have been used. Probably the most common is the width to the g = .707 point. It is fortunate that in almost all cases of practical interest the width to the 71 per cent point and W_A are only very slightly different. For example, for a number of RC coupled stages the difference is 6 per cent, for a number of shunt peaked stages .5 per cent, etc.

Now, how shall we measure excellence of transient response? A rough description of what would appear to be a logical procedure follows. Suppose an input, which is some chosen function of the time, be applied to an amplifier and the output recorded. Then we take the difference between the output and the input. This difference will be an instantaneous measure of the failure of the output to follow the input.

For the usual reasons we square this difference and integrate over time and so get a measure of departure of the amplifier output from perfect following of the input. This certainly seems a logical procedure though the details are somewhat nebulous. For example, how is the gain of the amplifier to be allowed for? Again, time delay is usually considered no defect—we must then allow for a translation in time before output and input are compared.

But, assuming such technical questions can be answered, we must, to proceed further, specify the "test function." What are the characteristics of a suitable test function? It should contain all frequencies and should be discontinuous enough to constitute a suitably severe test. Additionally, analytic and/or experimental simplicity would be highly desirable.

Two functions immediately come to mind, the delta function and its integral, the unit step. Both can be used and we have developed the theory for both to a considerable extent. But because of time limitations we will confine our discussion to the use of the delta function. We choose this because it is a more severe test, because the analysis is simpler, and because of the formal similarities with the amplitude band theory.

If then, we use a delta function as a test function, we may argue as follows: If the amplifier were perfect the output F(t) would be zero except during an infinitesimal time. The squared error is then the integral of $F^2 dt$. This must be normalized in some way to make the answer independent of gain and the obvious procedure is to divide by F_m^2 where F_m is the maximum value of F. This quotient is of dimensions time. While specifying the transient response in terms of time would probably be the best procedure ab initio it seems better at present to take the reciprocal and get instead an "effective bandwidth" in cycles per second. Doing so, and introducing a constant which makes $W_T = W_A$ for a square pass band with linear phase, we define

$$W_T = \frac{1}{2} \frac{F_m^2}{\int F^2 dt} = \frac{1}{2} \frac{f_m^2}{\int f^2 dt} = \frac{(f_m/2)^2}{W_A} \quad (4)$$

(Continued on page 218)

Table 1—Transient responses of amplifiers proportioned to have the same amplitude bandwidth

Circuit	W_A	W_T	f_m	$\frac{f^2 dt}{f_m^2}$
Single RC	1.00	4.00	4.00	.125
Two RC Stages	1.00	2.16	2.94	.231
Many Identical RC Stages	1.00	2.00	2.82	.250
Perfect Band Pass	1.00	1.00	2.00	.500
Seven Stage Stagger Tuned	1.00	1.21	2.20	.413
Sixteen Stage Filter Coupled	1.00	.54	1.28	.92

FM "BURSTS" SHOULD DIMINISH

by Dr. HARLAN T. STETSON
Cosmic Terrestrial Laboratory, Needham, Mass.
Massachusetts Institute of Technology

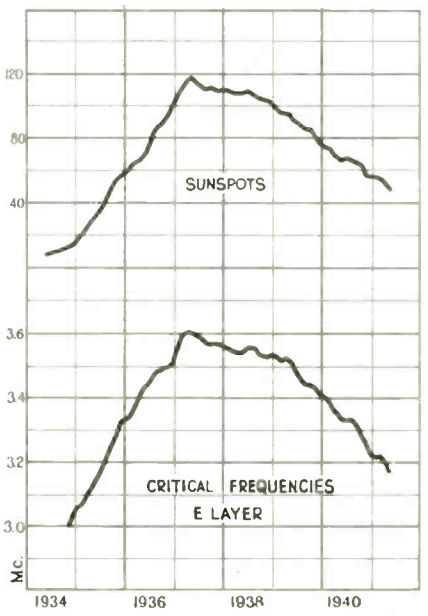
Present conditions most favorable for long transmissions, since ionosphere disturbances are now at minimum

● In "Electronic Industries" for July, 1944 (page 249), attention was called to troublesome interference on the high frequency FM bands, due to the occurrence of "bursts," a phenomenon which has been under study by the Federal Communications Commission. Since these interfering "bursts" have been observed up to levels in excess of those required for satisfactory FM reception and sufficient to take control of FM channels at faraway points, and have been heard up to distances of 1400 miles from the broadcasting stations, it is believed that should such interferences continue or be augmented in the future, serious difficulties might ensue in the use and allocation of FM frequency bands.

In several public statements, William B. Lodge, CBS director of engineering, has stressed the possibility that such troublesome interferences may markedly increase with the rise in solar activity incident to the coming sunspot cycle whose maximum may be expected near 1948. While it is true, as Mr. Lodge implies, that a fairly close correlation has been found between sunspot activities and critical frequencies which predetermine long distance transmission conditions, there are several factors that might well bring about quite the opposite of Mr. Lodge's conclusions relative to FM.

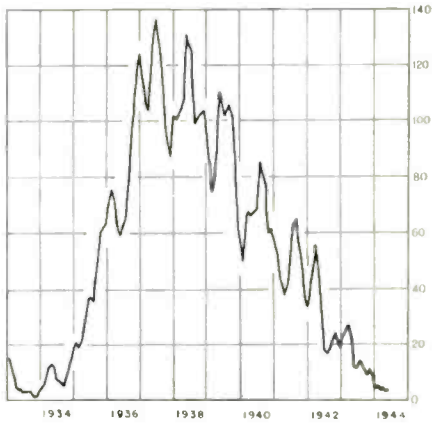
Experience has shown that during periods of minimum solar activity, such as have occurred during 1943-44, the relative tranquility in the ionosphere favors long-distance transmission of certain frequencies, and that constructive interference of such anomalous transmissions with the FM bands may be responsible for the spurious conditions that have been termed "bursts."

With the increasing amount of solar activity that may be anticipated accompanying the rise of sunspot numbers during the next few years, one may anticipate an increase in cosmic static and fadeouts due to sudden and irregular excesses in ionization at ionospheric and at lower levels in the atmosphere. Such static, however, should be far less troublesome to FM than to conventional broadcasting. It may be reasoned that a more disturbed condition incident to increased ionization and energy absorption in the lower layers may preclude the very possibility of "bursts" which have been noticeable during the last two years when solar activity has been at a minimum.



These curves show the manner in which critical frequencies closely follow sunspots. Curves are smoothed by 12-month moving average

Three-month moving averages showing the rise and fall of sunspot numbers



Certainly FM was sufficiently widely used during the years of the last sunspot maximum, 1937 and 1938, to have made possible many observations of such "bursts" during those years if this type of interference had been widely prevalent. With the meager amount of data at present available one might well conclude that increasing solar activity will be more favorable to short distant FM reception than otherwise.

It has long been known that in the broadcast band there are certain zones of short radius around the transmitting antenna where bad interference results during a sunspot minimum due to the unusually good transmission conditions in the broadcast band from distant stations. Such interference often results in a degree of "mushiness" troublesome enough when one is tuned in to local stations. On the other hand broadcast reception from distant stations is invariably superior during the quiescent state of the ionosphere that accompanies the lull in solar activity incident to low sunspot numbers.

Careful observations during the next year or two, with the beginning of the anticipated rise in sunspots should give sufficient data to test the validity of this hypothesis. With the close of the war when the large amount of radio data, now restricted, may become generally available, we shall probably find the evidence that can more satisfactorily predict the future of FM on the frequency bands now assigned.

UHF MEASUREMENTS

The Engineering Department of FCC late in September issued a "Report on UHF Field Strength Measurments." The data from which the report was compiled were obtained under a project for the continuous recording of selected FM and television stations in the frequency range from 42 to 84 mc. Four types of signals are investigated: (1) Tropospheric Signals; (2) Bursts; (3) Sporadic E Signals; (4) Long-distance F_2 Signals. Results of the investigation are charted.—Editor.

SOUND AMPLIFICATION

Multiple parallel slit orifices, separately modulated by voice operated vane, give high degree of linearity

● In almost every phase of modern construction, whether it be airfields, railroad yards, auditoriums, stadiums, etc., the factor of size is ever increasing. Where once a megaphone sufficed to augment the voice to do a particular job, it has been customary to use multiple speaker installations requiring heavy duty amplifier systems, running into many hundreds of watts output to drive them. It has not been too difficult to design an amplifier with, say, 100 watts output and a horn speaker unit to go with it, although tubes and transformers (especially the latter) capable of handling a wide frequency range at that power are neither simple or cheap.

The line of least resistance, when it came to covering greater areas, is usually to use many speakers in parallel, with a larger audio amplifiers, or several multipled smaller ones. Some applications, where the requirements would call for many kilowatts of audio power, have exceeded the point where the economical production of voice-modulated energy and its conversion into sound waves is possible and a reanalysis of the whole problem has taken place. For this reason a further report* on the sound system developed by Dilks, Inc., is of interest.

During the last few years much work has been done in regard to the sound energy requirements for interior installations (in auditoriums, etc.), where such factors as reverberation, absorption, etc., have been thoroughly investigated by the acoustical engineering profession.

In the open, however, the solution is not so easy, in spite of the usual absence of the factors of reverberation or reflection. While such a simple factor as wind, which may be moving only 3 per cent as fast as sound wave travels, might seem to be inconsequential in affecting its intensity, actually it is found that wind effects can influence the normal attenuation of sound over a field many times the normal value—either aiding or detracting according to conditions. And it is not always true that a sound traveling against a "head" wind will decrease the distance that it travels either!

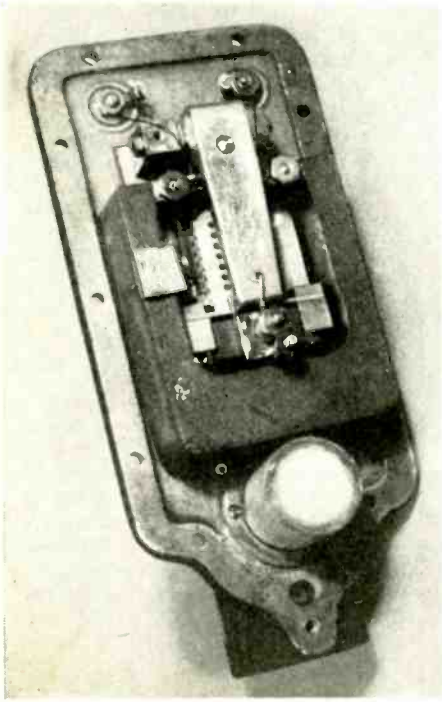
Ordinary observations show that a wind will usually blow loose articles upward. Wind rarely travels in a horizontal path. Actually wind velocity increases as its height off the ground is increased, at least for moderate heights. With a tail wind the sound wave-front will therefore move faster at a small height than at the ground surface. Thus the wave-front tends to bend downward and sound from a part of the ray that originally was projected slightly upward by the horn, reaches the observer at ground level along with the normal sound "quota." The character of the land surface and its vegetation, etc., will also cause many local disturbances and whirls when wind blows that cause erratic effects on the wave-front.

These gusts and whirls produce irregular disturbances which reduce the intelligibility of speech and add to the observer's impression of "distortion." Similarly a head wind has the reverse effect and sound is likely to take an increasingly elevated path and go over the head of an observer on the ground.

Other effects

Humidity and temperature are also important factors which complicate the problem still more. A uniform temperature gradient vertically will produce the same sort of wave-front distortion, although for another reason: here the velocity of the sound wave is altered —as it is proportional to the square root of the absolute temperature. If the temperature increases with height, the sound will be refracted

* "Sound Coverage for Airports," page 76, "Electronic Industries," May, 1943.



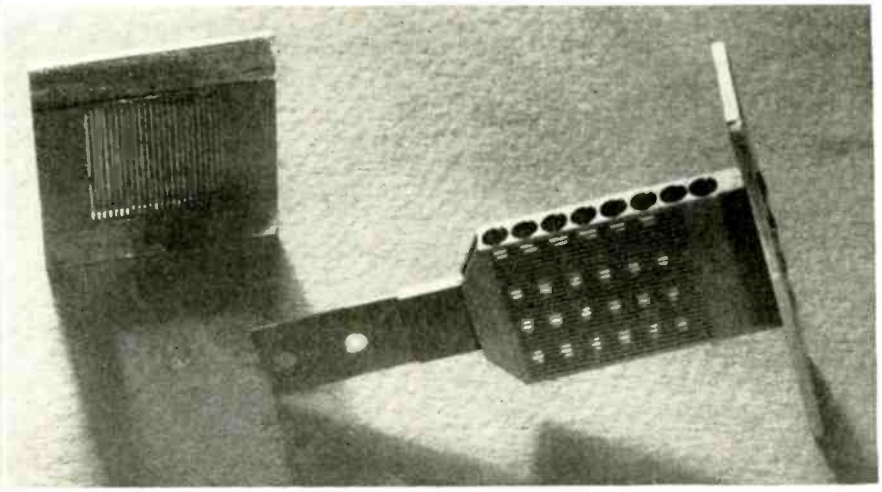


Fig. 1—Typical Dilks unit. Air enters through filter at bottom. Fig. 2—(Right) Fixed orifice plate at left and the vibrating armature plate at right, showing multiple slit orifices

BY AIR MODULATION

toward the ground, but as is the usual case the air becomes cooler with height, the sound is elevated and is lost to an observer on the ground. Both of these effects are important, and it sometimes happens that a head wind will apparently increase the sound intensity!

Inevitable horizontal disturbances in the temperature gradients, such as the heated air columns that are so important to the pilot of a glider, produce smaller refractions resulting in lost syllables, quiet pockets and therefore a reduction in intelligibility.

At sea, the combination of effects often brings about surprising results. Certain sounds may be reflected forward upon striking the water at an angle. Another condition that is noted—the temperature of the water may be seasonally out of phase with the general temperature of the air, although the air in contact with the water may be closer to the latter's temperature. Thus the distance sound travels over water (on account of the temperature gradient refraction) varies to a large degree upon the season, and this also is true over land, although to a less noticeable degree.

Nowhere above has the phenomena of neutralization been considered in the problem. It is evident that the surface wave-front and that which has been refracted downward by wind and temperature may interfere, so that at certain points a selective frequency attenuation is noted.

Since, heretofore, long distance listening has been confined to noises such as gun fire, fog horns, explosions, etc., which have either monotones or else no characteristic frequency, such interference effects have been noted only as points where such sounds were not heard or were abnormally loud. With high intensity voice transmission these phenomena will have to be studied by acoustical experts with all the precision that has been applied to sound system studies of auditoriums and enclosed spaces. The net result is, that for any unusually wide coverage of sound, it becomes necessary to use high intensity sources, to insure adequate distances.

A volume of air, when compressed contains potential energy which will be released when expansion is allowed. If the release constitutes a continuous streamline flow no sound is generated unless resonance effects are created by turbulance, intentionally or otherwise as in a whistle. If a stream of compressed air is modulated or its escape rate intermittently altered, sound waves are created (if the modulation rate is in the audible range). Experimental evidence indicates that the sound intensity is probably proportional to the square of the pressure at which the air is held.

No matter what the source of sound, by its fundamental nature some means of compressing air must be provided, and the efficiency of any system depends on the efficiency of the source of compressed air considered as a simple air pump, together with the effectiveness of the modulation system.

A diaphragm loud speaker is not a very efficient mechanism in this regard, no more than a diaphragm pump is a very effective fluid pump. When a large diaphragm is used,

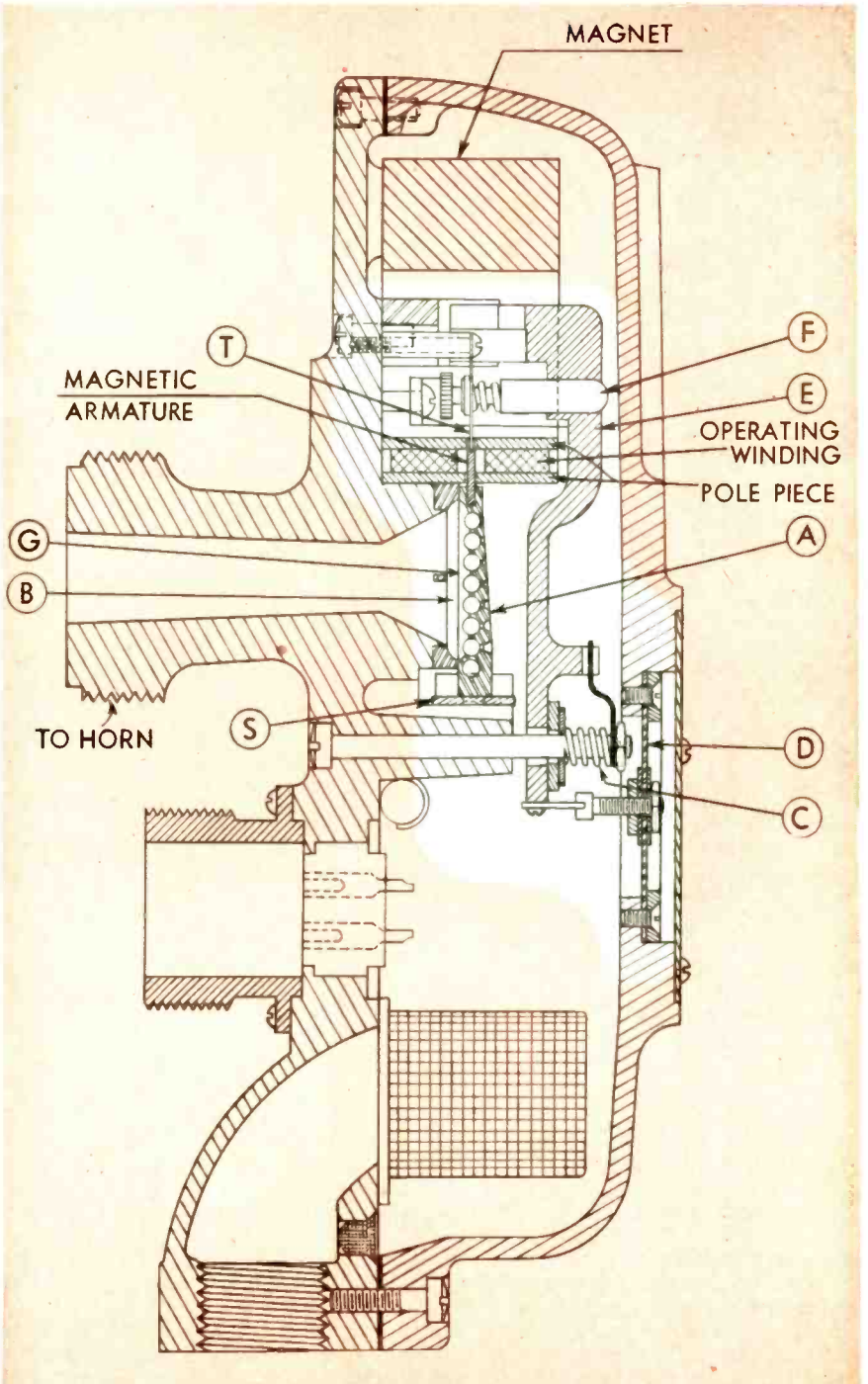


Fig. 3—Cross-sectional view of Dilks fluid flow unit. The automatic adjustment-stabilizing arrangement is shown in the white central section

Portable units are operated by either electric or gas engine drives. Fig. 4 shows a form of the latter, with source of power for amplifier and air compressor mounted integrally on the gasoline engine base, Fig. 5

the coupling to the air stream (or loading) may be theoretically quite effective, but here practical considerations show that it is difficult to drive a large diaphragm equally over its whole area, especially at high frequencies, and phase difference effects become to be troublesome. Considering the fact that a speaker has to be operated by expensively-produced audio frequency energy it is not surprising that the trend is toward other systems whenever high intensity sound coverage is considered. It is also reasonable to see why the systems of modulating a stream of compressed air as it escapes into the atmosphere has been the most logical development, since it has so many counterparts in nature.

One's vocal cords function in just this way. It is probable that if a person's vocal cords had to supply the total energy of speech and music, instead of modulating the air stream from the lungs, the speaking habits of mankind would be considerably abridged! When the simplicity and economy of producing high air pressures with modern motor-driven compressors are considered it becomes evident that here is the basis for an ideal system, once the principle whereby the modulation is effected was arrived at.

Many investigators have worked on this problem during the last fifty years or more, and many modulation principles have been advanced, but the unilateral differential of pressure affected the operation of the voice-operated air valve and usually introduced such a large harmonic content, that the device gave inadequate response for the reproduction of music and speech. The air valve had to be forceful enough to operate against the air stream in one direction and yet withstand the pressure when moving with the flow. The matter of unilateral operation is always to be considered in any kind of sound reproduction system — a true balanced unit always giving least even-harmonic distortion. This matter is the one main difficulty that must be overcome with any air modulated system.

These objections have been practically overcome in the Dilks, Inc., sound unit design, shown in Fig. 1, and a series of sound amplifier systems have been developed by that organization to handle a great many sound amplifier applications of a magnitude rarely attempted with the power amplifier — diaphragm speaker system.

A typical Dilks unit operating at 20-25 lbs. pressure and requiring 15 or 20 watts of audio power is shown in Fig. 1. The air valve utilizes the combined flow from a great number of parallel slit orifices from which the compressed air egresses into the throat of a horn, each slit being separately modulated by the movements of a voice-operated vane, of a very unusual construction, as seen in Fig. 2.

Fidelity requirements

Before describing the nature of this modulation, some details of the conditions whereby sound waves can be generated by compressed air waves may be of interest. Actually in any horn system compressional waves are produced by any kind of speaker unit and the resulting sound wave intensity depends upon the maximum instantaneous pressures and their rate of change. Beyond the generating unit, that is—in the throat of the horn and thereafter, any system of sound generation will give identical results, provided the same pressures and momentary acceleration rates have been produced at the various frequencies.

Fidelity is therefore a matter of making the pressure wave proportional to the electrical input potential at each instant. In the diaphragm system a non-linear relation between displacement and applied force always exists, since the diaphragm tautness increases rapidly as it moves away from the mean position. In the compressed air system a non-linear condition exists, on account of a somewhat non-proportional release of air as the valve moves away from its seat (where complete cutoff would take place). Actually the vane must be floating during use and never become seated or the resulting chatter would completely destroy the quality—the same as occurs when the armature of an ordinary speaker hits the pole faces.

After the discovery that a high degree of linearity could be obtained only by diverting the air stream through a large number of narrow (.006 in.) slits, and modulating each separately, could full and instantaneous control over the whole area

of the orifice be attained. Even then it was necessary to effect full control by extremely small movements, with the armature of the valve normally open only 0.0006 in. at 25 lbs. pressure. Another important factor was that the median position of this armature must be held fixed at the point where greatest linearity is maintained — irrespective of a possible differential between the compressed air tank on one side and atmospheric pressure on the other. This self-compensating feature that permits a lightly suspended armature capable of being easily moved by small changes in current in the electrical circuit, and yet withstands the high pressures of the compressor is shown in Fig. 3. The slotted armature (A) and its facing plate (B) are in contact at face (G) at zero pressure. The armature swings on a torsion spring (S) but its motion is further limited by an auxiliary spring (T) at its opposite end. As the air input pressure is increased, the diaphragm (D) moves outward moving the lever (E) with it against the adjustable spring force (C), the latter being adjustable for any operating pressure. The lever (E) pivoted at the opposite end is lined through a flexible coupling arrangement (F) to alter the tension of spring (T) in such a way to move (A) away from (B). The flow of air through the slits then starts. The rate of flow is delicately balanced since the mean value of the gap is established by that pressure. The greater the pressure setting the greater the opening. This permits the most efficient flow to be maintained at all possible operating conditions, and further permits the use of very small armature movements.

The small movement produces a high degree of modulation linearity, while a larger excursion would result in some sort of reciprocal law characteristics. However, after the mechanical problems attending the easy production of the valve elements were finally solved at Dilks, satisfactory modulation levels were attained in spite of the small movements. It will be noted from Fig. 2, that the armature has longitudinal slots that are offset from similar slots in the orifice plate. When the armature is close to the latter the air is essentially cut off. At the other end of its passage maximum flow occurs. This flow passes into the transverse channels in the armature (to be seen in the photograph Fig. 2) which equalize the flow paths in all parts of the system, so that all modulated air "lamina" work together to produce a single wave front at all frequencies.

Eighteen cu. ft. of air per minute compressed to 25 lbs. pressure, would be reduced to a little over six cu. ft. Conversely if this six ft. is released, it again expands to 25 ft. and produces an air movement away from the release point. If this release is in accordance with a modulation signal, a varying wave front results, in every way identical to any sound wave.

Theoretical considerations of this modulated air stream brings out many interesting mathematical relations, which will not be taken up here. There is no standard way of stating the efficiency of such a system in ordinary terms. In comparing electrical energy input with the resulting sound output for one series of tests, an efficiency of many thousand per cent was indicated if compared with the efficiency of a regular diaphragm unit which is less than 20 per cent. This is due to the introduction of an "amplifier effect" by the modulation principle.

Economics

Actually the system would have to consider the operating cost of a fixed potential compressor as a source of the air pressure, the same as the cost of direct current must be considered in the case of the usual heavy duty audio amplifier. There is no problem here in either case, even for portable speaker systems, as Fig. 4 shows a gas engine operated system.

The usual Dilks unit operates at 20 to 25 lbs., but here the best value is a compromise. Higher pressures give much greater outputs but the harmonic distortion also increases. The character of the transmission handled and the need for fidelity will establish the optimum pressure.

Referring to Fig. 2, the body of the orifice plate grid reed, made of 24 ST aluminum alloy, has a series of slots .006 in. wide and a series of bars .015 in. wide forming the modulating surface.

The slots are approximately 11/16 in. long, the bars of the same length. A piece of metal .015 in. thick, .020 in. wide, 11/16 in. long, is exceedingly flexible. To obtain the modulating area desired, which is the combined length of the edges of bars, narrow bars are necessary. These bars must conform to a semi-piston action while under a vibration, and must not vibrate, distort or deform to any degree to avoid distortion.

If the bars of the armature were not rigidly reinforced by some structural means, a muffled rattle or reedy effect would be noticed. The bars would also crystalize. Each bar vibrates at its own natural period; i.e., nodes, anti-nodes and segments which are natural periods and, of course, cause extraneous noises to be introduced into an otherwise pure sound. Therefore to strengthen these bars, the body of armature grid reed has a series of holes drilled through the narrow dimensions of the piece. The slots are then cut deep enough to intersect the transverse ports in body or armature grid reed. A series of conical ports are drilled through the top of body of reed terminating in the transverse ports to allow an even distribution of air to the transverse ports.

One method by which potential sound intensity of a given transmitter may be determined without elaborate set-up and instruments, is to find the modulating area of the slotted stator plate and the location of the rotor grid reed relative to it. This, with the volumetric flow of the fluid and the pressure permit a close estimate of the possible sound intensity at 100 ft. on the axis of the baffle, to be determined assuming no obstructions, and measured over level terrain.

The total modulating area is effectively equal to the linear strength of the edges surrounding all slots in the fixed plate. In the model S-34 unit, the slot apertures in stator grid are 11/16 in. in length. The armature is located in the high pressure side (that is in the lower resonance chamber). The operating pressure is 22 to 25 lbs. The volumetric flow is 15 cu. ft. per minute, at atmospheric pressure. There are 34 slots in the plate. With this construction, with the armature reed located in the high pressure side, tests show an approximate intensity of 130 db for signal and 120 db for voice at 100 ft. on axis of baffle. If the same armature were located in the upper resonance chamber (low pressure side) all other conditions remaining equal, an intensity of 118 and 110 db only would be produced.

The overall fidelity of the system depends to a large extent on the characteristics of the horn and its

(*Continued on page 228*)

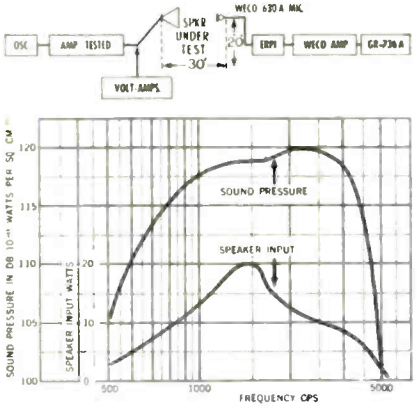


Fig. 5—Sound pressure/frequency curve for one style of unit designed for PA work. Pressure measured with input voltage constant with measured distortion at 1 kc was 12%

★ **National Electronic Conference Paper**

TUBE PERFORMANCE AT

by F. B. LLEWELLYN and L. C. PETERSON
Bell Telephone Laboratories

Physical and qualitative investigation of electron stream action in terms of equivalent networks

● Conventional representation of the equivalent network of a vacuum tube usually takes the form of Fig. 1. At (a) is shown the schematic diagram of a triode and at (b) is shown the equivalent circuit network. Such a representation was found to be entirely satisfactory at low frequencies. At moderately high frequencies the capacitances C_{gk}, C_{gp} and C_{kp} gave a little trouble. At quite high frequencies, however, troubles really begin and they multiply very rapidly with further increase in frequency. None of the elements forming the circuit remains quite independent of frequency, and some of them in fact, vary very rapidly at frequencies where the transit time of the electrons across the tube becomes an appreciable fraction of the period of the high frequency signal applied. Lead effects add a further complication.

At first sight, it would seem that these complications are unavoidable. There are three useful external terminals to the tube, and it would appear that the general form of the network diagram in Fig. 1 should be adequate to express the performance under any and all conditions. This in fact may be perfectly true, but does not indicate that the form of the diagram is suitable for expressing the high-frequency performance in the simplest way.

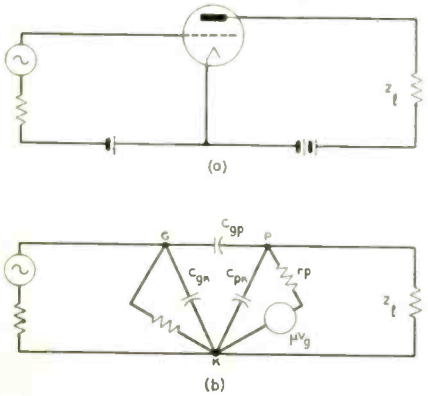


Fig. 1—Conventional representation of vacuum tube network

To see that this may be so, it is helpful to look inside the vacuum tube at what actually makes it tick, namely the electrons themselves, and inquire whether the diagram of Fig. 1 conforms most closely with the forces which act on the electron stream or whether the diagram, in fact, includes as part of the vacuum tube structure a number of elements that are disassociated from the electron stream itself, and therefore may be represented by simple passive network elements of inductance, capacitance, and perhaps even resistance.

Eliminating confusion

Such elements contribute nothing but confusion to the complete vacuum tube picture. If it were found to be possible to separate them from the actual electronic portion, it would seem that an important simplification should result. The passive network elements would be grouped with the external circuit elements, and the vacuum tube performance, in so far as it involves the electron, would be predicated upon a much simpler diagram.

That such a procedure is quite feasible was shown in a paper by the present authors which was published last March.* The present paper differs from that one only in that it attempts to attack the problem from the physical, and qualitative, viewpoint rather than from the mathematical and more quantitative one previously employed.

To do this, attention must be directed toward the electron stream itself rather than diverted to consideration of the electrodes and external geometry of the tube. For example, the electrons start from a cathode, pass through the grid, and finally wind up at an anode or plate. It is then obvious that the complete trip from cathode to plate may be subdivided into two stages, or regions. The first one corresponds to the space between the cathode and grid. The second one corresponds to the space between grid and plate. Each of these regions may be treated as an entity. The entire behavior of the electrons within it can be determined as soon as the terminal conditions are known.

In so far as the alternating-current performance of the tube is concerned, and for "small signals" in the usual sense, these terminal conditions are only two in number for each region. It is convenient to select the first condition as the alternating-current component of the electronic current (as distinguished from the capacitive, or displacement current) which enters through the inflow of electrons. For the second terminal condition the alternating-current component of the velocity of the entering electrons is taken.

In this way, it is possible to build up the equivalent-circuit structure of any region in terms of conditions in the preceding region, and hence ultimately in terms of conditions in the region across which the input signal is injected.

For example, consider a simple triode with cathode, control grid, and plate. The first region would be the one between the cathode and the plane of the control grid. As such tubes are usually operated, more electrons are emitted by the cathode than are drawn off by the anode through the control grid. This condition is one of "complete space charge." The average of the emission velocities of the electrons is quite small and hence the terminal condition depending upon initial velocities vanishes. For the same reason the coefficient in the term that depends upon the initial electron alternating current vanishes. This leaves only a relation between the alternating voltage across the region and the total current through it.

When such a relation is linear (as it is in this case for small alter-

*L. C. Peterson and F. B. Llewellyn, "Vacuum Tube Networks," Proc. I. R. E. March, 1944

nating currents) it defines an impedance. The whole alternating-current behavior of the electrons between the cathode and the plane of the control grid may consequently be represented by a simple impedance, as in Fig. 2, where the reciprocal of the impedance is shown as the admittance, y_{11}.

Fig. 2—Equivalent network between cathode and plane of the control grid

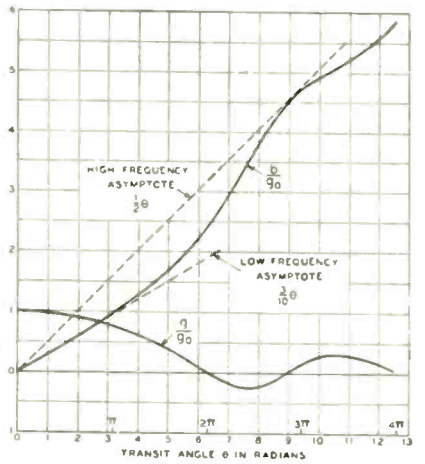


Fig. 3—Diode admittance with complete space charge

It is true that this admittance depends upon the transit angle of the electrons, but it can be calculated once and for all, and, in the ideal case where initial velocities are disregarded altogether, is shown in Fig. 3. Actually the initial velocities add a loading component so that the negative-conductance portion between transit angles of 1 and 1¼ cycle is usually (but not always) swamped by the resulting positive conductance.

From the conditions in this first region, it is possible to determine the alternating-current components of the electron current and electron velocity of the electrons entering the second region; the one between the control grid and the plate. In this region, as tubes are usually operated, the degree of space charge is very small. It results that the effect of initial alternating-current velocities may then be disregarded, and the whole effect of the electrons from the first region upon those in the second, may be represented by a transadmittance together with an internal admittance. Moreover, for the small degree of space charge usual between grid and plate of most tubes, the internal admittance takes the form of a simple capacitance. Its numerical value may be calculated by assuming the grid and plate to be solid sheets of metal.

Thus, the equivalent diagram of the region between grid and plate is shown in Fig. 4. The internal admittance y_{22} is a simple capacitance, whose value is easily calculated. The transadmittance, y_{12}, may be incorporated in an internal generator whose value is $(y_{12}/y_{22})\ V_1$ where V_1 is the applied signal voltage between the plane of the grid and the cathode.

Course of electrons

The complete course of the electrons from their emission at the cathode to their final arrival at the plate has been followed. The result may be shown diagrammatically by placing Figs. 2 and 4 end-on-end as shown in Fig. 5. This gives the essence of the vacuum tube, the electron stream itself, separated from the entangling alliances of external connections and actual physical terminals. However, in order to function, the tube must have these external connections. The electron stream being up in space, so to speak, is utterly useless without some way of connecting it to an external circuit.

Great care has been taken in the foregoing to speak always of the "plane of the grid" and not of the "grid." This is because the signal voltage at the plane of the grid means the voltage effective directly on the electrons passing through that plane. It is appreciably different from the signal voltage on the grid wires themselves. Therefore the problem arises of finding the equivalent diagram between the equivalent plane of the grid and the grid electrodes themselves.

In the case of a negative grid, this is not at all difficult. Because of its negative potential, no electrons flow to the grid wires. The relation between the alternating-current potential of the grid plane and that of the grid wires must be linear, and because of the absence of electrons, must therefore define a simple capacitance. The grid is thus easily disposed of.

By adding this capacitance between the grid and its equivalent plane to the diagram of the electron stream shown in Fig. 5, the complete diagram of a triode is finally built up as in Fig. 6. It is valid even at frequencies where the transit time of the electrons is a large number of cycles.

The magnitudes of most of the elements are not difficult to determine. Thus, the μ of the grid is the reciprocal of its screening factor, and is equal to the ratio C_g/C_{22}. The magnitude of the transadmittance y_{12} never varies more than 25 per cent from the low-frequency value of g_m, although its phase rotates continually as the transit angles increase. The phase is not equal to the transit angle, but is given by Fig. 7 for small transit angles, and more generally by the graph of Fig. 8.

For larger transit angles, Fig. 8 shows the phase as a function of the transit angle between cathode and grid. The assumption is made that the grid-plate transit angle is very small. The main thing to observe from these figures, is that the phase of the transadmittance does not vary as rapidly as the electron-transit angle, at least until the transit angle between cathode and grid becomes quite sizeable (greater than 5 radians). For smaller transit angles, the phase of the transadmittance is only 11/30 of that of the electron-transit angle between cathode and grid.

The diagram of Fig. 6 for the

Fig. 4—Equivalent diagram of grid-plate region

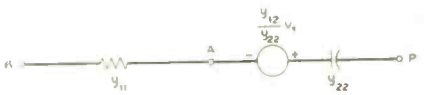


Fig. 5—Equivalent diagram of complete electron stream from cathode to plate

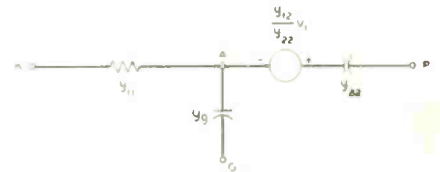


Fig. 6—Complete diagram of triode

$$\phi = -\left[\frac{11}{30}\theta_1 + \frac{1}{3}\,\frac{\sqrt{v_A}+2\sqrt{v_p}}{\sqrt{v_A}+\sqrt{v_p}}\,\theta_2\right]$$

Fig. 7—Phase of transadmittance for small transit angles

triode is particularly suitable for use at very high frequencies, where the impedance of the capacitances C_{22} and C_g is not much greater than the circuit impedances connected to the external terminals. At lower frequencies, these impedances of the capacitances become very high. At the same time, the internal generator becomes very large, and we approach the condition of an infinite voltage sending a finite current through an infinite impedance. Evaluation of the resulting indeterminate gives the correct answer, but shows that the older conventional diagram is the more suitable one to use for these very low frequencies. For the very high frequencies the newer diagram is simpler.

Best procedure

In the intervening frequency range, the best procedure found thus far has been to use the newer diagram, with the evaluation of the indeterminate condition as given in the aforementioned paper, "Vacuum Tube Networks" in the Proceedings of the Institute of Radio Engineers for March 1944. In applying this, it frequently is found helpful to perform the analysis of the particular circuit at hand, including the connected external impedances, before attempting to insert the detailed expression for the transadmittance.

Exactly similar methods may be extended to tetrodes and pentodes as were described above for triodes. The only added complication occurs because electrons actually flow to positive screens. This fact causes an added μ-generator to appear in the screen branch of a tetrode, but its magnitude is small when the direct current to the screen is small. Fig. 9 shows the diagram.

The capacitances C_{22} and C_{23} are calculated as though the grid and screen were solid metallic sheets. The reciprocals of the screening factors of the grid and screen give the values of C_g and C_s through the ratios

$$\mu_g = C_g/C_{22} \qquad \mu_s = C_s/C_{23}$$

Again, the magnitudes of the various transadmittances, y_{12}, y_{13}, y_{1s} remain fairly constant as the frequency is varied over very wide ranges. The phase angles increase regularly, but are less than the electron-transit angles.

If this diagram for the tetrode at very high frequencies begins to look complicated, it can only be pointed out that a direct extension of the conventional diagram is more so! If the screen were perfect in Fig. 9, then the generator in the screen lead would vanish and the impedance of the condenser C_s would become zero, giving a complete short circuit between the point A_2 and the screen. In such an event it is easy to see that the output becomes a segregated system. The presence of an appreciable impedance between A_2 and the screen provides a feedback, just as in the more conventional diagram, a capacitance between plate and grid is indicative of feedback.

Stray impedances

In these newer diagrams it is easier to introduce the effect of stray impedance in the leads to the various electrodes. By being completely segregated from the electronic stream, these strays do not become confused with the active portion of the tube, and hence may be regarded as belonging with the externally attached passive circuit.

To show the generality of the viewpoint presented by the methods leading to these vacuum tube diagrams, their application to tubes operating on the velocity-variation principle is useful. The diagrams have precisely the same general form as those given above. The magnitudes of the capacitances are calculated in the same way. The magnitudes of the transadmittances are different, of course, but the same general analysis gives them in a simple form.

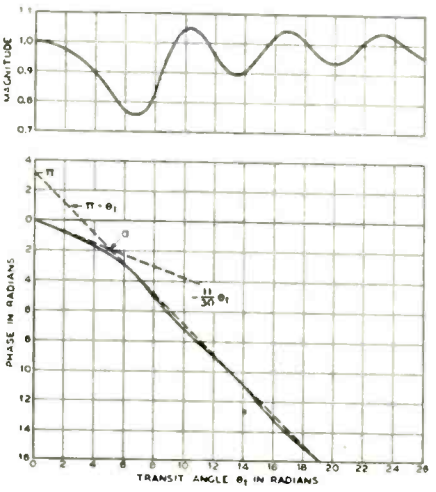


Fig. 8—Phase of transadmittance as function of θ_1

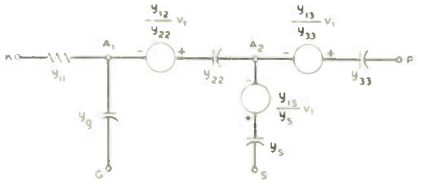


Fig. 9—Diagram for tetrode

same general analysis gives them in a simple form.

Except for some relatively minor phase shifts produced by transit angles across the input and output cavities, the phase of the transadmittance of a velocity-variation tube varies directly with the electron-transit angle across the drift space. In this respect the effect on phase is similar to that in the grid-screen region of a space-charge control type of tube. However, in point of magnitude, the latter transit angle is usually made as small as possible, while the former must necessarily be quite large, since it enters directly into the magnitude of the transadmittance of the velocity-variation tube.

When all is said and done, the results of this investigation constitute one more step in the direction of reducing all of the various effects which take place within an electron stream to a form where they can be represented by a network. In most cases, the impedance elements forming this network are simple passive circuit elements, usually capacitances. The active effect of the electron stream is then relegated to a set of transadmittances. These represent the effect on any succeeding region of forces which act on the electron stream in preceding ones. In the case of space-charge control tubes their magnitude is nearly independent of frequency, even for very large transit angles. In velocity-variation tubes, their magnitude depends largely on the transit angle in the drift space.

In the space-charge control tube, the amplification is largely limited by a loading impedance which appears across the input electrodes and by circuit losses, but not by a loss in transconductance magnitude, except in those cases where the electron stream becomes so confused by its passage through grids and by the effects of initial random velocities as to lose coherence of transit angle for groups of electrons emitted simultaneously.

Ship Radio Compass

Called the first test of the conventional aircraft-type radio compass applied to scheduled steamship operation, a unit made by the Bendix Aviation Corp.'s Radio Division was installed on a Pere Marquette ferry operating between Michigan and Wisconsin ports. The compass, tuned to a broadcasting station on shore, provides the pilot with a continuous bearing and direction indication as the ship sets its course. If the experiment is a success, similar installations are contemplated on a large number of Great Lakes freighters.

★ **National Electronic Conference Report**

ENGINEERS TALK SHOP

First National Electronic Conference draws great crowd of 2100 to Chicago to hear and discuss 54 addresses

● The first annual National Electronic Conference, which wound up in Chicago on Saturday, October 7, after three crowded days made attendance history. More than 2,100 engineers, scientists and executives of radio and allied organizations registered for the sessions and filled to overflowing the three auditoriums in which meetings were held simultaneously.

The lengthy program, divided roughly under three generic topics (Radio, Television and Communications; Industrial and Medical Electronic Applications; Electron Theory) included no less than 54 addresses, mostly illustrated with slides. They ran the gamut from the elementary to the far advanced.

That the Conference will be perpetuated was assured by the announcement that the second annual gathering will be held in Chicago, in October, '45, and by the current sponsors, who are the Illinois Institute of Technology, Northwestern University, Chicago Section of the Institute of Radio Engineers, Chicago Section of the American Institute of Electrical Engineers and the Chicago Technical Societies Council.

Equipment exhibit

Supplementing the technical dissertations, a small exhibition of electronic equipment served to interest delegates during the few brief intervals away from the meeting rooms. Participants included: General Electric Co.; Westinghouse Electric & Mfg. Co.; Sherron Electronic Co.; Tobe Deutschmann Corp.; Radio Corp. of America; Langevin Co.; Allis-Chalmers Co.

Ralph R. Beal, assistant to the vice-president in charge of RCA Laboratories, opened the conference with an urgent plea "that industrial research never relinquish the harmonious cooperation with the Army and Navy which has been so closely developed during the war.

"If our armies, battleships and bombers are equipped with the latest devices of science, no nation will be anxious to seek a fight," said Mr. Beal. "We know how destructive the weapons of science have been in this war. We know what the robot bomb has done; it makes us shudder to know what might happen were additional forces of science harnessed to its deathly wings. I can tell you, without revealing any military secrets, that based upon what I have seen developed for warfare in the science of radio-electronics alone, another war would be much more destructive."

"Wired" addresses

Of the 54 papers presented in the three days several are published in this issue of Electronic Industries. All are to be published in full in "Proceedings of the National Electronic Conference," which, it is anticipated, will appear late in November or early in December. Registrants are each to receive a copy; additional copies are to be made available at two dollars.

A high light of the dinner which brought the first day's sessions to a close were transcription addresses made by means of a wire recorder, sent to Washington for the purpose, by Major General Harry C. Ingles, Chief Signal Officer of the Army, and Rear Admiral Joseph R. Redman, Director of Naval Communications.

Both General Ingles and Admiral Redman highly lauded the performance of the electronics industry during the war. General Ingles stated that "my message to you from the War Department is, first of all, a message of congratulation —during the last three years the Army Signal Corps has had to ask for some virtually impossible things from the electronic engineers of America." Admiral Redman commenced to say "that electronics has played a major role in the war and will continue to play such a role is a conservative statement. The scientists of the Allies have pitted their wits against the Axis scientists, particularly in the field of electronics, and we believe that our scientists are winning their end of this war.

"That our electronics scientists and manufacturers have been fulfilling their roles with distinction," Admiral Redman added, "is attested by the fact that various Jap commanders are bewailing their lack of these very important and essential electronic weapons which the United States Navy is using against them daily. The Navy is truly grateful to you who have labored so effectively to provide us with these new electronics equipments. Admiral King, Commander-in-Chief of the United States Navy, has directed me to express his appreciation to the electronic industry for the wonderful tools you have provided and which are proving so effective against our enemies."

Following are abstracts of nearly all the papers not appearing in greater detail on other pages of this issue.

Television

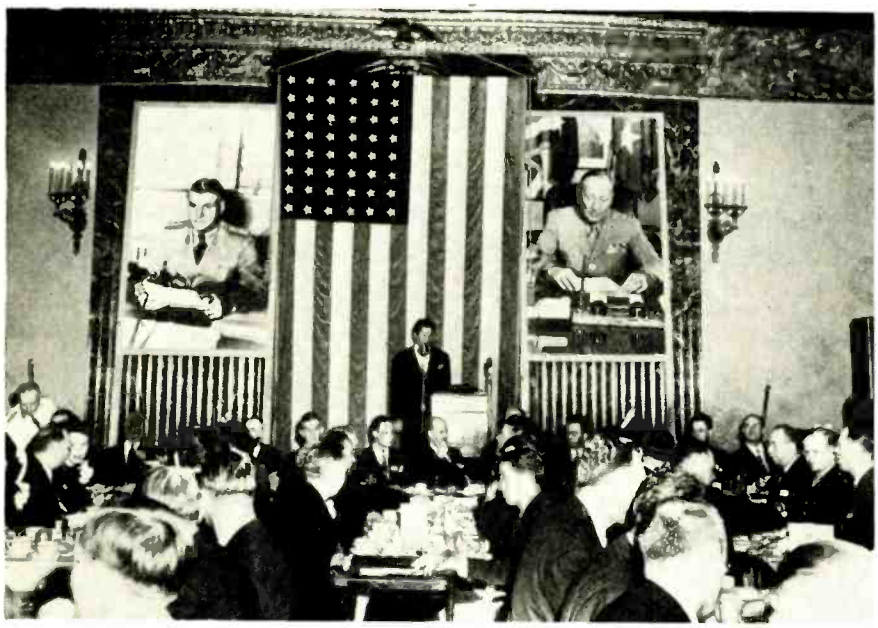
Reflective Optics in Projection Television—I. G. Maloff (RCA) and D. W. Epstein (RCA Laboratories): A number of reflective optical systems suitable for projecting television images with diagonals ranging from 25 in. to 25 ft. have been developed. The RCA system consists of a spherical front-surface mirror and an aspherical lens, positive in the central portion and gradually changing into negative near its periphery. The gain in illumination on the viewing screen is about six-fold and image quality is very satisfactory. High cost of the aspherical lens has been overcome by the development of a process for molding plastic lenses.

Color and Ultra-High Frequency Television—P. C. Goldmark and Robert Serrell (CBS): This paper discussed the present problems and probable future developments of television. Emphasis was placed on the use of color television and the use of ultra-high frequency channels.

Radio Relay Systems—C. W. Hansell (RCA Laboratories): Requirements and problems of relay system designs were reviewed and formulas provided for calculating required performance under various operating conditions. Preliminary analyses indicate repeater spacings of 35 to 45 miles should result in minimum overall operating costs, for systems which might be set up soon after the war. Radio relay circuits are more efficient conveyors of power than existing coaxial cables when required to accommodate present and future television modulation band widths, since the former require much less repeater gain.

Power applications

A Survey of Power Applications of Electronics—A. C. Monteith and C. F. Wagner (Westinghouse Electric and Mfg. Co.): Applications of mercury arc and ignitron rectifiers were discussed as also were electronic frequency changers. Electronic devices for solving difficult problems in America's industrial plants, such as the electronic regulator, variable speed



Just a few of the 1200 persons who attended the National Electronic Conference banquet, showing 8 x 10 ft. enlarged photos of Rear Admiral Joseph R. Redman, Chief of Naval Communications, and Major General H. C. Ingles, Chief Signal Officer of the Army, who spoke "by proxy" by means of a General Electric magnetic wire recorder

motor, control schemes, and testing equipments as well as the cleaning of gases were discussed.

Power Rectifiers and Inverters—J. A. Cox and G. F. Jones (Westinghouse): The mercury vapor rectifier has practically replaced all forms of rotating machines for the conversion of ac power to dc power because of higher efficiency, greater reliability, lower maintenance and in general lower installed cost. In addition many special applications involve conversion of dc to ac power: variable-ratio frequency changing and the closely associated problems of dc transmission, as well as the various requirements of variable speed drives.

Electronic Motor Control—B. J. Dalton (General Electric Co.): This paper discussed electronic methods for adjusting speed of a shunt wound dc motor. Signals from photoelectric tubes, variable reactors, current transformers, small rheostats or other low level devices can be used to control motor or generator fields or pilot motors as well as electronic power converters.

Medical science

Electronic Equipment in the Medical Profesession—H. A. Carter (American Medical Ass'n): This paper dealt with the development of the apparatus and what part the equipment currently in use plays in the diagnostic and therapeutic branches of medicine.

The Electroencephalograph and Its Applications—Ralph Gerard (University of Chicago): The development of electrical methods in neurophysiology were considered in relation to the electrical phenomena encountered in the nervous system. The advent and types of electroencephalographic equipment were reviewed with special attention to the electrical waves obtained from the human body, normally and in disease.

The Electrocardiograph in Physiology and Medicine—L. N. Katz (Michael Reese Hospital): This paper discussed the gradual evolution in the methods of recording the electric currents produced by the heart and the value of the electrical approach in understanding the physiology of the heart.

Applications of High Frequency Phenomena in Medicine—H. J. Holmquest (G-E X-Ray Co. and Northwestern University): The paper gave a resume of the use of high frequency fields and currents for medical use. The various effects of high frequency fields and currents on living tissues were discussed, and the evidence presented in substantiation of alleged effects critically evaluated. The electric and induction field for administering high frequency energy to a patient were discussed. Their relative merits and limitations as methods of producing heat in living tissues were set forth.

Communications

Frequency Modulation in Portable and Mobile Communication Equipment—D. E. Noble (Galvin Mfg. Co.): FM communication receivers are characterized by their high IF gain and their low voltage RF amplifier and mixer design. Adequate limiter action must be achieved at the lowest useable signal level and 20 db quieting is required at a low impedance signal input of 0.4 microvolt. Under conditions where the amplitude of the noise pulses exceeds the amplitude of the signal, the peak noise is limited and the level of the overall noise response is minimized by the reduction of the random noise between pulses. Automatic squelch to quiet the receiver during stand-by periods is necessary. The squelch sensitivity should not limit the range of useful signals.

Audible Audio Distortion—H. H. Scott (General Radio Co.): In the past, too much attention has been paid to frequency characteristics and harmonic measurements, with consequent neglect of the inter-modulation products resulting from "harmonic distortion." Moderate deviations from a flat characteristic and small alterations in the level of harmonics are not considered by a non-technical listener as "distortion" but the annoying discordance and a confusion of tone caused by the inter-modulation products are. The use of the double-beat oscillator for inter-modulation measurements is advocated. This simplifies distortion tests, and allows convenient measurement of difference (or sum) frequencies over the audio range as easily as running a response curve.

HF Incremental Permeability Tuning—W. J. Polydoroff (Consultant). This paper describes developments resulting from a study of hf powdered magnetic cores by dc permeameter. A closed magnetic circuit containing the rf inductance windings, is magnetized to a greater or less degree by an external dc field, and since the rf field does not pass into the magnetizing field, high Q circuits are obtained, suitable for tuning oscillatory circuits by means of a battery, a rheostat and an ammeter applicable for frequencies of 10-400 kc with a 2:1 tuning range.

Ultra-High Frequency Conversion and Conversion Diagrams—Harry Stockman (Cruft Laboratory, Harvard University): This paper described the Chaffee method of analyzing frequency converters which avoids direct graphical and analytical treatment of the mixer circuit and is centered on the behaviour of the nonlinear element and its IF load, the technical data being collected in the form of so-called conversion diagrams.

Recent Electron Tube Developments in Telephone Systems—S. B. Ingram (Bell Tele. Labs.): A description was given of a number of electron tubes which have recently found application in the telephone plant. Amplifier tubes for broad-band carrier telephone systems, ultra-high frequency tubes used in an ultra-short wave multiplex radio link and some typical tubes used in non-transmission part of the telephone plant were described.

Broad-Band Carrier and Coaxial Cable Networks—F. A. Cowan (American Telephone and Telegraph Co.): Unprecedented growth in the volume of long distance communications has been accompanied by the expansion of the carrier telephone routes into a nationwide network for broad-band carrier operations. This type of cable and associated equipment will transmit frequency bands several million cycles in width, which will provide large numbers of telephone circuits and in addition may be used in television network service. Features of these broad-band carrier systems were reviewed. The past and present use of coaxial cables together with the expected peace future was also discussed. The possible future development of systems transmitting wider bands of frequencies or using new features, such as radio or wave guide, were also considered.

Industrial radiography

Two Million-Volt Mobile X-Ray Unit—E. E. Charlton and W. F. Westendorp (G-E X-Ray Corp.): A two million volt 1.5 milliampere mobile X-ray unit was described which consists principally of a low frequency resonance transformer and with a coaxially mounted sealed-off multisection X-ray tube within, both contained in a steel tank and insulated with compressed gas.

Industrial Fluoroscopy of Light Materials—Scott W. Smith (Kelley-Koett Mfg. Co.): Fluoroscopy offers the means of directly viewing the image while the object is in motion, supplying a three dimensional impression; and it also eliminates the expense and delay of films. This paper discussed the factors which limit the sensitivity attainable in fluoroscopy from two standpoints: forming the image and viewing it, and visual acuity at low brightness.

Aeronautical applications

Electronic AC Power Regulators—R. F. Wild and L. B. Cherry (Brown Instrument Co.): The object of this paper was to describe an electronic ac power regulator, which is instantaneous and independent of frequency. A conventional unbalanced bridge circuit using gaseous discharge tubes (connected parallel opposing) in one arm, was discussed. Such a system can be arranged for regulating either dc or ac circuits with a high degree of stability and a high order of regulation.

Aircraft Electronic Appliances—A. P. Upton (Minneapolis-Honeywell Regulator Co.): Description was given of alternating current operated resistance bridges to provide flexible control circuits, several of which can be combined. Alternate relay operation or motor reversal through a common power supply of plates of discriminator tubes and bridge excitation was discussed. A pressure-operated variable resistance which senses engine manifold pressure changes and causes supercharger waste gate position correction through

the use of an amplifier was described, followed by motion pictures of its application to an aircraft engine.

Instrumentation

Electronic Mechanism Development for Process Plant and Laboratory—T. A. Cohen (Wheelco Instrument Co.): Automatic mechanism for the control of such variables as liquid and material level, material flow, pressure, temperature using the electron tube, have presented a new approach to the solution of automatic control problems. In some cases the electronic mechanism presents means which are simpler and sometimes more apt in solving automatic control problems which were usually relegated to earlier pneumatic, hydraulic or mechanical control mechanisms.

Electronics in Instrumentation—H. D. Middel (G-E): This paper dealt with the application of electronics to the measurement and control of process variables. It treated the measurements of both electrical and non-electrical quantities by electronic methods. Means were described for converting variables, which are non-electrical, into signals suitable to electronic devices. The general requirements of a measuring device, useful for automatic control were indicated.

Design Factors in the Application of Relays to Electronic Circuits—R. H. Herrick (Automatic Electric Co.): This paper presented the operating capabilities and design factors involved in the application of relays specifically to electronic circuits, with especial attention to the lesser-known ones. Design factors which must be considered include the effect of relay coil resistance, inductance, and associated capacitance on operating and release speed and on tube performance. Discussion was given of the data which the electronic equipment designer must furnish the relay supplier in order that the latter can give him a relay which will have the performance characteristics he desires.

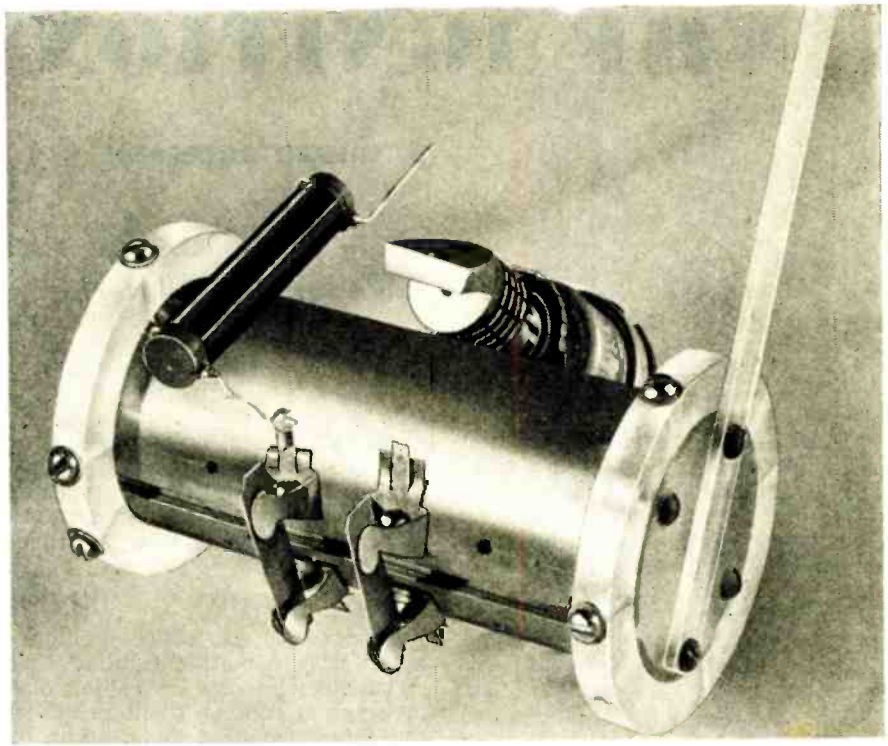
Industrial Electronics

The Electron Tubes of Industry—C. S. Roys (Illinois Institute of Technology): A general survey of the more important electronic devices encountered in industrial applications included both vacuum and gaseous types of tubes. Emphasis was placed upon the particular characteristics of each tube and some of its better-known applications.

Survey of the Field of High Frequency Dielectric Heating—M. J. Maiers (Commonwealth Edison Co.): Dielectric heating is a new industrial tool which makes possible the uniform heating of the complete mass of that class of low thermal conductivity materials, usually classed as electrical and thermal insulators. This paper described applications for which dielectric heating has been proven economically successful, or on which extensive research has been done.

The Supersonic Reflectoscope, An Instrument for Inspecting the Interior of Metal Parts by Means of Sound Waves—F. A. Firestone (University of Michigan): The reflectoscope sends into the metal part to be inspected a short train of ultrasonic sound waves. Any flaws on the interior give reflections back to the starting point before the reflection is received from the other side of the piece. Many feet of metal can be penetrated. The thickness of a piece can be measured when its opposite side is inaccessible, and discontinuities of bond of plated or soldered surfaces can be detected.

Cathode Ray Tubes and Their Applications—P. S. Christaldi (Allen B. DuMont Labs.): This paper described the results of progress made recently in both technics and designs of cathode-ray tubes and circuits. Both brightness and resolution of the fluorescent spot have been improved, and a practical method has been developed for minimizing masking effects.



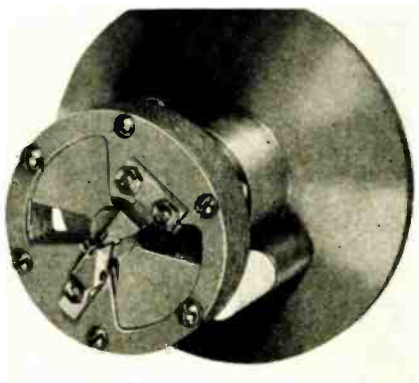
Cylindrical circuit covering the frequency range from 10 to 500 megacycles in four bands. The two strips between the contacts form the highest frequency "coil"

Wide-Frequency Range Tuned Circuits for High Frequencies—D. B. Sinclair (General Radio): This paper was largely devoted to improved designs of lumped-circuit assemblies better adapted to UHF operation than conventional coil-condenser combinations but which still retain the compactness and convenience of adjustment of the latter. The principal feature of the circuits described was the inclusion of both inductance and capacitance in the same mechanial structure with current paths arranged to give minimum losses.

Transmission lines have generally been used at these frequencies mainly to obtain high values of Q, but difficult forms of tuning control mechanisms have been necessary, especially when wide range of frequencies is desired in a single band, which required sliding contacts, with possible erratic tendencies. The several arrangements described by Dr. Sinclair produce wide frequency ranges without sliding contacts and of a type where rotary tuning movements are possible. One of the most interesting types described has become known as the butterfly type, as illustrated herewith.

Here is shown a 220 to 1100 mc oscillator unit intended for use with a door-knob type tube. The grid and plate terminals of this tube fit into the spring clips attached to the two

Butterfly circuit with terminals for door-knob type tube shown below



stator sections. These devices can be designed with a wide variety of characteristics, and with tuning ranges as high as 12:1 and with Q values of 300-650. Another form of tuning arrangement found of value is the cylindrical circuit also shown. A special shaped split cylinder rotates inside to produce the tuning variations.

The Mass Spectrometer and Its Practical Applications—J. A. Hipple (Westinghouse): The electronic problems involved in the practical application of the mass spectrometer to fields of particular interest to the oil and chemical industries were discussed. In obtaining satisfactory results with the mass spectrometer, the power supplies must be carefully regulated and the vacuum and gas-handling systems must be subject to careful control. To use the equipment effectively, and to obtain rapidity, a recording system of some kind is a necessity. A fast pen-recording system of wide range of response has been developed and was described.

Negative Feedback Amplifier Theory Applied to Regulators—J. M. Cage (Allis-Chalmers): The possibilities of applying amplifier concepts to regulators were outlined. The following three regulator design problems are treated, as examples of the suggested procedure: (1) Degree of regulation versus load. (2) Degree of regulation versus changes in internal regulator characteristics. (3) Hunting and transient response.

Some Applications of Electronic Equipment for Material and Design Testing—Dr. R. O. Fehr (G.E.): It was the purpose of this paper to present the various electronic and recording equipments which can be used with wire strain gages for the measurements of dynamic strains. This was done by a discussion of three typical tests, each of which has a different rate of change of strain. One is designed for the measurement of periodical varying strains, and one for the measurement of very slowly varying strains produced by thermal effects due to welding.

Strain Gage Amplifier Design—W. Mehaffey (Armour Research Foundation): The most practical circuits for use with strain gages are based on the use of a balanced ac bridge fol-

(Continued on page 236)

VHF IGNITION NOISE

by GILBERT SONBERGH

Study of the aircraft radio noise problem yields new facts of vital interest to all radio manufacturers

● Until quite recently, ignition noise in the radio and other electronic equipment carried in military aircraft was so commonplace that operation personnel had come to accept it as a basic limitation on the use of such equipment. As the art and science of radio progressed, the noise problem increased. A number of factors brought this condition about.

The conventional shielding of aircraft engine ignition systems dates back to the early Twenties, when voice communication and the use of radio beacons for navigation had their beginnings. By 1933, most commercial transport planes and military planes were equipped for two-way communication. For the next three or four years, noise was not a problem. Carrier power was fairly high, ranges required were rather short, frequency was rather low (300 kc), and adequate suppression measures were worked out for each "tailor-made" radio installation before production was standardized.

Improvements in radio as well as in the aircraft engine complicated the situation. Receiver sensitivity was vastly increased while transmitter power was decreased. Greatly increased compression ratios in power plants demanded increased spark-voltages. For military use, ranges over which the equipment was supposed to operate had to expand. For flexibility, equipment of any type had to be adaptable to almost any of the 300-odd types of military aircraft, and it had to work the moment it was installed.

Extensive investigation

Needless to say, these requirements were not often fulfilled. Unsatisfactory reports on radio noise in overseas combat theaters led to the formation of a large group of manufacturers and war agencies for the purpose of studying the problem and making recommendations. The Radio Noise Branch of Aircraft Radio Laboratory, the Signal Corps engineering body at Wright Field, Ohio, has devoted more than a year to extensive investigation of engines and ignition shielding, electric pumps, Servo motors, instruments, and gasoline heating devices.

As an aid in testing large engines under selected conditions, a special shielded room was built and equipped with an electric motor drive system to operate the aircraft engines without fuel. Several standard service receivers were modified to serve as noise measuring meters in the medium, high, and very high frequency ranges.

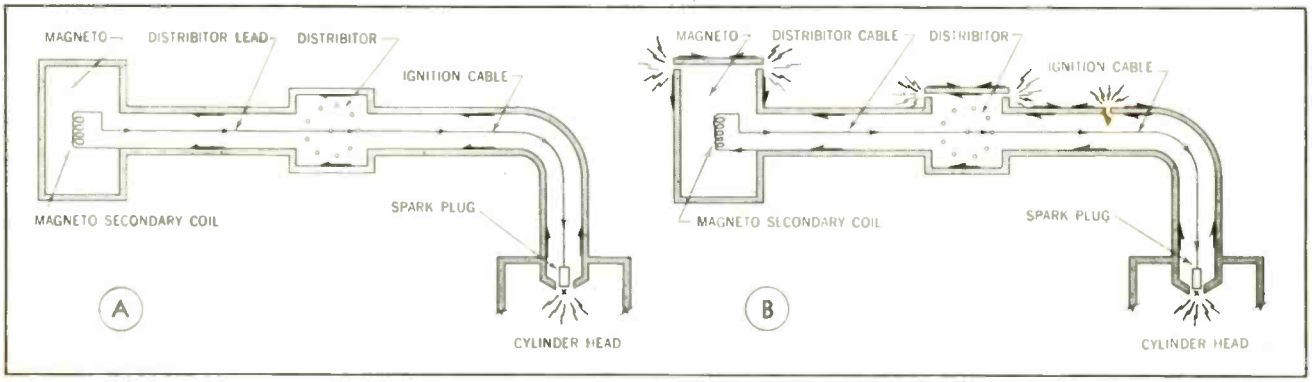
Another group, formed shortly after Pearl Harbor by the military services, consisted of representatives of engine manufacturers, ignition component and shielding manufacturers, the Signal Corps, the Air Forces, and the Navy, to study engine noise alone.

Much has been learned about ignition noise and its elimination. Unfortunately, there is no simple remedy for ignition noise, no magic elixir to rub into the high tension cables. "Bottling up" the damped waves at their source is one of the most effective methods of keeping them out of the receiver. However, a number of new technics of bottling them up have evolved. Detail has been added to the picture.

Recommendations to the manufacturers of aircraft engines, ignition components, and the fifty-or-so different kinds of noise-producing airborne electrical equipment have been made as a result of both of these studies. A field manual, prepared by the Aircraft Radio Laboratory, instructs service personnel in the practical methods for the immediate reduction of noise on existing service aircraft. Much basic theory and a body of future design suggestions have evolved.

At the outset, it was realized that a new attitude would have to be adopted. "Build the engine or equipment first and suppress it later" may have been all right in civilian days, but not now. Conventional receivers, as well as early non-radio electronic equipment, were unnecessarily susceptible to

Fig. 1—How VHF ignition noise originates. At A, ideally shielded ignition system which cannot radiate interference. At B, electrically "loose" joints permit a part of the return current (indicated by arrows) to flow on outer surfaces of shielding where radiation can occur

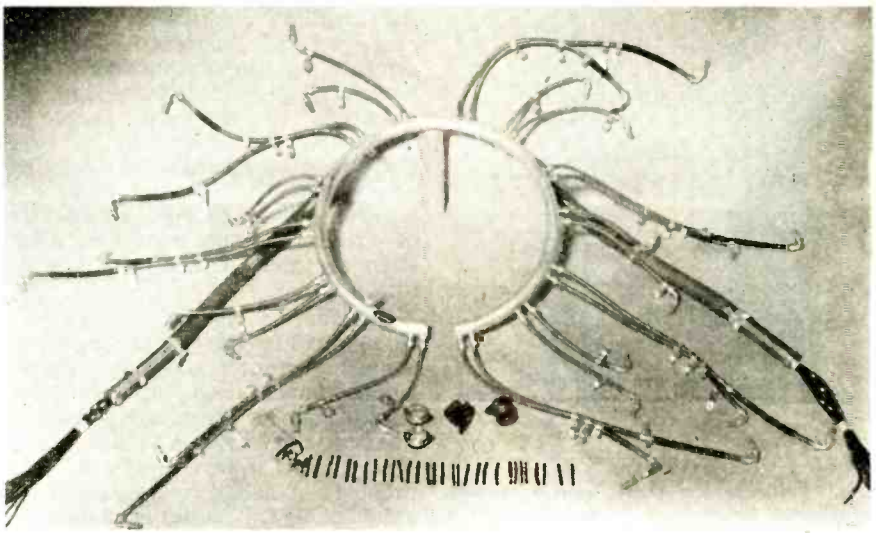


interference signals, through poor antenna lead-ins, lack of power-supply wiring filters, or because of generally poor shielding of the unit. The lack of an accepted standard method of noise measurement had stymied progress in the field of suppression, both because engineers are loathe to deal with something they can't measure and because their attention was frequently diverted to the elusive problem of measurement, the means, rather than the suppression itself, the end. For the urgent military purpose at hand, "satisfactory" reduction of noise strength was defined at that level where the noise could not be detected in the receiving equipment's headset or on an ac. rectifier-type voltmeter connected across the headset. Field strength measurements close to offending sources are of some significance. Present allowable limit for radiated noise is a maximum of 2.5 microvolts one foot from the source unit or its wiring, over a range from 150 kc to 150 mc. For conducted noise, the maximum permissible between any pair of conductors on the aircraft or between any wire and ground is 50 microvolts over the range of 150 kc to 20 mc. Equipment so suppressed requires only moderate physical separation from the receiving apparatus.

Practical suppression

The general principles of eliminating aircraft electrical noise are simple. Noisy motors and other low tension equipment producing radio frequency "hash" are bypassed to ground or filtered, close to the point of rf generation! Overall shielding is sometimes employed, using the unit's own case or cover when possible. The general use of shielded cable for all aircraft wiring has been outmoded. The trend is toward "stoppage at source." Except for high tension ignition cables and associated circuits, shielding is applied only to those wires which are especially susceptible, like the antenna lead-in, or whose functions would be adversely affected by use of conventional filters or capacitors. When possible, advantage is taken of the natural shielding effects of the aircraft's structure.

The practical principles of shielding against radiation of rf interference are likewise simple. **Thickness** of metal is required to prevent the passage of low or medium frequency waves, while **completeness** of metallic coverage is the secret of "bottling up" unwanted high and very high energy. Referring to Fig. 1, note that electrically loose joints in shielding cable or between cover plates and magneto or other housings allow interference radiation. The striking ability of high frequency radiation to "squeeze through" any joint that isn't virtually airtight, and through many that are, introduces a somewhat new trend into the shielding picture. Much study has been given to connectors for shielding conduit, to methods of bolting or securing cover plates, and to various conductive metallic pastes and gasket materials, for securing continuous, low resistance return paths for ignition currents.

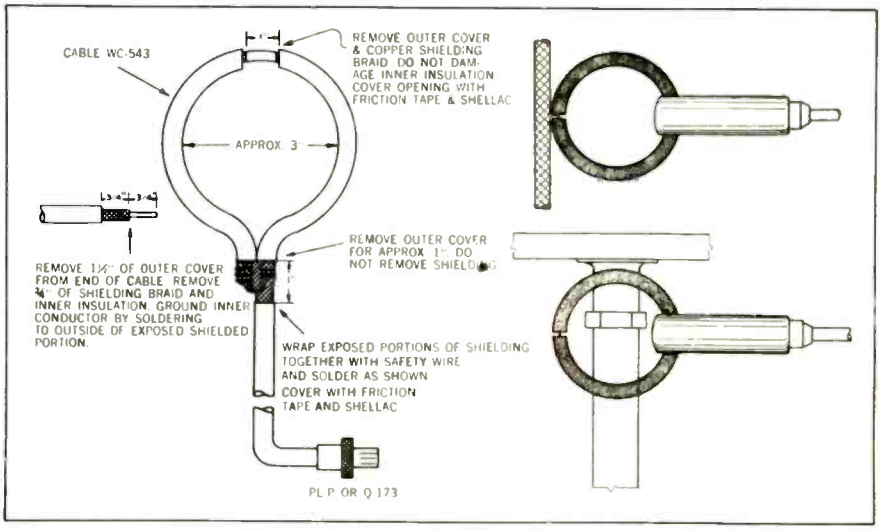


Complex ignition shielding harness required on radial type military aircraft engine. Such harness must of necessity have many joints in the conduit, to facilitate assembly and repair

Other significant trends in the aircraft radio noise problem are represented by the sharply declining emphasis placed on bonding of shielded cables to ground and on suppressors, or resistance elements of ten to twenty thousand ohms. It was once popular to bond a cable to ground (the engine or aircraft structure) every 18 in. or so, because it did in fact reduce radio interference. It has now been determined that such reduction was a result of increasing the resonant frequency of the intervals of cable by "cutting it up" into shorter sections. Radiation was due to resonant excitation by external rf currents and the sections acted as more or less efficient antennas, depending on their length. If there are no surface currents, if all of the RF is kept inside the shielding, there is no possibility of radiation and bonding becomes quite useless. Suppressors, while satisfactory from the interference standpoint, so reduce the ignition impulse that excessive fouling of spark plugs and difficult engine starting result. Better types of suppressors may be evolved eventually.

Ignition noise constitutes the most serious interference problem on aircraft. Such noise gets from the power plant to the radio re-

Fig. 2—Construction details of approved type noise probe loop. Coaxial line goes to antenna and ground posts of plane's receiver. At right, methods of use on cables and joints



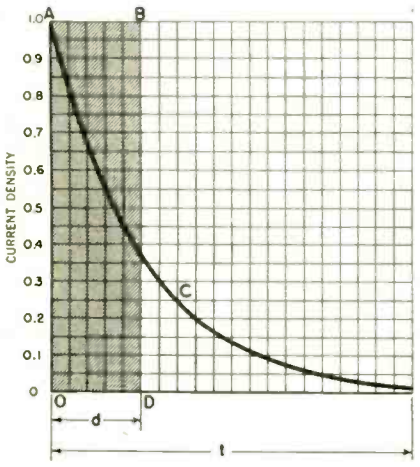


Fig. 3—Decay curve of current density distributed in sheet of conducting material

ceiver in one or more of five different ways. It may be transferred to circuits associated with the receiver by capacitive coupling, inductive coupling, by direct radiation or by conduction along metallic paths common to both the engine and the radio apparatus. It may be transferred indirectly by shock excitation of any metal part or structure able to act as an antenna. A nine foot propeller is a good 40 megacycle radiator. Other parts of the airplane completely cover the range of RF frequencies used in aircraft communication. All that is necessary to excite these spurious antennas to resonant frequency oscillation is receipt of a steep wave-front transient, by coupling, conduction, or radiation from the ignition system source. No method of attack can be imagined other than complete shielding of the ignition system.

Obviously it is not always easy to determine the exact source of a noise current leak from a system which appears to be completely "bottled up." Standard procedure involves the use of a "noise probe" of the type shown in Fig. 2. The probe is attached by means of coaxial cable of suitable length to the aircraft receiver's antenna and ground terminals. With the help of earphone cord of equal length, the prober is enabled to conduct a minute and thorough search for the actual source of the noise.

Shielding suggestions

Much of what has been learned in the ignition shielding field may be widely applicable to other phases of radio and electronics, and of course to automobiles, if the manufacturers can be persuaded to consider this problem in their postwar designs.

In any noise shielding problem, the first step is to select a suitable type of metal, consistent with other factors such as weight, cost, corrosion resistance, necessary thickness, and ease of fabrication.

A number of factors enter into the determination of adequate thickness. First is the theoretical decision as to the amount of noise field strength that can be tolerated on the external side or surface of the shielding. As is well known, more can be tolerated at the low than at the high frequencies. For once, Nature works with necessity, however, since any given thickness of metal is more effective as the frequency is increased. Penetration of noise current into the material of a shield roughly follows the exponential decay curve. Referring to Fig. 3, current decreases to 1/e, or 37 per cent of its initial value, after traveling the distance from the surface O to the point D. Distance d is referred to as equivalent depth of uniform current density, or simply depth of penetration. Area of the rectangle AODB is equal to the entire area beneath the curve C and represents an imaginary zone in which the total current density would equal the

Fig. 4—Resistivity and permeability of common metals and alignment chart for determining depth of penetration (distance "d" in Fig. 3). Adapted from chart of Bendix Scintilla Corporation

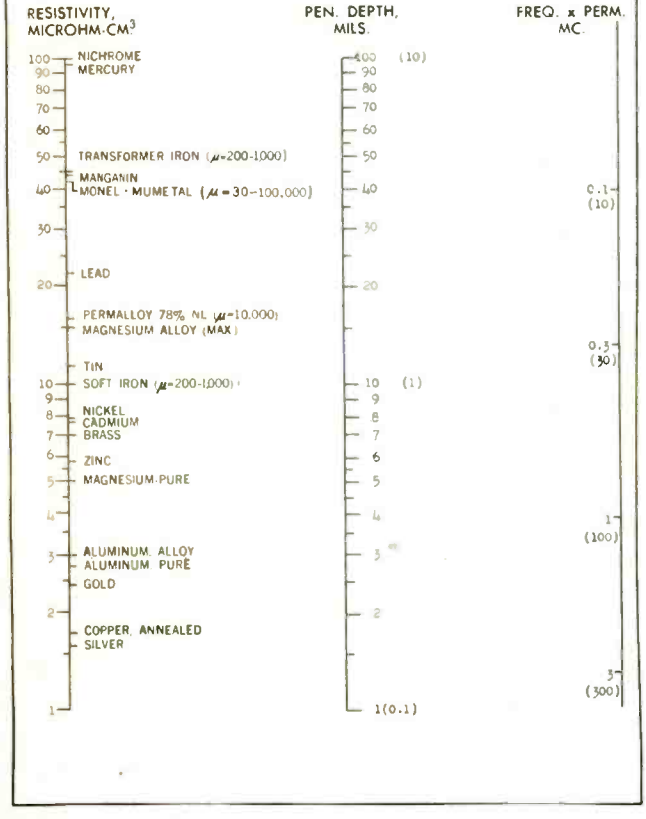
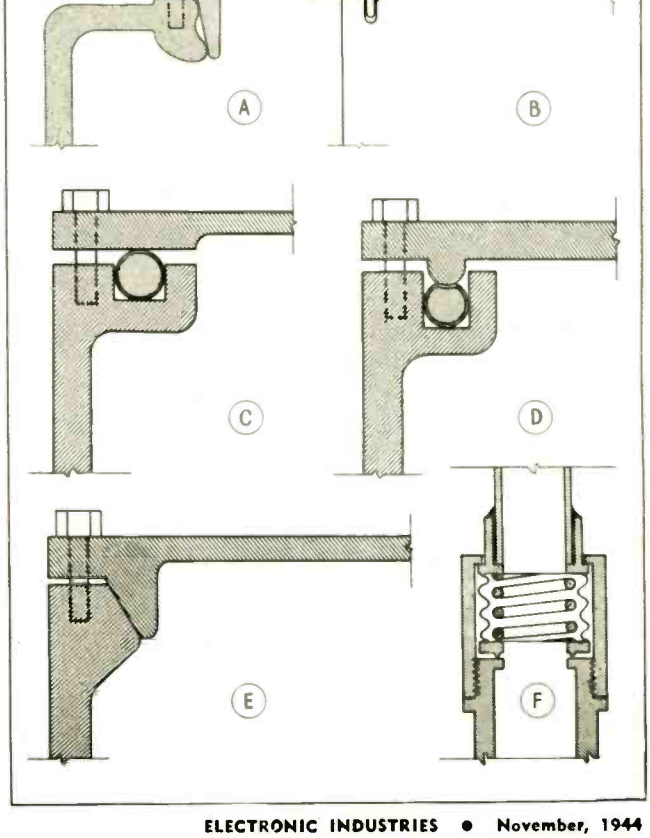


Fig. 5—A and E are types of taper or wedge cover-plate joints. C and D use rubber-filled metal braid for continuous contact. B is "paint can" for secondary shield. F, knife-edge conduit joint



initial current density at the surface O. The formula for depth of penetration (in cm) is:

$$d = 5030 \sqrt{\frac{P}{\mu f}}$$

where P is resistivity of material in ohms per cm^3

μ is permeability of material

f is frequency in cycles per second.

Values of d for various metals at any given frequencies are obtainable without calculation from the alignment chart, Fig. 4. With due respect to theory, there is still only one safe way to determine and specify minimum shielding thickness, which is to try it out in practice. Thickness of other metals might be determined, using the test as a basis.

The use of secondary shielding, popular in numerous radio applications, may have much to offer in the ignition shielding field. In addition to providing further attenuation of noise signals due to its thickness, such practice greatly reduces transmitted currents or waves due to the reflection loss factor introduced by the additional air to metal surfaces. Reflection losses may be determined by the equation:

$$R = 20 \log_{10} X \text{ db}$$

where X is the reflection ratio between air and the metal shield; for cylindrical shielding as used over ignition cables:

$$X = 89.5\ a\ f/\mu r$$

where a is inside diameter in inches

f is frequency in mc

μ is the permeability of the material

r is the resistivity in ohms per cm^3.

Cable and joint design

Many different types of flexible conduit have been investigated in the course of the current studies by military and manufacturing agencies. Ignition cable, in general, consists of a central, stranded conductor in a solid natural or synthetic rubber insulating casing chosen for low dielectric constant and other electrical and mechanical characteristics. This conductor is surrounded, first, by a flexible hose, either of the spiral convoluted type, seamless annular bellows, interlocked or square-locked, or thin, solid metal tubing types. The spiral convoluted hose, made of brass and with soldered spiral seam, is in most general use. Over this is wound a metal braid, using round or flat wire chosen for high conductivity, high permeability, or both, as well as low contact resistance. The complete cable may be covered with an impervious nonconducting coating for protection.

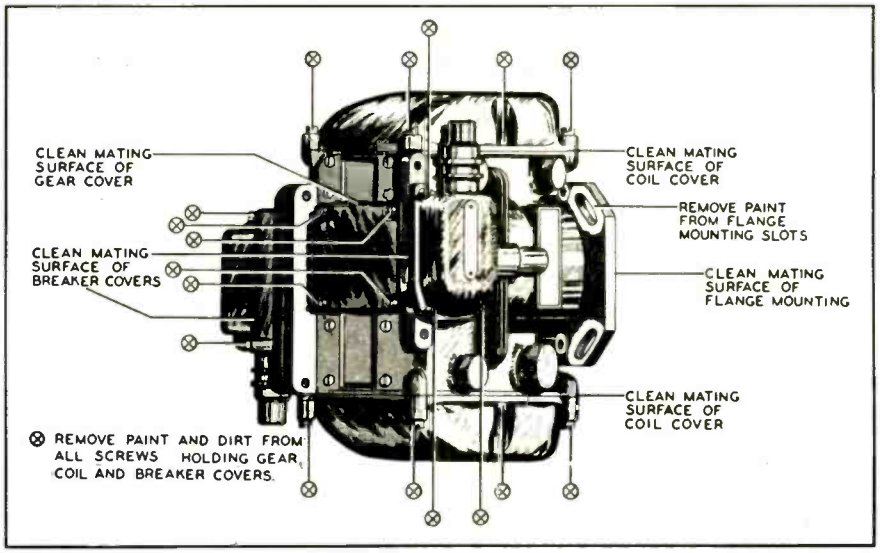


Fig. 6—Striking illustration of care necessary to insure "bottling up" VHF ignition noise. Note that all mating surfaces must make perfect contact. Paint on screws or flanges is fatal

In any ignition system for so complex a power plant as the modern aircraft engine, it is impossible to do without a large number of joints, which facilitate assembly and disassembly of the equipment. It has been found that these joints are the source of most of the ignition noise trouble. It is hard to understand how a conventional two-part metal joint, with several revolutions of threads engaged and set tight, can be a prolific jumping off point for ignition interference currents, but such is indeed the case. High contact resistance and minute air gaps seem to be responsible. Ignition impulses often have "a mind of their own" when it comes to choosing the shortest return path to the magneto ground.

Much research has gone into this problem of joints. Gaskets, often needed to insure water and gas-tight connections, are particularly troublesome and should be eliminated from cable and other joints whenever possible. Various types of conductive gaskets have been studied, including the neoprene impregnated fine wire screen, metal foil covered coroprene, sprayed metal neoprene, and serrated washer types.

The best joints from the moisture and air leakage standpoints as well as that of interference leakage are those which require no gaskets, but provide continuous line contact and high unit pressures for low contact resistance. One such type is illustrated in Fig. 5, the knife-edge construction. Another, more promising, is the spherical or ball and socket type often used for water, air, or gasoline-tight connections in copper and brass piping. The material of which good joints are

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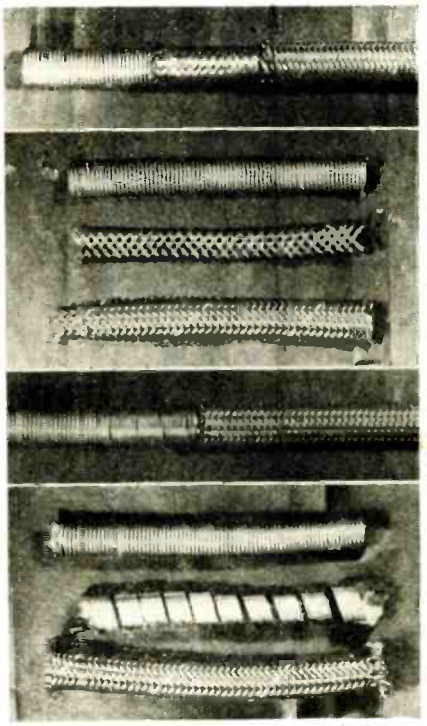
Component parts of two different types of flexible conduit shielding designed and manufactured by Titeflex, Inc., Newark, N. J.



Disassembled view of new spherical-type Titeflex joint to provide continuous line contact for low resistance return path

CHEMICAL RESEARCH

by **CLIFFORD EDDISON**
RCA Victor Division, Radio Corp. of America

Advances in electronic science have been largely dependent on investigations to enhance the value of materials

• The radio and electronic industries have been regarded primarily as the logical commercial expression of the findings of electrical and electronic engineers and scientists. This is a proper viewpoint. Yet, it must be evident that both electronic science and electronic industry is circumscribed by the limitations of materials.

Increased electrical efficiency depends in no small measure upon advances in the field of materials. Selection of the right material or an increase in material efficiency may result in the provision of properties giving increased resistance to heat and cold, to corrosion, to moisture and salt water, to abrasion, or may make valuable contributions to electrical characteristics such as Q and permeability, to increased electrical efficiency, or to any one of a number of other physical or chemical requirements.

The study of materials, or their synthesis, falls largely within the sphere of the chemical sciences. In the electronic field the term, chemical science, is, of course, used in a very broad sense. Problems of materials rarely fall into a single water-tight compartment in any branch of science. In the chemical sciences they may involve metallurgy, physical chemistry, organic chemistry, electroplating technics, and analytical procedures, etc., each contributing its own very special service and viewpoint.

The findings of these various branches must then often be brought together and interpreted in terms of electrical behavior over a useful period of life and under widely different operating and atmospheric conditions.

As the severity of operating conditions increases and wider variations of atmosphere must be met, the chemical sciences must provide new materials or different methods of processing older materials to yield new and desirable advantages. Waxes, for example, have been used for the impregnation of IF and RF coils and similar purposes for many years in the domestic radio field. However, waxes, because of their low softening point, had only limited value with respect to behavior at advanced temperatures (70-74 deg. C.) and suffered adverse physical change (crystallization) at lower temperatures (0 to —10 deg. C. depending on kind).

Other materials having desirable electrical properties have been the subject of much experimental investigation in order to effect higher softening points and simultaneously withstand exposure to extremely low temperatures without suffering detrimental physical change. Several lines of attack on this problem have been made. Some have included efforts to develop most of the required properties through the synthesis of a single material.

Other attempts included impregnation of the coils by suitable resins in solution, driving off the solvents and baking the resin coated coils. Another method employed chemical compounds, often with a catalyst, permitting the formation, by a chemical reaction, of resins directly on the coils followed either by an aging or baking treatment to ensure complete polymerization.

Still other methods of approach to the same problem employed various thermoplastic materials blended on hot rolls under pressure or by effecting solution of miscibility at more advanced temperatures, without pressure, by the "hot melt" process. Work of a similar nature, sometimes with similar materials, has done much to satisfy rigorous requirements with respect to transformer potting compounds.

Powdered iron cores

Metal powders, particularly iron, are finding present use and are destined to find wider use in the electronics industry. Perhaps a major application at the moment is the manufacture of iron cores from iron powder. Iron powder has been developed from four main sources; viz., by reduction of relatively pure iron ore by means of carbon according to the principles involved in the production of Swedish sponge iron, by the electrodeposition of metallic iron from a solution of an iron salt with subsequent grinding, by reduction of iron oxide by means of hydrogen and by the thermal decomposition of iron carbonyl.

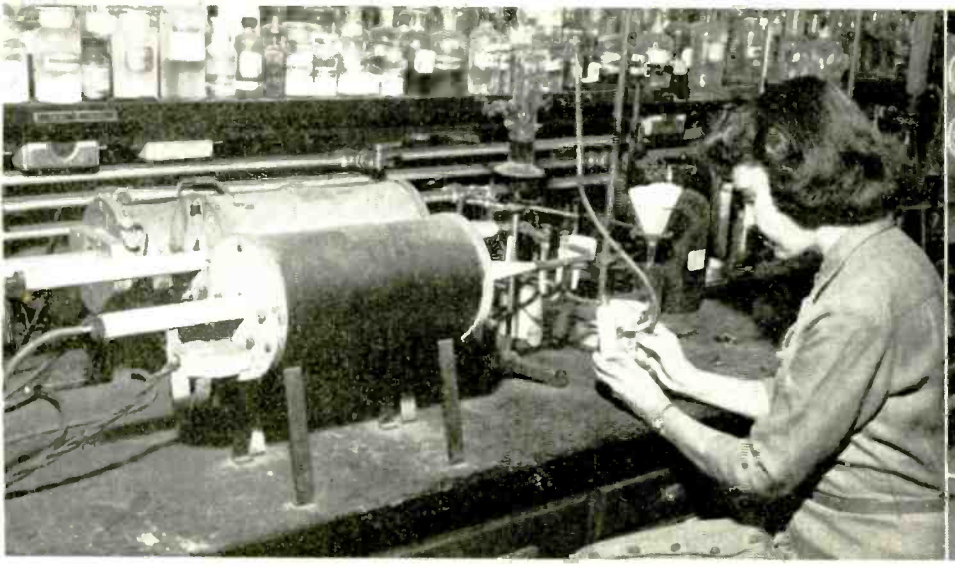
The electrical requirements for iron cores used with IF and RF coils specify required Q and permeability values. To satisfy these electrical requirements, the chemical sciences have concerned themselves with the metallurgical and chemical properties of iron powder made by any of the methods described and the chemical and physical treatment to which the powder may be submitted. This has entailed continuous studies of particle size and shape, particle distribution, purity and uniformity of powder, methods of insulating each individual particle and the effect of pressures to which the powder is submitted in the fabrication of cores.

The effective permeability of an iron core is largely controlled by the permeability of the metal powder from which it is made. The permeability of powder depends, in turn, on its chemical composition; that is, the actual amount of metallic iron present, the nature and amount and disposition of impurities such as carbon, oxygen, silica, moisture, etc.; its thermal history, crystalline size and orientation.

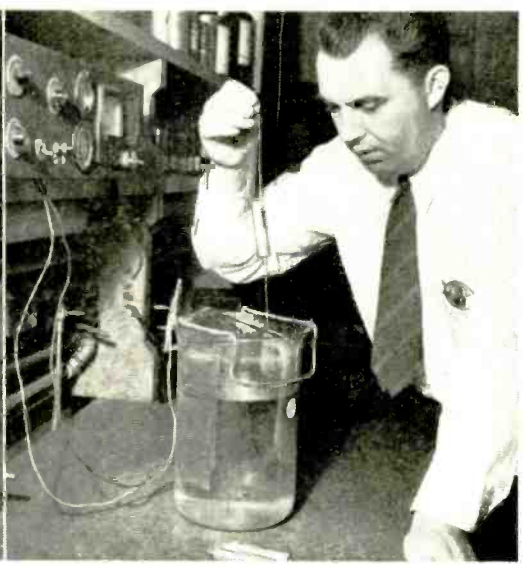
In addition to these factors the volume percentage and geometric arrangement of non-magnetic material within the core must be considered. These characteristics are affected by physical properties of the metal powder such as particle size and shape, hardness and ductility, compressibility and a physical-chemical state of surface relationships controlling wettability.

The denominator R in the formula $2\pi FL/R$ defining "Q," the figure of merit of core-coil combinations, includes eddy current and hysteresis losses in the core and is greatly influenced by the electrical current conductivity within the particle and across the particle and across the particle boundary. Hence, in addition to the factors affecting permeability, the chemical and physical properties of the insulators and binders used in iron core manufacture are of critical importance.

Free or moving electrons in a highly evacuated envelope are the



General view of part of the materials laboratory where research and analysis provide the yardstick for measurement of the suitability of a particular material for a given electronic purpose



Experimental set-up for determining methods and procedure in developing rhodium plating processes

primary agents in producing luminescence. Phosphor chemicals provide a material means by which the kinetic energy of moving electrons is converted to light and heat. Notable practical examples of this conversion of energy includes television kinescope screens, oscilloscopes, indicating lamps, etc. Another familiar example of this phenomenon, of course, is the fluorescent lamp where the electron energy is first transformed into ultra violet by means of mercury vapor. Ultra violet is converted to visible light by the phosphor chemicals with which the tube is coated on its internal walls.

It has been shown that phosphor chemicals are extremely sensitive to contamination, as little as one part per million being sufficient to cause color change, decrease efficiency and interfere with the persistence of luminescence. On the other hand, elements such as manganese and copper in minute amounts may enhance luminous efficiency.

The brilliance of phosphors has been greatly increased during the last few years and it is no longer necessary to use darkened rooms for observation. Phosphors may now be made to luminesce with intensities greater than the eye can view with comfort. During the war years, new phosphors have been developed through chemical research and development, particularly with respect to controllable persistence characteristics. These new phosphors will find many new industrial uses in electronic tubes when the war is won.

Ceramic research

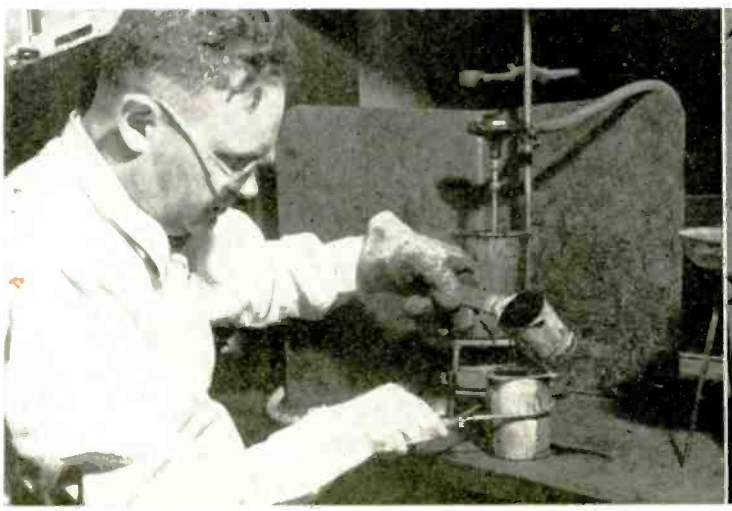
The use of ceramic materials in the electronics industry is due primarily to two valuable properties inherent in such materials; the dielectric or insulative quality and the ability to retain exact shape over wide temperature range.

The insulative quality is one which may be varied almost at will, dielectric constants from about two to several thousand being obtainable. Resistivity may be varied from semi-conductivity to 10^{13} ohms per centimeter and power loss factor from less than 0.01 per cent to more than 50 per cent should such a value be desirable. One of the important uses of ceramics of this type is the making of high capacity condensers of small weight and size, taking advantage of the unusually high dielectric constant materials which are available.

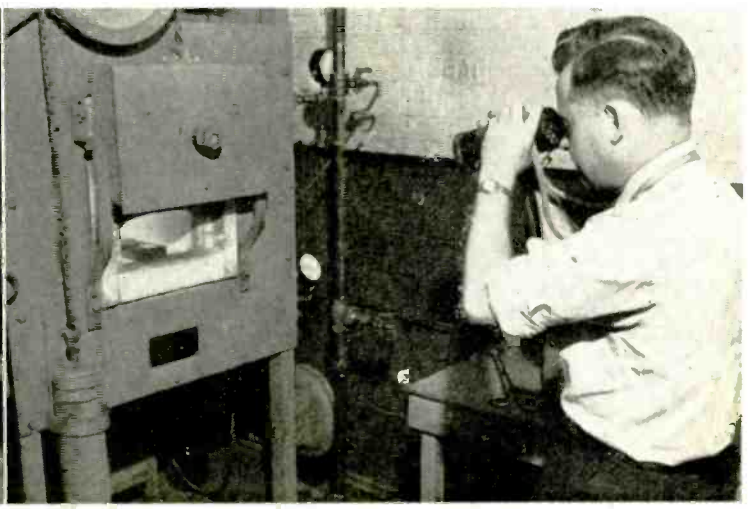
The relative ease with which ceramic materials can be formed into precise shapes and the retention of these shapes within critical tolerances over a wide temperature range have led to their familiar use as spacers in vacuum tubes, multiple contact switch bases, tube bases crystal holders and similar articles. These qualities are also highly desirable in making the condensers mentioned above, as slight variations in dimensions would change the capacity beyond specified limits.

Other properties of ceramics differentiating them from organic insulators such as rubber and plastics are oil and solvent resistance, better mechanical strength and longer life. Two other properties possessed by some ceramic materials which lend themselves to further exploitation are semi-conductivity and photo-sensitivity.

Compound made by the hot-melt process is here poured in a transformer casing during course of experimental potting operation

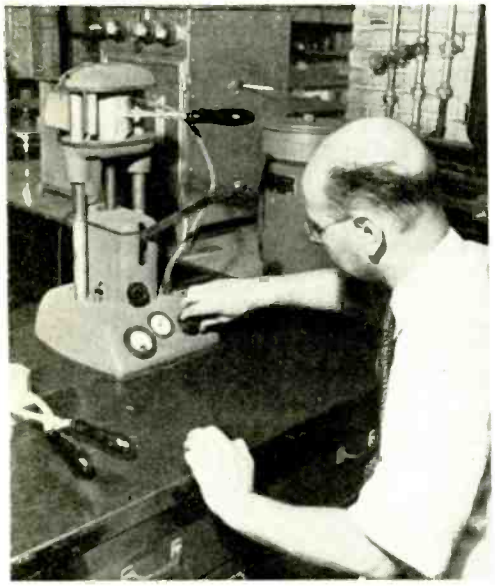


Firing of experimental ceramic samples in determining the relationship between composition of material and its characteristics



No single metal or alloy possesses the necessary properties of electrical conductivity, resistance to corrosion, strength, solderability, hardness and cost advantages to satisfy the requirements of the electronics industry. Because of this, considerable electroplating of metal parts used in the manufacture of electronic equipment is necessary, the plated metal or metals having one or more characteristics enabling the particular part to function at best efficiency.

Advantage of electroplating has been taken, in some cases, to control the Q of a circuit. Silver has found fairly wide application for this purpose. Experimental evidence has indicated that where silver is so employed the amount and nature of the plating deposit and type of finish at the surface are extremely important and must be kept to a standard for maximum performance.



Mounting a specimen of iron powder in a suitable resin for subsequent examination

Chemical, electrical and physical requirements of the electronics industries have led to extensive investigations of the precious metals such as platinum, palladium, rhodium, etc., as plated metals over other basis metals or alloys. Rhodium, an element in the precious metals series, is finding important use as a plated metal because of its exceptionally high resistance to corrosion, to oxidation and its hardness and resistance to wear. These properties assure the preservation of a permanently clean, durable surface, making it exceptionally valuable for contact uses.

The initial electrical properties of rhodium while not quite as good as silver are much better maintained for a longer period of time. Rhodium, unfortunately, is high in cost, a factor considerably restricting its widest possible use. The technics of its deposition vary appreciably with the thickness of deposit required. Where thick deposits are required, the basis metal requires very special treatment.

For example, where silver is required as an under plating or as a basis metal, the silver must be polished with very light pressure in order to eliminate any danger of flowing the silver by friction. If the silver is caused to flow, grease, present in many polishing compounds, may be worked into the metal. Should this happen, heavy deposits of rhodium cannot be built without the subsequent failure of the silver-rhodium bond. Since this may require from three to four times the customary polishing period, it is an added item to the total cost.

The electrical conditions of plating are also extremely important. While a current density of 30 to 40 amps per sq. ft., or even higher, may be used for thin mirror deposits, the rate of deposition for the building of the heavier thicknesses required for contact work should be much less if cracking and crazing of the plated rhodium is to be avoided.

Fungicidal agents

Much electronic equipment must operate under tropical conditions of high heat, high humidity and repeated dew point cycles. These conditions comprise a very severe test with respect to the quality of the various materials used in the equipment. Some materials which have a useful life in more temperate climates became practically useless when exposed to tropical conditions. Certain types of wire insulation, laminated phenol formaldehyde board, cellulosic materials such as paper, etc., disintegrate quite rapidly unless of the finest quality and are suitably treated; for example, by impregnation with water resistant materials.

To aggravate the results of conditions of high humidity, high heat, etc., practically all organic materials under tropical conditions are subject to attack by fungus of one kind or another. Fungicidal agents such as the chlorinated phenols, phenyl mercuric compounds, certain copper compounds, among others, are helpful in restraining fungus growth. To restrict fungus growth and preserve the electrical integrity of electronic equipment over wide ranges of temperature and humidities at one and the same time has presented a major chemical problem to the electronics industries and considerable work to attain these two desirable ends has been done and is still going forward.

Space will not permit of more than a brief review of some of the contributions of the chemical sciences to the electronics field. Not only must they provide new materials ensuring the proper functioning of electronic equipment all over the world but, through comprehensive studies of materials must assure design and engineering personnel that they will fulfill all expectations. It is essential, therefore, that some schematic arrangement be set up by which materials may be evaluated. Wherever possible, recognition of standard methods of test should be given. However, standard methods of test are devised on the supposition that the material tested will be used under a given set of specified conditions. When the use of a material involves different or perhaps more rigid conditions than were anticipated by the test, other means of evaluation must be developed in order that the behavior of the material might be measured in the light of the new conditions. Conditions of known importance in the electronic equipment field include:

(a) Resistance to moisture absorption.

(b) Resistance to excessive humidity.

(c) Exposure to prolonged elevated temperatures at varied humidities, to intense cold and, in many instances, to numerous temperature cycles varying between —60 deg. C. and 100 deg. C.

(d) Resistance to salt water and saline atmosphere.

(e) Effects of exposure to chemical reagents, various solvents, hot oils and waxes, various impregnation processes, etc.

(f) Various mechanical stresses of a fatigue nature or exposure to impregnation and shock.

Materials suppliers are generally in a favorable position to determine the properties of the materials they offer when processed under specified conditions. However, in a manufacturing plant, the methods by which various processes are carried out have a tremendous effect on the final properties of the completely processed material. Often, too, more is expected of material than the supplier anticipated.

Since processing varies from plant to plant, even within the same industry, it is essential that each plant be made aware of the effect of each processing step on the completed article. This, in turn, pre-supposes the availability of methods of test not necessarily covered by any standard test pro-

(*Continued on page* 224)

ELECTRONIC COLOR TELEVISION

British engineer Baird demonstrates cathode ray tube capable of direct color rendering without filters

● Electronic color television, using a cathode ray tube capable of giving direct color rendering without the use of intermediate filters of any kind was demonstrated to the British press, middle of August, by J. L. Baird who has been a prominent figure in British television circles for many years. Baird calls his system "Telechrome," and according to "Electronic Engineering":

"The 'Telechrome' television system is entirely electronic, the colored image appearing directly upon the fluorescent screen. Two cathode-ray beams are required for a two-color system and three for a three-color system. These cathode-ray beams are modulated by the incoming signals corresponding to the primary color picture and impinge upon superimposed screens coated with fluorescent powders of the appropriate colors.

Two-color screen

"For example, in a two-color system the two cathode-ray beams scan the opposite sides of a thin plate of transparent mica one side of which has been coated with orange-red fluorescent powder and the other with blue-green fluorescent powder. Thus the screen has formed upon its front face an image containing the orange-red color components and on its back face an image containing the blue-green components, these images being superimposed and thus giving a picture in natural color (Fig. 1).

"Where three colors are to be used the back screen is ridged and a third cathode-ray beam added; the front face of the screen then gives the red component, one side of the back ridges gives the green components, and the other side of the ridges the blue component (Fig. 2).

"A two-sided tube has been developed to receive a picture from a 600 - line triple - interlaced moving spot transmitter using a cathode-ray tube in combination with a revolving disk with orange-red and blue-green filters. The receiving cathode-ray tube is shown in the diagram (Fig. 1). The screen is a 10 in. diameter disk of thin mica coated on one side with blue-green fluorescent powder and on the other with orange-red fluorescent powder. The color may alternatively be provided for the back screen by using a white powder and coloring the mica itself.

"The tube shown in Fig. 1 may be viewed from both back and front, but if used in this way one set of viewers sees a mirror image. Also, colored mica must not be used, and a filter has to be inserted between the back viewers and the tube to keep the color values correct and compensate for the light lost in the mica and fluorescent powder when the direction of viewing is reversed.

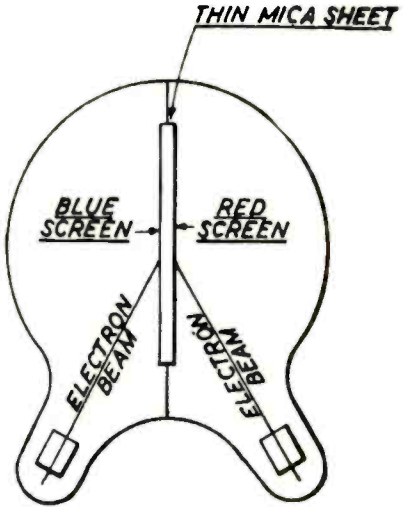


Fig. 1—Diagram of double screen cathode ray tube for viewing television images in two colors

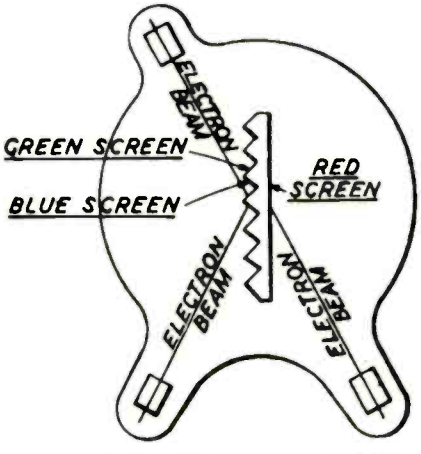


Fig. 2—Diagram of tube for television reproduction in three colors, the mica screen being stepped on one side as shown

Colors are bright

"The tube shown in the photograph of the apparatus can only be viewed from the front, but having one cathode-ray beam perpendicular to the screen simplifies the set-up of the apparatus. The tubes give a very bright picture due to the absence of color filters and the fact that special powders are used giving only the desired colors, which are seen additively.

"The tubes give excellent stereoscopic television images when used with a stereoscopic transmitter, the blue-green and orange-red images forming a stereoscopic pair and being viewed through color glasses.

"In the present form of scanning all the lines in successive frames are of the same color, the color changing with each successive frame. In a new form of scanning now being developed, successive lines are of different color and the number of lines is made a non-multiple of the number of colors, so that every line of the complete color picture has successively shown each of the primary colors.

Flicker reduced

"The object of this is to reduce color flicker. Where frame-by-frame color alteration is used, flicker becomes prominent in any large area of a single color. For example, if the picture is showing a large blue area, this blue appears in the blue frame only. While the red and green frames are appearing, it is not shown, so that the frequency of the repetition is reduced and flicker accentuated. With line-by-line color alteration, each color appears in every frame. This form of scanning does not lend itself to the revolving filter disk system."

1—Flat metal work is speeded up by Eastman Kodak Co., Rochester, N. Y. Kodak Layout Paint is sprayed on. Black ink drawing is photo-printed on metal by exposure to arc or mercury vapor lights. Print is "developed" by warm, weak, ammonia water and washed

IDEAS

3—*Induction Heating Coils*

Those who use water-cooled copper tubing work coils in particularly "hot" or otherwise unfavorable conditions know the rigors of frequent shorts and burn-outs due to formation of oxides and scales on the coils. Enclosing the tubing in fiber glass sleeves at RCA's Harrison, N. J., tube plant lengthened their life from weeks to months, saving time, money, and copper.

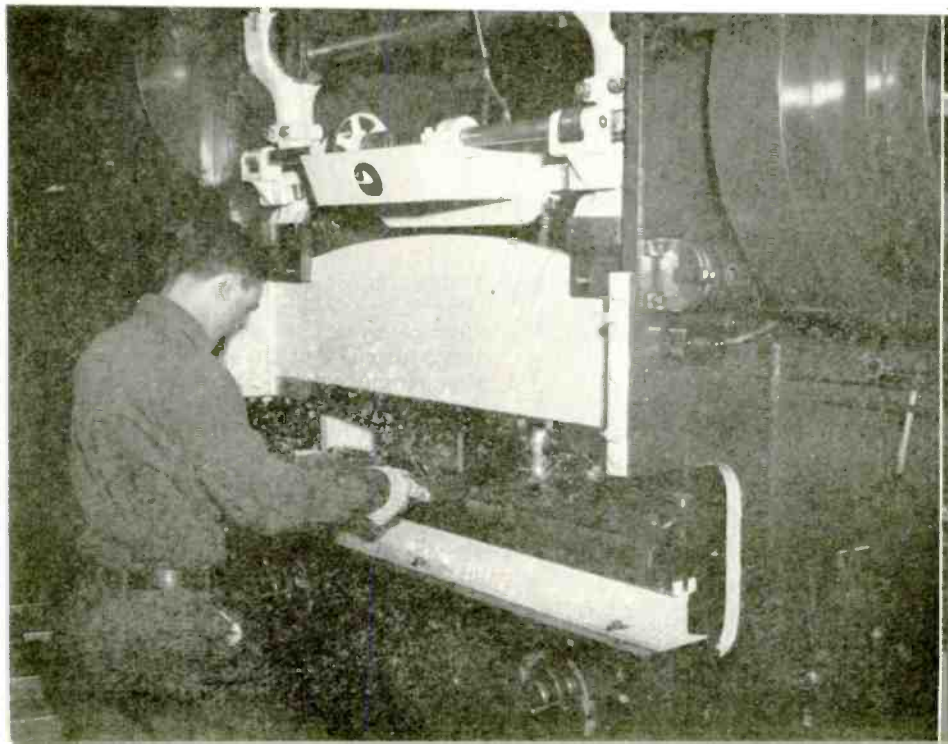
4—*Warped Condenser Plates*

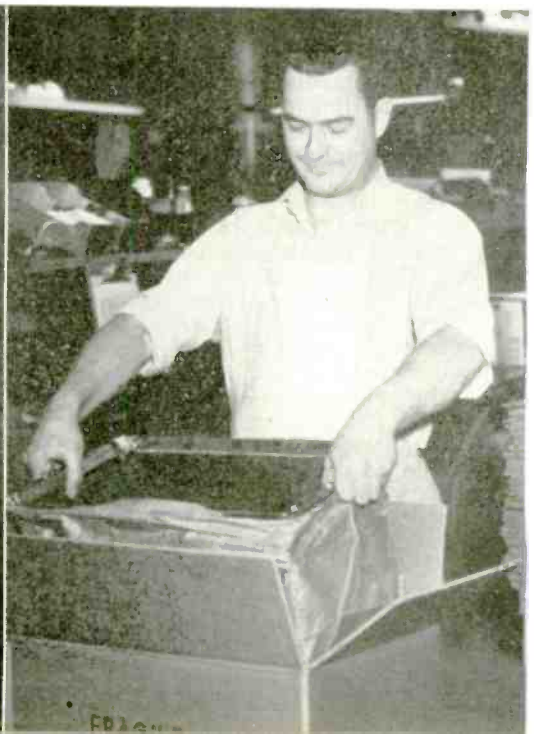
At Westinghouse, Mansfield, Ohio, warped condenser plates gave in, for good, to treatment consisting of clamping between steel plates and subjecting them to 400 deg. F. for 75 minutes.

5—*Too Much Specialization*

The moral of this story is, don't divide factory operations down to the least common denominator unless there's a practical as well as theoretical reason for doing so. A girl at Bausch and Lomb, Rochester, N. Y., won $430 for deciding that she wanted to do the whole job of matching, cementing, cleaning, inspecting, and optical truing up, at one bench position, thus producing as many binocular objectives in 5 days as used to be made in 12.

2—Gloomy factory surroundings and hard-to-see work areas mean slow production and frequent accidents. Lewyt Corp., Brooklyn, N. Y., contracting manufacturing service for electronic and other equipment, got around the problem by "3rd dimensional seeing," machine-painting





6—It's in the bag! Special framework devised at Farnsworth, Marion, Ohio, holds moisture-proof container open inside carton

TO SPEED PRODUCTION

7—*"Didies" Go to War*

Believe it or not, the most effective and dustfree wipers for lenses, crystals, and other critical items is the common commercial diaper, according to Minneapolis Honeywell. M-H has bought nearly a million to date, carefully laundering them and drying in hot, filtered air.

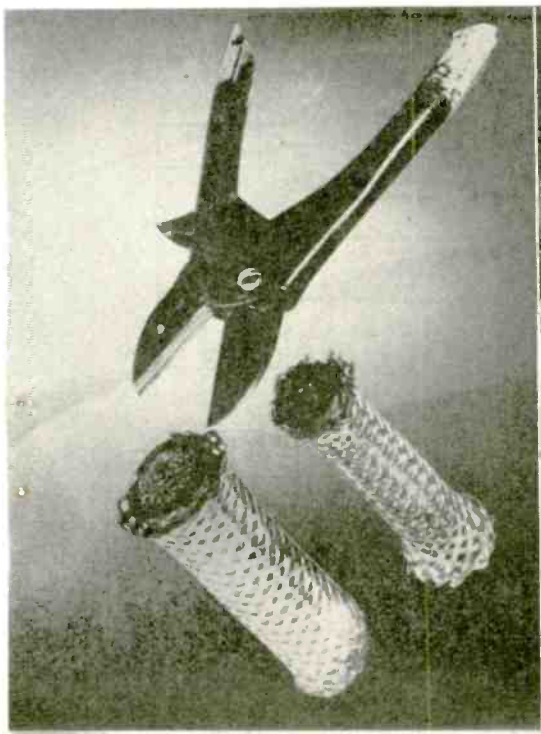
8—*Better Employe Morale*

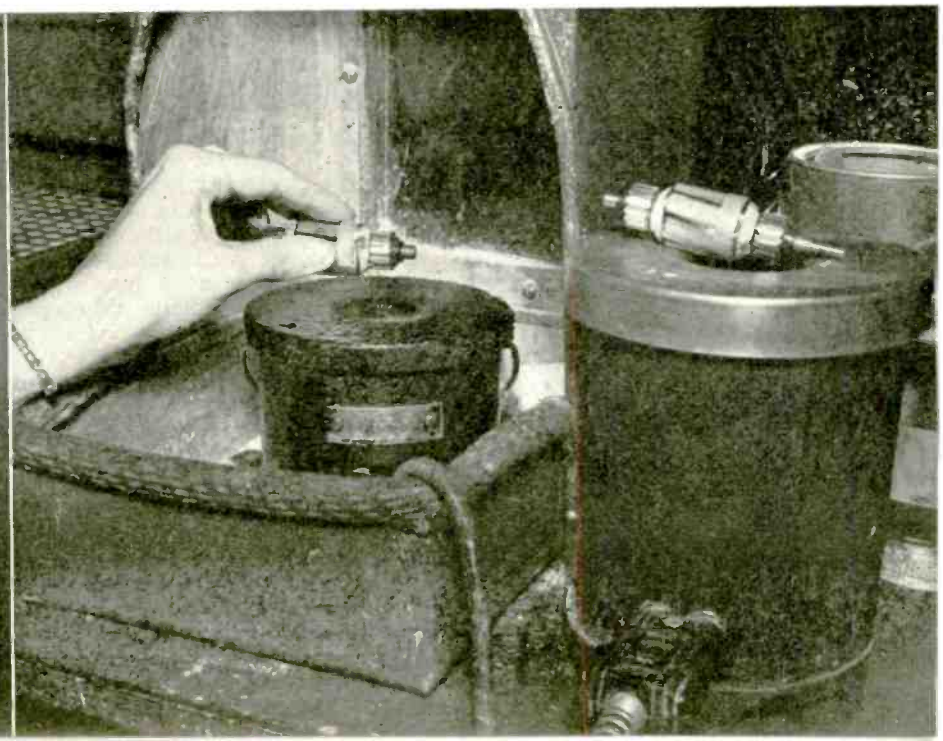
Here are three ideas to up production and make for a happier indutrial family: (1) Goodyear Rubber Co. and others place a sticker on desks, machines, or benches which says, "So and so worked here. He is now serving in the Armed Forces. While he is fighting for you, can you give less than your best for him?" Stickers by Avery Adhesives, 451 E. 3rd, Los Angeles, Calif. (2) General Instrument Corp., Elizabeth, N. J. Faulty parts become the subject of an "exhibit," or are taken tactfully to the worker who caused the reject. Basis of appeal is what would happen to flyer, tank pilot, etc., if the faulty part got through and gave out during height of battle. (3) Movies (or stills) showing the product in action do wonders for factory morale. Antenna housings for bombers tripled when employes, previously uninformed of the purpose of their product, saw it in Tokyo raid movie.

10—Idea for handling inflammable or corrosive solvents eliminates manual lifting, promotes safety, and speeds entire process of filling girls' individual containers at a Westinghouse plant. The safety can-tilting stand incorporates lever to pull stopper automatically

9—Garden variety of pruning shears, commercially available, cuts cable faster, cleaner than hack saw or diagonal pliers

11—Two solutions solve the problem of stripping Formex and Formvar from No. 36 or smaller wire, in new, patented process developed by Fairchild Camera and Instrument Corp., New York City. Ends are dipped in two solutions and Formex is pulled off as a tiny tube





★ **National Electronic Conference Paper**

HIGH SPEED X-RAYS BY

by Charles M. Slack
Assistant Research Director, Lamp Div., Westinghouse Elec. & Mfg. Co.

Edward R. Thilo
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Radiographs at one-millionth of a second made possible by controlled bursts of cold emission

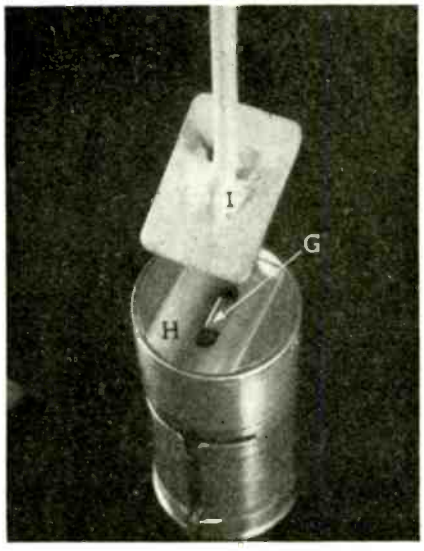
● In taking a radiograph, the time of exposure at any given voltage is determined by the intensity of the X-ray beam which in turn is dependent on the magnitude of the current passing through the tube. Using the normal tube current of several milliamperes, the exposures will range from a few seconds to perhaps minutes in duration.

It is obvious therefore, that if we wish to make an exposure of one millionth of a second, it will be necessary to pass about a million times the usual current, or some thousands of amperes through the tube. Since it is not practicable to obtain currents of this magnitude from a heated tungsten filament, it becomes necessary to seek some other source of electrons.

The first really successful step in this direction was taken by Max Steenbeck, who in 1938 built a rather simple tube, consisting simply of two pools of mercury enclosed in glass and connected by a glass capillary. When a condenser is discharged across such a tube, a cathode hot spot is formed, and the space charge being relieved by the positive mercury ions, heavy currents will flow.

However, in general the current is uncontrollable since at ordinary temperatures the discharge has a negative characteristic. Therefore, in order to obtain X-rays it is necessary to cool the tube to reduce the mercury vapor pressure to the rather critical range in which the tube is operable. The desired temperature is in the neighborhood of 0 deg. C. A further disadvantage of this construction is the necessity of operating the tube in the upright position. However, Steenbeck succeeded in taking pictures of low velocity bullets in free flight and passing through wood.

Fig. 1—Field emission cathode focusing cup and anode of high speed X-ray tube



Mercury discharge tube

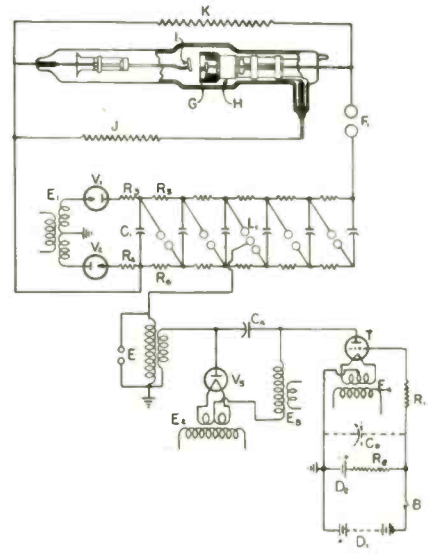
About this same time and independently of Steenbeck, Kingdon and Tanis of the General Electric Co. constructed a mercury discharge X-ray tube for the purpose of testing the reciprocity law in the killing of bacteria. The tube was similar in operation to that of Steenbeck but had a tungsten target. No effort was made to focus the electron stream and consequently the tube was not suitable for radiography, although the X-ray output was sufficient for simple exposures of a few microseconds duration. This tube was subject to the same limitations as that of Steenbeck.

Before passing to a description of the Westinghouse cold cathode X-ray tube and generator it may be of interest to consider some of the factors which led to its development. If we consider a simple two electrode tube filled with gas at or above atmospheric pressure, we find that the voltage required to produce a discharge is quite large. As the pressure is reduced, the voltage also decreases until a certain minimum value is reached after which further decrease in pressure causes the voltage to rise again (Paschen's law).

As the high vacuum portion of the curve is approached, the slope becomes very steep and the indications are that the voltage should reach infinity at extremely low pressures. It is also well known that the old gas X-ray tubes operated at higher and higher voltages as the vacuum improved. Reasoning along these lines, it has generally been concluded that when a tube fails to withstand high voltage it is because the vacuum has become impaired and the tube is said to be "gassy."

However, it is now recognized by most physicists that irregularities in operation often occur in the highest of vacuums and that gas, or at least volume gas, is not responsible for the phenomenom. As an illustration of this fact, the following experiment may be of interest. A deep therapy X-ray tube

Fig. 2—Schematic circuit of Westinghouse high speed X-ray tube



FIELD EMISSION ARC

was provided with an ionization gage and sealed off with a gas content of three microns of neon. The tube operated satisfactorily for some hundreds of hours and when the irregularities in operation usually attributed to gas did develop, the actual pressure as indicated by the ionization gage was less than .01 micron.

The erratic behavior of tubes referred to as "gassy," is apparently due not to the gas content of the tube, but to the emission of electrons under the influence of high electric fields which exist at points other than the heated cathode. The existence of sharp corners and points on the tube parts tends to accentuate the voltage gradients and the presence of impurities or occluded gas tends to lower the work function of the surface and make it easier for the electrons to escape. Such bursts of cold emission occur at voltages far lower than those calculated to be necessary to produce them from pure metals. This condition is not limited to X-ray tubes but applies to all high vacuum electronic tubes and is the cause of a large part of the irregularities which exist in such tubes, particularly in cases where the voltage rating is exceeded.

While investigating this phenomenon of "spitting" or "backfiring," with a condenser discharge machine, it was found that the magnitude of such bursts of current was surprisingly large, perhaps of the order of several amperes. Since the effect was so large in tubes designed especially to avoid it, the possibility of increasing it to the point where some useful purpose might be served presented itself. As a first step, a sharply etched tungsten wire point was placed close to a flat plate. Discharges of a condenser across this combination with the point negative, produced enormous currents with the best obtainable vacuum conditions.

The production of very large currents in vacuum at high voltages is of course just what we need for intense X-ray outputs which will permit the making of radiographs in very short intervals of time. The practical limitation of the tungsten filament X-ray tube is about one ampere of current due to the temperature and space charge limitations of the cathode. Here, however, was a source of extremely high currents running into a thousand amperes or more.

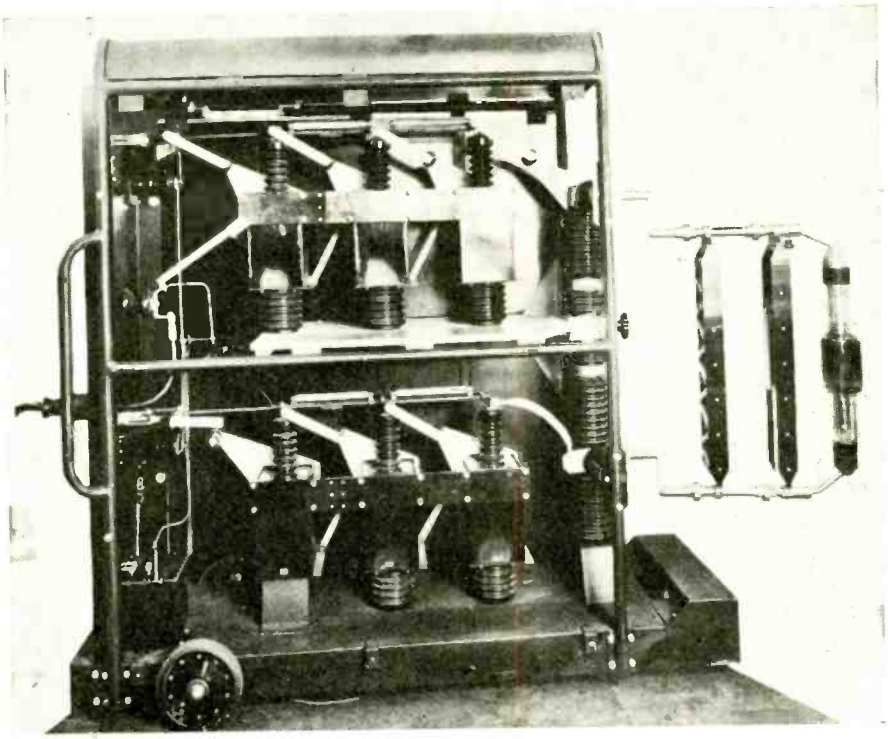


Fig. 3—Marx circuit surge generator for Westinghouse high speed X-ray tube

The problem of controlling these currents so that the electron stream would strike a suitable anode with the necessory velocity to produce X-rays was next considered. The addition of a control electrode placed in close proximity to a sharp edge gave promise of fulfilling the necessary conditions. Further development of this idea resulted in the design illustrated in Fig. 1, in which a sharpened electrode "G" is placed in a trough shaped auxiliary electrode "H." By this means a semblance of a rectangular focal spot can be obtained on the target "I."

The energy of the impacting electrons is dissipated in four different ways:

1—In the production of X-rays. This accounts for a fraction of one per cent of the energy.

2—Light and heat radiated from the focal spot account for 1—5 per cent of the energy depending on the exposure time.

3—Vaporization of the tungsten target accounts for perhaps 3 per cent of the energy.

4—Heating of the tungsten target at and near the focal spot absorbs from 90 to 98 per cent of the total energy.

It is obvious from these considerations that conduction of heat from the focal spot area to the surrounding tungsten must be relied on to play the major role in heat dissipation. Since the amount of heat conducted from a given area depends on time and the difference in temperature it can easily be seen that the heat dissipating ability of a focal spot will decrease as the exposure time decreases, so that one would expect it to be quite small for exposure times of about a microsecond such as we are considering here. It is fortunate that the heat dissipated varies with the square root of the exposure time according to the following formula:

$$W_m = T_m \frac{Kct}{2}$$

W_m = Loading in total energy permitted per unit area to raise surface to temperature T_m
K = Thermal Conductivity of anode material
c = Heat Capacity of anode material
t = Time of Exposure
T_m = Temperature

Calculated on this basis, using a condenser of .02 microfarad charged to 100 kv, and assuming a discharge time of one microsecond, a focal

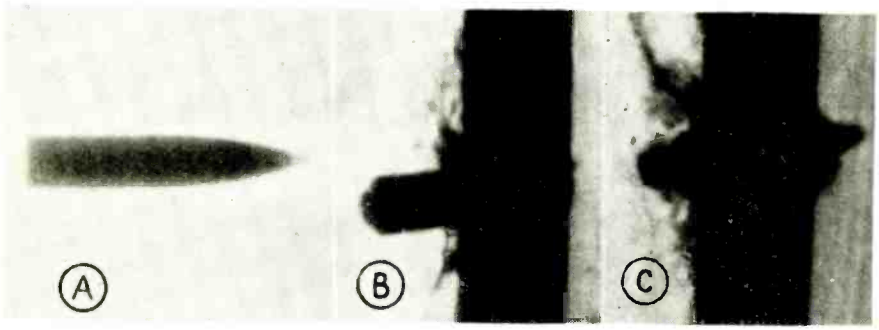


Fig. 4—High speed X-ray picture of bullet piercing armor plate. (A) Stationary X-ray picture of cal. .30 armor piercing bullet. (B) High speed X-ray picture of this bullet penetrating ½ in. thick armor. (C) High speed X-ray picture of same bullet 20 millionths of a second later

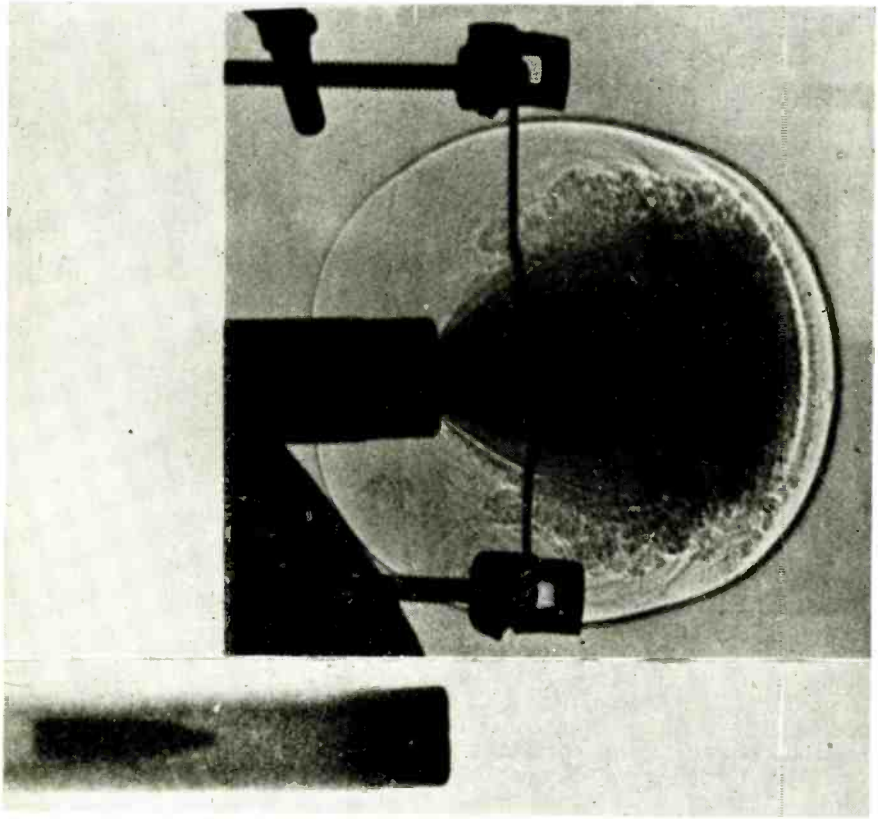


Fig. 5—Radiograph and spark picture showing blast and location of bullet in barrel

spot area of approximately 16 square centimeters would be required to dissipate the energy of the electrons without vaporizing the tungsten target. It has been found that focal areas of from one eighth to one quarter of the calculated values are sufficient in practice and that while some vaporization does occur, several thousand exposures could be given before the tungsten deposit becomes sufficiently thick to absorb the X-ray appreciably. The failure of the formula to hold in this case is probably due to a number of causes, the most important of which are:

1—The total discharge time of the condenser may be several times that of the X-ray exposure since the intensity of the X-rays falls off rapidly with decreasing voltage.

2—A considerable portion of the electrons may be deflected from the target and give up their energy elsewhere.

3—The discharge degenerates into a low voltage arc passing very high currents with little energy loss in the tube.

4—The time is so short that even with a high rate of evaporation the total material loss per exposure is small.

These conditions indicate that the focal spot and hence the obtainable definition can never be made as fine in a tube operating at these extremely short exposure times as they may be in tubes operating in the conventional manner. However, adequate definition for most purposes is easily obtained, and rather fine definition can be obtained in one direction by taking the X-rays off the target near grazing incidence.

The manner of operation of the tube may best be seen by referring to the schematic circuit diagram Fig. 2. The condensers are charged by the transformer "E_1" through the rectifiers "V_1 V_2" to a voltage somewhat less than that required to break down the spark gap "L." Simultaneously, condenser "C_4" is charged to about 1000 volts. When the circuit is broken at "B," the charge on the grid of the thyratron "T" leaks off, permitting "C_4" to discharge through the primary of the induction coil "E," which gives a sufficient impulse to the high voltage circuit to cause the gap "L" to flash over. This causes the surge generator gaps to break down which impresses a high voltage between "G" and "H." Field electrons are drawn from "G" and this initial discharge evolves into a metallic arc between "G" and "H" which spreads out into the focusing cup and becomes a virtual cathode at apparently unlimited current carrying capacity. Due to the action of resistance "J" Fig. 2, the discharge transfers to the anode "I" with consequent production of X-rays.

Field emission arc

The properties of such a "field emission arc" cathode which permit the drawing of such high current densities should find application to electronic devices other than X-ray tubes.

The time of formation of the discharge inside the tube must be even less than that required for a spark in air since a parallel rod gap will jump a considerably larger spacing without the tube in the circuit than with it in place. It is also of interest to note the small spacing between the external connections to the electrodes "G" and "H." This small spacing is sufficient to prevent breakdown, although the whole condenser voltage would be across these points were it not for the rapid field emission arc breakdown between these electrodes within the tube.

The time constant at the trigger circuit is about 20 microseconds and the time for complete discharge of the condensers through the tube about one microsecond. The time constant on the more recent timers has been reduced to less than one microsecond. The time delay of the trigger circuit is estimated by the distance a bullet travels after breaking the circuit at "B" before the radiograph is made, and the time of discharge can be measured by the amount of blur in the radiograph of a bullet travelling at a known velocity.

The time delay may be increased

to any desired value by adding capacity or increasing the value of the grid leak of thyratron "T."

Operating equipment

The generator which has been built to operate the high speed tube is shown in Fig. 3. Six condensers are arranged in a Marx circuit substantially as illustrated in the schematic circuit of Fig. 2. The exceedingly rapid breakdown of the X-ray tube has permitted closer spacing of the condensers than would normally be the case so that a relatively compact design has been possible. Power is drawn from a 200-250-v line through the control stand which permits regulation of the charging voltage from 30-60 kv in ½ kv steps.

The charging transformer is provided with four high tension cable sockets so that four surge generators may be used. The transformer case also contains two rectifiers, filament transformers, a grounding relay and two grounding resistors. The high tension secondary winding has been split and the center grounded which facilitates the use of a milliammeter in the center tap circuit. Under these conditions the milliammeter is at ground potential.

In most practical applications of the unit, it is desired to fire the surge generator at a given time interval after a certain reference point has been reached by the object under investigation. In order to facilitate accurate firing of the surge generator, a special interval timer has been designed. This is a thyratron timer employing a type 2050 thyratron tube and a type 634 thyratron tube. In normal operation the 634 thyratron is connected to the primary of a spark transformer which triggers the surge generator.

A capacitor is connected between the plate of this tube and ground through the primary of the high tension triggering transformer. When the thyratron permits discharge of the capacitor through the primary winding of this transformer, the resulting pulse is of sufficient magnitude to break down the trigger gap and thereby initiate a break-down of the entire surge generator.

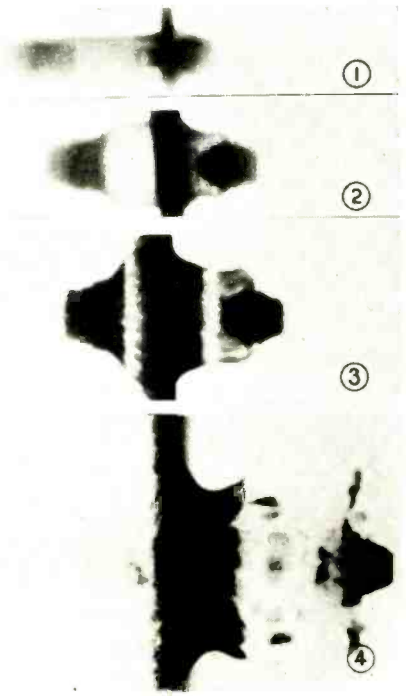
The timing circuit in the interval timer is capable of producing a time interval varying from 20 microseconds to several thousand microseconds. The timer is so arranged that the generator may be triggered by either a "make" or "break" type of operation. The "break" operation is used when it is desirable for the projectile or other object under investigation to break a conducting lead. In "make" operation, timing is initiated when two contacts are shorted.

The initiating gap in the surge generator is irradiated with a Sterilamp in order to maintain constant breakdown characteristics. The condensers are charged to 50 kv and when the initiating gap has broken down, the other gaps break down in sequence resulting in a discharge circuit of practically zero impedance and the full 300 kv appears across the tube.

The Marx circuit arrangement permits the use of condensers which need withstand only one-sixth the total voltage and a relatively small transformer suffices to charge them. When the gaps break down, there is of course some current leakage between condensers through the charging resistors. In the case of the field emission tube described here, the exposure time is so short that these losses are negligible. For the longer exposure times used in conventional X-ray tube technic, however, these losses are so high that the circuit is not suitable for such use.

The pictures published in 1940 showing some of the phenomena that could be revealed by means of high speed X-ray pictures (club striking a golf ball, shot gun charge passing through wood, etc.), came to the attention of the men at the Frankford Arsenal Laboratory.

Fig. 6—Series of high speed radiographs showing penetration of armor plate by an explosive shell. (1) Nose of the shell is through the plate. (2) Almost half of the shell has passed through the plate. The shell has swelled to approximately twice its normal diameter. (3) The shell has just burst open. (4) The shell has burst wide open. The petals on the back of the plate are curling back to make a larger hole.



Colonel L. S. Fletcher, at that time director of the laboratory, and the men under him recognized the possibilities of applying this new "tool" to the field of ballistics. It was arranged at this time to have the experimental equipment used at Westinghouse brought to the Arsenal for a series of tests. High speed X-ray pictures were obtained of caliber .30 armor piercing bullets penetrating a 1¾ inch diameter aluminum rod. The pictures gave useful information about the behavior of the bullet and the manner in which the penetration took place.

Millionth second exposure

The results of these tests were so promising that the laboratory ordered four units of the present form of this equipment developed for the Frankford Arsenal. The first of these units was delivered to the Ballistics Section of the Laboratory in January 1942 and the equipment has been in constant use ever since.

The X-ray exposure being of the order of a millionth of a second or less, it is necessary to use intensifying screens. Patterson No. 245 industrial combination intensifying screens have been used exclusively.

The first problem which was investigated at the Frankford Arsenal was the field of terminal ballistics; this is a study of what happens to the bullet when it strikes a piece of armor, also what happens to the armor during the penetration process. Ordinary photographic methods, including high speed photographs run into the difficulty of having the actual penetration obscured by luminous fragments thrown back at the time of impact. This difficulty is, of course, not present in the case of X-rays.

High speed X-ray pictures were taken of armor piercing bullets during the actual penetration. Two mutually perpendicular pictures were taken of the bullet as it penetrated the armor. The pictures were taken simultaneously or in sequence.

Fig. 4 shows two mutually perpendicular high speed X-ray pictures, taken in sequence of a caliber .30 armor piercing bullet penetrating a small 2 by 2 inch piece of ½ inch thick armor. On the first of the high speed X-ray pictures taken at the time when the core of the bullet had penetrated ⅜ inches into the armor, one can see fragments of the bullet jacket and of armor splashing back.

The jacket which cannot penetrate the armor has telescoped forward on itself and exposed the base of the core. The second high speed

(*Continued on page 196*)

★ **Report of FCC Frequency Allocation Hearing**

FM-TELE SHIFT SLIGHT

If RTPB recommendation is followed; would put Television 10 mc higher, expand FM allocation

● It appears fairly certain that there will be only minor shifts made in frequency allocations for FM and Television. A move looking toward leaving things pretty much as they are was made by the Radio Technical Planning Board in Washington at the end of September, when the Federal Communications Commission opened its public hearing for the purpose of:

"Determining the present and future needs of the various classes of non-governmental services for frequencies in the radio spectrum from 10 kc to 30 mc with the view of ultimately assigning bands of frequencies to such services."

The hearing was called by FCC primarily so that everyone interested might have an opportunity of getting their estimated requirements for spectrum space on record —and justifying those requirements. Only non-governmental services are being considered. The Interdepartmental Radio Advisory Committee on June 15 last had already proposed substantial revision of Article 7 of the General Radio Regulations (Cairo Revision). Now RTPB with its 13 Panels, all under the general chairmanship of Dr. W. R. G. Baker, which had been charged with the duty of formulating plans for the technical future of the radio industry and services, was to have its chance to make public its deliberations, its findings and its recommendations.

No coordinated report

As a matter of fact, RTPB made no overall coordinated report and may not find it possible to do so for some time to come. In the meantime preparations for a postwar International conference are on the slate and FCC hopes that it may be possible to so coordinate RTPB and IRAC proposals that definite conclusions may be reached by December 1.

The 13 Panels making up the RTPB organization have worked hard and long at the solution of their individual problems. As indicating the amount of work that has been done, Dr. Baker let it be known that to date the board has distributed "A total of approximately 100,000 documents," and there still remains a great task to be finished. Dr. Alfred N. Goldsmith, chairman of Panel 1 (Spectrum Utilization) and vice-chairman of RTPB, told the gathering that it will require at least a year more for his particular group to bring their labors to a satisfactory conclusion.

That there would be a great many more requests for frequencies than can be accommodated in the available spectrum was a foregone conclusion. Dr. Goldsmith's Panel had prepared a series of 30 charts (the originals aggregate 3 ft. in height, 150 ft. in length) on which all requests for spectrum space were plotted and the considerable overlap which exists in certain places is quite apparent, if not astonishing. As Dr. C. B. Jolliffe, chairman of Panel 2 (Frequency Allocation), pointed out, most of these overlaps occur in the region up to 2,000 mc. "It is like trying to put 1½ bushels into a 1 bushel measure," he said, and added, "something must give and it most certainly won't be the measure."

Obviously, there will have to be many compromises. One such conflict which existed between the requests of Panel 5 (FM Broadcasting) and Panel 6 (Television) already has been resolved. Others likewise will be resolved as work progresses.

In the case of FM and Television Panel 2 has adopted the following resolution which effectively freezes these two services at least in so far as RTPB is concerned with very little change from existing approved allocations:

"In order that there may be unanimous agreement in RTPB regarding assignment to television and FM and to make it possible to design equipment now in order that FM and Television can start on a largely expanded scale immediately following the war, it is recommended that the following assignments be approved:

"Educational FM broadcast, 41 to 43 megacycles;

"Commercial FM broadcast, 43 to 56 megacycles;

"Amateurs, 56 to 60 megacycles, and a 4 megacycle band between 114 and 150 megacycles;

"Commercial television, 96 megacycles, channels 60 to 114 megacycles, and 17 additional 6 megacycle channels below 250 megacycles:

"The present licenses of television below 108 megacycles are to be kept in approximately the same relative position in the 60 to 114 megacycle band as they now occupy in the 50 to 108 megacycle band."

One solid reason for the recommendation that no shift in the FM band is necessary came as a result of the solicited opinion of Dr. J. H. Dellinger, Chief of the Interservice Radio Propagation Laboratory of the U. S. Government, who had been asked about the possible effect of long distance skywave interference, or "bursts". Dr. Dellinger stated:

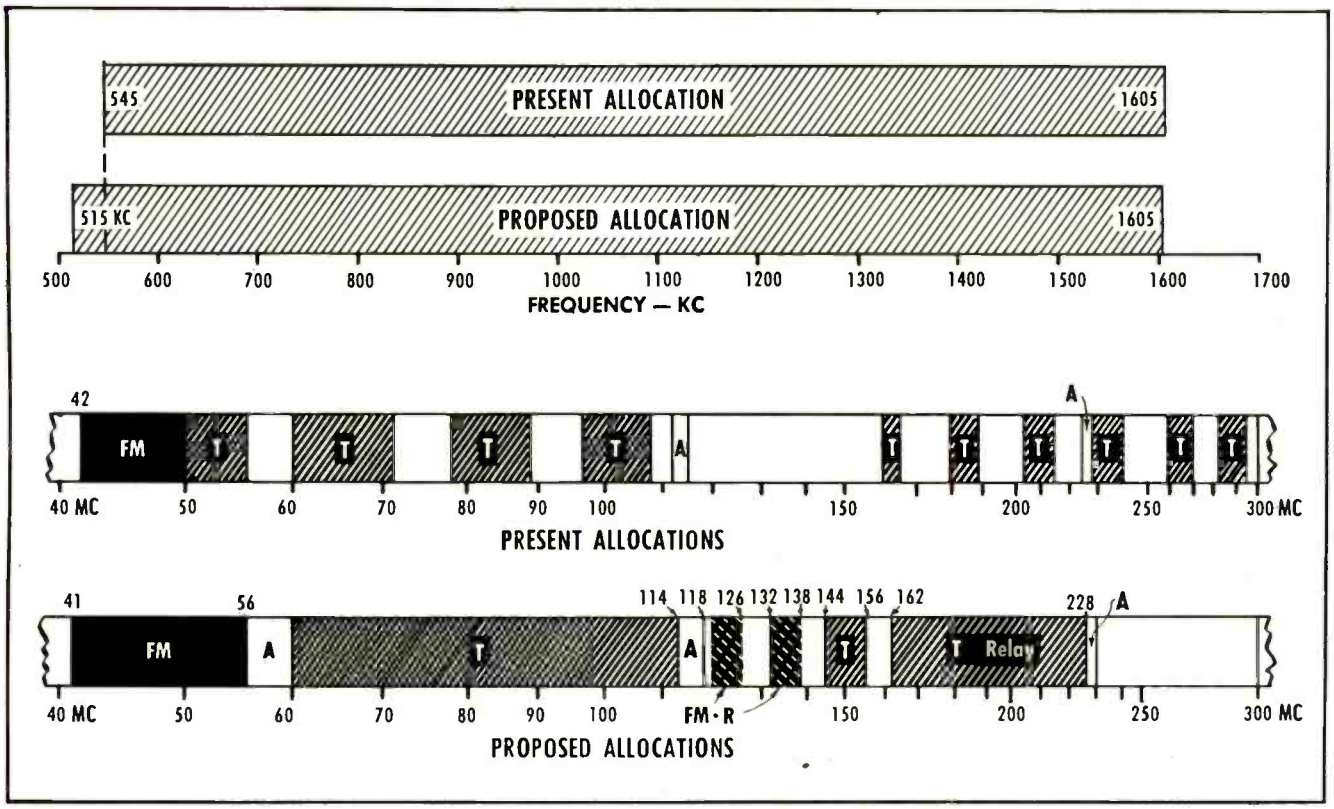
"Bursts" unlikely

"The point in question is that the frequencies concerned are sometimes affected by long-distance interference, contrary to an expectation that was widely held at one time, and there is a fear that this interference may be so great as to seriously impair the usefulness of those frequencies for broadcasting. Essentially the Panel appears to request that I inform it whether that fear is well founded. I believe I may, with propriety, respond to this request, and the answer is that the fear is not well founded."

That opinion is corroborated by the brief article by Dr. H. T. Stetson appearing on page 83 in this issue.

As respects television, Chairman David B. Smith offered as the recommendations of Panel 6 (Television) that:

"The Panel was of the unanimous opinion that commercial television broadcasting should be resumed and expanded on the present six megacycle group A channels plus



In this chart, which shows bands presently occupied by broadcast services, together with shifts that have been recommended by various Panels of RTPB, no attempt has been made to include the great many other governmental and service frequencies which eventually will be located somewhere in the spectrum between 60 and 300 mc, and higher. Intent is to show only proposed changes in AM, FM and Television bands

some additional ones. It found as a technical fact that the theoretical lower limit of television broadcasting is approximately 40 megacycles. It estimates that in order to provide a competitive system in accordance with the American way of broadcasting, approximately 30 channels would be required and that for technical reasons these channels should be grouped together in a substantially continuous band. The Panel recognized that as a practical matter it would have to consider the needs of other services, and with this in mind proposed an allocation plan that would provide 26 six megacycle channels between 50 mc and 246 mc. This allocation plan includes gaps for some existing private and Government services. The Panel hopes that it may be possible within the next few years for some of these intervening services to move to other frequencies, and in that event, television can take over the channels and fulfill the requirements of an ideal allocation scheme."

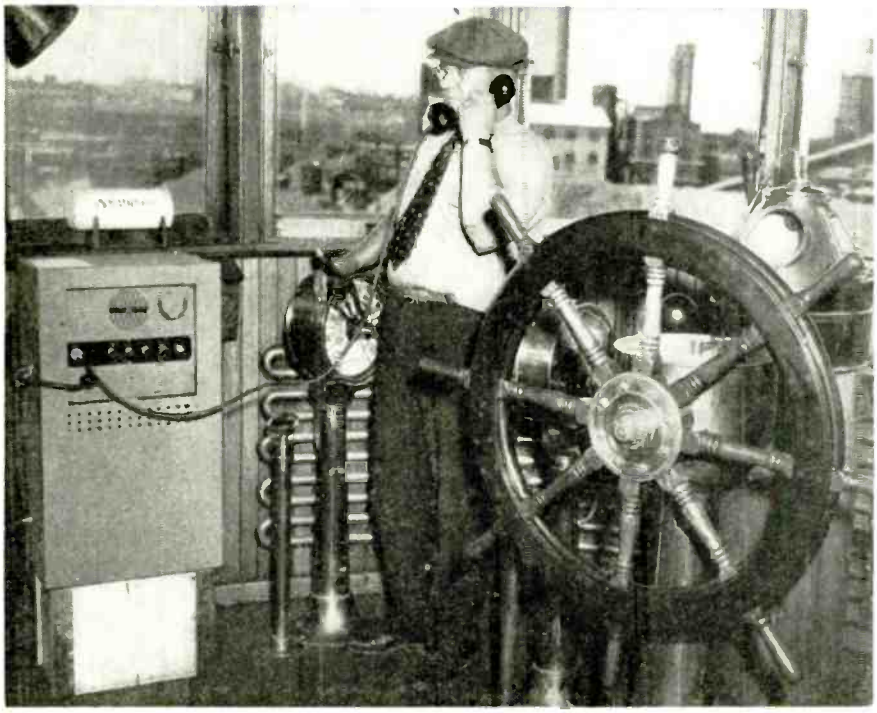
"With respect to color television," the Panel reported, "it was decided that adequate standards for color television for a six megacycle channel cannot be established at this time. This action was taken without prejudice to the continuation of experimentation in color television in such channels."

In the meantime, the motion picture people have projected themselves into the television picture by urging a proposed National Theatre Television Service with 75 channels of 20 megacycle bandwidth or a total of 1500 megacycles, planned by the Society of Motion Picture Engineers and revealed in

(*Continued on page* 190)

NAVY'S DATA ON TRANSMITTER TUBE DEVELOPMENT

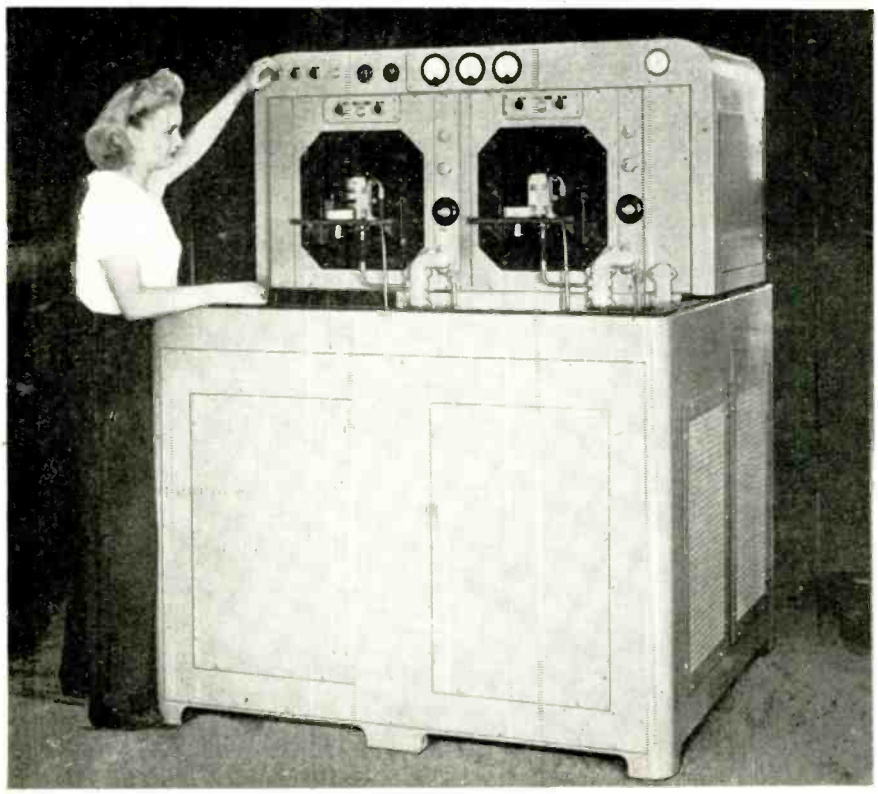
Operating Frequency Megacycles	Power Output Watts	Stage of Development	Remarks
400	1 kw	First	In first stage of research
400	250	Second-third	In preliminary stages of production
500	200	" "	
600	150	" "	
400	500	First-second	
500	400		
600	300		
400	700	Second	Concluding stages of research; can probably be operated to 700 mc
600	700	"	
400	1 kw	Four	In factory and production stages; operates at 40 per cent efficiency at 400 mc
400	3 kw	Second	In concluding stages of research; this is a water-cooled tube. Operates at 40 per cent efficiency at 400 mc. Will take a year to get into production
600	1 kw	"	



Participating in the first of a series of FM radio communication tests on the Great Lakes, Acting Captain Walter Dummer of the car ferry, S.S. Madison, is seen talking to the Port Washington, Wis., station of the Lorain County Radio Corp., using FM radio equipment developed by General Electric engineers. Seen at the left in the photo, the equipment is completely self-contained, except for the power supply. These FM tests, in operation since late July, are being conducted over a 90-day period. In addition to the equipment at Port Washington and aboard ship, five other FM transmitter-receiver units are being operated on car ferries, fish tugs, and others

TUBES on the JOB

New Tocco high frequency heating unit which features two stations operable at the same time on widely different frequencies. It has a normal frequency of 450,000 cycles, a 20 kw output



Rugged Recorder

An improved electronic recording instrument, so compact and well balanced it can withstand drop hammer vibrations and still maintain a sensitivity of six points in 10,000, is announced by the Brown Instrument Co., Philadelphia, precision industrial instrument division of Minneapolis-Honeywell Regulator Co. The latest models of the instrument, the electronic potentiometer, will be shown at the National Chemical Exposition to be held in Chicago, Nov. 15 to 19.

The continuous balance theory of new strip and circular chart electronic potentiometers is emphasized, said Brown engineers, by the fact that the improved models can be operated upside down. Earlier models of this instrument have been used successfully in speedier and more uniform production of high octane gasoline, butadiene, styrene, plastics, ball bearings, aluminum and other wartime products. Under the name of the flight test recorder, they have long been used for testing airplane parts.

Induction Heating Unit

A new entrant into the field of high frequency induction heating was revealed at the National Metal Congress in Cleveland, Ohio, when the Tocco Division of the Ohio Crankshaft Co. introduced a new type of two-station high frequency electronic heating machine.

With normal frequency of 450 kc and a 20 kw output capacity, it is the first tube-type unit to be designed with two independent work stations that can be operated at the same or widely different frequencies. This provides versatility for the brazing, hardening, annealing, soldering or heating of small parts. One-station models will also be manufactured.

Controls and operating meters are conveniently located above the work panels and in the timer cabinet situated on the left side of the "penthouse" frame. Manual controls for use during setups can be switched to automatic for production runs once the heating cycle is determined. The power output control includes plate voltage, grid drive and grid bias variation. Meters include grid current, plate and radio frequency tank current.

A pistol-grip handle set at easy working level at the rear of the machine is used to change the plate voltage taps while a dial with a tap switch for the grid drive is located at the rear control station. The grid bias control, a rheostat that offers fine and coarse control, has a convenient position on the front meter panel.

6 KEYS to ENGINEERING SUCCESS

by DR. ALLEN B. DuMONT
President, Allen B. DuMont Laboratories, Passaic, N. J.

Study eternally, practice salesmindedness, win executive responsibilities, high spots in message to Rensselaer graduates

● For the technical man, tomorrow's world means change and progress and new openings on a positively fantastic scale. The very last ounce of knowledge and skill and effort is being poured into the desperate global conflict which is to decide the future of mankind. Thus it is not surprising to find technological advances on an astounding scale. In most fields the advances already amount to 25 years of usual peacetime progress. For example, the text books in many fields are probably 2 to 3 years behind times, already. One can have had excellent training in the fundamental sciences, but unless you continue your own education, your opportunities will necessarily be definitely limited.

Keep up with procession!

My second point is the need to keep up with this rapidly-moving technological procession. If you would get up-to-date and stay up-to-date in your chosen field, by all means cultivate a craving for information. To offset the rapid obsolescence of knowledge and experience and practice these days, we have engineering and technical journals covering every field of technology. To top it all, we have engineering and technical societies which meet regularly for the presentation and discussion of papers that bring us right up to the present moment. The proceedings of such societies are indispensable in the working library of the successful technician. Keeping up-to-date is of the very essence of success.

For a third point, consider the intricacies of modern development, design, production and control of various technical items, particularly in meeting the stringent specifications of global war, which require a greater range of conditions than ever before encountered, and which will continue in the postwar world. In radio and electronics, we have such conditions as flying in rarefied atmosphere, with temperatures down to minus 40 deg. F.; operation in tanks, with temperatures up to 125 F.; fungus growths and cain-raising insects of the jungles; intense vibration and mechanical shock of the order of 100 and above; high-humidity conditions even approaching 100 per cent saturation; corrosive effects of salt water spray, and so on. All these conditions must be studied by the technician. Laboratory setups, approximating actual conditions, are now commonplace, so that equipment can be tested and checked for intended conditions of operation. Never before has there been such need for technicians in the development, design, production and control of almost all products.

My fourth point concerns creative thinking—and doing. It has been my observation that too many engineers and technicians have a basically negative approach to any new idea. The average technically-trained man knows, of course, the inherent technical difficulties in a given technical situation, almost at a glance. He knows why it can't be done, offhand. And often he makes no attempt whatsoever to do anything further about it. He stops at the first technical objection.

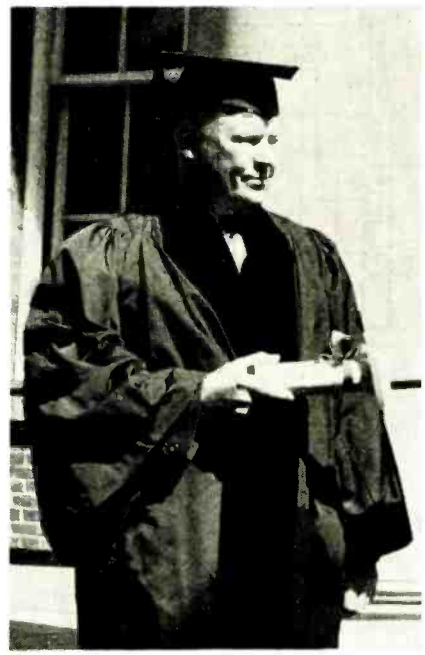
As a jibe to such negative thinkers, however, many war plants these days have this sign very much in evidence: "The difficult, we do immediately; the impossible takes a little while longer." It is in that spirit that our country, in three short years, has caught up with and surpassed the Axis powers who had a twelve-year head start on our production.

Faced with the negative attitude of many of his co-workers in the great research laboratories of General Motors, Dr. C. F. Kettering, patron saint of modern industrial research, has this to say on the subject: "Tell me just why it can't be done. Once you have mentioned all the reasons in sufficient detail, you have the problem more than half solved."

Yes, the negative attitude accounts for the financial predicament in which many technicians find themselves. They work for others. They are under others. They take their orders from the business and sales departments. And when there are extra financial rewards to be divided, the technicians usually come in at the very tail end, if at all.

My fifth point, then, is to urge you to develop a commercial viewpoint, along with your technical outlook. Remember, your salary will ultimately come out of sales. A business lives or dies by its income. And yet so many technicians are not interested in the slightest in the selling end. Nevertheless, I say to you: To be a successful technician, be a salesman. Be salesminded. See that your efforts have a direct bearing on selling more and better goods for bigger and better profits. In this way you will be fattening your own pay envelope. You will enjoy more prestige. You will be more successful.

(*Continued on page* 222)



DR. ALLEN B. DuMONT

Awarded the degree of Doctor of Engineering, Dr. DuMont cited six principles of growth for the modern engineer:

1. **Present-day world offers tremendous opportunities.**
2. **Ceaseless study is necessary to keep abreast.**
3. **Growing complexity demands more technicians.**
4. **Engineers must stop thinking negatively.**
5. **Be salesminded. Be business-minded.**
6. **Hold yourself in proper esteem.**

SURVEY of WIDE READING

Electronic news in the world's press. Review of engineering, scientific and industrial journals, here and abroad

Wavemeter for 14 cm. Waves

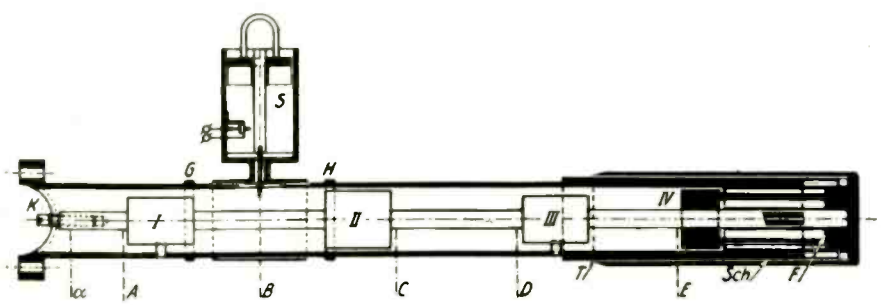
A. Weissfloch (Zeitschrift fuer technische Physik, Berlin, No. 2, 1943)

Frequency deviations can be measured with an accuracy of 10 kc (5.10^{-6} times the original frequency), or a change of about 0.0007 mm. in the 140 mm. wave will be indicated by the instrument. Calibration is required for absolute frequency measurements.

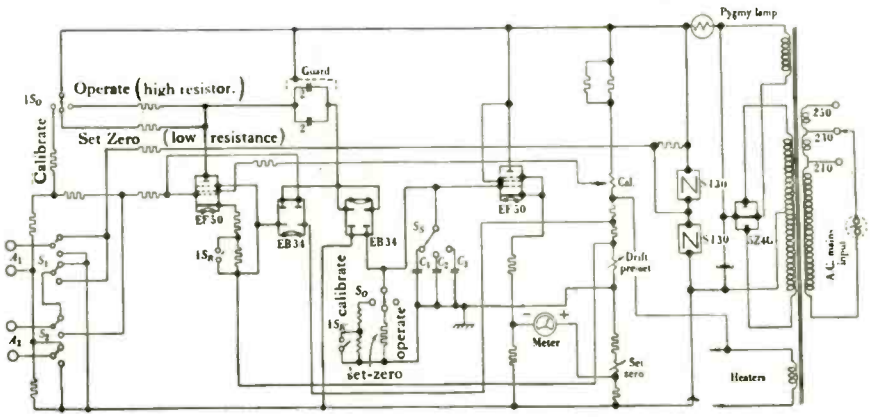
If a homogeneous, concentric, shorted line, approximately five meters in length, is connected to a 14 cm wave generator, standing waves with about 70 voltage nodes will build up within the line. Assuming a change in wavelength of 0.01 mm., the voltage node at A will be shifted by $0.01 \times 70/2 = 0.35$ mm. The wavemeter shown corresponds to this principle, but its length is reduced to about 40 cm. by the insertion of suitable transformer sections I, II, III, IV; (on theory of transformer sections see "Discontinuities in UHF Lines," Electronic Industries, May, 1944).

Section II is designed to transform any impedance Z at the point C into an impedance of about 50Z at the point B. Sections III and IV are dimensioned to provide a voltage node exactly at point D compensating for unsatisfactory contact of the shorting stub at E. The distance CD is adjusted to be equal to a half wavelength at the center frequency of the measuring range, and, at that frequency, a voltage node at D will result in voltage nodes at C and at B.

In operation, the short-circuit at E and D is moved by sliding the end stub with a micrometer screw until the voltage minimum is exactly at B, as indicated by equal currents in the probe S at stops G and H. Depth of modulation of FM waves can be measured with the instrument.



Wavemeter for 140 mm. waves detects changes of 0.0007 mm.



Measuring time intervals of 100 μ sec. to 1 sec.

Measuring Short Time Intervals

R. K. Dundas, Ltd. (Journal of Scientific Instruments, London, August, 1944)

The instrument measures short time intervals between 100 μ sec. and 1 sec. The two parallel, large reservoir capacitors 2,2, which have been charged by the high voltage supply, are discharged, during the time interval to be measured, through the constant current circuit (left-hand EF 50 tube, preset anti-drift potentiometer, second diode of the right-hand EB 34 tube) into one of the high-stability precision capacitors C_1, C_2 or C_3. The voltage developed across the selected precision capacitor is a function of the unknown time interval and is indicated by the following, negative-feedback, dc tube voltmeter (right-hand EF 50).

The purpose of the four diodes, reading left to right on the drawing, is as follows: The first diode provides a path for the reservoir capacitor charging current, the second limits the grid potential of the left-hand EF 50 tube, when conductive, to a constant value so as to maintain the current through this tube constant, the third prevents the precision capacitor from undue over-charging should the time interval to be measured exceed the range, and the fourth prevents the charge introduced into this capacitor from leaking out after the interval has passed.

During calibraton the left-hand EF 50 tube is made conductive and the precision capacitor is paralleled by an accurately measured wire-wound resistor. The instrument is calibrated by varying the current through this tube until a definite meter reading.

Deflection-Modulted CR Tube

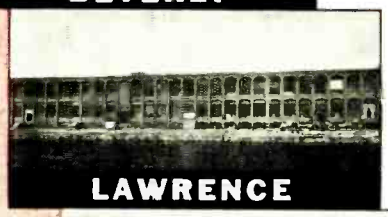
P. Nagy (Journal of the Television Society, London, June, 1944)

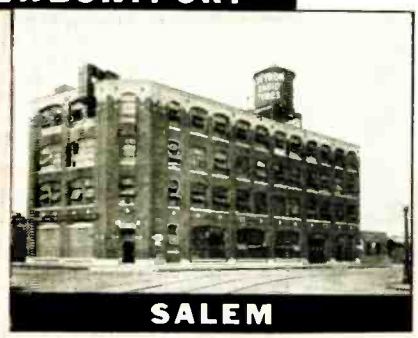
In the deflection-modulated cathode-ray tube, capacitor C may be alternately charged in a positive and negative sense. The image of the cathode K, elongated in a direction perpendicular to the plane of the drawing, is focused with the aid of grid G, anode A_1 and second anode system A_2, P, into a sharp elongated image at the tip of the member Y of the secondary emission output electrode X-Y.

Within a certain range of electron velocity, the equilibrium po-

(*Continued on page 202*)

Some INTERESTING FACTS ABOUT HYTRON





★ Hytron is the oldest manufacturer in the United States specializing on radio receiving tubes. The first Hytron tube was made by hand in 1921.

★ The now standard BANTAM GT receiving tube is a Hytron origination. Hytron designed and developed over 70 of the popular GT types. These small glass receiving tubes contributed to the development of the miniature table radio and to large scale production of radio and radar equipment for the Services.

★ The tiny BANTAM JR. tubes originated by Hytron were the first subminiatures. They made possible hearing aids and pocket radio sets. Similar Hytron tubes serve in wartime electronic devices.

★ Hytron has pioneered transmitting and special purpose tubes for the radio amateur and for police radio. Its very-high-frequency tubes and its instant-heating r.f. beam tetrodes for mobile communications, have also become extremely popular with the Services.

★ Hytron combines long experience in high-speed receiving tube techniques with the know-how of special purpose tube engineering. The result is economical mass production of special tubes.

★ First of the receiving tube manufacturers to convert 100% to war production, Hytron will be just as alert in serving the post-war market.

CONSULT HYTRON regarding your needs for these tubes: receiving, ballast, hearing aid, very-high-frequency triodes and pentodes, miniatures, medium and low-power transmitting triodes, r.f. beam tetrodes (particularly instant-heating), r.f. pentodes, gaseous voltage regulators, and rectifiers.

OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON CORPORATION ELECTRONIC AND RADIO TUBES

SALEM AND NEWBURYPORT, MASS.

HYTRON RADIO TUBES

ARMY NAVY

BUY ANOTHER WAR BOND

WHAT'S NEW

Devices, products and materials the manufacturers offer

Milliseconds Meter

The Rowe radio type MM100 elapsed milliseconds meter measures, electronically, small periods of elapsed time directly in milliseconds on a linear scale meter. The start and finish of the period to be measured are made to initiate and terminate operation of the unit by various mechanical, electrical or photo-electronic means. Start of the period causes the meter to rise and termination stops the meter, at which position it remains for taking the reading. Range of the standard instrument is 100

milliseconds. Other ranges can be had covering both higher and lower elapsed periods. Made by Rowe Radio Research Laboratory Co., 2422 North Pulaski Rd., Chicago.

H V Ceramic Capacitors

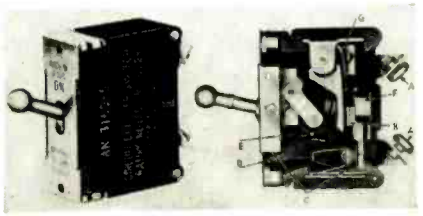
Originally engineered by Centralab Division of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee, Wis., for specific items of war equipment, three new types of high voltage capacitors are now in production for general use. All units have the general double-cup design that simplifies positive attachment of the terminal and gives maximum flash-over distance between the terminals. Plates are pure silver fixed to the ceramic. Standard terminals are silver-plated brass or bronze. Capacitance is determined by the area and thickness of the ceramic center partition or bottom of the cups and by the dielectric constant of the ceramic. Units have zero temperature coefficient and maintain a constant capacitance with temperature change. The dielectric constant of this ceramic body is approximately 40.

Thermoplastic Insulation

Thermolex is a new thermo-setting plastic designed for insulating and to make components salt, moisture and acid resistant as well as impervious to fungus growth. It is a phenolic resin with very low density primarily intended for deep penetration. Several types are produced by Thermolex Liquid Plastics Co., Yonkers, N. Y., for thick, medium and light coatings and in opaque form. All types may be dipped or sprayed.

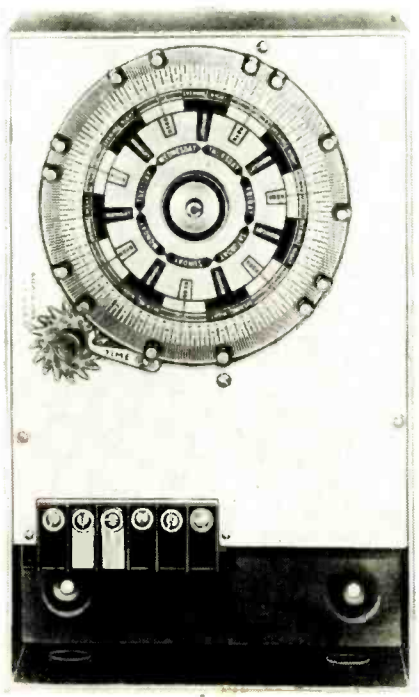
Switch Breaker

A new circuit breaker relatively free from the effects of extreme high and low temperatures has been added by Littelfuse Inc., 200 Ong St., El Monte, Calif. and 4757 Ravenswood Ave., Chicago. The actual trip temperature of the new breaker without flow of current is 350 deg. F., ambient temperature. This resistance is accomplished by new bi-metal design. The bi-metal is used as the finger that pulls the trigger. No appreciable mechanical load is exerted on the bi-metal as it trips the breaker. The range is 5 to 50 amperes at 32 volts, ac or dc. It is capable of breaking 2500 amperes on short circuit. It meets the requirements of holding for one hour at 115 per cent of rated current; breaks within the hour on 138 per cent of rated current; breaks at 200 per cent of its load between 10, and 100 seconds. These tests are all at the ambient temperature of 77 deg. F. ± 1.8 deg. F. The breaker is enclosed in moisture-proof black-bakelite case.



Dial Switch

The Paragon 700 series 7 day calendar, dial time switch for timing automatic heat, ventilating, lighting, pumping or flushing operations is equipped with a 6 in. calendar dial which makes one complete revolution every 7 days. Dial trippers can be independently set for different daily ON and OFF schedules. Settings can be made in advance for an entire week. Any day or days operations may be omitted entirely on a pre-set program. Operations from ON to OFF or from OFF to ON can be set as close as three hours apart and can be separately adjusted throughout each 24 hour day in the week. Maker is Paragon Electric Co., 39 West Van Buren St., Chicago 5, Ill.



Communications Mike

The Electro-Voice Corp., South Bend, Ind., has placed on the market a new model, 600-D communications microphone designed for police, airport, utility, mobile communications and portable public address installations. Among features is a "press-to-talk" switch which opens the microphone and closes the relay simultaneously, if desired. A high impact molded phenolic case was built to requirements of rugged military usage, yet it weighs but 9 oz. The microphone will withstand temperatures

from —40 to +185 deg. F. The frequency response ranges from 50 to 8,000 cycles per second with an output of —57 db, 0 db = 1 volt/Dyne/CM^2. The curve is substantially flat for highest articulation.

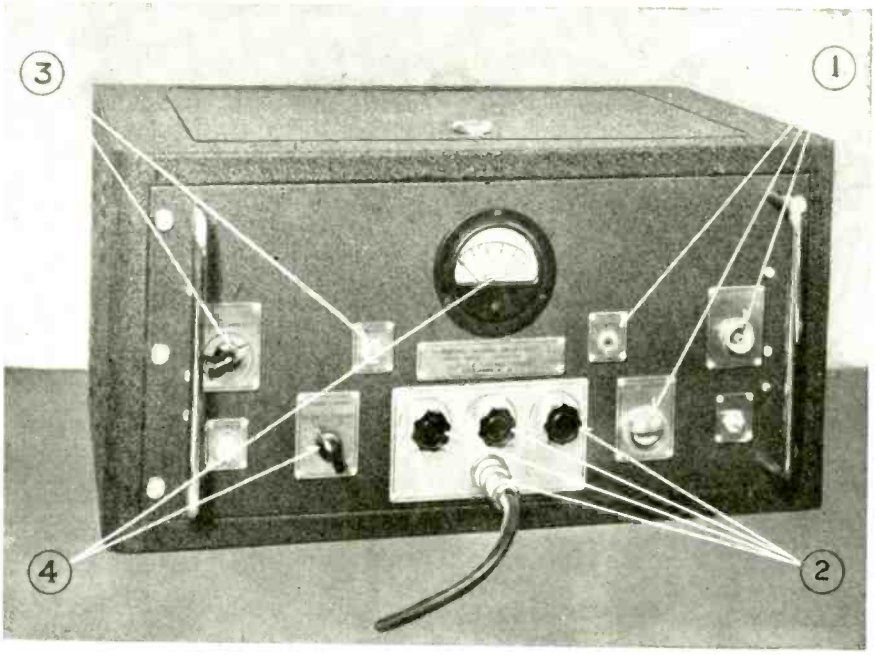
Compact PA System

A compact public address system including a radio receiver, record changer, amplifier and two loud speakers all contained in a single case has been brought out by Pacific Electronics, Sprague and Jefferson Sts., Spokane, Wash. The receiver tunes from 5.5 to 18 megacycles, the amplifier has three stages with push-pull output; the record changer has a sapphire cutting head and playback. Source of power is the usual 110-v lines.

Solderless Wiring Tool

Aircraft-Marine Products Inc., Harrisburg, Pa., has developed a new hand tool which combines all the steps involved in preparing a wire for a solderless terminal and in crimping the terminal to the wire. In addition to the usual crimping notches the tool includes an efficient wire cutter and an insulation stripper with the correct stripping length clearly indicated. Terminal stud hole sizes are also marked on the tool for quick checking. Three types of Amp. terminals, for wire sizes 22 to 10, are crimped by the tool, the Flag type, Standard (Type B), and the One-piece terminal. Crimping notches are marked to correspond with terminals they will crimp and stripping notches are marked with Navy Shipboard and Commercial AWG wire sizes. Fully insulated handles of molded plastic are light in color and permit the tool to be easily identified in repair kit and in storeroom. Construction is of heat-treated steel with a rust-resistant finish.

• Recommended for Fast, Easy, ACCURATE Calibration of Wavemeters, Signal Generators, Oscillators, Receivers, etc.



* * *

The Secondary Standard
LAVOIE C-200 CALIBRATOR

The LAVOIE C-200 Calibrator is an instrument that establishes *crystal-controlled* frequencies at UHF up to and beyond 2000 megacycles. By means of a switch it cuts out 10's and produces only 40's on the megacycle frequency range . . . or by means of an Identifier, selects any ONE of these frequencies for purposes of identification. A detector and amplifier on the panel expedite the calibration of signal generators, etc. Detailed information promptly upon request.

High Lights

1. BEAT DETECTOR UNIT provides easy calibration with either aural or visual indication of zero beat.

2. OUTPUT and ADJUSTMENTS give crystal-controlled harmonic frequencies up to 2000 megacycles.

3. MODULATION CONTROLS permit selection of either modulated or unmodulated output as well as degree of modulation.

4. MILLIAMMETER and SELECTOR SWITCH facilitates easy adjustment of output controls.

* * *

U H F

Lavoie Laboratories

RADIO ENGINEERS AND MANUFACTURERS

MORGANVILLE, N. J.

Specialists in the Development of UHF Equipment

WASHINGTON

Latest Electronic News Developments Summarized
by *Electronic Industries'* Washington Bureau

RECONVERSION—It is still some time off and will not follow the pattern of an immediate floodtide of civilian production as had been pictured, more or less rosily, two months ago. First, V-E (Victory in Europe) Day is not coming so soon as had been anticipated by the Allied Forces' onrush through France and there will be NO CIVILIAN PRODUCTION until after V-E Day. Second, even when reconversion gets the "green light," there can only be effected a limited amount of civilian home receiver production.

COMPONENTS SHORTAGE—That is due to the fact that there is a lack of critical tubes and components, including capacitators, loud speakers and electrolytic condensors, resulting from the heavy military requirements. Manufacturers must review their supplies of these limited components and gage their plans for civilian production on the basis of these limitations.

ALLOCATIONS AND FUTURE CIVILIAN SETS—Because the frequency allocations determination by the FCC may not be too well-defined in terms of the permanent places in the spectrum for such vital postwar services as television, FM broadcasting and facsimile, manufacturers, in the opinion of some of the most competent Washington government observers, will at the outset of reconversion concentrate on standard broadcast (AM) receivers, largely along the lines of prewar models and types.

FIRST COMES AM—All the manufacturers naturally want to get into the market with their products as soon as possible and it is believed that over half of the civilian home sets produced after V-E Day will be the AM type. Combination AM-FM-Video sets will come later when the bands for FM and television have been fixed by the governmental agency, the FCC.

CONSIDERING FM—The FCC in the allocations hearings has evinced desires to place FM broadcasting temporarily in the 42-50 mc band and make 88-108 mc a permanent place for FM which could be enlarged when television moves out. The FCC viewpoint is that the lower portion of the spectrum has been definitely shown to be subject to bursts, sporadic E, and troposphere disturbances.

PERFORMANCE IS QUESTION—Set manufacturers have indicated that there is not enough known about performance in the 88-108 mc range and the upward move would mean redesigning and retooling of the planned set production on the basis of the RTPB recommendation of 42-56 mc. Undoubtedly the band width of 200 or 150 kc which is supported by the majority of radio engineers will remain. The outlook is that there will be some 2000 stations in the country within 5 or 10 years after the war and FM will get additional space of at least 84-88 mc in future shifts.

TELEVISION—The outlook, based on the testimony and viewpoints from the FCC, is for limited space in the lower portion of the spectrum, possibly 50-84 mc and then the major space would go "upstairs" around 300 mc where 529-line color and high fidelity definition pictures can be broadcast. Former FCC Commissioner Craven proposed 40 channels, 13 mc wide, in the 480-1000 mc range because it would give better quality video service and there is little investment in commercial television, both transmitters and receivers, in the lower portion of the spectrum. With 30 to 40 channels, he estimates stations can be spaced about 200 miles apart. RTPB has recommended virtually continuous space from 56-246 mc with 30 channels and color video channels to be 20 mc in width.

CHANGES COMING—No matter how the presidential election goes there will be changes in the top officials of key governmental agencies of significance to the radio-electronic industry. There are to be two vacancies at the FCC—that already existing by reason of the resignation of Craven and the anticipated resignation of James Lawrence Fly who may be leaving to join Muzak Corp., which plans a $10,000,000 nationwide non-advertising FM transcription home reception service along the same lines as "wired radio" of a decade ago. Because both FCC vacancies are Democrats, President Roosevelt, regardless of the vote results, is expected to make the appointments. One of the new appointees will take Fly's place.

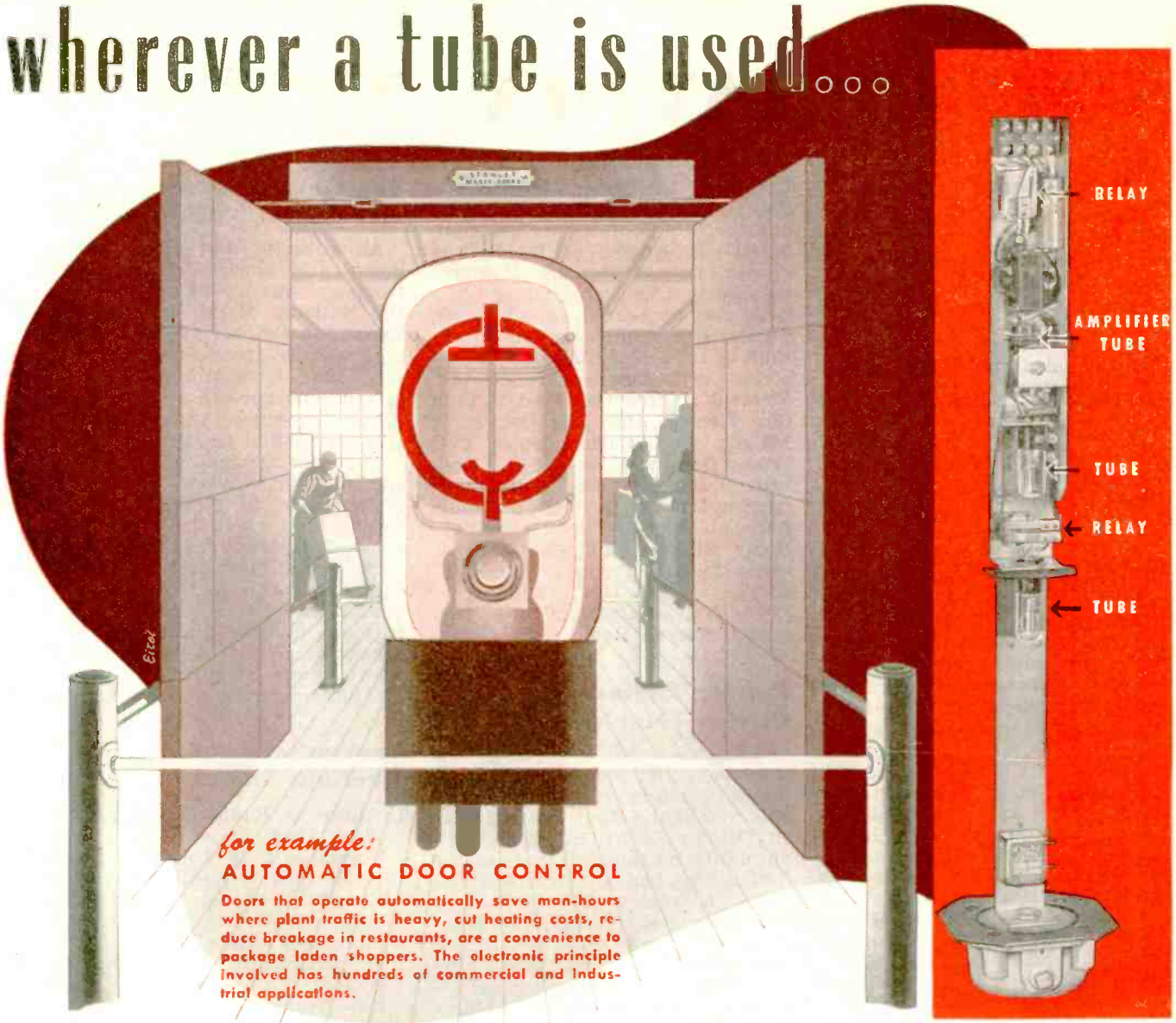
RECONVERSION UNDER KRUG?—Another change, likely to occur, will be WPB Chairman Krug going to a top post with the Demobilization — Reconversion Agency and the WPB Radio & Radar Division is slated to diminish rapidly both in staff and work as reconversion comes closer. The Surplus War Property Administration activities are now marking time—it won't get going until the three-member board is named. In fact, the recent SWPA report showed only a gain of about $1,500,000 in surplus material in the past month.

MISCELLANEOUS — OPA has three industry advisory committees, covering set manufacturers, parts manufacturers and tubes, hard at work studying changes in costs of production since civilian output was stopped; sub-committees are gathering statistics and holding discussions with OPA on adaption of the 1942 prewar price levels under Price Regulation 188 to present production expenses; final decision is long way off. . . . Only research and development of Signal Corps, mainly Aircraft Radio Laboratory at Wright Field and Airborne Radar and Electronics branches in the War Department, are being transferred to the Office of Air Communications Officer of the Army Air Forces; airborne radio and radar procurement is to remain with Signal Corps until after Germany's surrender and then will go to the Air Forces. . . . Brigadier General T. J. Tully, former Chief Signal Officer of the Fifth Army in Italy, has been made Chief of the Signal Corps Distribution Division, replacing Brigadier General George H. Gardner who died suddenly.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

wherever a tube is used...



for example:

AUTOMATIC DOOR CONTROL

Doors that operate automatically save man-hours where plant traffic is heavy, cut heating costs, reduce breakage in restaurants, are a convenience to package laden shoppers. The electronic principle involved has hundreds of commercial and industrial applications.

PHOTO-ELECTRIC DOOR CONTROL
Above unit manufactured by General Electric Co., is a part of STANLEY "MAGIC DOOR" CONTROLS.

THERE'S A JOB FOR *Relays* BY GUARDIAN

★ The "Magic Door" made by The Stanley Works of New Britain, Conn., uses a General Electric control unit which operates automatically at the approach of a pedestrian or vehicle. In this unit a beam of light focused on the cathode of a phototube causes a tiny current to flow. Enlarged through an amplifier tube this current operates a sensitive telephone type of relay such as the Guardian Series 405. Another phototube with an auxiliary relay, Guardian Series R-100, is employed to hold the doors open for anyone standing within the doorway.

The telephone type of relay is extremely sensitive and able to operate on the small current supplied through the electronic circuit. The auxiliary relay, Series R-100, is required to handle a greater current. It is a small, efficient relay having a contact capacity up to 1 KW at frequencies up to and including 28 megacycles. Contact combinations range up to double pole, double throw. Standard coils operate on 110 volts, 60 cycles, and draw approximately 7 V. A. Coils for other voltages are available. For further information write for Bulletin R-6.

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

Series 405 Telephone Type Relay

Series R-100 H. F. Relay

GUARDIAN ELECTRIC
1622-M W. WALNUT STREET CHICAGO 12, ILLINOIS
A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY

ASSOCIATION NEWS

APCO Re-elects Officers

Accenting the importance of retaining present police radio channels and providing for adequate additional radio frequencies in the postwar period, the 11th Annual National Associated Police Communication Officers, Inc., Conference concluded three days of intensive postwar planning on September 20 at Toledo, following the selection of a large police radio committee to appear at the Federal Communications Commission allocations hearing at Washington in October, under the leadership of Captain Robert L. Batts, of the Indianapolis police department.

Adopting the International Association of Chiefs of Police attitude, keynoted by Captain Donald S. Leonard of the Michigan State Police, who maintained that much more would be accomplished for the public's police radio through a clear presentation of the nation's postwar police radio frequency requirements, on its safety of life merits, the large representation from 31 states approved the Radio Technical Planning Board Panel 13 report and ruled out the use of pressure politics for the attainment of radio facilities.

Acclamatory re-election of the principal officers for 1945 included, President Frank W. Walker, Michigan State Police; 1st vice-president, Ray S. Groenier of Madison, Wis.; Bulletin Editor Capt. J. M. Wherritt, Missouri State Patrol, Jefferson City; and secretary-treasurer Ero Erickson of the Illinois State Police, Chicago. Sergeant D. J. McFarlane of the Boston Metropolitan Police is the new 2nd vice-president and the 1944 Conference Chairman, Sgt. C. H. Knudel of Toledo was chosen sergeant-at-arms. Members listened to a long program of technical and semi-technical addresses, wandered at times through an exhibit by these firms: Aircraft Accessories Corp.; General Electric Co.; Victor J. Andrew Co.; Fred M. Link Co.; Electric Auto Lite Co.; P. R. Mallory Co.; Carter Motor Co.; Owens Corning Fiberglas Co.; Doolittle Radio, Inc.; Peel Sales Engineering Co.; DX Crystal Co.; Radio Corp. of America; Eicor Co.; Shure Bros.; Eitel-McCullough Co.; Sylvania Electric Products Co.; Electro-Voice Mfg. Co.; Wincharger Corp.; Galvin Mfg. Co.; WiRecorder Corp.; Warren Radio Co.

Picture Engineers Discuss Television

More than 300 experts in the technical and scientific branches of the motion picture industry, gathered at the Hotel Pennsylvania on October 16 for the 56th semi-annual technical conference of the Society of Motion Picture Engineers. A total of 38 papers on a wide variety of subjects, from technical developments to production experience in unusual fields, were presented at morning and afternoon sessions on each of three days. Technical advances and the economic outlook for theater television were the highlight of the first session, of which Dr. Alfred N. Goldsmith, was chairman.

1945 National Officers of the Associated Police Communication Officers, Inc., elected at the 11th Annual Conference at Toledo, Ohio, September 18 to 20, 1944. President F. W. Walker (Michigan State Police); Secretary-Treasurer Ero Erickson (Illinois State Police); 2nd Vice-president Sgt. Donald J. McFarlane (Boston Metropolitan Police); Capt. J. M. Wherritt, Bulletin Editor (Missouri State Patrol); Sgt. C. H. Knudel, Sgt.-at-Arms and '44 Conference host of Toledo, Ohio, Police Dept.

New Geiger-Counter Spectrometer Exhibited

An entirely new X-ray instrument, the Geiger-Counter spectrometer, was unveiled publicly at the National Metal Congress and Exposition October 16-20 in Cleveland. North American Philips Co., Inc., also demonstrated self-contained shockproof and rayproof X-ray inspection units and film-type diffraction apparatus.

The new Geiger-Counter X-ray spectrometer utilizes a Geiger-Muller tube to measure the intensity and position of interference lines which are encountered in X-ray diffraction analysis work. Where film-type equipment is used, quantitative intensity measurement is more difficult — thus, the new spectrometer fills a definite need where such quantities must be measured with extreme accuracy.

Conventions and Meetings Ahead

Institute of Radio Engineers (330 West 42nd Street, New York), November 1, 29 West 39th Street (G. L. Beers); special meeting of New York Section on industrial electronics, November 22, 7.30 p.m., Auditorium Cooper Union, Cooper Square, New York; December 6, 29 West 39th Street, New York.

Rochester Fall Meeting, November 13-14, Sheraton (formerly Sagamore) Hotel, Rochester, N. Y.

Electron Microscope Society, November 16-18, Chicago.

Society of Rheology (R. B. Dow, Aberdeen Proving Ground, Maryland), November 17-18, New York.

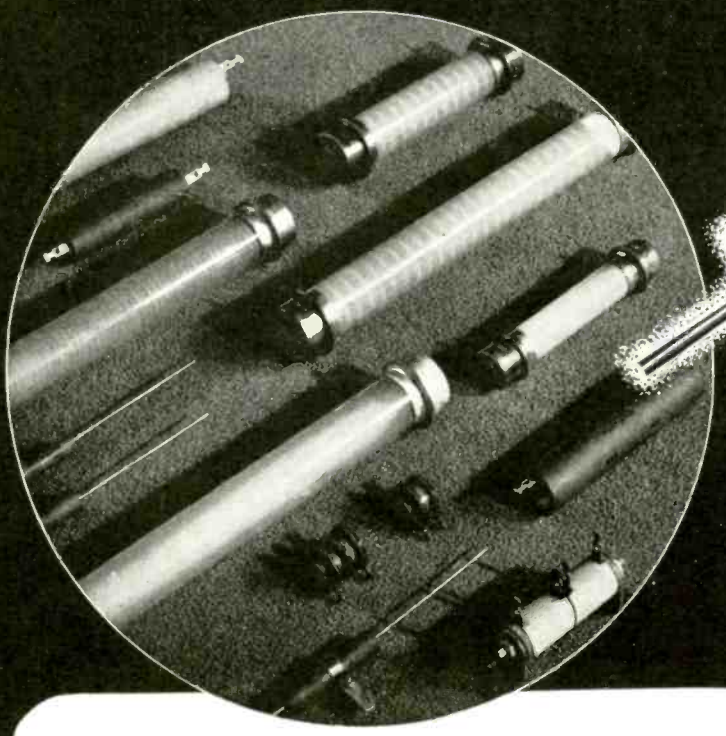
American Society of Mechanical Engineers (Ernest Hartford, 29 West 39th Street, New York), Annual Meeting, November 27-December 1, New York.

Television Broadcasters Association, Inc. (500 Fifth Avenue, New York 18, Room 1038), first annual conference, December 11-12, New York City, Hotel Commodore.

American Institute of Electrical Engineers (H. H. Henline, 29 West 39th Street, New York), Winter Technical Meeting, January 22-26, New York.

Society for Measurement and Control, joint meeting of the New York and New Jersey Sections, November 14 (Sosman on Pyrometry in the Steel Industry).

DON'T LET OLD-FASHIONED RESISTORS CRAMP YOUR ENGINEERING STYLE!



***The only Resistors wound with* CERAMIC-INSULATED WIRE**

INSULATION APPLIED BEFORE WIRE IS WOUND

A Major Resistor Improvement—*Not just a minor change*

Don't waste time engineering "around" the handicaps imposed by conventional resistors! Use Sprague Koolohms and get exactly what you want.

No power resistor can be one whit better than the insulation given its windings—and Koolohm ceramic insulation applied to the wire before it is wound gives you the maximum in this respect. Koolohms can be used safely up to their full rated wattage values. Their use of insulated wire permits larger wire sizes to be used, and guards against shorts and changed values. They give more resistance in smaller size, and are readily adaptable to almost any mounting style best suited to your production.

Standard Sprague Koolohms include 5- to 120-watt power types. Other Sprague Resistors include bobbin types, hermetically sealed power resistors, 5- to 150-watts, and meter multipliers. Write for new catalog—just off the press.

SPRAGUE ELECTRIC COMPANY, Resistor Division
(Formerly Sprague Specialties Co.)
North Adams, Mass.

ARMY E NAVY

SPRAGUE*KOOLOHMS

Totally Different . . . Outstandingly Superior

*TRADEMARK REG. U.S. PAT. OFF.

★ TELEVISION TODAY* ★

New Developments in the Video Field

Federal Has New Home Tele Receiver

Signalizing the addition of another well-known name to the lengthening list of manufacturers of home receivers, Federal Telephone and Telegraph Corp., Newark, N. J., has let it be known that an advanced type of television receiver is shortly to emerge for presentation to the public. No details have been revealed.

Federal to Build UHF Tele for CBS

The first broadcast application of the principle of transmitting both sight and sound signals on the same carrier frequency will be incorporated in a new television transmitter which is to be produced by the Federal Telephone and Radio Corp., for the Columbia Broadcasting System. The new equipment, which it is expected will be put in operation atop the Chrysler building in New York in about eight months is to operate in the very high frequency portion of the spectrum between 460 and 472 mc. It will be used for both black and white and color pictures. The transmitter is in addition to the 1 kw job ordered from General Electric last July and which, it was announced, would be used for experimental transmissions of wide band black and white pictures in the 400 to 500 mc band.

International Telephone and Telegraph, of which Federal is an associate company, is no newcomer into the television field. It was the engineers of IT&T associated companies that were responsible for the great Eiffel Tower television station and have been credited with the development of the microwave technic, forerunner of modern high frequency relay methods.

Power of the new transmitter has not been disclosed though it is pretty generally known that Federal has under development a new type of tube construction which will make possible the use of higher powers at the high frequency for which the transmitter has been designed. Video channel is to be 10 mc wide to permit transmission of wideband, fine screen pictures.

Standard Tele Tube

A new size and type of cathode ray tube for home television receivers may evolve as a standard if efforts of Corning Glass Works bear fruit. Corning has been making a survey among manufacturers in an attempt to develop a standard which will permit mass production. Interest appears to center in a tube with a flat screen 10 in. in diameter. This would permit a picture 8 in. wide and 6 in. high. With estimated production running to or better than one million tubes a year, standardization is desirable. Corning's interest comes by reason of its production of envelopes.

New York's Newest Television Studio

Newly completed studio and control room facilities at WABD, the Du Mont tele station in New York City. Lamp banks are incandescent and adjustable. Two dolly-type cameras are used

ATS Asks FCC to Leave Channels Undisturbed

The American Television Society late in September wired the Federal Communications Commission commending experimentation between 400 and 1,000 megacycles but urging that, for early development of television, present channels remain.

The wire reads: "According to the trade press, there is a definite implication, based on Mr. Fly's address in New York last week, that television will soon be shifted from its present frequencies to those above 400 megacycles. While we are definitely in favor of channel allocations between 400 and 1,000 megacycles for experimental purposes, we are amazed that any consideration should be given to eliminating the present frequencies as we feel their continued use will make it possible for television to become a public service immediately upon cessation of hostilities and aid materially in absorbing labor from war plants and giving jobs to returning veterans. We urge you to leave present television channels undisturbed and that you grant a hearing to a representative of the American Television Society, an independent, non-profit organization with no axe to grind other than the furtherance of television as a public service."

TBA Chairmen Appointed

O. B. Hanson, general chairman of the first annual conference of the Television Broadcasters Association, Inc., scheduled for Hotel Commodore, New York, Monday and Tuesday, December 11 and 12, has appointed committee chairmen for the event. The following men will serve as committee chairmen: Speakers: Allen B. DuMont of the DuMont Laboratories; Displays: James McLean of G-E, chairman; T. J. Bernard of RCA Victor, James Shouse of Crosley, Leonard Cramer of DuMont Laboratories, and James Carmine of Philco, co-chairmen; Reception: Robert L. Gibson, G-E; Budget: Douglas Day of Buchanan and Co.; Program: Ralph Austrian of RKO Television, Worthington Miner of CBS, and William Morris of the William Morris Agency, co-chairmen; Awards: Paul Raibourn of Television Productions, Inc.; Panel Meetings: Dorman D. Israel of Emerson Radio and Phonograph Co.; Publicity: Will Baltin of TBA.

* Title registered U. S. Patent Office.

Specify C. T. C.

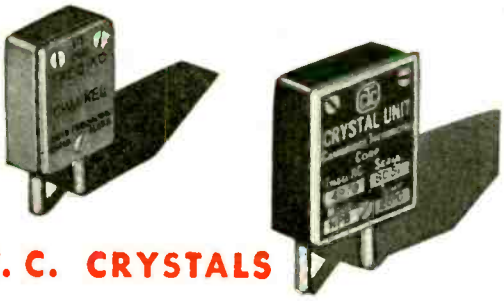
CRYSTALS

I-F TRANSFORMERS

TURRET TERMINAL LUGS

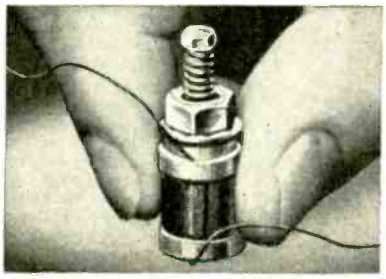
SPLIT LUGS

DOUBLE END TERMINAL LUGS



C. T. C. CRYSTALS

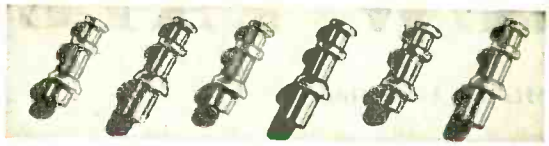
Accurate cutting of each slice — thanks to X-RAY ORIENTATION — insures constant frequency over a wide temperature range. Multiple mechanical lapping operations; dimensioning by edge lapping and finishing to final frequency by etching, are other important steps in the manufacture of C.T.C. Crystals that guarantee high activity and constant frequency throughout their entire life.



I-F TRANSFORMERS

These tiny, *ultra-high frequency,* slug tuned I-F Transformers are doing an efficient, thoroughly dependable job in many important radio and electronic applications.

Ask us about LS-1 (pictured above actual size) and LS-2 transformers.



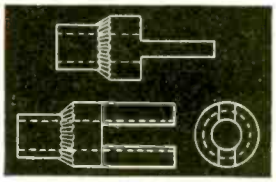
C. T. C. TURRET TERMINAL LUGS

Just swage these heavily silver plated Turret Terminal Lugs to the board and in a jiffy you have a good, firm turret terminal. Quick soldering, too. Sufficient metal is used in the Lugs to give them strength but not enough to draw heat thus increasing soldering time.

C. T. C. Turret Terminal Lugs are stocked to meet 1/32", 2/32", 3/32", 4/32", 6/32", and 8/32" board thicknesses.

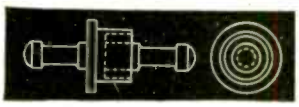
C. T. C. SPLIT LUGS

A .050 hole through the shaft permits wiring to these Split Lugs from either top or bottom without drilling or cutting. Just swage them to the board, then wire. Made of brass, heavily silver plated, C.T.C. Split Lugs are available in two sizes to fit 3/32" and 5/32" boards.



DOUBLE END TERMINAL LUGS

Use these Double End Terminal Lugs when you need terminal posts on both sides of the board. Like C.T.C. Turret Terminal and Split Lugs, C.T.C. Double End Lugs simply swage to the terminal board — provide twin terminal posts which may be wired from top and bottom. Heavily silver plated brass. Stocked to fit 3/32" terminal boards.



For complete information get in touch with

CAMBRIDGE Thermionic CORP.

441 CONCORD AVENUE

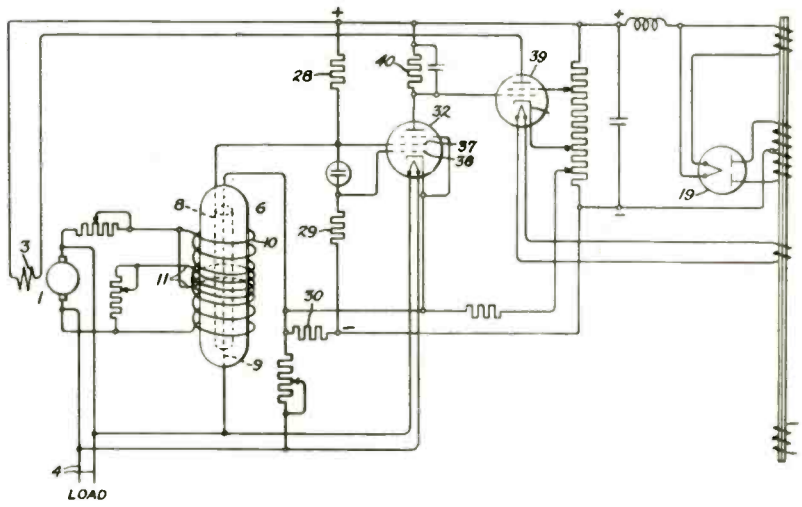
CAMBRIDGE 38, MASSACHUSETTS

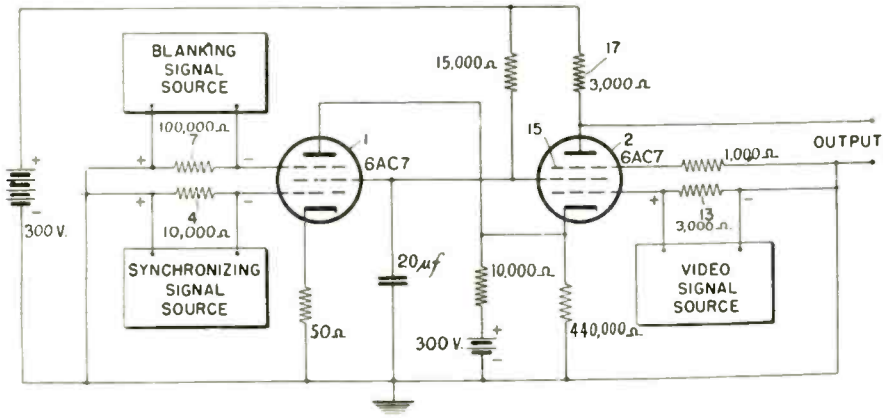
NEW PATENTS ISSUED

Signal Mixing Amplifier

The circuit is designed to eliminate the use of a limiter and to minimize the effect of tube capacitances across the load resistor 17 of the mixing tube in the television amplifier; the mixing tubes are inserted to combine the video signal with synchronizing and blanking signals. If the minimum positive voltage developed in the resistor 13 by the video signal source represents black, the conduction of space current in tube 2 will be at a minimum value. As the voltage across resistor 13 increases to represent whiter portions, the space current through tube 2 increases correspondingly.

During a scanning period the voltages across resistors 4 and 7 are at their minimum negative value so that tube 1 conducts maximum current, which lowers the positive potential of the cathode of tube 2, increasing the space current through this tube. The blanking signal will increase the positive potential of the cathode of tube 2 so that this tube now works in the remote





cut-off region where the space current is practically independent of grid voltage variations. The current through tube 2 will be further reduced by the synchronizing signal.

Limiting action for the blanking and synchronizing signals can be obtained by suitably adjusting the plate voltage of tube 1 so that the tube is driven into space current saturation if these signals exceed the desired level. It is possible to apply one of the signals, for instance the horizontal synchronizing signal, to the suppressor grid 15 of tube 2. Tubes with more than three grids may be used and suitably connected.

M. Cawein, Farnsworth Television and Radio Corp., (F) November 1, 1943, (I) July 18, 1944, No. 2,353,876.

Transmission of FM Waves

If, during the times of zero or weak program current, the carrier wave in the program channel 15 is allowed to remain at one frequency or within a narrow band, the crosstalk would be confined to one or two of the twelve multiple-carrier-system channels 17. To reduce the crosstalk into each channel, the energy is spread over the entire transmission band, regardless of the amplitude of the modulading carrier. An increase in program level of the order of 5 decibels may be obtained.

For this purpose amplifier 22 is inserted and provided with a feedback coupling 23 which causes the amplifier to generate a pilot wave of about 25 cycles, the amplitude of which is complimentary to the impressed program signal. The modulating signal,—consisting of the program signal plus the pilot wave,—will then be of constant amplitude, and the frequency excursion of the modulated carrier will also be constant and have its maximum value. At the receiver, the 25 cycle pilot frequency is filtered out by a high pass filter.

H. E. Curtis, Bell Telephone Laboratories, Inc., (F) July 23, 1943, (I) June 27, 1944, No. 2,352,254.

Voltage Regulator

Magnetically controlled tube 6 permits the interconnection of the low impedance circuit 4,—which is the load circuit of the dc voltage generator 1 to be controlled,—and the high input impedance of vacuum tube 32. Windings 10 and 11, fed by the generator 1, produce opposite magnetic fields which control the amount of current passed by tube 6; the windings are dimensioned to compensate for any variation of the magnetic field with temperature.

If the voltage of the load circuit 4 increases beyond a predetermined desired value, the resultant field strength produced by windings 10 and 11 will be increased. As a result, the current transmitted between anode 8 and cathode 9 will be decreased, causing a reduction in the current transmitted through resistance 30. Consequently, the potential of grid 36 of tube 32 will rise, causing an increased amount of current through resistance 40 and a reduction in the current through tube 39 and winding 3 of generator 1, restoring the voltage of the load circuit 4 to the predetermined value. Conversely, if the voltage of the load circuit 4 tends to fall below the predetermined value, there will be an increase in the current through tube 39 and winding 3.

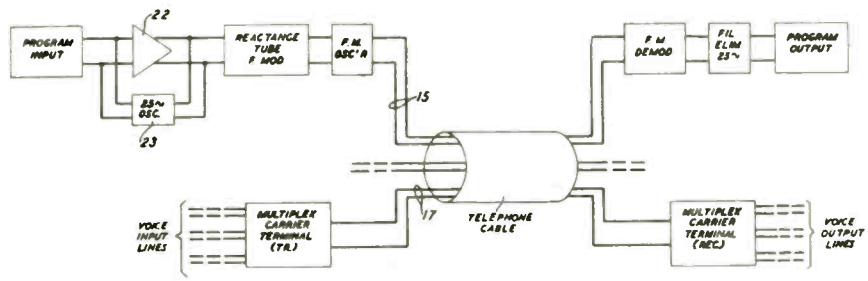
Resistor 29 is designed to have several times the ohmic resistance of resistor 28, so that the potential at grid 37 does not vary appreciably when the voltage rectified by tube 19 varies. However, upon variation of this voltage, the potential at the upper terminal of resistor 29 does vary, changing the current through tube 32 and, consequently, through tube 39, maintaining the current through winding 3 constant in spite of the variation in supply voltage.

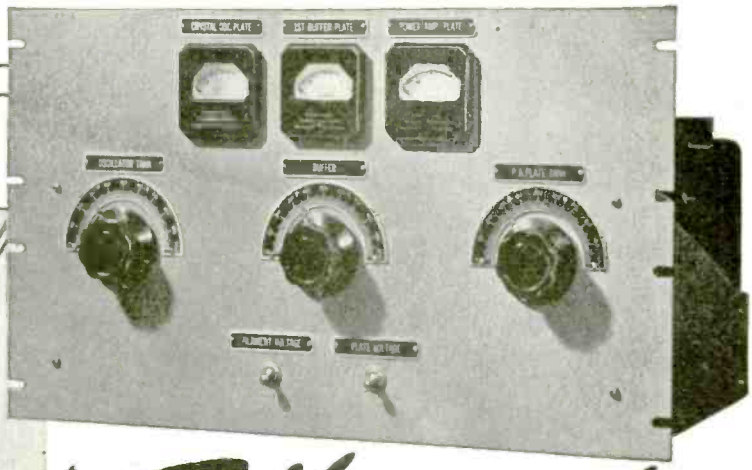
J. L. Stratton, General Electric Company, (F) November 24, 1941, (I) June 27, 1944, No. 2,352,231.

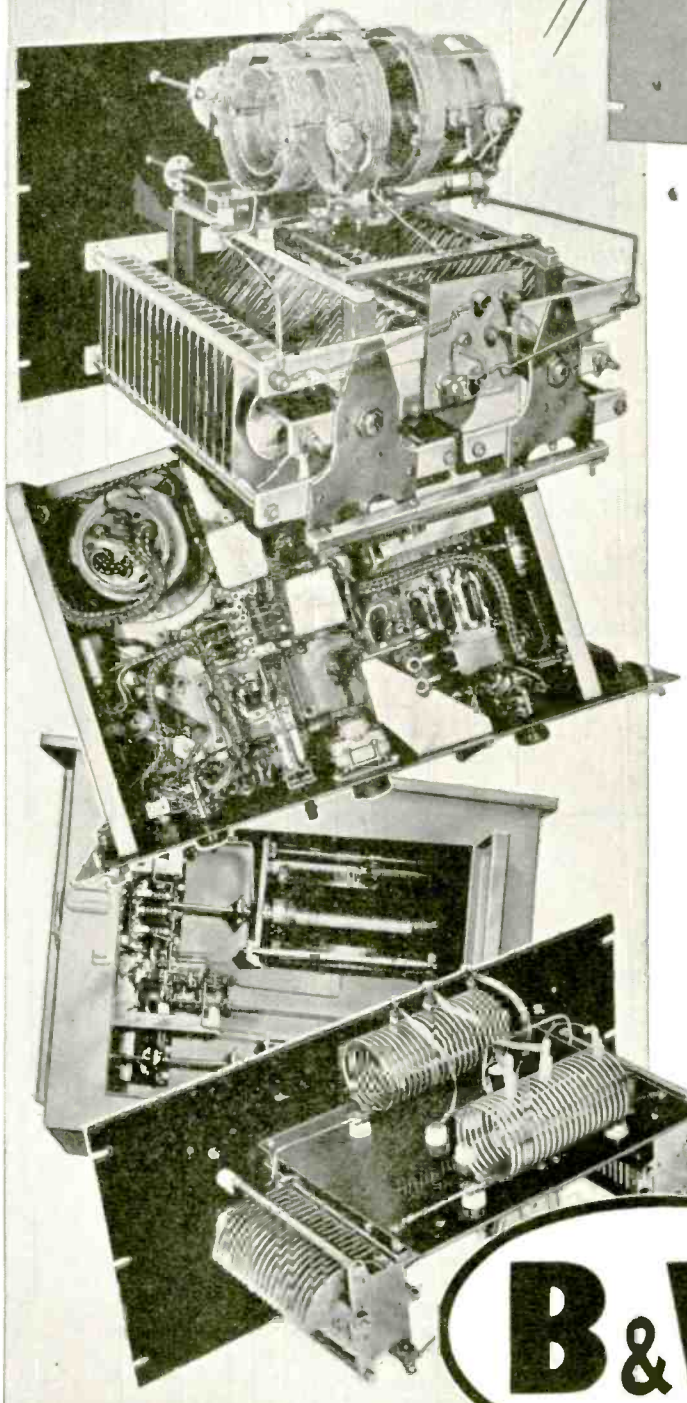
Frequency Converter

A negative transconductance tube oscillator 4, 11, 14, L and C, is made coercible by the insertion of resistor R; the coercing frequency is generated by oscillator 1 which may be connected in either one of the three alternative positions shown. In a negative transconductance tube the plate current decreases when the control grid potential increases, i.e. becomes less negative. Assuming that a positive pulse occurs at closure of the plate supply circuit, a voltage will be developed across resistor R and tuned circuit L, C. This voltage will affect the potential of the control grid across capaci-

(*Continued on page* 242)







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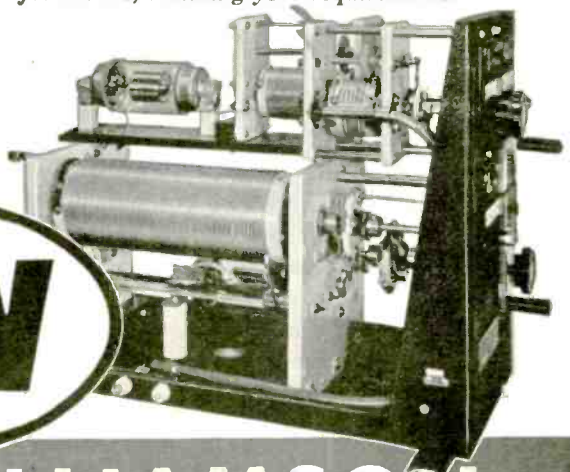

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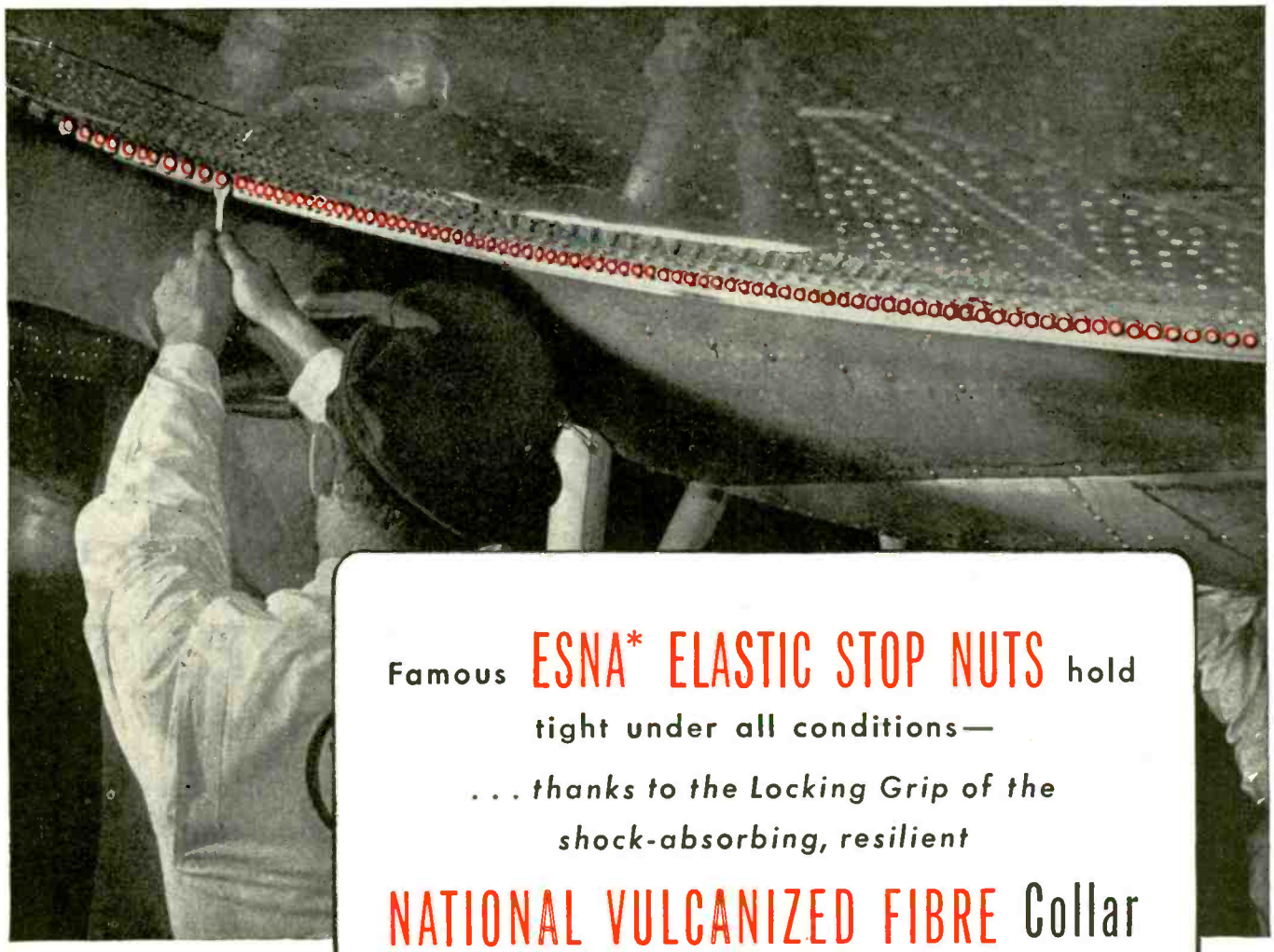

Famous **ESNA* ELASTIC STOP NUTS** hold tight under all conditions—

. . . thanks to the Locking Grip of the shock-absorbing, resilient

NATIONAL VULCANIZED FIBRE Collar

In thousands of applications—in countless industries, can be seen the familiar red collar that marks Elastic Stop Nuts. This well-known red collar is National Vulcanized Fibre, the remarkable material that possesses such an unusual combination of properties. These properties are toughness, great mechanical strength, resilience, light weight, good machinability and forming qualities, high dielectric strength, exceptional durability.

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Send for Free Copy of National Vulcanized Fibre Hand Book. Please write on your company letterhead.

*ESNA is the trade mark of Elastic Stop Nut Corporation of America.

Here's why the ESNA ELASTIC STOP NUT locks fast and stays put even under shock or severe vibration.

This nut and its mating bolt are put together like any ordinary nut and bolt—up to a point. This point is where the bolt meets the unthreaded compression-locking National Vulcanized Fibre Collar.

The bolt then impresses its own thread path into the elastic National Vulcanized Fibre compression collar. In passing through the collar the bolt threads squeeze the locking fibre—the locking fibre collar squeezes back. Thus the compresssed fibre collar, in its confined pocket, grips the bolt threads on both sides—with a grip which never relaxes.

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National Vulcanized Fibre Co.

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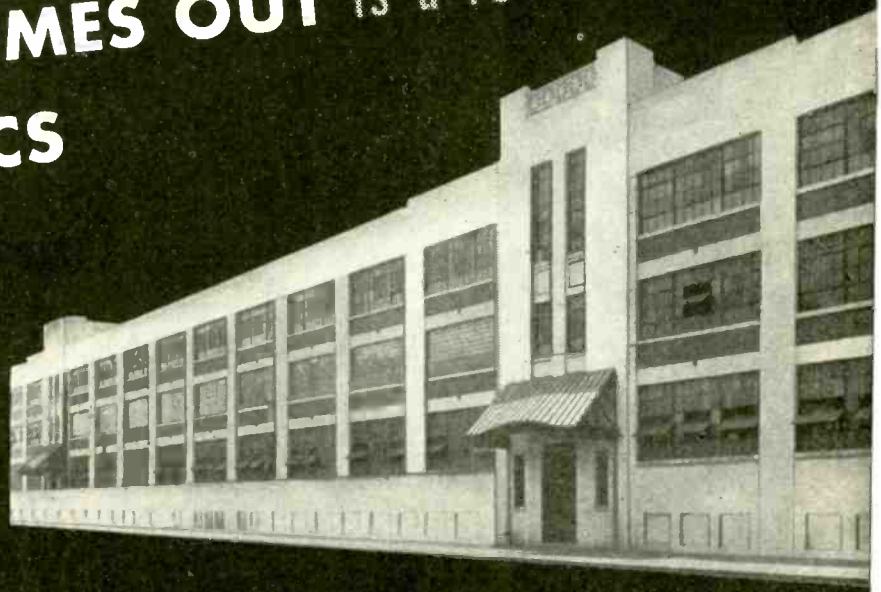
what goes on in, here is a military secret

WHAT COMES OUT is a revelation in ELECTRONICS

at its working best



- LABORATORY
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Housed in this block-long Sherron Electronics building is a busy laboratory in which many valuable discoveries have come to light. Here has been developed the widely used Sherron Test Units that are serving many of America's foremost electronics manufacturers in maintaining the quality control so vital to the integrity of their products. Here, working full time, day and night, a corps of electronics engineers are blazing new trails. Here a hard-working staff of technicians and scientists are evolving new applications of the amazingly versatile tool that is electronics.

Sherron Electronics

We invite correspondence with manufacturers who are thinking in terms of post-war electronics. They will find our specialized experience, resources and skills of real value.

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ELIMINATE { ALL TIME AND LABOR COSTS INVOLVED IN THE USE OF SEPARATE INSULATION SLEEVING

PROVIDE { THE SAME MAXIMUM SERVICE EFFICIENCY GIVEN BY SOLDERLESS TERMINALS WITH SEPARATE SLEEVING

PERFORMANCE DATA

1. For protection against flash-over the insulation of the installed AMP Pre-Insulated Terminal extends not less than 1/32" beyond metal parts in the direction of attached conductor.
2. Heavy pre-insulation .017" thick takes pressure-type terminal installation and assures against abrasion and abuse which may be encountered in stacking, installing, or service.
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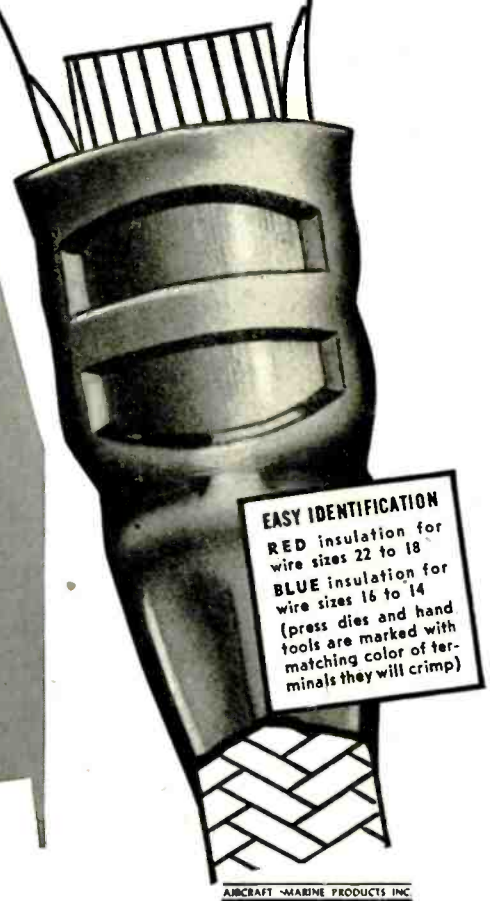
5. Tested in accordance with ASTM Specification #D350-40T, the AMP Pre-Insulated Terminal does not support combustion.

Send for samples and Bulletin 29

THE INSULATION IS BONDED TO THE TERMINAL!

THE TERMINAL IS DELIVERED READY TO CRIMP AND USE!



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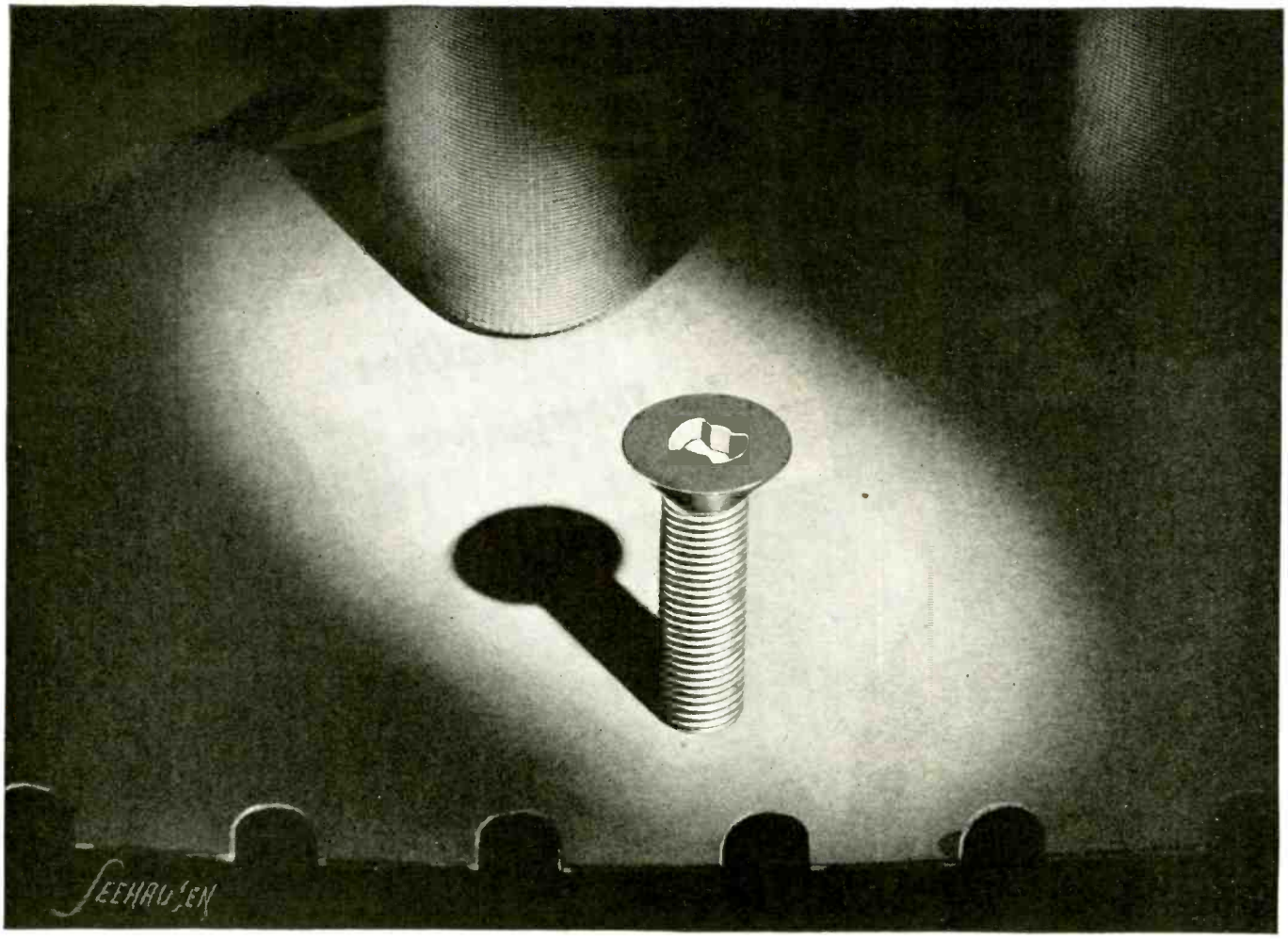

A Star Performer is conceded the center of the stage . . . *only* by virtue of outstanding merit. In the field of fastenings, CLUTCH HEAD is a star performer by any measure of comparison. It gives you every conventional advantage offered by any or all other assembly line screws, *plus several exclusive features that are not matched by any other screw on the market* . . . features that definitely contribute to reduced cost through higher speed, greater safety, and effortless ease in driving. CLUTCH HEAD also simplifies field service problems as no other screw can because the Clutch recess is designed for operation with an ordinary type screwdriver or any flat blade of proper width . . . the only modern screw engineered for Screwdriver Control.

Make your own test of CLUTCH HEAD'S *seven major features. You may do so by asking us to send you BY MAIL assortment of* CLUTCH HEAD *Screws, sample of the Type "A" Bit, and illustrated Brochure.*

CLUTCH HEAD Machine Screws are available in regular and thread-forming types...production backed by this organization and by responsible Licensees.

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This Type "A" Bit requires only a 60-second application of the end surface to a grinding wheel for full reconditioning to its original high efficiency.

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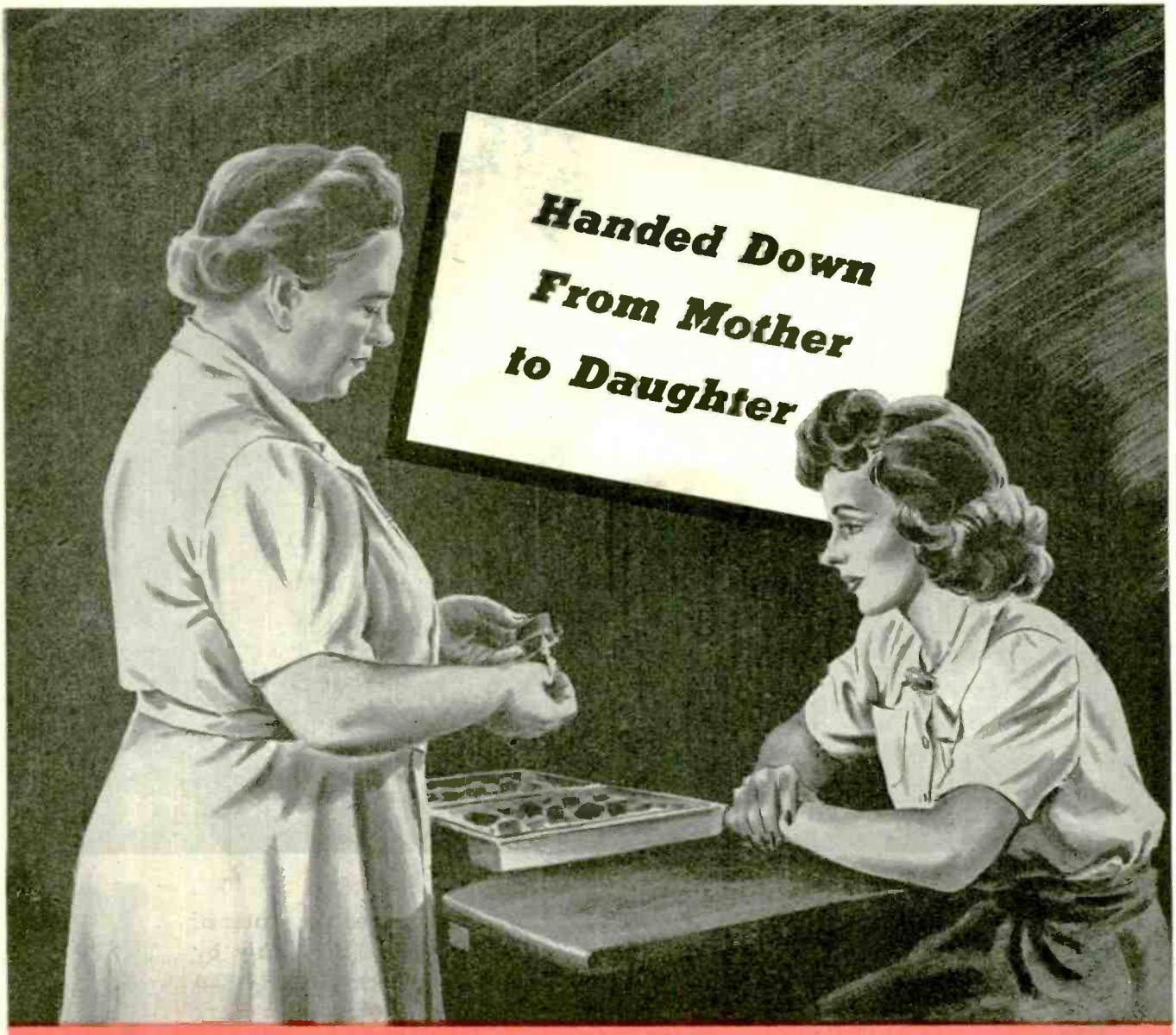
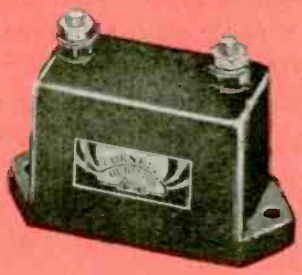


The train of events leading to Victory is speeding right into Tokyo and Berlin . . . and many of the deciding factors may be traced back to the service of skilled hands on the home front.

Here at Cornell-Dubilier skills handed down from mother to daughter as well as from father to son have helped to bring Victory nearer. Some of our workers have been with C-D almost as long as modern capacitors have been in existence. Others are proud — as we are — of their five, ten and twenty years with C-D.

C-D's expanded production facilities and expert workmanship are at your service. Write us for further information. Cornell-Dubilier Electric Corp., South Plainfield, N. J.



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As you look through the ads in this magazine...

FIND THE GLASS PARTS NOT MADE AT CORNING

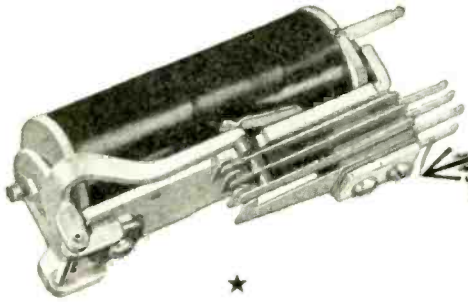
IT'S really not much of a gamble on our part. The truth is that most of the electronic glass equipment built today comes from Corning Glass Works.

Bulbs, flares, insulators, transformer bushings, tubing, resistor tubes, coil forms, are just a few of the hundreds of electronic glassware products produced under our Army-Navy "E" flag. Here you will find glasses with high electrical insulating qualities; glasses with an expansion coefficient practically equal to that of fused quartz; glasses extremely resistant to mechanical shock; glasses that can now be made into intricate shapes formerly considered impossible. And behind them all, 75 years of pioneering in glass research and experience gained in the development of more than 25,000 glass formulae.

We hope this doesn't scare you. All it means is this: If you have a problem you think glass might be helpful in solving, feel free to call on Corning! Everything we know about glass is at your service. Just to get started we'd like to send you a copy of an informative new booklet, "There Will Be More Glass Parts In Post-war Electrical Products." If interested, write Electronic Sales Dept. 1-6 Bulb and Tubing Division, Corning GlassWorks, Corning, New York.

"PYREX" and "CORNING" are registered trade-marks of Corning Glass Works

Why we pull Relay Screws apart



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Vibration, humidity and extremes of temperature can be bitter enemies of relay dependability. That is why the contact springs on Automatic Electric relays are clamped by special screws, which exert the necessary pressure without breaking or stretching. Such screws must meet the exacting tensile tests prescribed by our designers.

These tests, and scores of others like them, are vital contributions to the long life and dependability for which Automatic Electric relays are famed.

When you need relays or other electrical control devices, take advantage of our unique fund of design data and experience. First step is to write for the Automatic Electric catalog. Then, if you need sound technical advice on your problem, call in our field engineer. He will be glad to put his knowledge to work for you.

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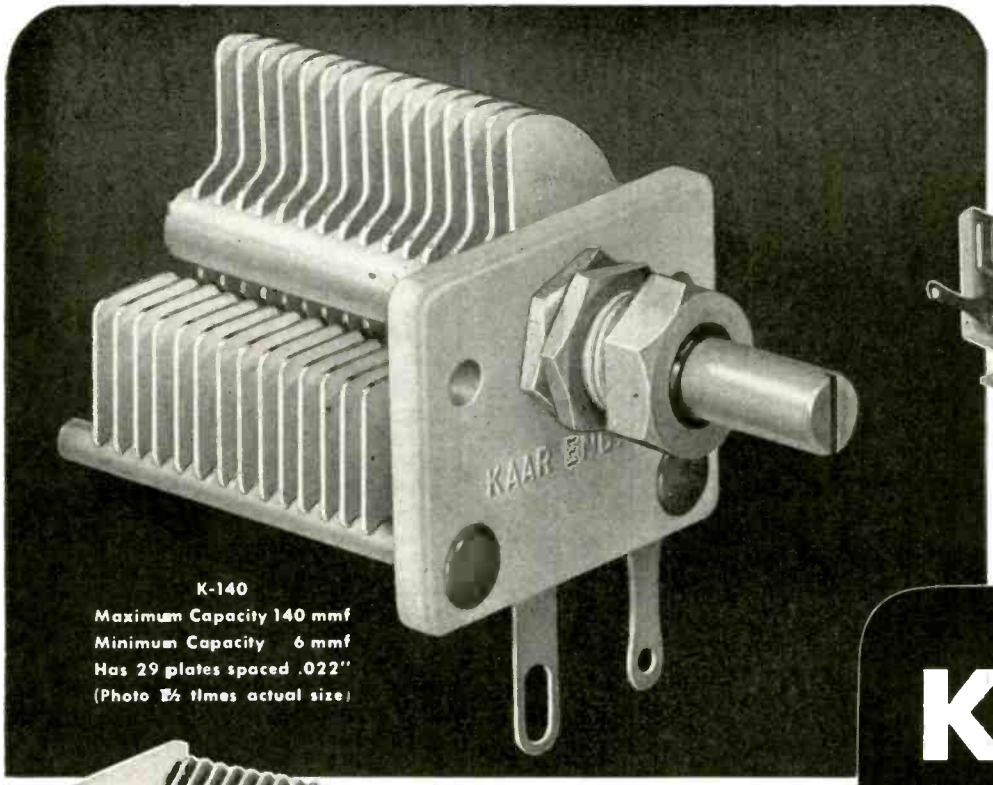
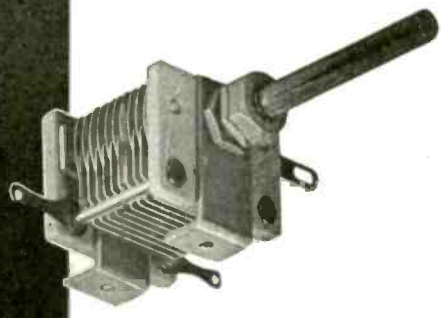
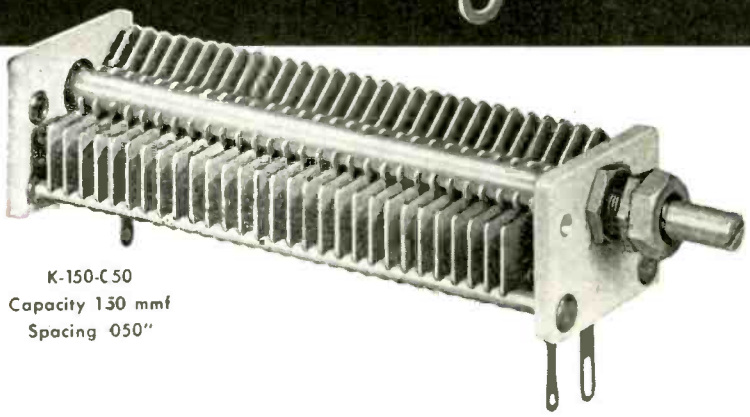


K-140
Maximum Capacity 140 mmf
Minimum Capacity 6 mmf
Has 29 plates spaced .022"
(Photo 1½ times actual size)



K-100-28
Capacity 100 mmf
Spacing .022"



K-150-C50
Capacity 150 mmf
Spacing .050"

KAAR

VARIABLE AIR CONDENSERS

FOR TANK CIRCUIT AND ANTENNA TUNING

Use this reliable West Coast source for Variable Air Condensers

Kaar Engineering Company now offers prompt delivery of standard and special types of variable air condensers suitable for many applications in radio transmitters and receivers. They are particularly useful as tank and antenna tuning capacitors in low and medium power transmitters.

The small cross-section of Kaar condensers allows a number of them to be assembled in multi-channel radio equipment in a minimum amount of space. Every Kaar capacitor is substantially constructed with soldered and plated brass rotor and stator plates. Shafts can be furnished slotted for screwdriver adjustment, and tapered lock nuts and split bushings assure positive locking without disturbing the adjustment.

Special types are available with very wide air gaps, double rotors and stators, high maximum capacities or special mounting brackets. Further information will be gladly furnished upon request.

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Export Agents: **FRAZAR AND HANSEN**
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MOBILE RECEIVERS — Crystal controlled superheterodynes for medium and high frequencies. Easy to service.

CRYSTALS — Low-drift quartz plates. Fundamental and harmonic types available in various holders.

TRANSMITTERS — Mobile, marine, and central station transmitters for medium and high frequencies. Instant heating, quickly serviced.

MICROPHONES — Type 4-C single button carbon. Superb voice quality, high output, moisture-resistant.

POWER PACKS — Heavy duty vibrators and power supplies for transmitters, receivers. 6, 12, 32 volts DC.

Induction Radio

A military application of induction radio technic was described by W. S. Halstead in a recent address before the International Municipal Signal Association. In this instance, induction radio was employed in providing radio coverage of all portions of Camp Lee, Va. The camp, which is operated by the Quartermaster Corps, U. S. Army, is one of the largest in the United States, and extends for approximately eight square miles.

The problem at Camp Lee was to provide the equivalent of a localized broadcasting service throughout the entire camp area, without radiation of effective signals beyond the confines of the area. The initial problem was complicated by the fact that the proposed service involved the use of standard broadcast receivers already in the hands of enlisted personnel and located in a large majority of barracks and office buildings throughout the camp area. This required that the service operate at normal broadcasting frequencies without causing sufficient radiation of wave energy to enable reception of military information in civilian homes at points outside of the camp area.

Through the use of induction radio technics, engineers of the Halstead Corp. were able to solve this communications problem. Carrier signals at a low radio frequency in the neighborhood of 100 kc were inductively impressed on electric power and telephone circuits extending throughout the entire area. These primary signals, transmitted from a central control point, followed the wire circuits to all portions of the camp area, with negligible radiation of wave energy.

At strategic points in different portions of the camp area, the primary signals were retransmitted over wire circuits by means of automatic, unattended, repeater equipment. Each repeater served a specific zone, retransmission being accomplished on a locally-unutilized frequency in the standard broadcast band.

Through regulation of the amount of radio frequency power impressed on the wire circuits by the local zone transmitters, a strong signal could be received within all buildings of each zone, without radiation of wave energy beyond the service area. Signal strength as received in various buildings of the area in most cases was greater than that provided by a standard 50-kilowatt broadcasting station located at a distance of approximately 20 airline miles from the camp.

By the use of frequency modulation in the 100 kilocycle primary distribution system, operation of the induction radio network was

Extraordinary

RECOGNITION

The United States Navy has created a special award of merit. This certificate of achievement was presented to the Radar-Radio Industries of Chicago in a colorful ceremony at Wrigley Field on Sunday, September 10th, for their extraordinary contribution to the successful prosecution of the war. The Galvin Mfg. Corporation, manufacturers of Motorola F-M radio for home and car, is proud of its membership in the Radar-Radio Industries of Chicago . . . and also proud of the part it has been privileged to play in the winning of this signal honor.

Since considerably before Pearl Harbor, Motorola has designed, built and delivered military radio communications in great quantity among which are the famous "Handie Talkie" (an exclusive Motorola Radio First) and the equally celebrated F-M "Walkie Talkie." When victory has been won Motorola's greatly expanded production facilities will be available for the immediate production of Home and Car Radio, Portables and Automatic Phonographs.

BUY ANOTHER WAR BOND TODAY!

GALVIN MANUFACTURING CORPORATION, CHICAGO 51

Motorola Radio

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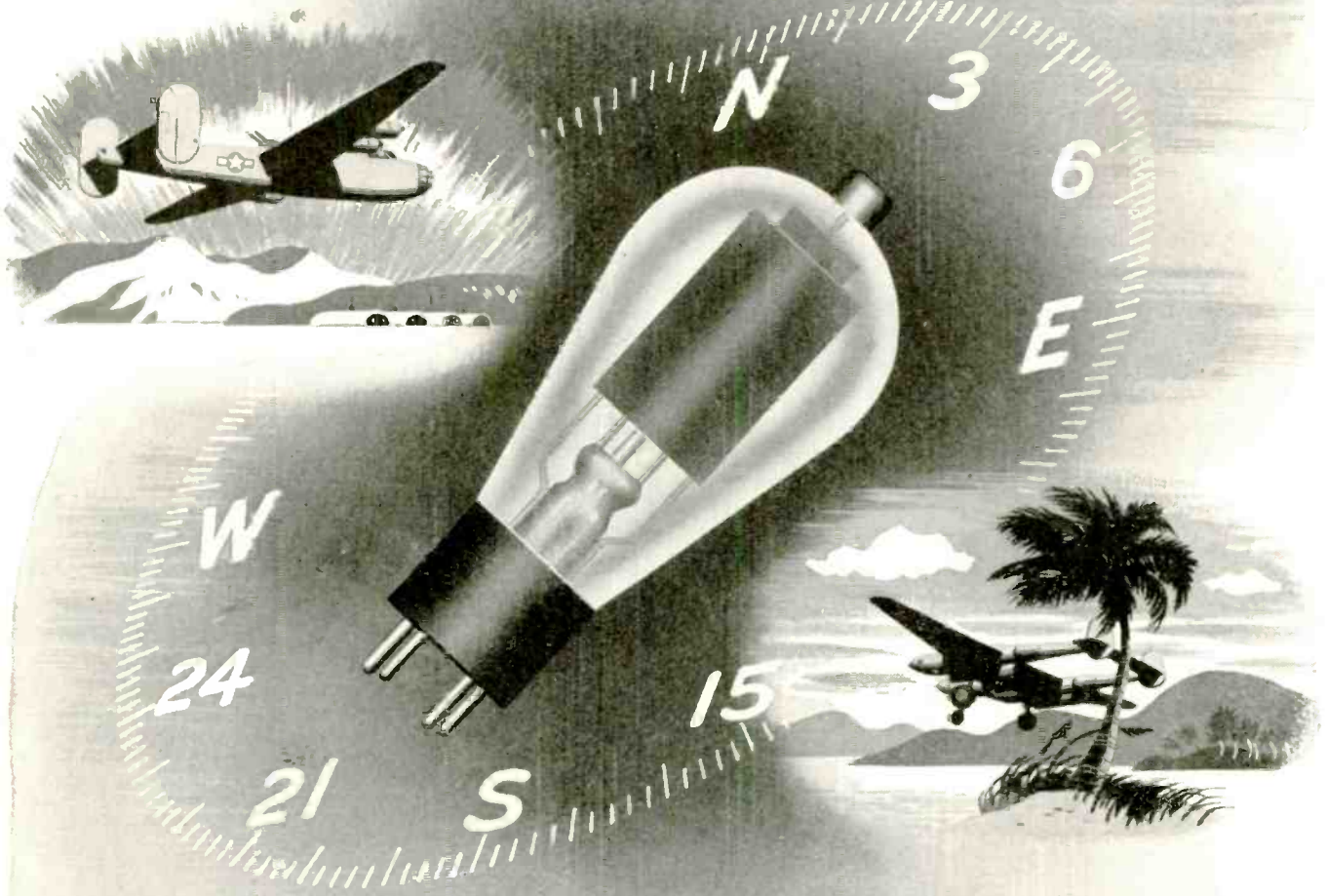
Delco Radio products have worldwide use



In every theater of war, Delco radio and electronic equipment is helping to coordinate the movement of Allied ranks, aircraft, ships, mobile artillery and field units. Besides these military applications, millions of Delco auto radios are in use both at home and abroad. Whatever the requirement and wherever they serve, Delco Radio products are respected as an effective combination of engineering vision, manufacturing precision. Delco Radio Division, General Motors Corporation, Kokomo, Indiana.

Put Your Dollars in Action—BUY MORE WAR BONDS

Delco Radio
DIVISION OF
GENERAL MOTORS

relatively noise-free. In tests at Camp Lee during the height of the summer static season, musical programs and announcements have been transmitted from the central studio throughout the camp area during heavy thunderstorms, with little interference from static except during occasional bursts of lightning.

ASME Section Resumes

The Metropolitan Section of the American Society of Mechanical Engineers resumed its program of meetings, papers and lectures after the summer recess with a series which began October 17. These technical meetings cover a wide range of subjects such as electronics, postwar managerial problems, safety in machine design, filters, marketing, electric air cleaners, gas for space heating, materials handling, plant engineering and improvements in the paper industry.

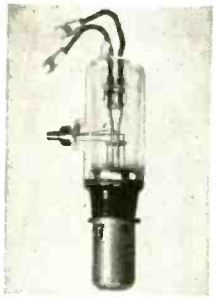
Men prominent in their various fields participate in the program. Among the subjects are: "Electronics in Industry," by Carl P. Bernhardt, of the Westinghouse Electric and Mfg. Co.; "Methods of Analysis for Management—Postwar Problems," by Andries J. Verkozen of the Verkozen Engineers; "Machine Design for Safe Production," by Dan L. Royer, Chief Engineer,

Rare metals are of increasing importance in radio transmitting tubes, and the simple operation above is proof of Machlett's ability to handle them. Here beryllium is being rolled into sheets from 0.004 to 0.020 inch thick, sheets that are vacuum-tight, and have adequate ductility at high temperatures.

Formerly it was believed to be impossible to make beryllium malleable, but Machlett decided to produce it in this form, because it then could be used as part of the envelope in an X-ray tube. This would result in new tubes of superior utility in certain important applications, particularly X-ray diffraction, one vital use of which is in determining the axes of quartz crystals for radio frequency control; also there are manifold uses in metallography.

So Machlett did the impossible — beryllium was made malleable. Details are given in a scientific paper, copies of which are available.

Such an achievement is typical of the Machlett determination to overcome obstacles to the production of the most effective and desirable types of vacuum tubes, whether they be r-f oscillators for communications or induction heating, or X-ray tubes for industrial, scientific, medical or dental uses. The type of skill that produces "impossible" malleable beryllium is reflected in the construction of the Machlett ML-893 illustrated here . . . Machlett Laboratories, Inc., Springdale, Connecticut.



ML-846—An U. H. F. transmitting tube for television and F. M. and short wave broadcasting.

MACHLETT

X RAY TUBES SINCE 1898

TODAY THEIR LARGEST MAKER

a 4th CITATION

for continuing leadership in war instrument production

This succession of citations and stars awarded to WESTON is recognition of WESTONS unremitting war effort . . . and their record in supplying instruments to the *exacting standards* essential for the most vital assignments of our armed forces.

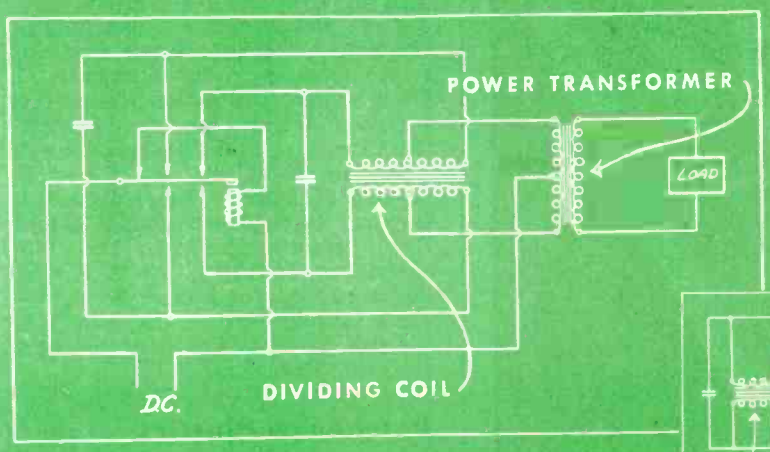
That WESTON has been *first* in this highly specialized instrument field to receive each of these successive honors is the inevitable consequence of a *leadership* acknowledged throughout the years by governments and industry alike. Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark 5, New Jersey.

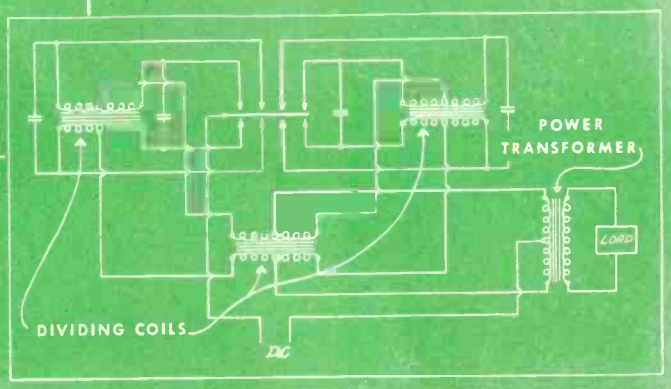
Weston

FOR OVER 56 YEARS LEADERS IN ELECTRICAL MEASURING INSTRUMENTS

NEW VIBRATOR CIRCUIT BY ELECTRONIC

Triples POWER SUPPLY *Capacity!*





Typical E-L Circuits Which Divide Current Equally Between Multiple Vibrator Contacts

Electrical Current Division Circuit Between Contacts

A tremendous increase in wattage output is one of the striking advances made by Electronic Laboratories in Vibrator Power Supplies in the last few years. Now, 1,000 watts output capacity is easily attainable for Heavy-Duty use while still maintaining all the inherent advantages of vibrator power supply.

The *crux of the problem* was the development and perfection of a *current dividing circuit* which *actually distributes the current equally* between the vibrator contacts. This was necessary because the wattage output of vibrator power supplies depends on the volt-ampere capacity of their vibrators. This in turn is determined by the ability of the electrical contacts which make and break the current at each cycle to resist disintegration. E-L engineers found that *multiple and enlarged contacts operating in parallel were not enough.* The contacts could not be adjusted with sufficient precision to assure striking at the same instant. Therefore, the first contact which closed received the full burden of the electrical load which caused pitting and burning.

Equal division was finally accomplished with a special *electrical current dividing circuit* which incorporates a balancing reactor of small inductance relative to that of the main transformer of the power supply. When properly combined with the buffer network, this reactor effectively forces the *equal division* of the make and break energy in each cycle and at the same time retains the economic advantage of a *single large transformer.*

The current limiting reactor in the typical circuits shown above, *limits by reactance* the current which flows in the leg which has the completed circuit. When the second contact closes, the reactive effects are *cancelled* and the current is limited only by the DC resistance of the reactor. In the tandem type vibrator the division is carried out by first equalizing the current between the pairs of contacts. Then, by additional reactors, the current is equally divided between the individual contacts. This exclusive and patented* E-L development opens many new fields and applications to the benefits and advantages of Vibrator Power Supplies. Consider your needs in the light of this increased capacity.

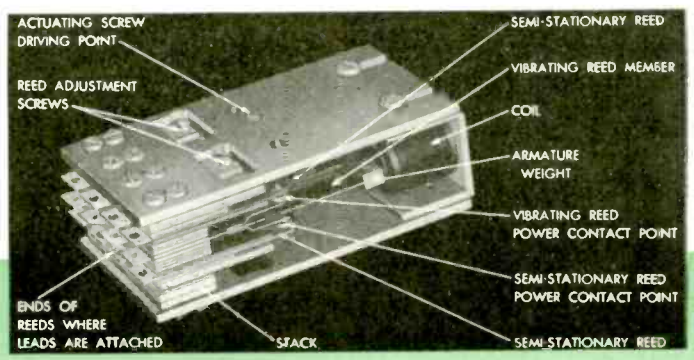
. . .

E-L Vibrator Power Supplies have wide application in many fields: radio, marine, railroad, electronic and electrical. Their high versatility with multiple input and output voltages enables them to meet many power supply needs. They may be designed to provide any wave form needed for specific equipment. Another important and exclusive E-L feature that can be built into your vibrator power supply is constant output voltage, despite wide fluctuations of input voltage . . . economy is assured because of long, efficient service with minimum maintenance. E-L Engineering Service is available to discuss your power supply problem and to design a vibrator power supply to meet specific voltage, power, size and weight requirements.

. . .

(Below: A typical tandem type vibrator, which, used in conjunction with the electric current division circuit (see write-up above) has an input capacity of 1,000 volt-amps. at 110 v. DC.)

*Patent Number 2327577



Electronic LABORATORIES INC. INDIANAPOLIS

VIBRATOR POWER SUPPLIES FOR LIGHTING, COMMUNICATIONS, AND ELECTRIC MOTOR OPERATION • ELECTRIC, ELECTRONIC AND OTHER EQUIPMENT

Ocean Accident & Guarantee Corp.; "Electric Air-Cleaning for Industry," by J. C. Fitz, Precipitron Specialist, Westinghouse Electric and Mfg. Co.; "Manufactured Gas for Space Heating," by Gebhard C. Beck, Gas Utilization Engineer, Brooklyn Union Gas Co.; "Modern Organization and Engineering in Materials Handling," by Oscar E. Johnson, Plant Superintendent, General Cable Corp., Long Island City; "Improvements in the Pulp and Paper Industry," by C. J. Sibler, Supervisor of Power, West Virginia Pulp and Paper Co., and J. E. Warner, Chief Engineer, Robert Gair Co., New York.

Batcher on Plastics

Ralph R. Batcher, Consulting Editor, "Electronic Industries," is to be one of the speakers at the two-day conference to be held by the Society of Plastics Industry at the Waldorf in New York, November 13 and 14. Second afternoon of the gathering is to be devoted to a forum on plastics in industry to be addressed by editors of prominent trade publications. Among them are: F. W. Waggoner (Premium Practice); Arch Knowlton (Electrical World); Julien Elfenbein (House Furnishing Review); R. H. McCready (Playthings); Ralph Batcher (Electronic Industries); C. W. Brown (Modern Packaging).

A COMPLETED POSTWAR PLAN

Based on Mutual Experience

Two kinds of experience went into the formulation of our postwar plan.

1 **Our Customers' Experience** with our wartime services. So far as we can determine, it has been thoroughly satisfactory. Our prewar customers called upon us for stepped-up quality and quantity in communication and electronic specialties for wartime. We met that demand promptly.

Many new customers who, before the war, manufactured all parts of their equipment, placed their problems in our hands. We believe that their experience will point to the continued use of our facilities after Victory.

2 **Our Own Experience** with wartime production has been tremendous. No one can say whether the past three years have been worth six, twelve or twenty years of normal peacetime experience. But the fact is clear that it has helped us develop production "muscles" that enable us to carry greater loads than ever before.

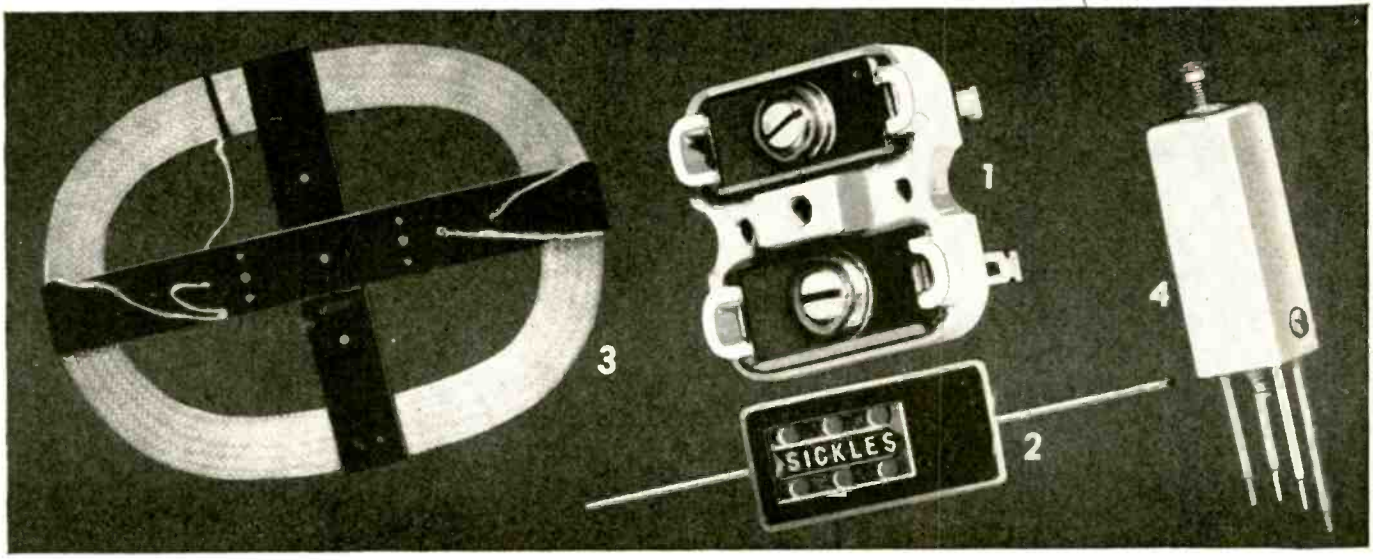
So, based upon our customers' and our own experiences, we have a very simple postwar plan. It is to continue to serve our host of customers with our facilities, skills and experience in producing equipment to meet their specialized needs for performance, quality, quantity and low cost. We are confident that our customers' wartime experiences assure us a sound future.

SOME SICKLES FIRSTS

1. 1933—Dual Mica Trimmers*
2. 1936—Silver Cap Condensers*
3. 1940—Low-loss "Ripple" Loops*
4. 1941—Midget I.F. Assemblies
5. 194V—More Coming

* *Patented*

THE F. W. SICKLES COMPANY • CHICOPEE, MASSACHUSETTS



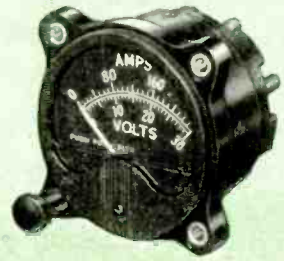
SICKLES

Radio and Electronic Specialties for Today and Tomorrow

New INTERNAL-PIVOT PANEL INSTRUMENTS

2½- inch—1 inch deep

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



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

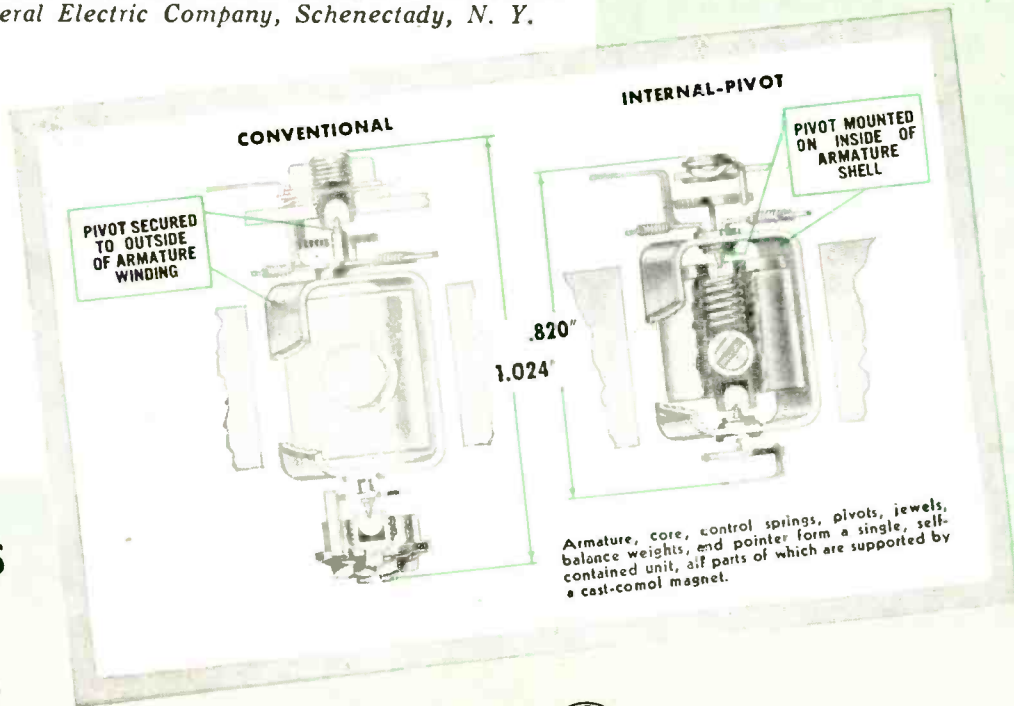
A New Design That Puts More Instrument into *Less* Space

These new, internal-pivot instruments were developed to fill a vital need—particularly in the radio and aircraft fields—the need for compactness. They are *thin*—in most ratings, less than 1 inch deep.

More important is the way their thinness was achieved. In the sketch below, see how the pivots are solidly anchored to the *inside* of the armature shell so they cannot work loose. The moving parts are permanently aligned with stationary parts by bolting the core assembly to a one-piece cast-comol magnet.

Other features are: large-radius pivots, high torque and good damping, lightweight moving element, and ample clearances. Added up, they give you an instrument well able to withstand vibration and hold its rated accuracy, one that is fast on response and easy to read accurately—a design that packs all-round fine performance in a small space.

For ratings, price, and dimensions, ask our nearest office for Bulletin GEA-4064, which covers instruments for radio and other communications equipment; or Bulletin GEA-4117, which describes those suitable for naval aircraft. *General Electric Company, Schenectady, N. Y.*



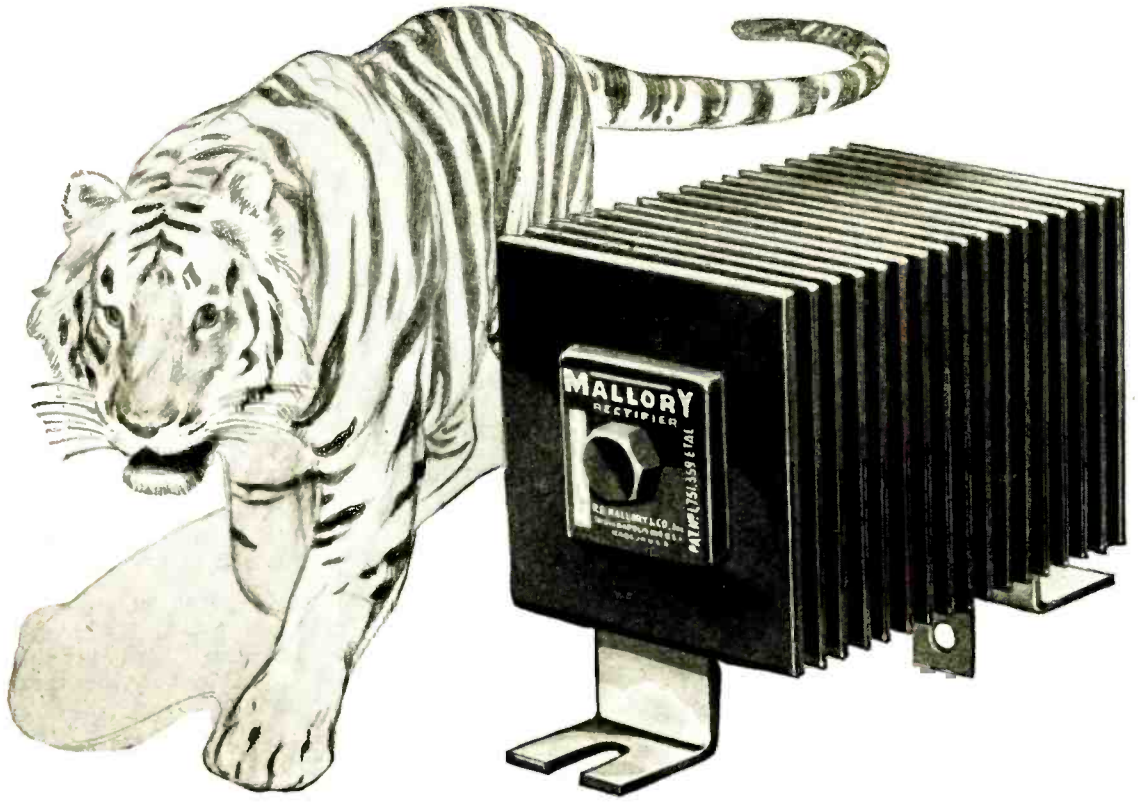
Invest in your future BUY WAR BONDS

HEADQUARTERS FOR ELECTRICAL MEASUREMENT

GENERAL ELECTRIC

802-66-6200

Silent Power At Work



PEOPLE who make radio and other electrical equipment have a lot of good things to say about Mallory magnesium-copper sulphide rectifiers.

Rugged construction, for instance, is a feature they appreciate, because that's important in wartime applications. They find it highly useful that Mallory rectifiers are built to withstand high ambient temperatures as well as extremely low temperatures. And they talk about the absence of liquids, bulbs and sparking contacts, because that means more dependability—less chance of something going wrong.

But most of all, Mallory rectifiers are famous for their silent operation. That's because they have no moving parts . . . nothing to wear out.

For these and other reasons, Mallory rectifiers are in great demand today for battery charging . . . supplying power for magnetic chucks, communications equipment, instrument manufacturing and testing, as a power supply for laboratory work and wherever a dependable source of low potential direct current is required.

Mallory magnesium-copper sulphide rectifiers are adaptable to numerous other applications—some of them of the greatest difficulty. For additional information, see your Mallory distributor or write direct.

Mallory manufactures complete rectifier units for the following: Rectostarters* for the aviation field . . . Automotive and aviation battery chargers . . . Rectopower supplies for low voltage, medium and high current applications.

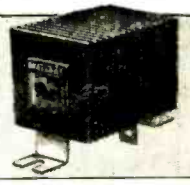
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Buy an Extra War Bond!

*Rectostarter is the registered trade-mark of P. R. Mallory & Co. Inc., for rectifier units for use in starting internal combustion engines.

P.R. MALLORY & CO. Inc
MALLORY

MAGNESIUM COPPER SULPHIDE RECTIFIERS—
STATIONARY AND PORTABLE D. C. POWER SUPPLIES—
BATTERY CHARGERS AND AVIATION RECTOSTARTERS*



Lectures on Electronic Applications in Industry

A series of lectures on "Electronic Applications in Industry" is being conducted during November and December under the auspices of the Electrical and Gas Association of New York, Inc., 480 Lexington Ave., New York 17, N. Y., under the general direction of Ralph Neumuller, executive vice-president. R. B. Oliver is chairman of the educational committee. The complete schedule follows:

November 2, "Electronic Controls" by A. H. Moore, General Electric.

November 9, "Electronic Heating" and "Electronic Regulators" by C. P. Bernhardt, Westinghouse.

November 16, "Sound and Related Equipment in Schools, Churches, Colleges, Ships, etc." by Arthur W. Schneider, Commercial Radio-Sound Corp.; "Sound in Industry" by A. G. Schifino, Stromberg-Carlson Co.

November 30, "Light-Sensitive Relays" by A. H. Moore, General Electric; "Light-Sensitive Regulators" by C. P. Bernhardt, Westinghouse.

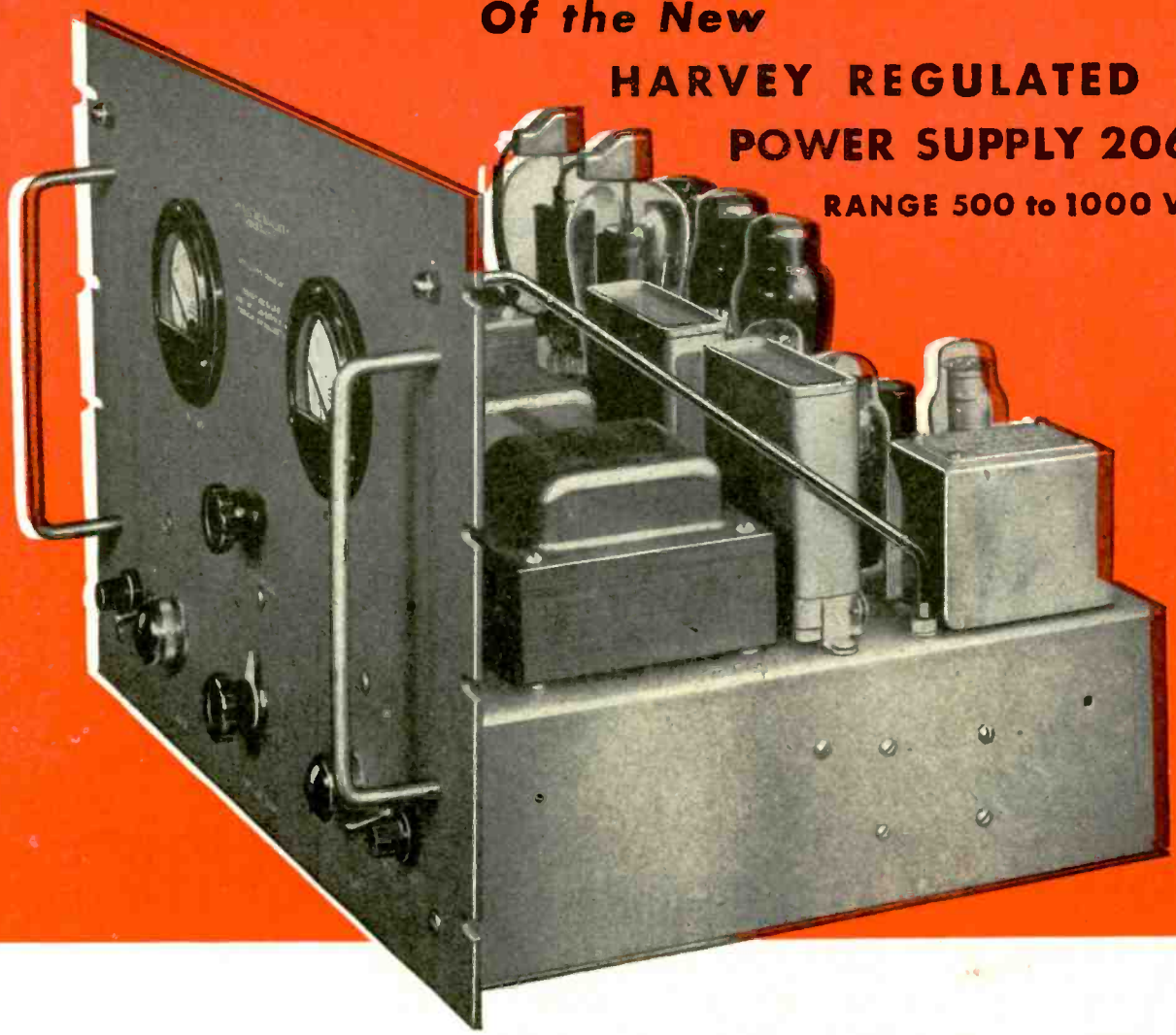
December 7, "Electronic Applications and You!" by Dr. O. H. Caldwell, editor Electronic Industries.

FIRST OFFICIAL PICTURE

Of the New

HARVEY REGULATED POWER SUPPLY 206 PA

RANGE 500 to 1000 VOLTS



Look It Over! You'll see the quality craftsmanship and compact construction of this new HARVEY 206 PA—its sound design, precision assembly and easy accessibility. Notice the gray, crackle-finish panel and the copper plated chassis.

The new Harvey 206 PA is equipped with spare fuses, a generous 6 ft. heavy duty Typex cord, two interlocks for safety, overload and time delay relays — everything to make it a thoroughly dependable, easy-to-operate source of laboratory D. C. power.

Although the picture gives you an indication of why the HARVEY 206 PA operates smoothly and efficiently, it can't show you how this precision instrument operates in two ranges — 500 to 700 volts at ¼ of an ampere; 700 to 1000 volts at .2 of an ampere — with both ranges accurately regulated within one per cent. That's up to the instrument and us. We'd like nothing better than the chance to show you just what this important new development can do. Get in touch with

HARVEY
OF CAMBRIDGE

HARVEY RADIO LABORATORIES, INC.

441 CONCORD AVENUE • CAMBRIDGE 38, MASSACHUSETTS

Craftsmen

ARE AS GOOD AS THEIR TOOLS . . . .

● Up at the Yale and Towne Manufacturing Company in Stamford, Connecticut, craftsmen have been making the well-known "Yale" locks and builders' hardware for many years. The enviable reputation enjoyed by this company is the result of their insistence for fine quality.

Now as a major contributor to the war effort, Yale and Towne are producing hydraulic pistons and cylinders. Constantly endeavoring to improve their already superior quality, they use the Brush Surface Analyzer in both laboratory and shop. With this instrument they are able to study surface finishes, accurately measured to one millionth of an inch (.000001") from chart recordings instantly made as the specimen surface is explored.

THE BRUSH DEVELOPMENT COMPANY

3433 PERKINS AVENUE • CLEVELAND 14, OHIO

WANT 10 OR 20 MILLION... IN 30 OR 60 DAYS?

BTR ¼-Watt, IRC Insulated "Metallized" Resistor L.⅜" – Di. 3/32"

No, it's *not* a dream! It's an actual postwar reality. For that's the kind of production capacity we've developed at the I R C plants for turning out these midget ¼-watt insulated resistors for Uncle Sam. And that's the way we can continue to turn them out . . . for you, immediately we have fulfilled our basic obligation and restrictions are eased to any appreciable extent.

World's Smallest ¼-Watt Resistor

You'll find the same high quality standards present in these tiny trojans that you have long recognized in the popular I R C type BT's. One of the smallest insulated resistors on the market, the BTR will find wide application in all types of postwar electronic equipment requiring low-power resistors. Samples and technical data sent on request.

INTERNATIONAL RESISTANCE CO.

401 NORTH BROAD STREET • PHILADELPHIA 8, PA.

PREFERRED FOR PERFORMANCE • IRC • FIXED & VARIABLE RESISTORS

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

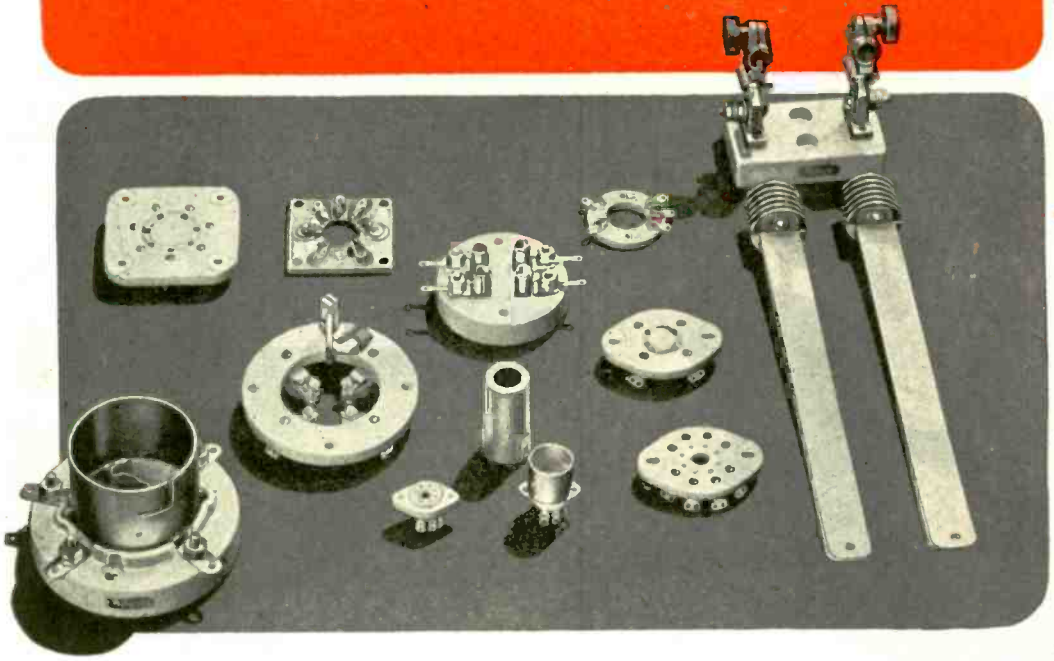
Wood Heads City Signallers

G. E. Wood, City Electrician, Houston, Tex., was elected president of the International Municipal Signal Assn. at its 49th annual meeting in Boston, Oct. 2. Other officers elected were: John J. Alles, Wilkes-Barre, Pa., 1st vice-pres.; Wm. F. Qualls, South Bend, Ind., 2nd vice-pres.; Adin W. Chase, Niagara Falls, N. Y., 3rd vice-pres.; Irvin Shulsinger, New York, N. Y., secretary, and Charles S. Downs, Altoona, Pa., treasurer.

Television Films

Practical demonstrations of films made for television, with detailed explanations of how they differ from other movies, were featured at the October 12 meeting of the American Television Society. A demonstration of rapid newsreel coverage of news events by television consisted of the WRGB film recording of the launching of the SS Missouri. This picture was made at an hour when no broadcast was scheduled, processed in about two hours and had been shown in the Schenectady area at the regular program time.

Sockets
FOR ALL TRANSMITTING TUBES



- ANTENNAS
- CONDENSERS
- TUBE SOCKETS
- PLUGS & JACKS
- INSULATORS
- INDUCTORS
- BROADCAST EQUIPMENT
- CONCENTRIC LINE

Fom the miniatures (such as the IT series or 9000 series) to the big ones (such as 204A, 833 or 889R) Johnson can usually supply the sockets. Most Johnson tube sockets have been designed in cooperation with the tube manufacturers and many of them were actually in production and ready for delivery before the tube was announced. This explains why the Johnson line is the most complete and why Johnson is the only manufacturer producing many of the types.

This confidence, cooperation and assistance on the part of the tube manufacturers explains too, why Johnson's mechanical and electrical design is superior. Both the Army and the Navy have recognized this superiority in Johnson wafer sockets for example, by specifying both the ceramic and the contacts used by Johnson.

Quantity production and economical manufacturing procedures make Johnson the best buy on the socket market — in fact the price is usually less than that of poorly designed imitations.

On that new socket requirement, investigate Johnson.

Write for Catalog 9680

JOHNSON
a famous name in Radio

E. F. JOHNSON CO.
Waseca, Minnesota

MEETING THE HIGHEST INDUSTRIAL STANDARDS

Nationally recognized engineering talent . . . sharpened by intelligent specialization . . . broadened by the exacting tests of war . . . explains, in part, PLASTIC'S amazing progress in the field of thermoplastic insulation. Also responsible are latest equipment, careful materials control, and a personnel whose loyalty and devotion is "above and beyond the call of duty." You can utilize to advantage . . . in today's planning and tomorrow's production . . . this experience and ability. Available for the asking is the "know how" which can make your product a BETTER product. You can DEPEND on PLASTIC for design . . . development . . . delivery.

THERMOPLASTIC SPECIALISTS

PLASTIC WIRE & CABLE CORPORATION

NORWICH · CONNECTICUT

L. W. LORD, Pres. M. H. PHILLIPS, Vice-Pres. and Treas. A. D. BLADE, Plant Manager

ELECTRONIC RESEARCH FOR INDUSTRY

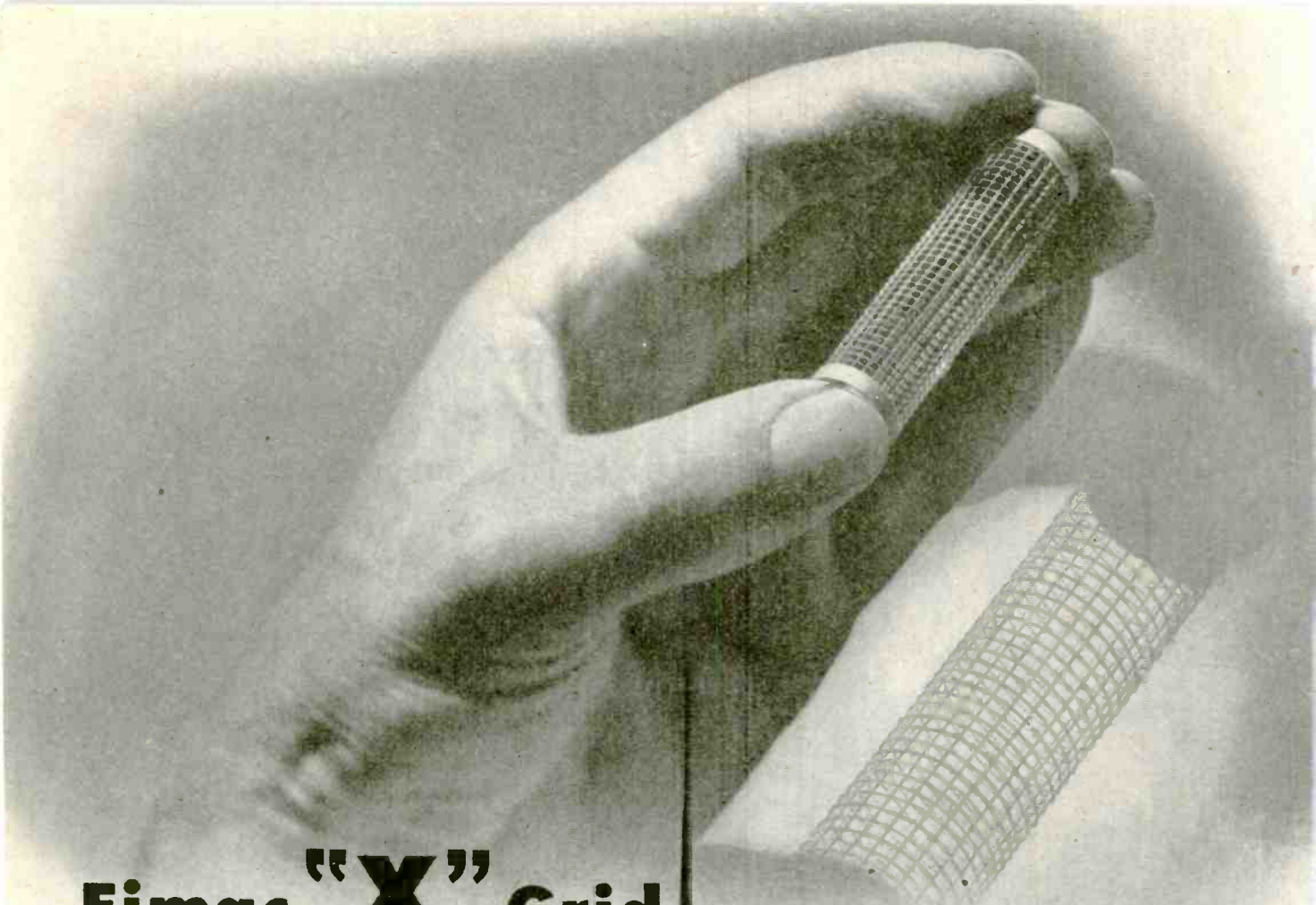
The National Union Laboratories are now available to complete your established engineering facilities

There is no need to postpone your electronic research program, awaiting the day when competent engineers, costly equipment and scarce materials can be obtained. You can start right now and be far ahead by having National Union Laboratories take over this highly specialized part of your work, thus rounding out the development activities of your existing engineering group.

Whether you are interested in a single project or a complete service—we invite you to investigate National Union Electronic Research. Let's talk it over. There is no obligation whatever. Please address inquiries to Department A.

NATIONAL UNION RESEARCH LABORATORIES

National Union Radio Corporation **Newark 2, New Jersey**



Eimac "X" Grid

Solves grid emission problem!

Grid emission, with the resulting instability of operation, parasitic oscillations and prematurely burned out filaments, has become a thing of the past. The new Eimac "X" grid will not emit electrons even when operated at incandescent heat.

The solution to the problem of grid emission lifts a great barrier which has long stood in the path of electron vacuum tube development and the progress of electronics. Eimac Engineers in developing the "X" grid have made a real contribution . . . and a very important one . . . toward the development of new and more efficient vacuum tubes. It is such heads-up Engineering that has made Eimac first choice of leading electronic engineers throughout the world . . . and maintained them in that position year after year.

Follow the leaders to

Eimac REG. U.S. PAT. OFF. **TUBES**

ELECTRONIC TELESIS

The layman's handbook of Electronics will be sent you upon request without cost or obligation.

EITEL-McCULLOUGH, INC., 874 San Mateo Avenue, SAN BRUNO, CALIF.
Plants located at: San Bruno, California and Salt Lake City, Utah

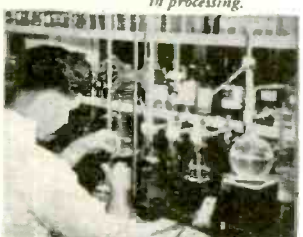
Export Agents: FRAZAR & HANSEN, 301 Clay St., San Francisco 11, Calif., U.S.A.

The Science Behind the Science of Electronics
is the focusing of all branches of science upon the development and improvement of electron vacuum tubes.

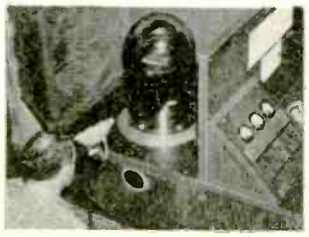
PHYSICS... Especially designed electron microscope enables operator actually to view electron emission.

OPTICS.. Photomicrographic studies help achieve perfection in processing.

POWDER METALLURGY... Compounding special alloys.



CHEMISTRY... Experimentation with metallic components and preparation of chemical compounds.



THERMO-DYNAMICS... Vacuum furnaces heat materials to exceedingly high temperatures.

ELECTRONICS... Determining facts about and recording data on vacuum tube capabilities.

874

RCA

Westinghouse

Doolittle RADIO, INC.

Signal Corps

Federal Telephone and Radio Corporation

SPERRY GYROSCOPE COMPANY, INC.

GENERAL ELECTRIC

CROSLEY

WILCOX ELECTRIC COMPANY

WEBSTER ELECTRIC

RAYTHEON MANUFACTURING COMPANY

Western Electric

THE BEST KNOWN NAMES ON THE WAR PRODUCTION FRONT DEPEND ON THORDARSON QUALITY

Throughout the trying periods encompassed by 3 wars . . . and in all the intervening years of peace since 1895 . . . Thordarson leadership has been accentuated by its association with the most outstanding concerns in America.

Especially on the present world-wide war fronts...where the marvels of research laboratories and the handiwork of production geniuses may be seen in action...there also will be found the results of Thordarson experience and Thordarson engineering ability.

Thordarson Transformers and Amplifiers are "good right hands" to a host of America's leading organizations who are concentrating on winning the war as quickly as possible. Thordarson products are helping to do everything from making communications easier and more accurate to conducting fatigue tests which insure more dependable airplane propellors. All of these services and experiences, now devoted to war, will enable us to serve you better when peacetime needs are again paramount.

ARMY E NAVY

THORDARSON

TRANSFORMER DIVISION
THORDARSON ELECTRIC MFG. CO.
500 WEST HURON STREET, CHICAGO, ILL.

Transformer Specialists Since 1895
. . ORIGINATORS OF TRU-FIDELITY AMPLIFIERS

Nazis Loot Philips Eindhoven Plant

As one of their final looting acts the Germans in the Netherlands shipped to the Reich 36 carloads of machinery and technical equipment which they stripped from the Philips Lamps and Radio Works of Eindhoven, only a few days before that city was liberated by the allied troops. The Philips factories—whose headquarters since the Nazi occupation have been located at Willemstad, Curacao, N.W.I. — are the largest industry in Holland with plants and scientific laboratories occupying 78 acres and employing 20,000 people at the time of the invasion. Before the invasion it also operated a short-wave broadcasting station; listeners throughout the world regularly heard Station PCJ.

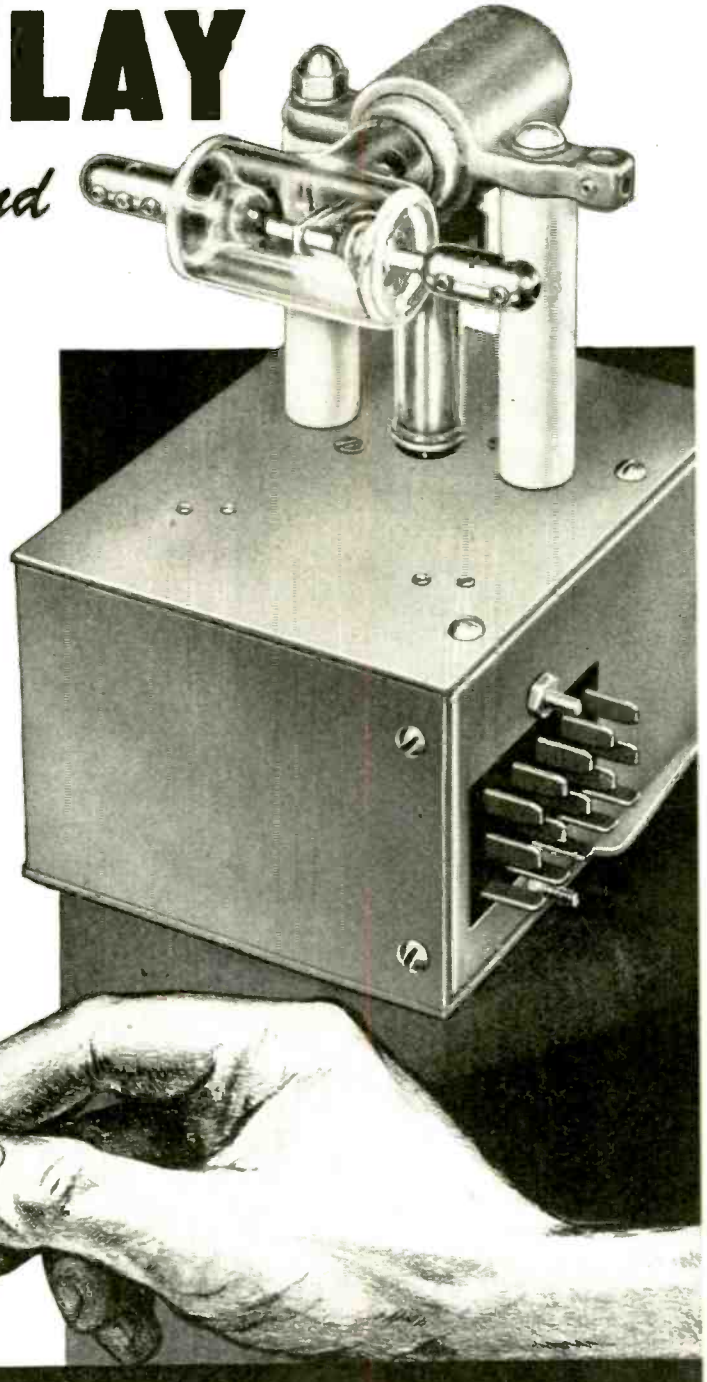
While the Philips organizations and factories outside the occupied motherland worked diligently for the allied cause, the Dutch workers at Eindhoven were forced to produce for the German war machine. On two occasions the plants were severely damaged by R.A.F. bombing attacks; moreover, the laborers committed sabotage in every conceivable form.

Nonetheless, the Germans managed to keep the Philips plant in operation, though from time to time they could not help expressing their "disgust" with the uncoopera-

A New Vacuum Switch

KEYING RELAY

. . . . for Aircraft and Other Applications



Here is convincing proof that a keying relay does not have to be complicated to be efficient. In fact, just the reverse! Actually, the extreme reliability with which Struthers-Dunn Type 78CCA100 Relay holds its adjustments is the direct result of its new simplified and rigid design which utilizes an absolute minimum of parts.

Originally made for aircraft use, it weighs little, is exceptionally sturdy, and has all parts readily accessible. Tests show a minimum life of five million operations.

The Relay has seven poles, including one double-throw pole which handles high-voltage radio frequency currents by means of a vacuum switch. All high-voltage parts are rounded to reduce corona.

Write for complete details, or get in touch with your nearest Struthers-Dunn Field Engineer.

STRUTHERS-DUNN, Inc.
1321 ARCH STREET PHILADELPHIA 7, PA.

ONE OF THE STRUTHERS-DUNN 5,312 RELAY TYPES

DISTRICT ENGINEERING OFFICES: ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND
DALLAS • DENVER • DETROIT • HARTFORD • INDIANAPOLIS • LOS ANGELES • MINNEAPOLIS • MONTREAL
NEW YORK • PITTSBURGH • ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO • WASHINGTON

• • • "Among their Latest Triumphs is an inter-communicating telephone for interior use in buildings, which furnishes in itself, by pressing buttons complete exchange connections, with all parts of the building, and releases the same automatically and comprises the only successful system of its kind of the present age."

The glowing phrases above, written not long after the turn of the century, describe a Connecticut Telephone and Electric "First" which doubtless caused grandpa to wonder, "What won't they think of next!"

The things our engineers are thinking up today in cooperation with U. S. Army engineers are full of interest and promise, but they can't be talked about now. You can count on better communications... in fact, you can confidently expect war-born improvements in all branches of electrical and electronic science.

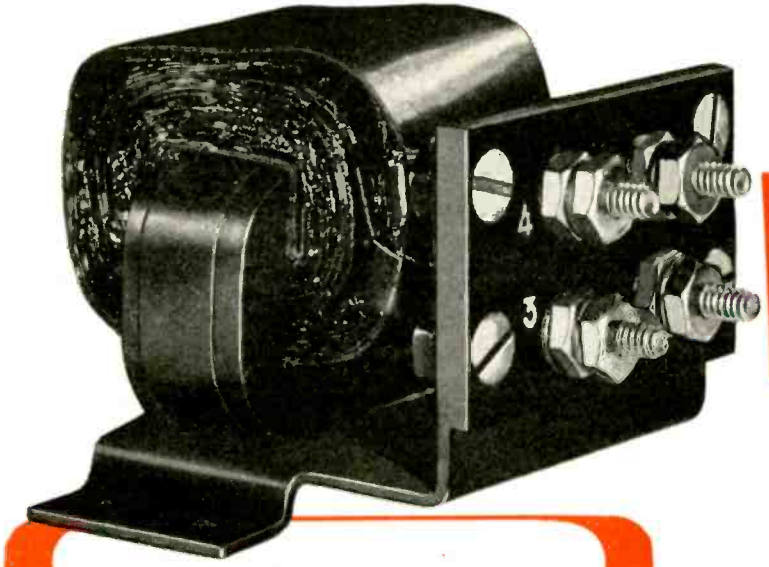
If your product-development plans involve a problem of electrical or electronic engineering and manufacturing, perhaps we can be of assistance. We also invite preliminary inquiries connected with inter-communicating and signalling systems for postwar buildings now in the design stage.

CONNECTICUT TELEPHONE & ELECTRIC DIVISION

GREAT AMERICAN INDUSTRIES, INC.

MERIDEN, CONNECTICUT

TELEPHONIC SYSTEMS • SIGNALLING EQUIPMENT • ELECTRONIC DEVICES • ELECTRICAL EQUIPMENT • HOSPITAL AND SCHOOL COMMUNICATIONS AND SIGNALLING SYSTEMS • IGNITION SYSTEMS



HIPERSIL* CORES

Reduce weight 40%

HIPERSIL CORES COMBINE THESE ADVANTAGES:

- 30% to 50% lighter weight
- 33⅓% more flux-carrying capacity
- Very high, high-density permeability
- High, low-density permeability
- High incremental permeability
- Very low losses in direction of rolling
- Space factor as high as 95%... thin glass films insulate adjacent laminations.

This aircraft transformer is tangible proof of the weight and space savings made by Hipersil Cores.

With them, engineers cut the weight of the transformer to 8 ounces, approximately 40% less than the nearest competitive item of the same output. The unit has a low temperature rise of 30° which permits operation over all ambients from minus 65° to plus 70° C at all altitudes up to 50,000 feet.

Hipersil Cores release engineers from the limitations of ordinary silicon steel. Hipersil affords a wider range of linear response... approximately ⅓ greater straight-line response for winding and core section. Construction is simplified because there are no "tissue-thin" laminations to stack . . . only 2 or 4 pieces to handle. Learn the facts about Hipersil. Write for Booklet B-3223. Address: Westinghouse Electric & Manufacturing Co., P. O. Box 868, Pittsburgh 30, Pa. J-70433

*Registered Trade-Mark Westinghouse Electric & Mfg. Co., for HIgh PERmeability SILicon steel.

Westinghouse HIPERSIL

PLANTS IN 25 CITIES... OFFICES EVERYWHERE

tive attitude of its personnel. Some time ago the Dutch Nazi weekly, "Volk en Vaderland" denounced the entire staff of the Philips factories. It was on the occasion of a collection for the German - instituted Winter Help that the paper wrote: "Even the suffering of the wounded failed to move these people who are simply unable to overcome their anti-Nazi sentiments and their hatred of Germany."

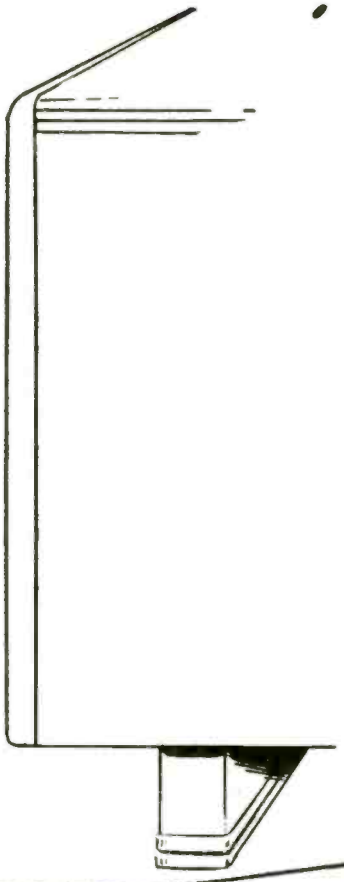
Navy Honors Folsom

The Navy's highest civilian honor was bestowed on Frank M. Folsom, former chief of the Procurement Branch, Office of Procurement and Material, when Secretary James Forrestal presented the Distinguished Civilian Service Award to him for exceptional performance in that capacity from February, 1942, to December, 1943. Mr. Folsom is now a director and vice-president of the Radio Corp. of America, in charge of the RCA Victor Division. In the citation accompanying the award.

"By his unusual ability to organize and administer the Procurement Branch of the Office of Procurement and Material, by his adroit skill, leadership and ingenuity in adapting sound business practices to the Navy's wartime procurement problems, and by his

WE'RE IN IT UP TO OUR NECKS

. . . and We Like It!



Prewar we built Steel Age Office Furniture. With the war, we started to build for the electronics industry such units as transformer housings, shelf assemblies, panels, cabinets and related equipment.

Frankly, this "war baby" has grown up to be part of the family. We like him and we want him to stay.

You for whom we have worked have been kind enough to say we do accurate work at fair prices and with a fine regard for quality. That has been our aim—and will be postwar. Naturally, we're going back to building "Steel-Age" Office Furniture, but along with it we'll build electronic equipment.

Cordially we invite you to send in your specifications.

★ **BUY WAR BONDS** ★

Steel Age

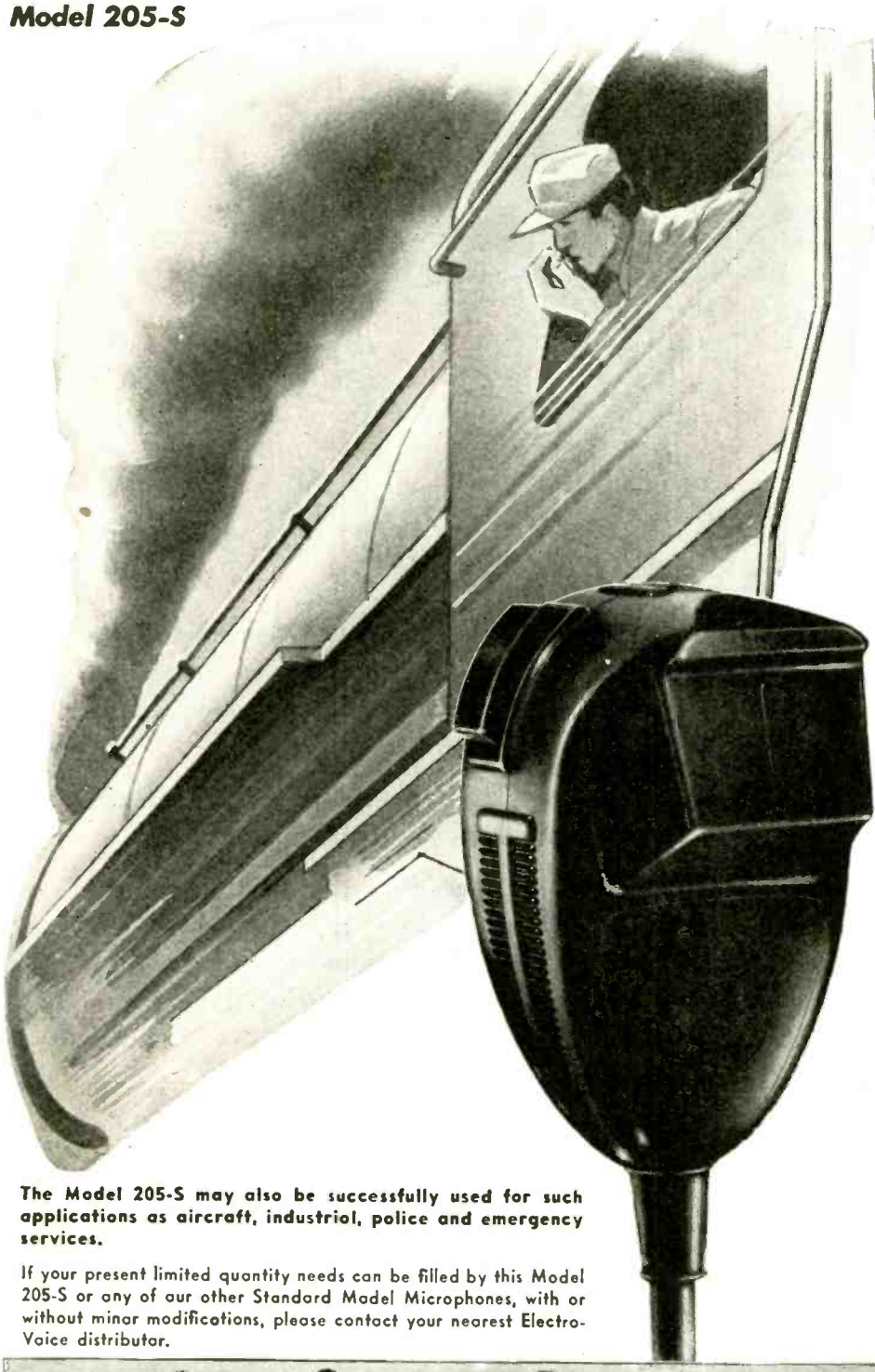
CORRY - JAMESTOWN

MANUFACTURING CORPORATION ★ CORRY, PENNA.

FOR SAFETY'S SAKE!

Electro-Voice Hand-Held Differential Microphone

Model 205-S



The appalling number of railroad accidents in recent months has stimulated the demand for installation of radio communications on railway lines. Eventually, all lines will be thus equipped. Splendidly suited "for safety's sake" is the Electro-Voice Differential Microphone Model 205-S. A noise-cancelling microphone, it enables the transmission of voice clearly and distinctly, unaffected by shrieking whistles or grinding wheels. Ruggedly constructed, it can "take" the punishment of a hard-riding locomotive.

FREQUENCY RESPONSE: substantially flat from 100-4000 c.p.s.

LEVEL: —20 DB (0 DB = 1 volt/dyne/cm²)

ARTICULATION PERCENTAGE: 97% under quiet. 88% under 115 DB ambient noise

TEMPERATURE RANGE: —40° to +185°F

WEIGHT: Less than eight ounces

INPUT REQUIREMENT: standard single button input

BUTTON CURRENT: 10-50 milliamperes

MECHANICAL DETAILS: molded, high impact phenolic housing. Minimum wall thickness, 1/8". Vinylite carbon retainer.

SWITCH: press-to-talk, with or without hold-down lock. Double pole double throw contacts provide an optional wide assortment of switch circuits. Standard circuit provides closing of button circuit and relay simultaneously.

THERMAL NOISE: Less than 1 millivolt with 50 milliamperes through button

IMPACT RESISTANCE: capable of withstanding more than 10,000 drops

POSITIONAL RESPONSE: plus or minus 5 DB of horizontal

CABLE: 5' three conductor, overall synthetic rubber jacketed

BACKGROUND NOISE REDUCTION: 20 DB and higher, depending on distance from noise source

The Model 205-S may also be successfully used for such applications as aircraft, industrial, police and emergency services.

If your present limited quantity needs can be filled by this Model 205-S or any of our other Standard Model Microphones, with or without minor modifications, please contact your nearest Electro-Voice distributor.

Electro-Voice MICROPHONES

ARMY E NAVY

ELECTRO-VOICE CORPORATION • 1239 SOUTH BEND AVENUE • SOUTH BEND 24, INDIANA

Export Division: 13 East 40th Street, New York 16, N. Y., U. S. A. Cables: Arlab

Proving ground for Norelco Cathode Ray Tubes

Reg. U. S. Pat. Off.

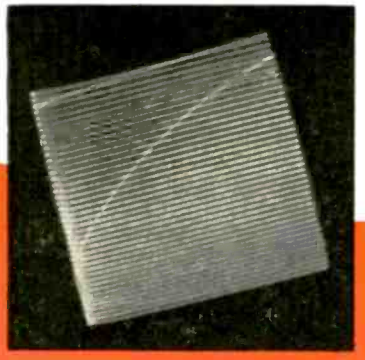
THE uniform characteristics, long life and outstanding performance of NORELCO Cathode Ray Tubes are the result of exceptional manufacturing skill supplemented by rigid tests applied to each tube as it comes off the production line.

As an example of the care exercised, the electronic test set, shown here, subjects every cathode ray tube to 30 different checks, such as line width, light output, plate alignment, base-to-shell alignment, uniformity of cathode surface, astigmatism, presence of gas, and screen condition. A total of 90 exacting tests of raw materials, parts, sub-assemblies, assemblies and performance guard cathode ray tube quality.

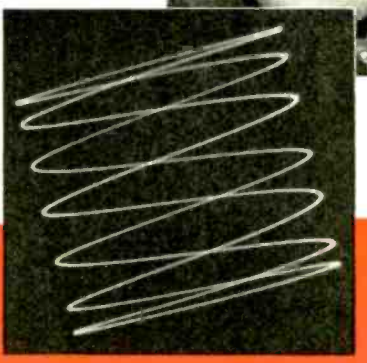
This is typical of the great lengths to which North American Philips goes in producing high performance NORELCO electronic tubes. Behind this company is an organization with world-wide experience resulting from over fifty years of electrical research and development.

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

Uniformly bright spot on screen of 5 CP1 cathode ray tube in test set indicates perfectly formed cathode.

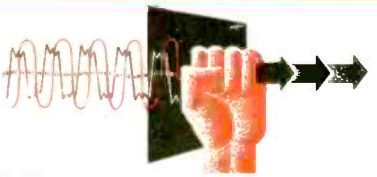


Pattern used for measuring light output by means of photoelectric cell. Frequency—60 x 2940 cycles.



Trace showing absence of astigmatism. Frequency—60 x 420 cycles.

Write today for interesting booklet, describing the background of North American Philips in the science of electronics.



Norelco Reg. U. S. Pat. Off. *Electronic Products by*

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

NORTH AMERICAN PHILIPS COMPANY, INC.

Dept. D-11; 100 East 42nd Street, New York 17, N. Y.
Factories in Dobbs Ferry, N. Y.; Mount Vernon, N. Y. (Metalix Div.); Lewiston, Me. (Elmet Div.)

devoted attention to duty, Mr. Folsom distinguished himself during this extremely critical period of the Navy's greatest expansion."

Home Radio Demand

Pent up demand for home radio sets currently is figured at 41,100,000 sets by Office of Price Administration. The figure is based on 1941 production, choked off since early 1942 by the war.

In another estimate by Arno Huth, international radio investigator of Switzerland's Research Center in Geneva, the requirement for home sets in the U.S. immediately after the war is put at eight to ten million; Europe five million, Latin America two to three million, Asia two million. The figures are from "Radio Today and Tomorrow" which Huth is publishing in Zurich. He suggests:

"The European industry will be unable to cover this demand. English factories will be busy filling home orders; the German industry will be badly wrecked by air raids; and the biggest European exporter, Holland's Philips' works in Eindhoven, must be rebuilt. France and Italy will be out of international competition for some time to come. Hungary's production capacity is a maximum of 50,000 sets annually. Switzerland and Sweden are both producing good-quality sets and might export to world markets."

New RR Radio Test

Six FM transmitters, five of them on locomotives and the other on the site of the world's first scheduled radio broadcast, will link a central dispatcher's office and five Diesel-electric locomotives in two-way communication, on terminal lines of the Westinghouse Electric and Mfg. Co., East Pittsburgh, Pa.

Immediate purpose of the system will be to speed wartime switching operations to and from Westinghouse plants in East Pittsburgh, Trafford and Linhart, Pa., a five square mile area in the industrial Monongahela River Valley. A second purpose is to allow experimentation in the field of railroad radio.

The main station, a 50-watt FM transmitter, will be at the East Pittsburgh Works of Westinghouse, in the same room where radio station KDKA on November 2, 1920, sent out the first officially scheduled broadcast—returns of the Harding-Cox presidential election. The mobile transmitters will put out 40-watts. All six stations will occupy the 10-meter band.

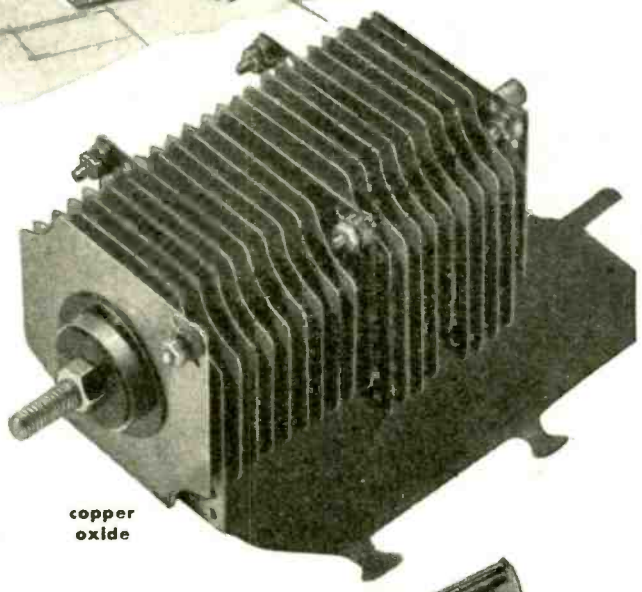
FCC authorization for construction of the unique radio system has been granted, as well as WPB priorities for the necessary equipment.

An Impartial Answer to a Rectifier Question

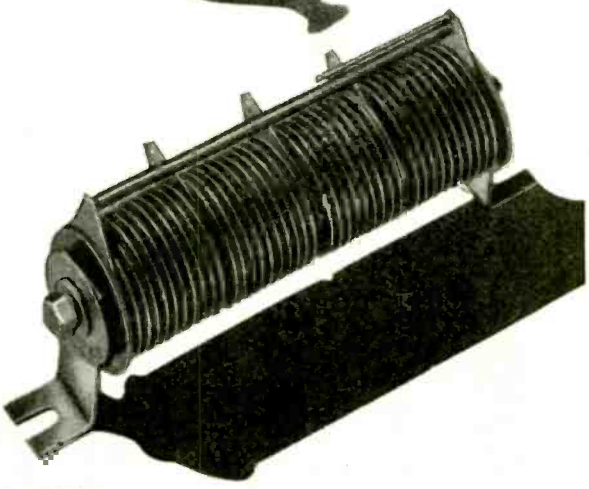
Here are the three types of low-voltage rectifiers most commonly used—copper oxide, selenium and Tungar. They're all good. Which is best? The answer to that question depends entirely upon the application and the conditions under which the rectifying unit must operate.

General Electric alone designs and manufactures all three types. The quality, efficiency and economical performance of G-E rectifying units have long been established. Through years of experience G-E engineers know that only after a careful analysis of the job and the conditions under which the units must operate can the proper rectifiers be selected.

When next you need rectifiers, consult G.E. first. Remember G.E. and only G.E. builds the three types of low-voltage rectifiers commonly used. It will pay you well to get impartial advice from G-E engineers regarding your particular rectifier needs. For more information, write to Section A1148-124, Appliance and Merchandise Department, General Electric Company, Bridgeport, Connecticut.



copper oxide



selenium

Tungar

BUY WAR BONDS AND KEEP THEM

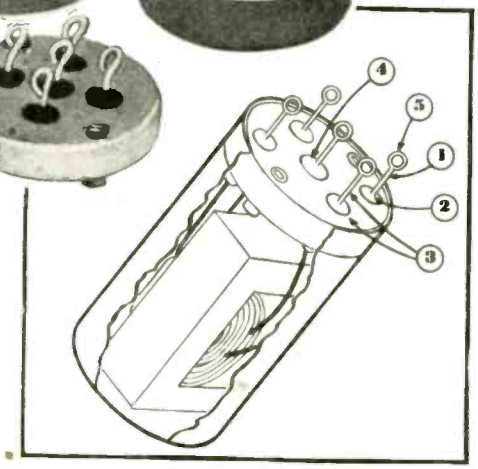
Hear the General Electric radio programs: "The G-E All Girl Orchestra" Sunday 10 P.M. EWT, NBC. "The World Today" news every weekday 6:45 P.M. EWT, CBS.

GENERAL ELECTRIC

PROVED IN SERVICE

FOSTER TRANSFORMERS

MEET EVERY NEW NEED WITH THE SAME DEPENDABLE PERFORMANCE THAT HAS MADE THEM *"FIRST"* IN ELECTRONIC REQUIREMENTS.



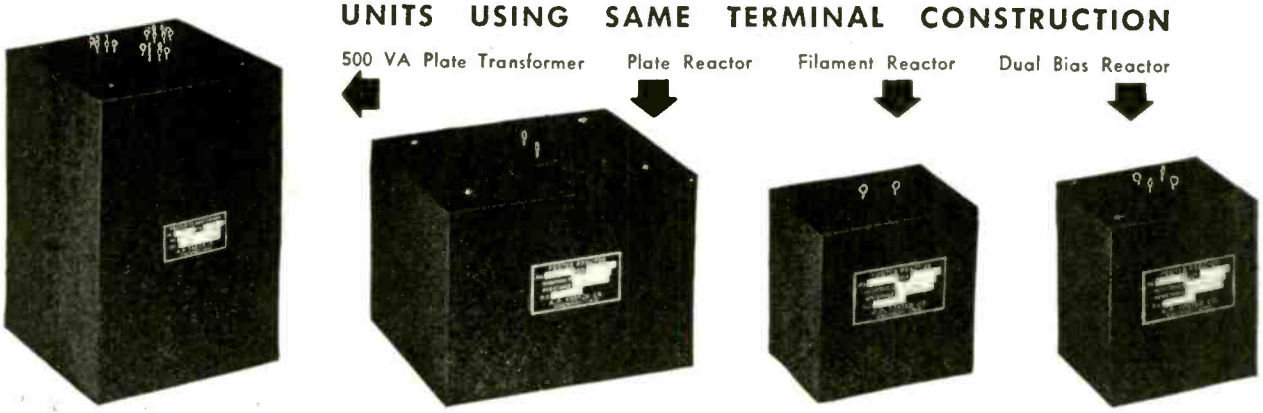
FOSTER IS FIRST AGAIN WITH THEIR NEW "VITROSEAL" TERMINAL

a development that has definite advantages over other types of hermetic seals for tropical use.

1. The electrode can be bent at an angle 90° from the upright position without breaking the glass in the seal. In fact, it can be bent and straightened several times and then the terminal will break *before* the glass is damaged.
2. Extremely high resistance to thermal shock.
3. The metallic parts are cold rolled steel, rather than expensive alloys.
4. The terminals are fused directly into the metal in multiple. Ordinary seals are made up individually and are soldered into holes in the transformer case.
5. A loop is provided for easy hook-up.

UNITS USING SAME TERMINAL CONSTRUCTION

500 VA Plate Transformer | Plate Reactor | Filament Reactor | Dual Bias Reactor



SPECIALISTS IN BUILDING TRANSFORMERS SINCE 1938

A. P. FOSTER COMPANY

TRANSFORMER ENGINEERS & MANUFACTURERS

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Unique research, engineering, tool design and production skills combine, not only to build control devices that fulfill the most exacting requirements, but also to build special purpose devices for which no specifications exist. Our list of customers, the most exacting in government, aviation and manufacturing, attest to these skills.

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Control Devices

EAD

EASTERN AIR DEVICES, INC.

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An Affiliate of THE FRED GOAT CO., INC., Est. 1893

J 80 A

AXIAL FLOW BLOWER

AIR DELIVERY (FREE AIR)

170 C.F.M. (NEMA CODE)

65 C.F.M. (NAFM CODE)

60 cycles • 115 volts • single phase capacitor run • 3100 R.P.M. • 12 watts input • 1 oz. in. starting torque • 1 mfd. condenser required • Weight 16½ oz. Overall length 3 1/16" • Motor diameter 1¾" • Fan: 4 blade propeller type, 4" diameter.

We invite inquiry!

Television Studio Lighting

R. E. Farnham, commercial engineer of the General Electric Company, Nela Park, Cleveland, Ohio, addressed members of the Society of Motion Picture Engineers at a New York meeting September 27, appraising available illuminants for studio lighting. Water and air-cooled high pressure mercury vapor lamps of the type used by WRGB, Schenectady, medium and high temperature incandescent sources, and commercial 40 watt fluorescent lamps were the chief sources considered.

Lighting problems

Factors discussed in some detail were the spectral sensitivity of present iconoscopes, reflection of human skin and other surfaces as a function of light wavelength, and spectral distribution of the energy of the available light sources. It was brought out that, by the use of m-v sources only, a white man in a blue serge suit might be delivered to the television audience as a negro in a white suit. Using incandescent illumination alone, an actress with dark red lips and a light yellow dress might appear with white lips and a dark dress. She might appear "wilted," in the bargain, since the high levels of illumination required (on the order of 1000 foot candles, as compared with the movies' 200 or 300) create a monstrous heat problem. Mr. Farnham concluded that the best combination of light sources in the future might be a combination of m-v and tungsten sources, generally ruling fluorescents out, on the grounds that their light output was too low for convenient use in limited spaces.

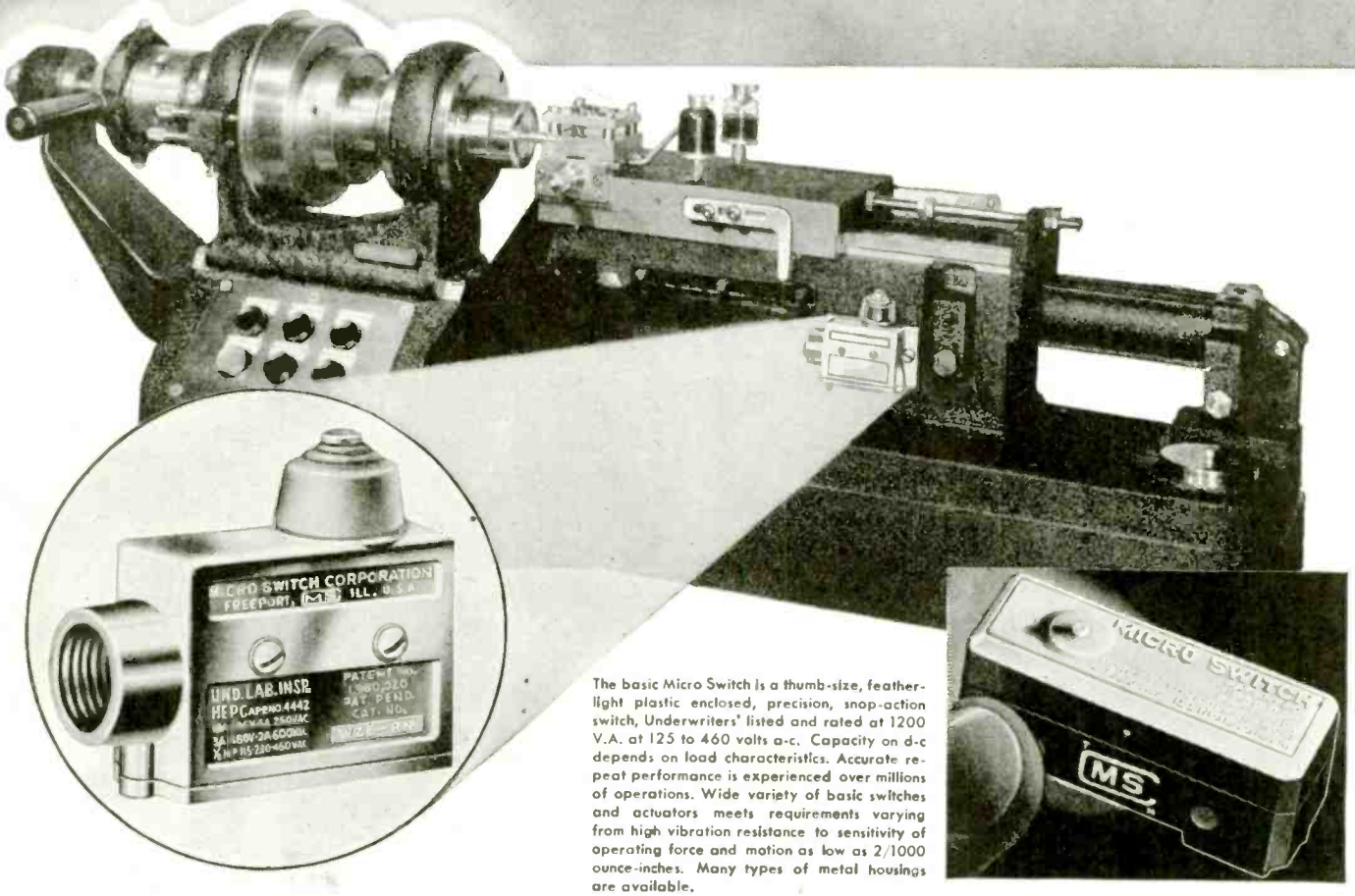
Worthington Minor, CBS Television expert, spoke briefly on television lighting from the studio's standpoint and discussed future plans of WCBW, which will include a thorough trial of the fluorescent-incandescent combination.

TBA Studies Interference

A policy committee, will make recommendations to the Board of Directors for positions which the American Television Society should take on questions pertaining to television. Chairman is past president Norman D. Waters. Dan D. Halpin, president of ATS, and George T. Schupert, chairman of the ATS Membership Committee are the other two committee members. One of the first questions to be explored pertains to the curbing of interference in reception and transmission of television signals by diathermy and other electrical heating apparatus, ignition systems and other devices which have impaired clarity of television and FM signals in the past.

Die cast enclosed MICRO SWITCHES

CONTROL THE AUTOMATIC CYCLE OF THE GILMAN HYDRAULIC TURNING MACHINE



The basic Micro Switch is a thumb-size, feather-light plastic enclosed, precision, snap-action switch, Underwriters' listed and rated at 1200 V.A. at 125 to 460 volts a-c. Capacity on d-c depends on load characteristics. Accurate repeat performance is experienced over millions of operations. Wide variety of basic switches and actuators meets requirements varying from high vibration resistance to sensitivity of operating force and motion as low as 2/1000 ounce-inches. Many types of metal housings are available.

THE hydraulic turning machine, manufactured by the Gilman Engineering Works of Janesville, Wisconsin, makes use of the long life, dependability, and accuracy of repeat performance of the Micro Switch to control its entire operating cycle automatically.

Actuation of the Micro Switch at the exact point in the movement of the hydraulically driven slide when the Elgin Head has completed a cut swings the slide away from the work. This motion actuates a second Micro Switch which controls automatic return of the slide to its starting position.

The die cast enclosure of the Micro Switch, mounted on the apron of the machine, provides rugged conduit connection, and a synthetic rubber bellows on the operating plunger protects against the entrance of coolant, oil, chips, and dirt throughout the switch life of millions of operations.

The small size of the Micro Switch and a wide selection of easy-to-use actuators and enclosures has fitted it into many special additions to machines already installed, as well as to new designs. The Micro Switch has electrical capacity, at line voltage, to control many classes of single phase motors directly, without intermediate relays or contactors, providing accurate, positive, trouble-free control.

Send for Micro Switch Catalog-Handbook No. 60 for complete details on the wide range of housings, actuators, and electrical characteristics in which Micro Switches are available. If the switch is desired for aircraft use, also ask for Handbook-Catalog No. 70.

Let's All Back the Attack
Buy EXTRA War Bonds!

Micro Switch Corporation, Freeport, Ill.
Branches: 43 E. Ohio St., Chicago (11) • 4900 Euclid Ave., Cleveland (3)
11 Park Pl., New York City (7) • 1709 W. 8th St., Los Angeles (14) • Sales & Engineering Offices: Boston - Hartford

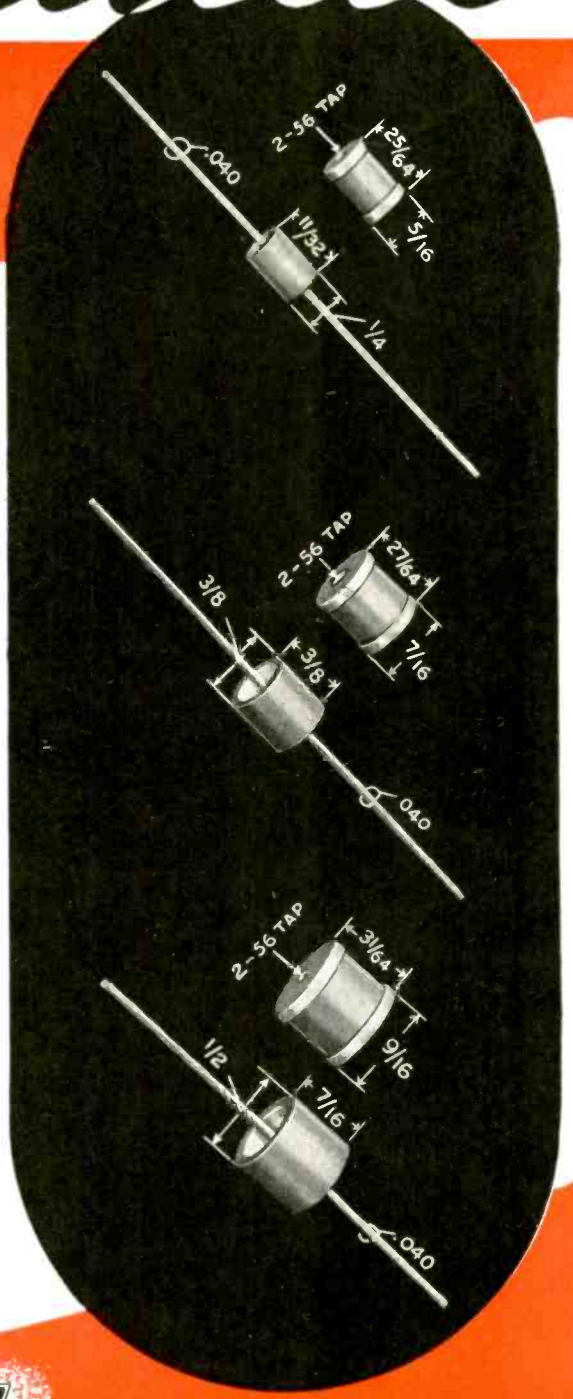
MICRO MS SWITCH

TRADE MARK

MADE ONLY BY MICRO SWITCH CORPORATION, FREEPORT, ILL., U. S. A.

Centralab

CERAMIC CAPACITORS *for* HIGH VOLTAGE



These capacitors are engineered by Centralab for special applications . . . accumulative capacities ranging from 2MMF to 20MMF in zero temperature coefficient . . . to 4MMF to40MMF in maximum negative (N750 PPM) temperature coefficient.

Individually the capacity ranges are as follows:

855	2MMF to 5MMF	in zero T. C.
	4MMF to 10MMF	in N750
854	5MMF to 10MMF	in zero T. C.
	10MMF to 20MMF	in N750
853	10MMF to 20MMF	in zero T. C.
	20MMF to 40MMF	in N750

Working voltages from 8,000 to 10,000 D.C. Energy dissipation up to 2 KVA with 15°C rise.

End lead or axial screw terminals available.

Send for Bulletin No. 814.

ARMY (E) NAVY

Producers of Variable Resistors • Selector Switches • Ceramic Capacitors, Fixed and Variable • Steatite Insulators.

Centralab

CRL

Division of **GLOBE-UNION INC., Milwaukee**

PERSONNEL

David J. Finn has been named manager of the Chicago region for RCA Victor Division of RCA, and **James W. Cocke** has been appointed manager of the Dallas, Atlanta region, with headquarters in Dallas. Prior to his appointment, Mr. Finn was sales manager for the RCA Industrial and Sound Department. Mr. Cocke directed sales activities for RCA in Dallas and Atlanta for many years.

Ray T. Schottenberg, William J. Doyle and **Allen J. Stark** will direct sales for the Astatic Corp., Conneaut and Youngstown, Ohio, during the ensuing year.

Dr. Mervin J. Kelly, director of research of Bell Telephone Laboratories, has been elected executive vice-president of the Laboratories. A scientist of distinction, Dr. Kelly has made substantial contributions to photoelectric cells for sound pictures; to the water-cooled tubes widely used for high power broadcasting, and to the vacuum tubes which make long distance telephony possible. He graduated from the University of Missouri in 1914 and received the Ph.D. from Chicago in 1918. In that year he entered the Laboratories as a research physicist. He became vacuum tube development director in 1930 and director of research in 1936. Dr. Kelly has had charge of Bell Laboratories development in radar and other important fields. He is an advisor to the government on technical war projects; a Fellow of American Institute of Physics, American Institute of Electrical Engineers, Institute of Radio Engineers, Acoustical Society of America, and a member of the Directors of Industrial Research. **Alva B. Clark** and **Dr. Reginald L. Jones** have also been elected vice-presidents of the Laboratories.

Dr. M. J. Kelly who has been made director of research for Bell Telephone Laboratories

MYCALEX

SOLVES ANOTHER TOUGH INSULATION PROBLEM

Bushings for this G-E Temperature-Controlled Crystal Unit had to provide a high degree of electrical and thermal insulation. Yet they not only had to be small, but able to withstand great compressional stress.

Organic materials (phenolic, for example) could not be used for technical reasons. When ceramic and vitreous products were tried, the bushings broke under the strain.

Only G-E mycalex was found to be ideal on every count. In addition to showing small electrical loss and low thermal conductivity, it proved immune to fracture or crushing. In fact, when the bushings were tested for physical limits, G-E mycalex demonstrated no change whatever—even when screws broke off and compressing nuts were stripped of their threads!

G-E mycalex is the answer—often the *only* answer—to difficult electronic insulator requirements. These features explain a few of the reasons:

1. High mechanical and dielectric strength.
2. Low loss at high frequencies.
3. Arc resistance and heat resistance.
4. Easily subjected to drilling, filing, sawing, grinding, polishing.
5. Metal parts can be inserted or anchored during the process of molding.

Yes, General Electric specializes in producing fabricated parts as well as standard sheets, rods, and strips. For a free sample and detailed information about G-E mycalex mail the coupon at the right.

Tune in General Electric's "The World Today" and hear the news from the men who see it happen, every evening except Sunday at 6:45 E.W.T. over CBS. On Sunday evening listen to the G-E "All Girl Orchestra" at 10 E.W.T. over NBC.

GENERAL ELECTRIC

177-M-C11—8915

Over 21 Years of Mycalex Experience —Your Assurance of Quality!

FREE—G-E MYCALEX BULLETIN

Electronics Department
General Electric Co.
Schenectady, N. Y.

Please send me a free sample and my copy of the booklet describing G-E Compression-Molded mycalex.

Name .....

Company .....

Address .....

.....

E. H. McCarthy has been appointed manager of the sales division of Farnsworth Television & Radio Corp. Mr. McCarthy, who has been with the Farnsworth organization since its inception, has, since the company's total conversion to war production in the spring of 1942, been district manager of the field expediting division for New York and the New England states.

Norman J. Foot has been appointed development engineer for the Hallicrafters Co., Chicago. He will have charge of the design of new UHF and VHF equipment as well as models of the company's S-27 high frequency FM-AM receiver.

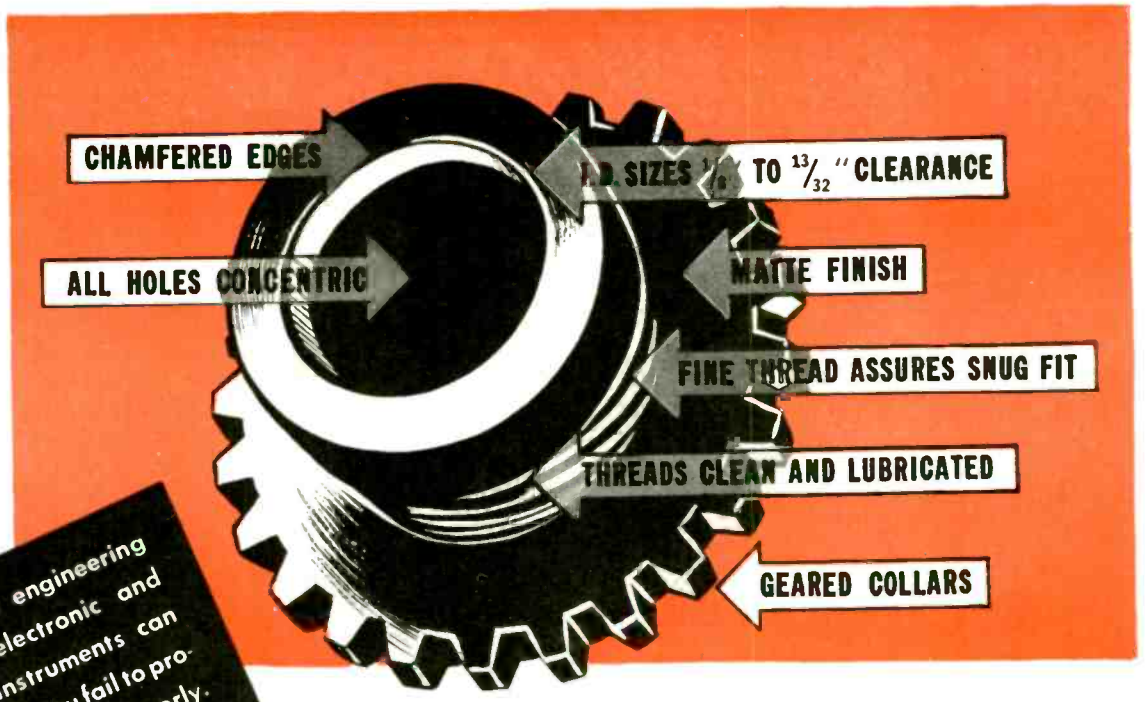
L. A. McNabb has been made vice-president in charge of electronic design and production of the Bell and Howell Co., Chicago. **B. E. Stechbart** is now vice-president in charge of engineering and research.

A. J. Hall has been appointed production and research engineer for the Universal Microphone Co., Inglewood, Calif. He joins Universal after several years of service with the Kellogg Switchboard and Supply Co., Chicago, as engineer in charge of design, research and development laboratories. Previously he had been planning engineer with the Western Electric Co., Chicago, as well as production manager for the Leich Electric Co. in the same city.

Universal's new research engineer, A. J. Hall

DuMont Honored

Middle of last month, Allan B. DuMont was presented with the American Television Society award for outstanding contribution to commercial television at the September meeting of ATS. A year's program, having to do mostly with programming, has been mapped out to start with the Oct. meeting.



All the finest engineering on radio, electronic and electrical instruments can go to waste if you fail to protect your wires properly.

PROTECT YOUR WIRES

with CREATIVE *Insulating* GROMMETS

If you are not already using CREATIVE INSULATING GROMMET BUSHINGS in your chassis, by all means let us furnish you with samples.

When you see the superb protection these 100% phenolic bushings give to your wires, and when you discover that they don't "pop out" when you pack your wires through them snugly, the chances are you will want to specify Creative.

Five standard sizes are available from stock, either from our plant or from the distributors listed at the right.

Send for samples and literature.

CREATIVE'S CUSTOM SERVICE

You don't have to build molds to get Plastic Parts with Inserts such as knobs, terminals, etc. Get the facts about this unusual custom service . . . *Call on CREATIVE.*

Here's News!

Western users can *now* get CREATIVE grommets from stock directly through:

DISTRIBUTORS

Allied Radio Corporation
833 West Jackson Boulevard
Chicago 7, Ill.

Lew Bonn Company
1211 LaSalle
Minneapolis 4, Minn.

Seattle Radio Supply, Inc.
2117 Second Avenue
Seattle 1, Washington

DIRECT FACTORY REPRESENTATIVES

Mr. Bruce Cumming
201 N. Wells Street
Chicago 6, Ill.
Tel. ANDover 5837

Nelson R. Thomas Agency, Inc.
344 East First Street
Los Angeles 12, Cal.
Tel. Michigan 3829

Creative

PLASTICS CORP.

968 KENT AVE, BROOKLYN 5, NEW YORK

Jack and Bill

Jack McCullough and Bill Eitel don't very often get a chance to sit around like this. The plants of Eitel-McCullough, Inc., in San Bruno, Calif., and Salt Lake City keep them both pretty much on the jump

"E" Awards

Cinaudagraph Corp., Stamford, Conn. (star added)

The Simplex Radio & Chicago Divisions, Philco Corp., Philadelphia.

Ward Products Corp., 1523 E. 45th St., Cleveland, Ohio

Dr. Skellett Heads National Union Research

Dr. A. M. Skellett formerly of Bell Telephone Laboratories has been appointed chief engineer in charge of research for National Union Radio Corp. Widely known in scientific circles, Dr. Skellett has made many contributions to the advancement of electronics during his years of service with Bell Telephone Laboratories. As a writer he has published twenty-five scientific papers in Proceedings of the National Academy of Science, Proceedings of the Institute of Radio Engineers, Physical Review, Science, Review of Scientific Instruments, Journal of Applied Physics, Journal of the Society of Motion Picture Engineers, and Nature, the oldest scientific journal known to scientists throughout the world, which is published in England.

As an inventor, Dr. Skellett has been issued thirty patents, has twenty-five currently in process, principally on electronic devices, ten of which are in the secret category. Worldwide recognition came to him in the field of astronomy as a result of his perfection of the coronaviser and adaptation of television technic to astronomy which made possible the study of the sun's corona without recourse to costly expeditions at times of solar eclipse. Dr. Skellett's inven-

..which will make post-war products tick!

Out of the maelstrom of war—with its complex of electronic intricacies in communication, control, operation and guidance—have come these N. Y. T. transformer developments. Ranging from units for navigational aid to firing mechanisms, these N. Y. T. components are an integral part of the "sixth sense" of the Army, Navy and Air Forces.

With the quickening tempo of war, and the casting of furtive looks by industry towards the post-war future, the importance of transformer products with comparable accuracy, efficiency and dependability will be emphasized in civilian production. The acid tests of combat will be the proving grounds of tomorrow's simple household gadgets and industry's tools.

N. Y. T. technicians can be instrumental in the fulfillment of electronic-functioning phases of your products, equipment and appliances. Association with leading electrical manufacturers and services — as transformer designers, consultants and producers — will corroborate the distinctive and exceptional nature of N. Y. T. facilities.

The N-Y-T Sample Department is prepared to give immediate consideration to special problems pertaining to post-war applications and deliveries

NEW YORK TRANSFORMER CO.

22-26 WAVERLY PLACE **NEW YORK 3, N. Y.**

tion of the secondary emission trigger tube in 1942 was a major contribution to the electronic art. More recently his radial beam tube has gained wide attention.

Prior to 1929, Dr. Skellett was Assistant Professor of Physics on the faculty of the University of Florida. He also served as Chief Engineer of Radio Station WRUF. From 1929 to 1934 he worked on problems of radio transmission and transatlantic telephony for Bell Laboratories, and from 1934 to 1942 devoted himself to electronic research. He has spent the past two years on secret projects for the armed forces.

Recorders From Universal

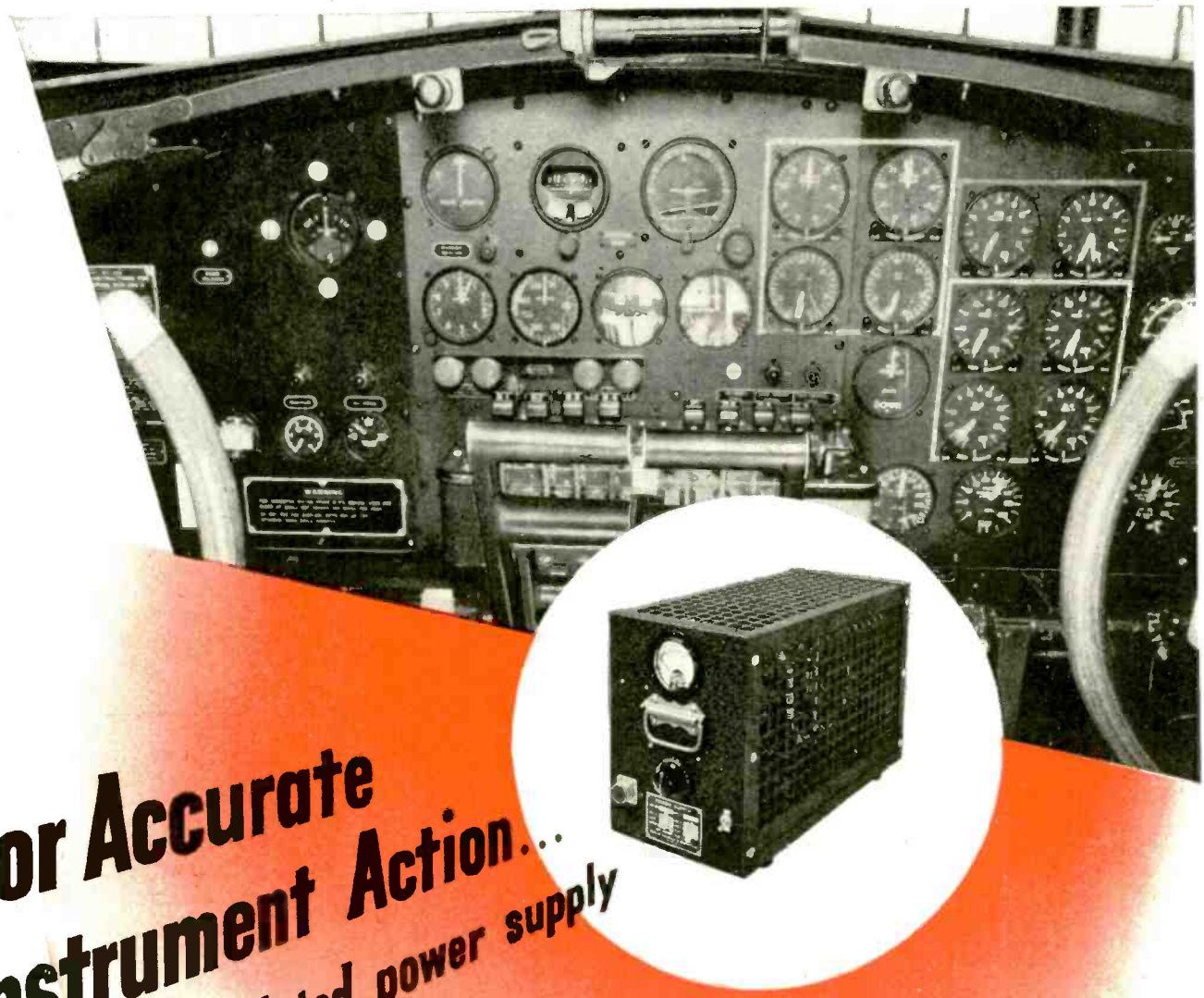
Universal Microphone Co., Inglewood, Calif., will return to the recording field, postwar, as well as continuing its microphone manufacturing activities. The firm had previously made its own complete professional recorders but discontinued this production five years ago. The new Universal recording activity, however, will not include complete sets. The organization will manufacture all recording components for firms making their own radio chassis for assembly in their own complete recorders and combinations. The line will include cutting heads, recording mechanisms, assemblies and other parts and accessories.

Electro-Voice Renamed

The Electro-Voice Mfg. Co., Inc., South Bend, Ind., has effected a change in name to Electro-Voice Corp. The change was made for the purpose of simplification. Personnel and policy remain unaffected by the change.

War Workers Award

Donald Henry Mitchell, chief engineer of the Galvin Mfg. Corp., Chicago, receiving coveted Chicago Tribune War Workers Award from Colonel Frank J. Schaal, deputy commanding officer of the Chicago Signal Depot. The award was made in recognition of Mitchell's contribution to the war effort by creating, in conjunction with the U. S. Army Signal Corps, the Motorola Handie-talkie. Witnessing the presentation ceremonies are: Mitchell; Walter Stellner; Colonel Leland Stanford, signal officer of the Sixth Service Command; Colonel Schaal; Jack Davis, assistant chief engineer of Galvin



For Accurate Instrument Action...

Federal's regulated power supply

Reliable aerial navigation depends upon absolute accuracy of aircraft instruments.

Constant testing of these instruments under flight conditions . . . in the air or on the ground . . . is possible with Federal's regulated-voltage power supply.

Designed to replace unwieldy storage batteries normally used for this purpose, this light-weight Federal power supply converts 115-volt alternating current into a closely-regulated, filtered direct current for the accurate testing of electrical instruments and other aircraft accessories.

This is only one of the many types of all-purpose power supply units powered by Federal Selenium Rectifiers . . . another example of Federal design and manufacturing leadership . . . and another good reason why you should *consult Federal first.*

FEDERAL TELEPHONE & RADIO — FTR

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark 1, N. J.

Harry Berman

Dr. Harry Berman, former curator of the Harvard University Mineralogical Museum and expert for two electronics companies, was one of the 26 persons killed late in August in Prestwick, Scotland, where an American trans-Atlantic plane crashed. On leave of absence from Harvard, he was in charge of research laboratories and of crystal production for the Reeves Sound Laboratories, Inc., and the Hudson

The late Dr. Harry Berman

American Corp., both of New York. At the time of his death he was en route to England, where he was to supervise work for the Royal Air Force and the United States Army 8th and 9th Air Forces.

Before joining the electronics companies for special war work, Dr. Berman was a professor in the Department of Mineralogy at Harvard and an authority on precious and semi-precious stones. He had also served as consultant to mining companies throughout the world.

Templetone Expands

Templetone Radio Co., Mystic, Conn., has acquired a new (90,000 sq. ft.) plant in New London and will occupy it this month. Most of the company's electronic manufacturing will be moved to the new plant where AM and FM radio sets and television receivers will be made. The Mystic plant will be used for cabinet production.

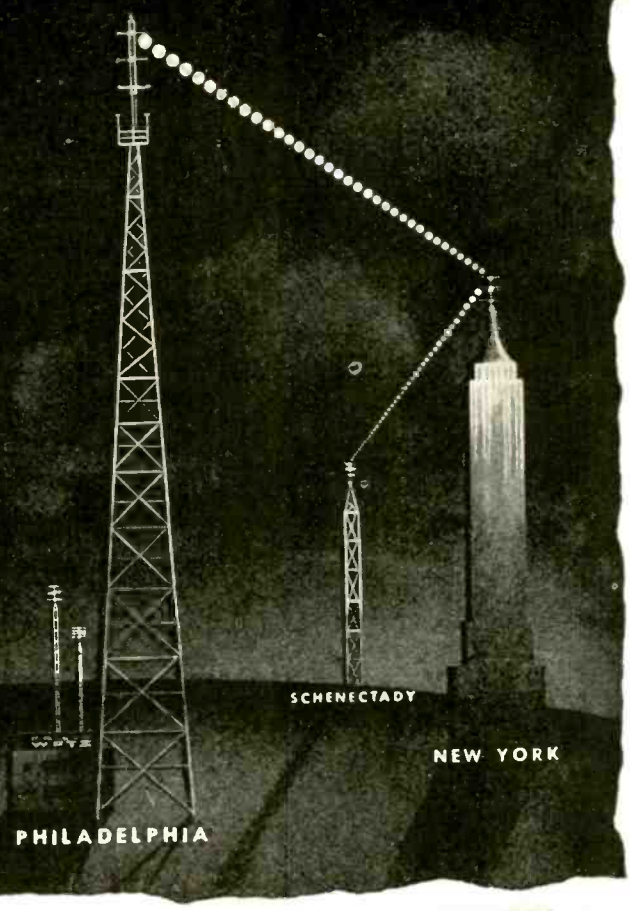
Green Adds Crown

Crown Rheostat & Supply Co., Chicago, is to be exclusive distributor for W. Green Electric Co., Inc., New York (rectifier engineers) in Illinois and Wisconsin. Crown will also handle Green products in several adjacent states.

The First Network!

ANOTHER MILESTONE IN THE PROGRESS OF

TELEVISION



CHAIN television is here! With the recent dedication of the new Philco Relay Transmitter at Mt. Rose, N. J., the first Television Network, linking Philadelphia, New York and Schenectady, is in actual operation today. Now Philadelphians enjoy clear reception of programs from New York through their local Philco television station. Thus the first step has been taken through which millions will eventually witness events that take place thousands of miles away . . . *by television.*

HOW PHILCO RESEARCH SPEEDS THE ADVANCE OF TELEVISION

This first television network is an example of how Philco research is working to establish transmission principles which can extend chain television broadcasting from coast to coast. At the same time, Philco research is improving the clarity, sharpness and detail of the television picture . . . so that future television sets will have the greatest possible sales appeal. Thus in two ways . . . by helping to broaden the market for television, and by designing a more saleable product for that market . . . Philco leads toward the goal of television as tomorrow's "billion dollar industry."

Radio Hall of Fame Orchestra and Chorus.
Tune in Sundays, 6 P. M., E. W. T., Blue Network.

★

BACK THE ATTACK—BUY WAR BONDS

WITH PROGRAMS LIKE THESE, PHILCO TELEVISION STATION WPTZ HAS PIONEERED IN TELEVISION BROADCASTING

Since 1932, Philco has owned and operated its own television station, a rich laboratory of research and experience for television progress.

The Philco station has televised football, boxing, wrestling and other sports as well as news events direct from the scene of action.

Movies, variety acts, dramatic sketches, illustrated news talks and civic programs have been televised from the Philco studios.

PHILCO

THE OVERWHELMING LEADER IN RADIO FOR 12 STRAIGHT YEARS

NEW BOOKS

Fields and Waves in Modern Radio

By Simon Ramo and John R. Whinnery, published by John Wiley & Sons, New York, 1944, 500 pages, $5.00.

This book is concerned with certain aspects of electromagnetic theory and their relations to many of the problems in modern radio and electronic engineering. The volume gives a basic background chapter on oscillation and wave fundamentals. The next two chapters outline the characteristics of static electric and static magnetic fields along with general solutions to typical problems. The fourth chapter introduces Maxwell's equations. The subject of units is taken up and a convenient conversion table provided. The following chapters include information on circuit concepts at high frequencies including propagation and reflection of electromagnetic waves, guided electromagnetic waves including characteristics of common wave guides and transmission lines. Chapter Ten is devoted to resonant cavities and chapter eleven is a thorough treatment of simple antenna systems.

The authors have explained various mathematical operations which are more or less uncommon to many readers. All of the symbols used in the equations throughout the book are separately identified in the appendix.

Direct Current Circuits

By Earle M. Morecock, published by Harper & Bros., New York, 1944, 388 pages.

This text book is one of a series prepared by the faculty of Rochester Athenaeum and Mechanics Institute. It is designed as a fundamental volume to acquaint the student with the physical and electrical properties of electrical components and to present the basic laws associated with direct current operation. The chapters include elementary electric circuits, magnetism and electromagnetism, electric measuring instruments, power and energy, conductors and insulation, batteries, magnetic circuits, electromagnetic induction, capacitance and electrostatics.

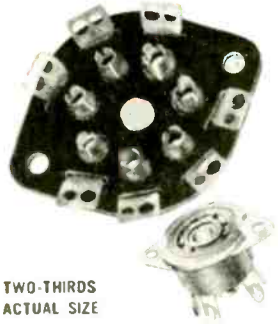
Each chapter includes a number of typical problems to be solved by the student and also a series of laboratory experiments.

A number of tables on conductors, electrical symbols, etc., are included in the appendix. Answers to all problems are also given in the appendix.

(*Continued on page* 182)

More often than not, the socket in service is a CINCH

it's "Know How"



TWO-THIRDS ACTUAL SIZE

Sixteen years ago Cinch started manufacturing sockets for radio sets. As the years went along we kept expanding and adding to our line. Continual pioneering on socket development as new tubes were designed has always been the Cinch policy. In addition to original research on sockets, both laminated and molded, we were first in the field with a complete line of miniature socket assemblies together with nut straps, shields and associated items. Special types, too, have been an important contribution to the electronic program. Such a performance indicates socket engineering KNOW HOW and the Cinch socket line is as complete as practical volume considerations would warrant.

"First in the field" with a complete line of Miniature Socket Assemblies and Mountings

CINCH Fasteners ★ Miniature Sockets
Filler Necks ★ Octal Sockets ★ Lugs
Terminal Strips ★ Metal Stampings

CINCH MANUFACTURING CORPORATION
2335 West Van Buren Street, Chicago 12, Illinois
Subsidiary of UNITED-CARR FASTENER CORPORATION, Cambridge, Mass.

NEW BOOKS

(*Continued from page* 180)

Ultra High Frequency Radio Engineering

By W. L. Emery, published by The MacMillan Co., 1944, 295 pages, $3.25.

This book is a combination of circuits and their characteristics which are particularly useful to ultra high frequency equipment. It includes a mathematical treatment of transmission lines used as reactive elements as well as in their conventional manner. The chapters cover voltage regulated power supplies, electronic switching and synchronization, cathode ray tubes and sweep circuits, amplifiers, square wave testing, ultra high frequency circuit elements, oscillators, modulation and detection, radiation and wave guides.

The volume also contains the outline for 24 experiments covering major points in the text.

Throughout the chapters on circuit functions, the book is of a descriptive nature although a moderate amount of mathematical treatment is given for transmission lines, frequency modulation and square wave analysis.

NEW BULLETINS

Micrometer Frequency Meter Engineering Data Sheets

A new bulletin has recently been published by Lampkin Laboratories, Bradenton, Fla. This booklet brings together the operating details pertinent to the micrometer frequency meter. The information is divided as follows: Instructions and the transmitter chart sufficient guidance for operating the MFM; deviation chart supplements the transmitter chart and may be preferred for some classes of work. Also included are engineering data sheets which amplify in greater detail, various aspects of the MFM, and specifications for the Type 103 and the Type 105 meters.

Polyethylene Resins

The Plastics Division of Carbide and Carbon Chemicals Corp., 30 E. 42nd St., New York 17, N. Y., has just published a 12-page booklet entitled, "Polyethylene Resins." The brochure describes the forms, properties, fabrication procedures, and uses of this new group of thermoplastic materials. Data tables are included which present graphic summaries of the plasticity, electrical properties, and thermal expansion of this latest resin. All

PERMANENT MAGNETS MAY DO IT BETTER

America's Pride Flies with the B-29!

AS the giant Boeing B-29 Superfortress carries destruction to Japan, the pride of America echoes in the roar of her mighty engines. And to the ingenious Boeing engineers who created her, the Nation owes a great debt.

We have special reason to be proud of the B-29's performance, for Boeing incorporated no less than 300 permanent magnets in her magnetos, instruments, compasses, audio speakers, radio equipment, automatic pilot, remote gun controls and other vital devices.

It is our job to manufacture a large portion of these permanent magnets, as well as those for other types of war equipment. And our specialized designing skill has often resulted in increased efficiency and lower costs.

Our engineers are in an excellent position to help solve your permanent magnet problems. Write for a copy of our "Permanent Magnet Manual."

The
INDIANA STEEL PRODUCTS
Company

★ SPECIALISTS IN PERMANENT MAGNETS SINCE 1910 ★

6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILLINOIS

NEW BULLETINS

available information which has been gathered to date is presented in "Polyethylene Resins." Copies are available to engineers, chemists, and executives upon request.

Resistor Guide

An attractive combination calendar and resistor engineering guide is being distributed by Madison Electrical Products Corp., Madison, N. J. The guide gives information regarding wire wound resistors, their use and application.

Bakelite Booklets

Two new booklets of 24 pages each have been issued by the Bakelite Corp., 300 Madison Ave., New York, to better acquaint users with the characteristics of resin baking coatings and bakelite and vinylite plastics. The first is entitled "Catalog of Bakelite and Vinylite Plastics." It is published by Bakelite corporation and the plastics division of Carbide and Carbon Chemicals Corp., and contains a complete listing of all the products marketed by these two organizations. Within the 24 pages are descriptions of molding and extrusion compounds; laminating

Announcing

MYKROY #51

Glass-Bonded Mica Plastic High Frequency Insulation for INJECTION MOLDING

MYKROY

PERFECTED MICA CERAMIC INSULATION

THE perfection of MYKROY #51, glass-bonded mica ceramic insulation, which can be injection molded, and the processes developed for handling it rapidly and uniformly has opened a new field of applications. It is now possible to produce injection molded plastic ceramic parts of MYKROY having shrinkage characteristics of less than .001" per inch. In addition, parts molded from MYKROY #51 can be machined by grinding, drilling, tapping or cutting.

Electrical characteristics of MYKROY #51 are of the highest order and do not shift under any conditions short of actual destruction of the material itself. This, plus chemical and physical stability—high resistance to oil, gas and water—resistance to acute temperature changes—high coefficient of thermal expansion and excellent metal bonding properties, make it one of the best insulating materials ever developed for general and high frequency applications.

MYKROY #51 is already being molded into a large variety of parts for use throughout the entire Electronic and Electrical engineering field. It may be the answer to your own insulation problems. So ask for detailed information. Request a copy of the special MYKROY INJECTION MOLDING BULLETIN #103.

WRITE FOR MYKROY INJECTION MOLDING BULLETIN #103

A comprehensive manual containing complete working data including mold designing criteria.

MYKROY SHEET BULLETIN #102

Contains full information about the largest size sheet (19¼" x 29¾") of perfected mica ceramic insulation now available.

MYKROY IS SUPPLIED IN SHEETS AND RODS . . . MACHINED OR MOLDED TO SPECIFICATIONS

MADE EXCLUSIVELY BY ELECTRONIC MECHANICS INC.

70 CLIFTON BOULEVARD • CLIFTON, NEW JERSEY

Chicago 47: 1917 NO. SPRINGFIELD AVENUE . . TEL. Albany 4310

Export Office: 89 Broad Street, New York 4, N. Y.

NEW BULLETINS

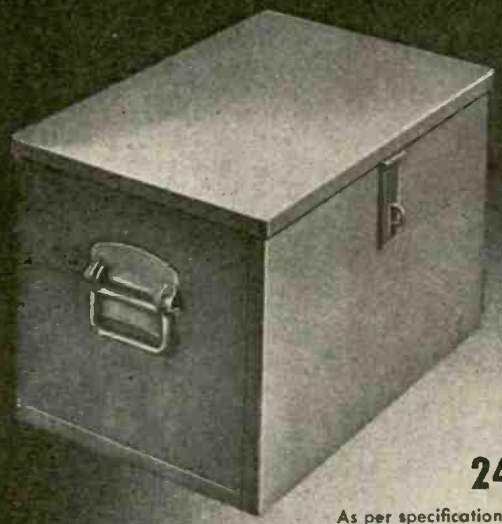
plastics; sheets, sheeting, and film; rods and tubing; cast resins; glues and adhesives; bonding materials; coating products; impregnating, sealing, and calendering materials; and special copolymer resins.

Not only are descriptions of the materials included, but, also, their applications and specific characteristics and properties. In addition to being a catalog of all Bakelite and Vinylite plastics, this handbook serves as a businessman's guide to both thermoplastic and thermosetting plastics. The other booklet is entitled "Bakelite Resin Baking Coating." This is an illustrated booklet containing specific information on the properties and characteristics of phenolic resin baking coatings. It includes technical information on the types of surfaces which can be coated with these finishes; methods of application; baking methods and equipment.

Selenium Rectifiers

Selenium rectifiers for a wide variety of purposes are illustrated and described in a four-page catalog insert issued by the Benwood-Linze Co., St. Louis. The brochure gives sizes and normal convection cooling ratings of rectifier plates from ¾ in. to 4⅜ in. diameter as

SPARE PARTS BOXES



No. 1025—6
18" x 9" x 9"

No. 1025—1
12" x 6" x 6"

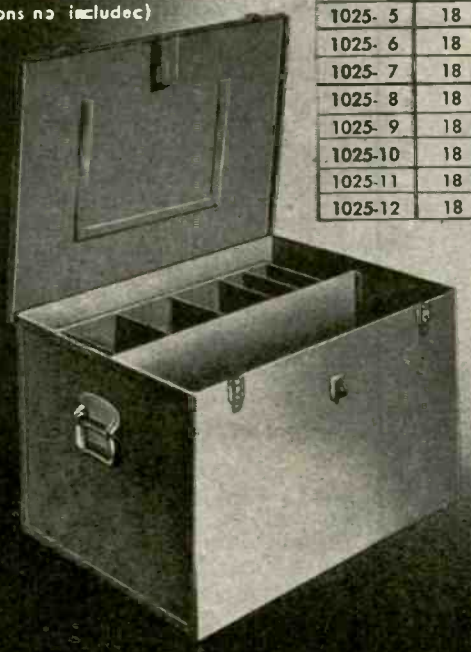
24 STOCK SIZES

As per specification 42 B 9 (Int) for shipboard use, Electrical and Mechanical. Navy grey finish. Immediate Delivery.

— WRITE FOR PRICE LIST —

Number	Length	Width	Height	Number	Length	Width	Height
1025- 1	12	6	6	1025-13	18	18	12
1025- 2	12	9	6	1025-15	24	15	12
1025- 3	12	12	6	1025-16	24	15	15
1025- 4	12	9	9	1025-17	24	18	12
1025- 5	18	9	6	1025-18	24	18	15
1025- 6	18	9	9	1025-19	24	18	18
1025- 7	18	12	9	1025-20	24	12	9
1025- 8	18	6	6	1025-23	30	15	9
1025- 9	18	15	9	1025-14	30	15	12
1025-10	18	12	6	1025-22	36	12	9
1025-11	18	15	12	1025-21	42	9	9
1025-12	18	12	12	1025-24	42	12	9

No. 1025— 4
30" x 15" x 2"
(Partitions not included)



Cole steel office equipment will again be available after the war

COLE STEEL EQUIPMENT CO.

349 BROADWAY, NEW YORK 13, N. Y.

FACTORY: BROOKLYN, N. Y.

NEW BULLETINS

well as efficiency curves and engineering data covering such things as forward and reverse voltage drop characteristics, regulation, output voltage vs. ambient temperature, overload vs. operating time, etc.

Electronic Book Guide

Under the stimulus of World War II the science of radio and electronics has rapidly developed over widely divergent fields, and its literature has mushroomed in the last few years. As a guide to this literature, to permit rapid selection of books by title, author, publisher, subject, or application, Allied Radio Corp., 833 W. Jackson Blvd., Chicago, has released for distribution a booklet containing a wide selection of publications on radio, electronics, and related subjects. Listings cover simplest fundamentals to advanced practices for beginner, student, radio amateur, instructor, technician, service and maintenance man, and engineer.

The listings are divided into two major parts: (1) A classified directory by subject (Aeronautics, Electricity, Engineering, Basic Training, etc.); (2) A listing under publisher, by author and title, with a brief summary of contents, size, number of pages, price, etc.

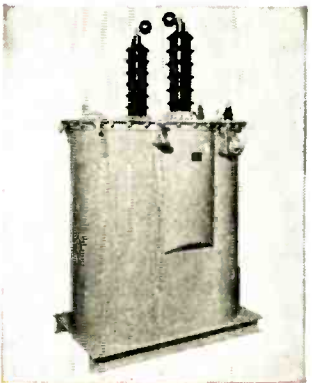
New Crystal Products

An unusually functional and profusely illustrated catalog of quartz crystal units has been produced for the postwar trade by Crystal Products Co., 1519 McGee St., Kansas City, Mo. The catalog includes all fields: broadcasting, filter test, amateur, aircraft, police-marine, multiple crystal units and blanks. Standard types of crystals and mountings, as well as special types produced according to individual specifications, will be available shortly.

New Lofting Method

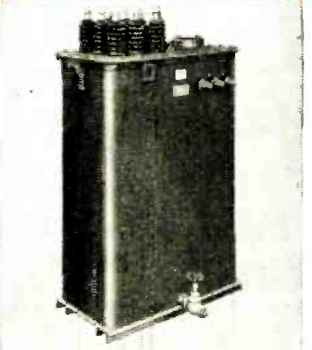
A new brochure, "Precision Lofting," issued by the Template Reproduction Co., 401 North Broad St., Philadelphia 8, Pa., gives management, engineering, tooling and production executives an insight into the new industrial "lofting" method for producing, with accurate templates, a variety of products ranging from automobiles, aircraft and household appliances, to small components of every description.

The method, already in use in a majority of the larger aircraft plants, involves the mechanical reproduction of full-size detail drawings, directly on tooling materials. Considerable manual duplication of scale drawings, and manual transferring from blueprints to tooling

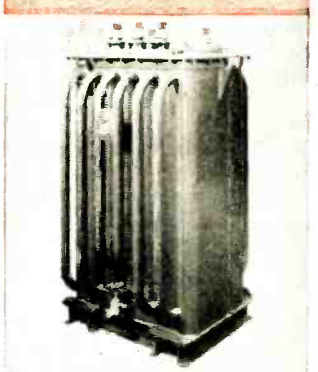


Single phase, half wave rectifier plate transformer, 60 cycles, 220 volts primary, 110,000 volts secondary.

300 VA Filament transformer, single phase, 60 cycles, 6 secondary windings of 5 volts each; 3 secondary windings operating 40 KV above ground and 3 secondaries operating 20 KV above ground.



60 KVA, three phase, 60 cycles, 2?1 volts, Delta primary, 3900 / 6755 / 7800 / 13510 volts Wye secondary.



150 KVA Distribution transformer, single phase, 600 high voltage, 240/120 low voltage.

Fire!

REDUCE THE HAZARD WITH AMERTRAN ABESTOL IMMERSED TRANSFORMERS

Fireproof AmerTran Abestol Immersed Transformers reduce both the possibility and the extent of fire damage. That's why they earn lower insurance rates and permit vaultless indoor installation, with its convenience, flexibility and accessibility. To industry, AmerTran Abestol Immersed Transformers offer the advantages of load center installation: copper savings, finer voltage regulation, lower line losses and improved motor performance. If necessary, they may be mounted overhead because the chemically inert Abestol, which requires no maintenance, is sealed. In comparison to transformer oil, Abestol possesses higher insulating properties and similar heat transmission characteristics.

Send for further information.

AMERICAN TRANSFORMER COMPANY
178 EMMET STREET, NEWARK 5, NEW JERSEY

AMERTRAN

MANUFACTURING SINCE 1901 AT NEWARK, N. J.

Pioneer Manufacturers of Transformers, Reactors and Rectifiers for Electronics and Power Transmission

materials are thereby eliminated, and substantial savings in time are made. There is a complete follow-through on accuracy, which is particularly noticeable on the assembly line, where all parts fit, and the necessity of rework is abolished.

FM-TELE SHIFT

(*Continued from page* 109)

an exhibit filed in the FCC Allocations hearings. The video service would be by multiple addressee stations on a network, it is proposed.

In the exhibit which has also been submitted to the RTPB, the SMPE proposed that these channels, taking up an aggregate of 1500 megacycles would be known as the Group C Channels. The proposed allocations to the motion picture industry for television would be as follows:

1—8 contiguous 20 mc cleared channels or a band of 160 mc from 600-760 mc.
2—7 contiguous 20 mc cleared channels or a band of 140 mc from 860-1000 mc.
3—15 contiguous 20 mc cleared channels or a band of 300 mc from 1900-2200 mc.
4—15 contiguous 20 mc cleared channels or a band of 300 mc from 3900-4200 mc.
5—30 contiguous 20 mc cleared channels or a band of 600 mc from 5700-6300 mc.

With regard to the power that eventually will be available for ultra high frequency services, FCC's chief engineer, George P. Adair, interpolated between the report of C. M. Jansky, Jr., and that of David B. Smith, some hitherto restricted information revealing development work on tubes. "The Navy Dept.," he said, "has consented to outline the present status of transmitter tube development. The 6 groups are given on page 109.

The present FCC hearing is to be continued at least until October 31 with the Commission considering evidence from the various services which for convenience have been divided into four groups as follows:

Group I—Fixed Public Service (other than Alaska); Coastal; Marine Relay; Ship; Mobile Press; Fixed Public Service in Alaska; Aviation; Amateur; International Broadcast.

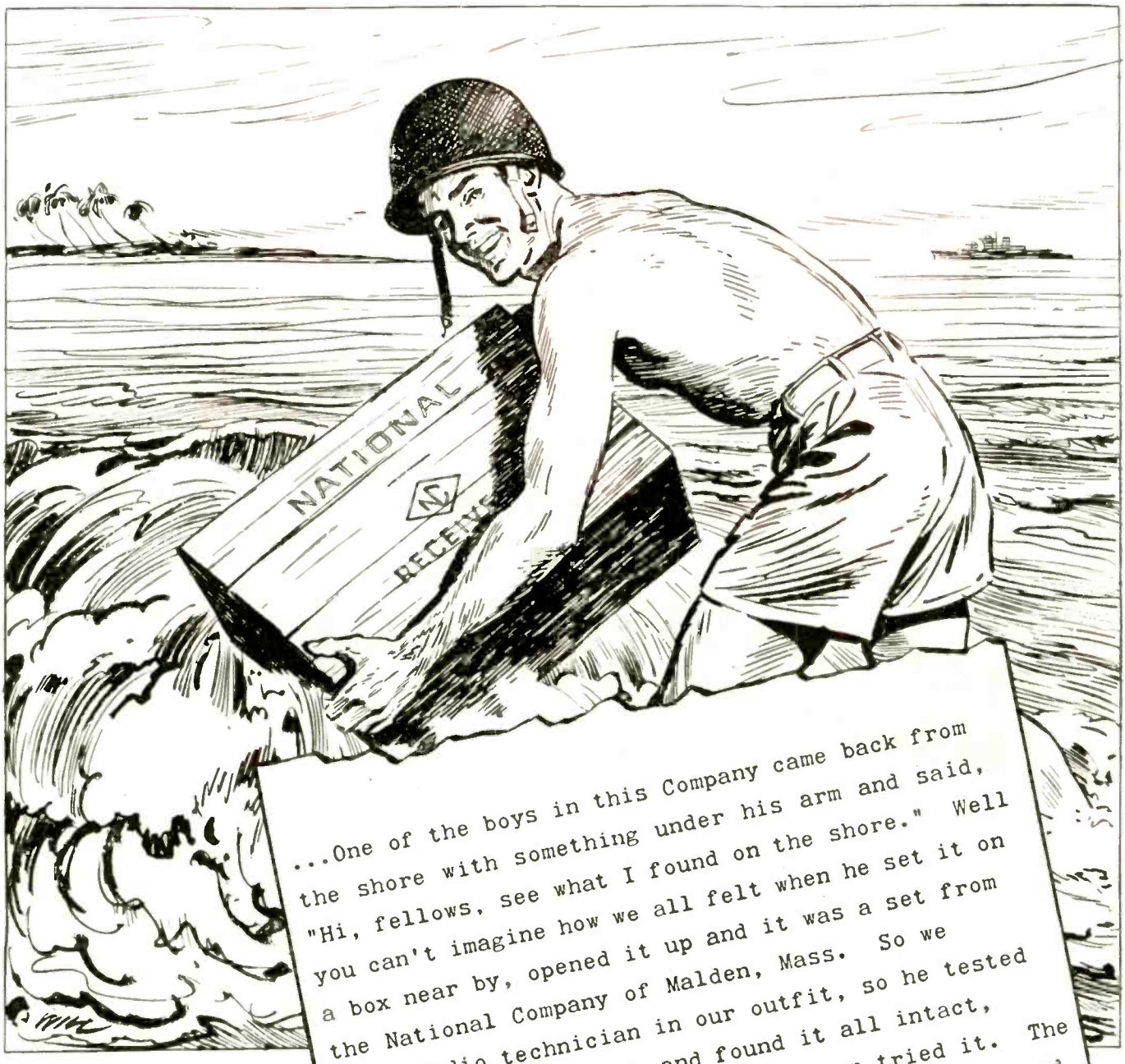
Group II—Standard Broadcast; High Frequency (FM) Broadcast; Non-commercial Educational; Television; Facsimile Broadcast and other broadcast services.

Group III—Police; Fire and Forestry Services; Special Emergency; Provisional and Motion Picture Services; Special Services (Geophysical, Relay Press).

Group IV—Industrial; Scientific and Medical Services; Relay Systems (Program and Public and

(*Continued on page* 194)

"HI, FELLOWS, SEE WHAT I FOUND"



...One of the boys in this Company came back from the shore with something under his arm and said, "Hi, fellows, see what I found on the shore." Well you can't imagine how we all felt when he set it on a box near by, opened it up and it was a set from the National Company of Malden, Mass. So we had a Radio technician in our outfit, so he tested it, looked it all over and found it all intact, closed it up again, grounded it, then tried it. The salt water had not hurt it one bit—it gave us grand reception and each night, we, or about 12 of us, listened in and it seemed like a message from home.

(Excerpt from a letter we received from a soldier in the Pacific.)

NATIONAL COMPANY, INC.

MALDEN MASS, U. S. A.

NATIONAL RECEIVERS ARE IN SERVICE THROUGHOUT THE WORLD

METAL INSERTS FOR STRONGER MECHANICAL ASSEMBLIES

Where extra strength is required or where insulators or assemblies are subjected to unusual mechanical strains and stresses, greater strength can be had by using General Ceramics metal inserts. These threaded metal inserts are *permanently bonded* into the steatite body, thus assuring an extremely solid construction. The metal inserts are drilled and tapped so that a perfect thread is obtained.

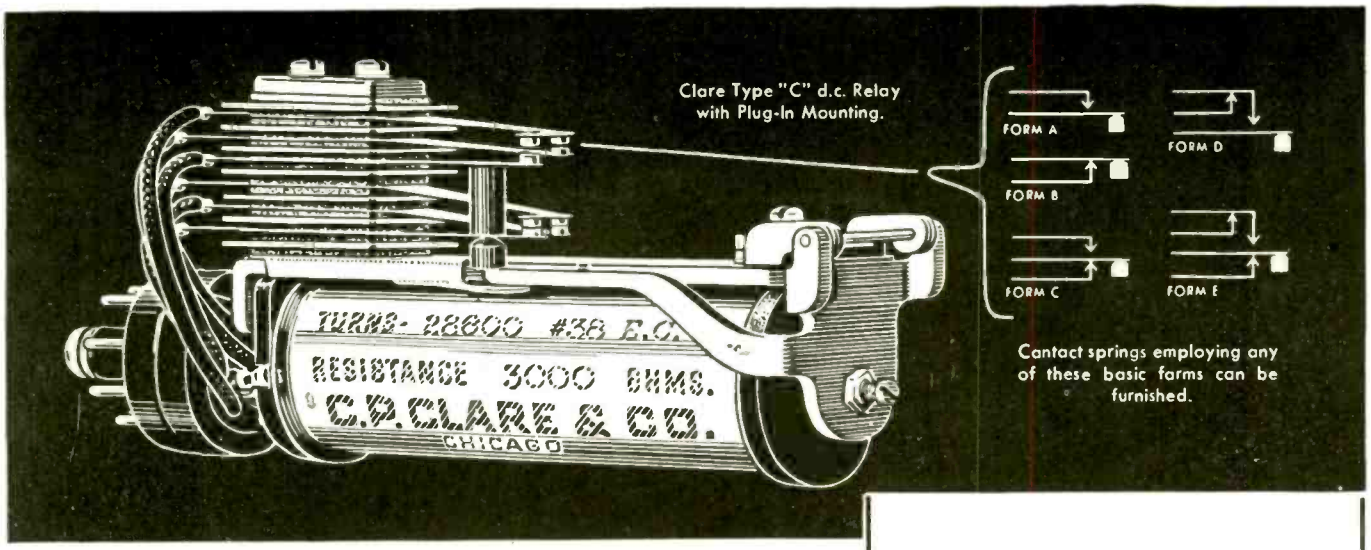
Our engineers will be glad to cooperate with you in designing steatite insulators with metal inserts for your special use.

ARMY NAVY

General Ceramics AND STEATITE CORP.

GENERAL

KEASBEY NEW JERSEY



WHY CLARE "Custom-Built" RELAYS GIVE MOST RELIABLE OPERATION

Under Severe Conditions of Temperature . . . Humidity . . . Atmospheric Pressure . . . Voltage . . . Vibration

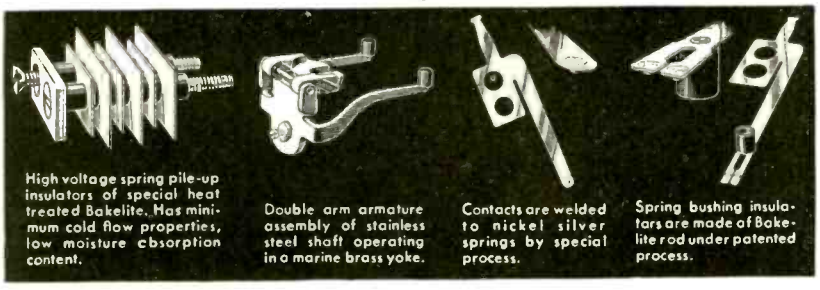
Clare "Custom-Built" Relays offer design engineers a flexibility of construction and operating characteristics to exactly fit the demands of the widest variety of modern industrial uses.

These Clare "Custom-Built" Relays are the product of young-minded thinking . . . of an organization devoted to the manufacture of relays . . . created to free the industrial designer from the limitations of ordinary, telephone type relays. Clare "custom-building" selects from a wide range of precisely built materials exactly those most suited to perform the special functions of the application. All Clare Relays are carefully designed, well manufactured from best materials and precisely adjusted for perfect operation.

Does your design call for definite times for operation and release of the relay . . . high speed keying without contact chatter . . . margin operation which may include close pick-up and drop-out values . . . the transfer and switching of high frequency circuits? These and many other special relay functions find Clare Relays give most reliable operation under severe conditions of temperature, humidity, atmospheric pressure, voltage and vibration.

Clare "custom-building" meets these exacting requirements with a design that permits each Clare Relay a wide range of contact ratings . . . choice of five different contact forms or any combination of them . . . either flat or hemispherical contacts of rare metals or special alloys . . . coil windings to match the circuit and application.

Simplify your design, reduce your overall relay costs, insure better and more dependable performance by calling on Clare to supply a "custom-built" relay exactly suited to your application. Send for the Clare catalog and data book. Address: C. P. Clare & Co., 4719 W. Sunnyside Avenue, Chicago 30, Illinois. Sales engineers in all principal cities. Cable address: CLARELAY.



High voltage spring pile-up insulators of special heat treated Bakelite. Has minimum cold flow properties, low moisture absorption content.

Double arm armature assembly of stainless steel shaft operating in a marine brass yoke.

Contacts are welded to nickel silver springs by special process.

Spring bushing insulators are made of Bakelite rod under patented process.

FEATURES OF CLARE RELAYS

Permit exceptional service in spots where hard usage, long life and absolute dependability are of prime consideration:

1
THE MAGNETIC CIRCUIT

This consists of the heelpiece, armature and coil core, all of the highest quality magnetic iron. After all machining operations are complete, these units are annealed in precision controlled furnaces. The armature assembly is fastened securely to the heelpiece with screw and clamping washer.

2
THE COILS

These are wound on a spool assembly which consists of a coil core equipped with spool heads and acetate or bakelite winding washers. Both coil core and spool heads are insulated from the wiring. Coils are usually wound with enameled copper wire but other types of insulation are used for special applications.

3
THE SPRING ASSEMBLY

This consists of contact springs and insulators assembled to the heelpiece. The assembly is clamped under hydraulic pressure and special high-tensile screws are fastened with a power driver to insure a rigid assembly.

4
THE CONTACTS

Contacts of various materials and sizes are available. These may be of precious metals or alloys, such as silver, palladium-irridium, tungsten and elkonium. Various types can be incorporated in one relay.

CLARE RELAYS

"Custom-Built" Multiple Contact Relays for Electrical, Electronic and Industrial Use

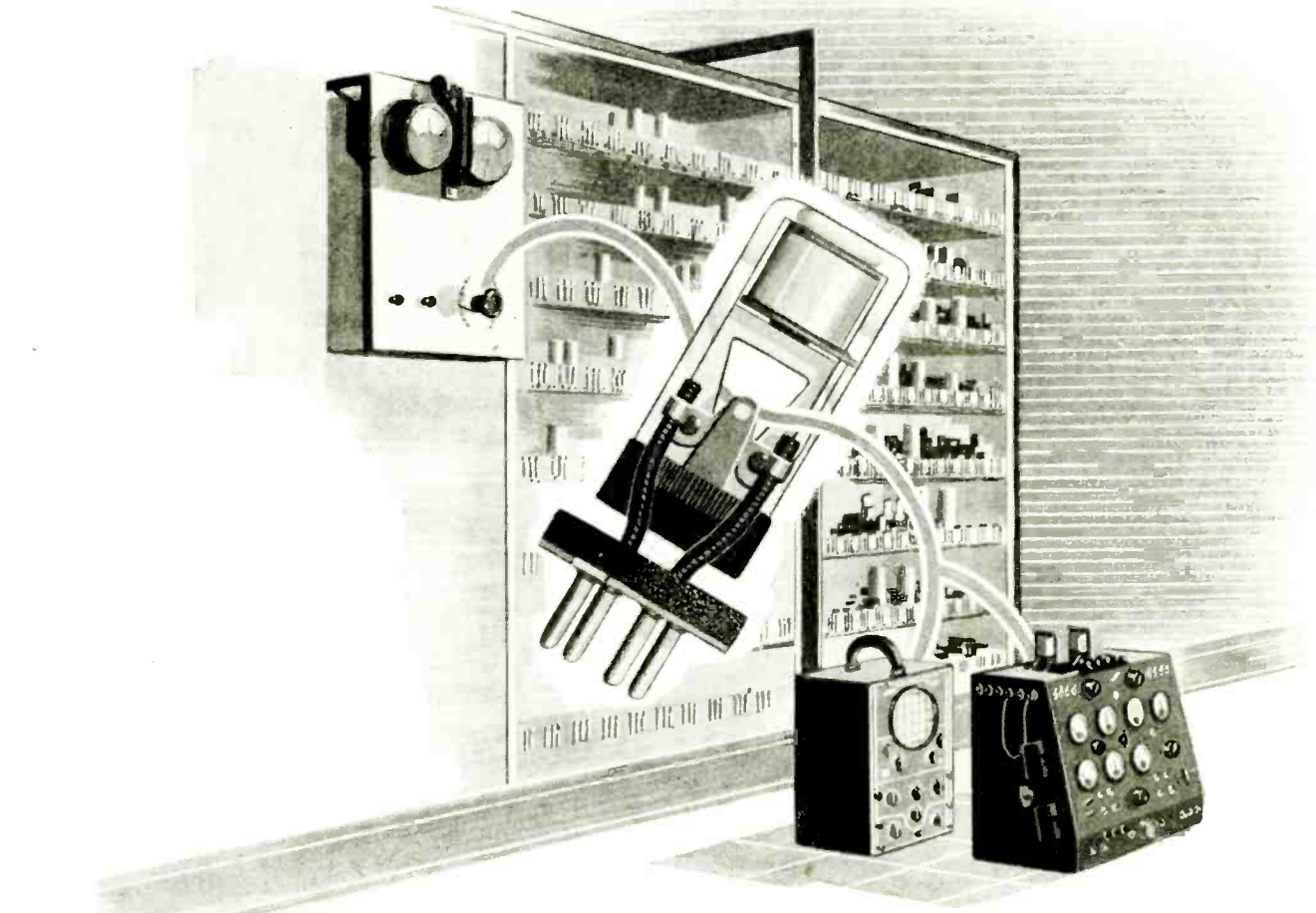
(Continued from page 190)

Private Communications). New Radio Services.

Upon completion of this testimony the Commission will then again receive evidence from the chairmen of Panels 1 and 2 of the RTPB concerning the recommendations they have to make for overall allocations in light of the evidence adduced at the hearing. The Commission at that time will also receive evidence from any other person or group that has recommendations to make concerning overall allocations.

Following collection of the great mass of evidence that will result it will be up to FCC to digest the material, coordinate it with the previously published IRAC recommendations and come up with a set of allocations that will represent a working compromise of the many resulting conflicts.

At the present moment the impression prevails that insofar as non-governmental services are concerned the considered recommendations of RTPB will be pretty closely followed. What the forthcoming world conference will do to such schedules is, of course, for the future to reveal. It is unlikely, however, that it will have any material effect on such public services as are included under the general heading of broadcasting which means AM, FM and television.



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Here in our laboratory on a test rack these Utah Vibrators are placed in continuous operation against the time-clock until they finally break down.

Thus Utah engineers prove the worth of design and the quality of materials that give their product such an enviable record of long, trouble-free service.

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utah

Utah Radio Products Company, 850 Orleans Street, Chicago 10, Ill.

HIGH SPEED X-RAYS

(*Continued from page 107*)

X-ray picture was taken of this same bullet approximately 20 microseconds after the first picture. The core of the bullet has penetrated the armor and its tip is projecting through the back. Part of the armor pushed out by the penetration can be seen. The jacket of the bullet has continued to telescope on itself and even more of the base of the core is in evidence. Other high speed X-ray pictures taken during this study showed the flow of the jacket material and the breaking up of the core as the bullets penetrated the armor.

The high speed X-ray equipment is pre-eminently fitted to study the bullet motion and behavior inside a gun barrel. No other means is available for taking a picture of a bullet as it passes down the bore of the gun. When a bullet is fired in a gun barrel, the blast which accompanies each shot reaches the muzzle before the bullet does. Fig. 5 is a spark shadowgraph of the blast which preceded the bullet exit. This spark shadowgraph was taken at the instant the silvered glass rod placed at the muzzle of the gun was broken. The location of the bullet, still several inches from the muzzle, was determined by means of a simultaneous high speed X-ray picture also shown in Fig. 5.

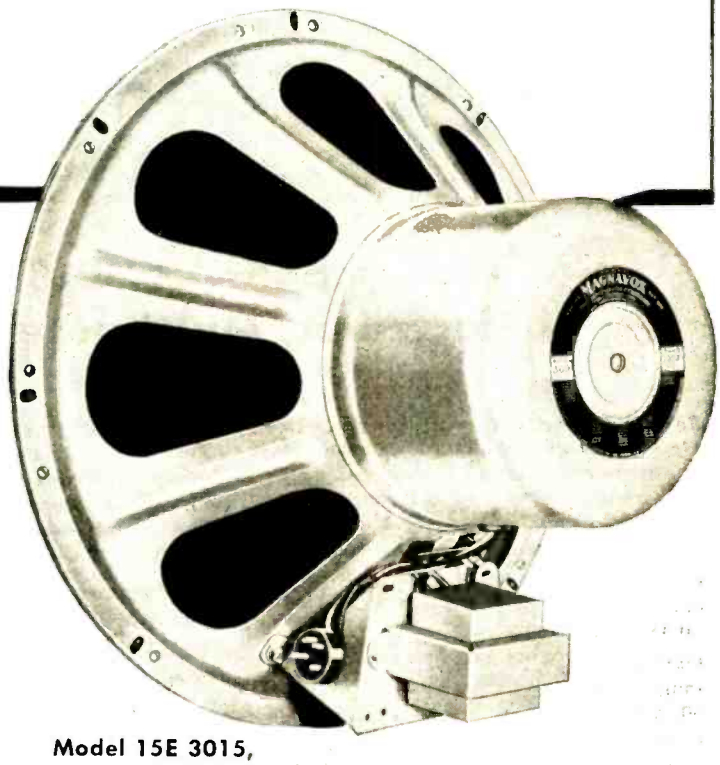
It has been suggested that strain gages fastened to the outside of the gun barrel at various positions along its length might be used to indicate the passage of the bullet down the bore. Some preliminary work has been carried out at the Frankford Arsenal to determine the reliability of the gages to record the position of the bullet.

The high speed X-ray equipment has been used to observe the realignment of component parts inside the bullet when it is fired. A stationary X-ray picture is taken of the bullet in question. The bullet is then fired and a high speed X-ray picture is taken of this same bullet in flight. A comparison of the two X-ray pictures reveals any shift of the component parts which has taken place. This same procedure could be used, for example, to study the motion of the component parts of valves during their operation.

A series of high speed X-ray pictures have been taken of 20 mm. high explosive shells passing through steel plate. It was necessary to place a steel plate ¼ inch thick over the X-ray film holder in order to protect it from the force of the explosion and the flying fragments. A new protection plate was required after every shot.

Despite the fact that all the pictures were taken through ¼ inch of steel, the details of the explosion are clearly evident. One of the

LOUD SPEAKER HEADQUARTERS— MAGNAVOX



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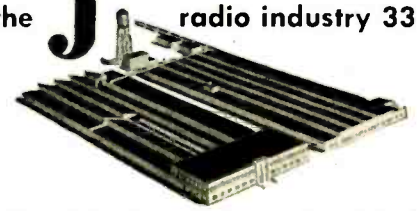

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amazing things revealed by this study is the immense swelling of the shell to almost twice normal diameter before it finally bursts open.

A series of representative pictures showing the manner in which the shell explodes is shown in Fig. 6. These pictures are all to the same scale and the changes in size and shape during the explosion can easily be seen. The extreme usefulness of the high speed X-ray equipment is certainly well brought out by these pictures.

Frankford Arsenal is not the only army installation using high speed X-ray equipment. The ballistics laboratory at Aberdeen has two units; several units are located on the West Coast and in Great Britain. Many other applications have been made both at Frankford and at these other locations but due to the nature of the investigations they cannot be discussed at this time.

Max Steenbeck — Wissenschaftliche Vergoeffentlichen aus den Siemens-Werken. (Julius Springer, Berlin 1938), Vol. 17 Chapter 4, Pages 363-380.

K. H. Kingdon and H. E. Tanis, Jr. — Physical Review, Vol. 53, 1938, Page 128.

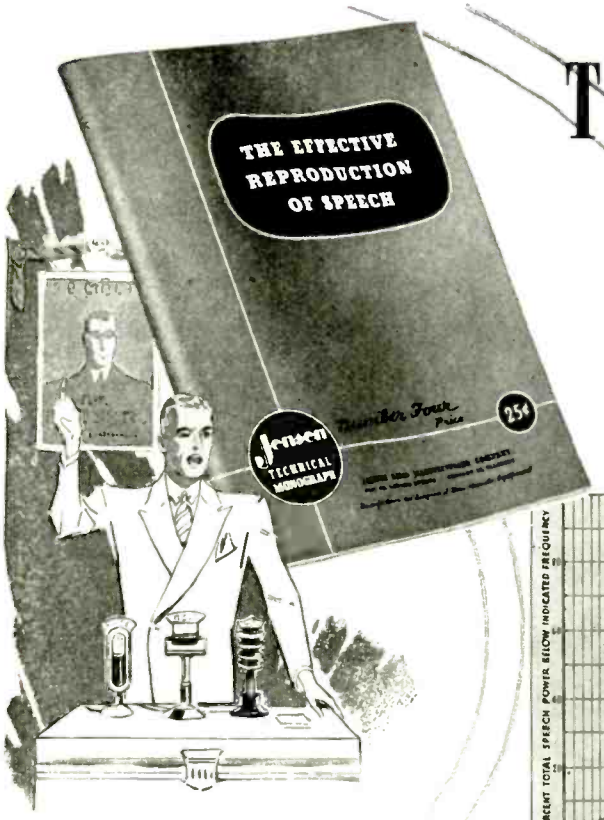
W. J. Oosterkamp—Philips Technical Review, January, 1940, Page 22.

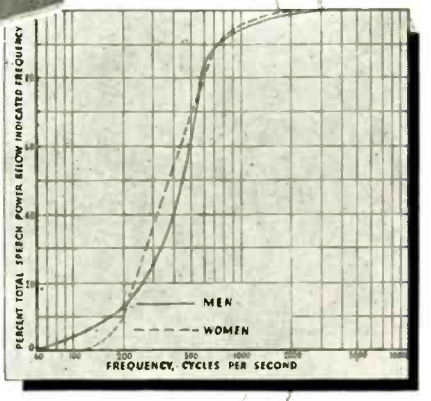
C. M. Slack and L. F. Ehrke—Journal of Applied Physics, Vol. 12, February, 1941, Page 165.

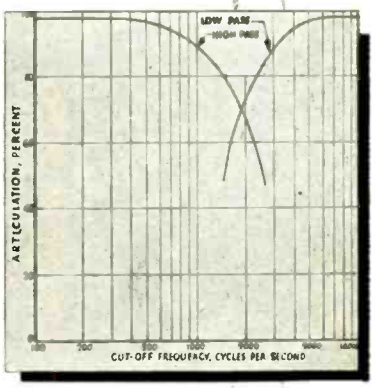
L. F. Ehrke and C. M. Slack—Photo Technique, January, 1941, Pages 52-55.

L. F. Ehrke and C. M. Slack—Electrical Engineering, September, 1941, Pages 432-435.

THE EFFECTIVE REPRODUCTION OF SPEECH...







When casually considered, the reproduction of speech may appear to present less exacting requirements than the reproduction of music. Yet *faithful* speech reproduction requires a frequency band almost as wide as for music. Amplified speech for strictly *communication* purposes usually presents a different requirement. Here, such matters as articulation, loudness, masking, power requirements and the ability to deliver the message through noise, become the more important considerations.

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IGNITION NOISE

(*Continued from page 97*)

made should resist corrosion in order to avoid the later development of high contact resistance. It should not comprise two metals widely separated in the emf scale, in order to avoid electrolytic corrosion.

Flange and cover-plate joints are a constant source of trouble. Again, gaskets should be eliminated wherever possible. Conduction through the bolts which secure such joints is not sufficient. Several promising types of cross sections are shown in Fig. 5. Circular shapes of covers and flanges should be used when possible because of the ease with which such shapes can be accurately machined for fit.

One other point which must be borne in mind when designing ignition system components is the necessity for maintenance. Dirt and careless handling of one type or another take their toll. Many rugged conditions of service must be met. The complexity of the maintenance problem from the radio noise standpoint is well illustrated by the magneto of Fig. 6.

Grateful acknowledgment is made for much of the information represented in the foregoing article to the Signal Corps Aircraft Signal Agency, the Air Technical Service Command, and to the Detroit Edison Co., Titeflex, Inc., Breeze Corp., Wright Aeronautical Corp., American Bosch Corp., Scintilla Division Bendix Corp., and the General Electric Co.

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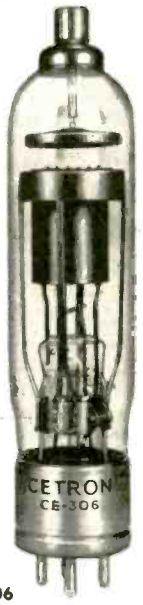

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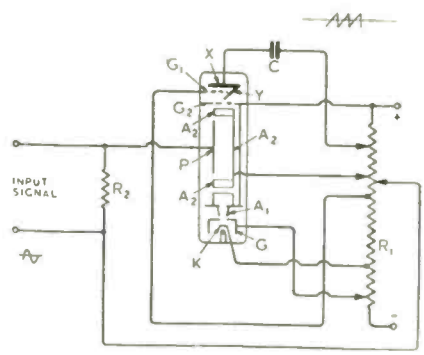
WIDE READING

Deflection-modulated CR tube

(*Continued from page* 112)

tential of a floating secondary emission electrode is equal to the potential of the associated accelerating and collecting screen. By providing the two parts X and Y of the output electrode with the two accelerating screens G_1 and G_2, respectively, the equilibrium potential of the output electrode will be equal to either the potential of G_1 or G_2, depending on whether part X or part Y of the output electrode is hit by the electron beam. Consequently, the output electrode potential will increase while the electron beam impinges on the part with higher equilibrium potential and decrease while the electron beam impinges on the part with lower equilibrium potential, so that when the electron beam is deflected by an alternating voltage across the deflection plates P, A_2, the output electrode potential will vary within the range given by the grid potentials.

In television systems where the tube may be used for producing the time base voltages from the synchronizing signals, the input signals are applied in such a phase to the deflection plate P that during the scanning period the electron beam impinges on X, and during fly-back on Y. The current to the output electrode, during the scanning period, can then be made independent of the potential of this electrode so that a linear voltage-time relation is obtained. Also, the fly-back period is very short. The time base output amplitude is independent of the input amplitude as long as the electron image falls on the correct part of the output electrode; the signal intensity may change 20 fold, in an example given, without affecting the output amplitude. Consequently, the synchronizing signal does not have to be separated from the picture signals, both can be applied to the tube input. The time base is automatically synchronized with the input signal, start of fly-back and start of



Deflection-modulated CR tube

Standard on the "Route of the Flagships"

IN 1939, American Airlines adopted the Collins 17F Autotune* aircraft transmitter as standard equipment for its entire fleet.

Previous experience on a lesser scale had indicated the wisdom of this step. Succeeding experience has confirmed it.

Compared with previous equipment, the 17F's doubled the power output (to 100 watts) with slight increase in weight, and the Autotune* provided thirteen quickly available operating frequencies instead of three.

Daily through the years, these rugged, uniquely efficient airborne 17F's and powerful Collins ground transmitters have given trustworthy support to a superb Operating Department in maintaining the great American Airlines tradition of safety and dependability.

After the war, Collins will again specialize in the development and production of advanced types of communication equipment for commercial aviation.

Its designs will bear the fruit of intense research and outstanding engineering achievement now engaged in meeting the hard demands of military service all over the world. Collins Radio Company, Cedar Rapids, Ia.

*The Collins Autotune is a repositioning mechanism which quick-shifts all transmitter or receiver controls simultaneously and with extreme precision to any one of a number of pre-determined frequencies. U. S. Patents issued and pending.

COLLINS

scanning period being synchronized, while only the fly-back is synchronized in conventional systems. Further, if the potential of the output electrode is applied directly to the deflection plates of the cathode ray tube of the television receiver, the potential applied to the plates at the beginning of each scanning may be made equal to the potential of G_2 so that each scanning starts at exactly the same level.

Another similar type of tube, incorporating two adjacent output electrodes having the Y parts displaced in the direction of movement of the electron beam, may be used to produce both, the line and frame time bases. An auxiliary electrode and another deflection plate have to be added. A high order of multiple interlacing can be achieved. Asymmetrical deflection is produced and the cathode ray tube must be corrected. If electromagnetic deflection is employed the output of the deflection-modulated CR tube is applied to a conventional amplifier which is loaded with the deflection coils of the picture tube.

Electro-Magnetic Wave Crystal

N. S. Japolsky (Nature, London, July 1, 1944)

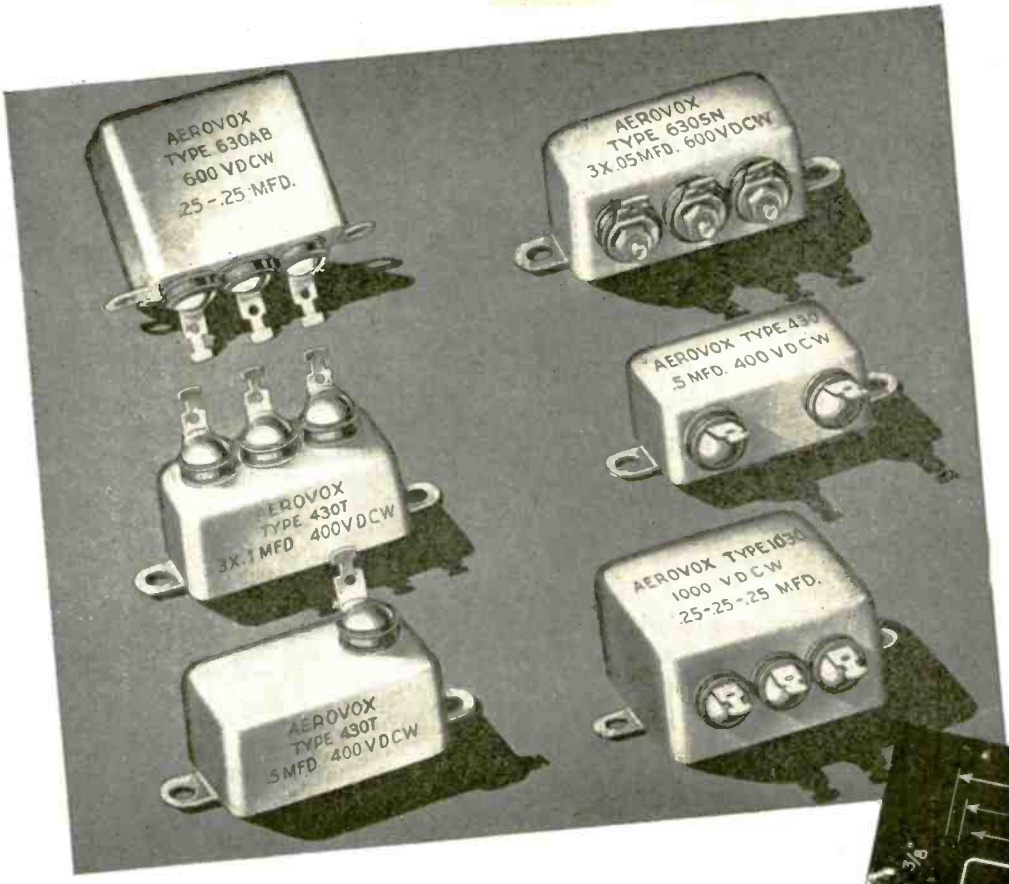
It is proposed to cause crystallization to proceed in a space filled with stationary electro-magnetic waves with the nodal points—which are the points of maximum stability of corpuscles,—corresponding to the positions of the atoms in the crystal. The stationary electro-magnetic waves forming such crystals can be produced by interference of monochromatic X-ray beams or by using electron diffraction.

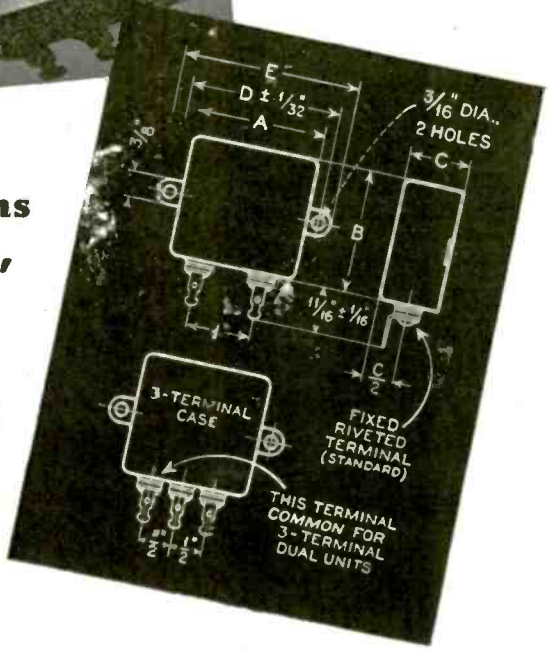
For instance, diamond could be formed by the solidification of carbon vapor in a stationary electromagnetic field; the wavelengths required would be about 2A. No experiments along these lines have been made as yet, and the author publishes the suggestion in the hope that some who have the opportunities and equipment may be inclined to follow it up.

Temperature Coefficient of Air-Cored Coils

A. Bloch (Wireless Engineer, London, August, 1944)

The temperature coefficient of air-cored coils is computed for the case of a thin conducting skin, taking into account the thermal changes of the coil dimensions as well as the inductance changes caused by variations in the resistivity of the coil conductor and of other conductors situated in the





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WIDE READING

field of the coil. These conductors can be considered as the closed secondaries of a transformer which influence the total inductance L; the resulting contribution to the total inductance is called the internal inductance, L_i, as distinguished from the self-inductance, L_o, of the coil. Increasing the resistance of those secondaries will decrease the eddy currents in them and consequently decrease their influence.

By a simple first approximation the internal inductance, L_i, is found to be equal to L/Q, where L is the total inductance of the coil, or $L = L_o L_i$. It is shown mathematically that the temperature coefficient of the internal inductance equals ½ of the temperature coefficient α of the resistivity of the material used, for instance 2100×10^{-6} for copper. The corresponding temperature coefficient of the total inductance of the coil will then be equal to $\alpha/2Q$, for copper $2100 \times 10^{-6}/Q$. The effects of various parts, such as the coil proper and the shielding, are additive. The internal inductance is independent of changes in wire dimensions.

However, the self-inductance of the coil, L_o, is proportional to the coil dimensions, and any change in dimensions due to temperature will consequently influence the

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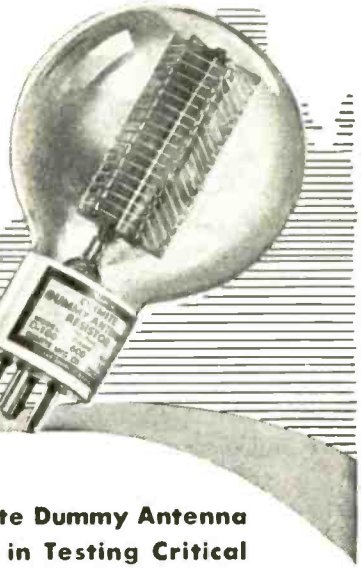

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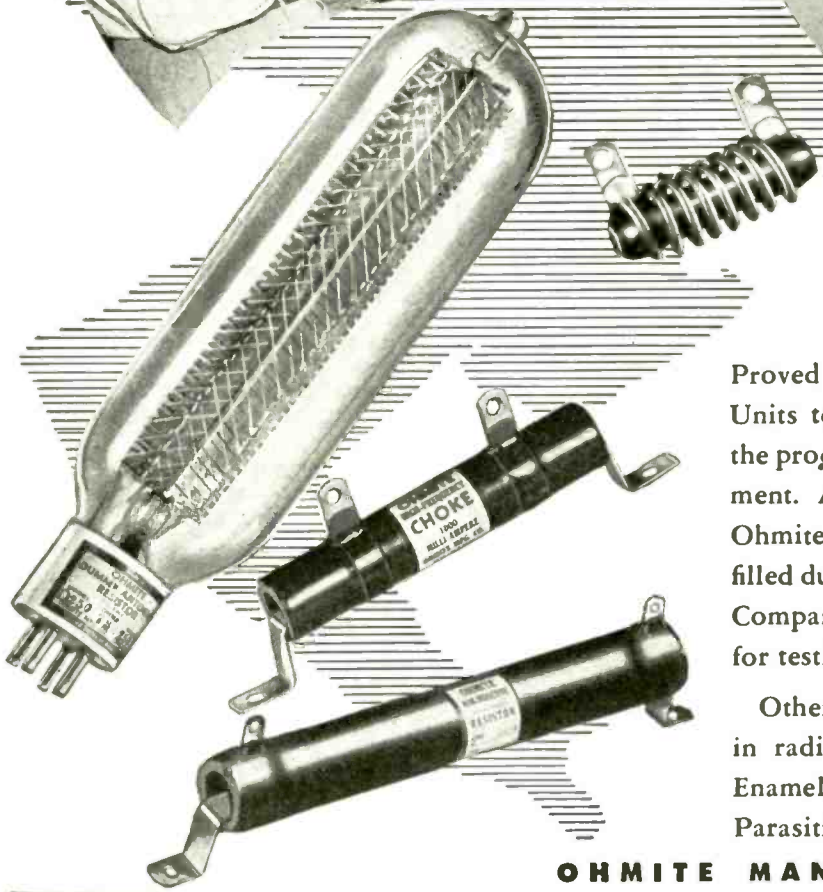

Proved by use before war came . . . Ohmite R.F. Units today are performing vital functions in the production and operation of vital war equipment. An interesting example is the use of Ohmite hermetically-sealed, glass-enclosed gas-filled dummy antenna resistors by Collins Radio Company, and other well-known manufacturers for testing and measuring power output.

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WIDE READING

total inductance. The corresponding temperature coefficient will have to be added to the temperature coefficient due to the internal inductance.

Electron-Optical Voltmeter

L. Jacob (Beama Journal for the British Electrical Industry, London, May, 1944)

In an electron lens system where the cathode is completely surrounded by the modulator, the beam angle α depends exclusively on the ratio of anode voltage to modulator voltage, varies linearly with the modulator voltage for constant anode voltage, and, at zero modulator voltage, is the same for all anode voltages. The beam angle α varies from zero at the suppression point, when the modulator is biased negatively to the cut-off value, to the maximum beam angle when the modulator is at zero potential.

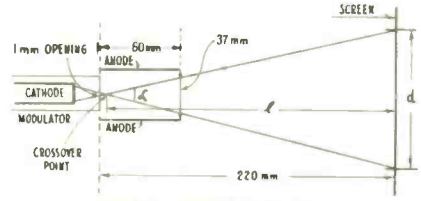
The beam angle α is determined by the distance 1 between crossover point and screen and the beam diameter d at the screen. The crossover point being practically fixed and, consequently, 1 constant, the beam diameter d can be used for the measurements.

The measurements can be carried out by applying the unknown voltage to the anode and finding the modulator voltage for cut-off either by visual observation of the fluorescent screen or by a Faraday cage placed behind the screen. The slope of the experimental calibration curve was about 7 volts modulation per kv applied to the anode; the cut-off point was constant to about 1 volt, i.e., the error is about 3 per cent at three quarter full-scale.

The second method of measurement is to keep the beam angle constant, but not at cut-off, by adjusting the modulator voltage. The constant beam angle can be read from a scale engraved on the screen or determined with a Faraday cage. Visual observation of the width of the beam gives an average accuracy of 5 per cent, while the Faraday cage method gives an accuracy within the 3 per cent limit.

Also the value of the beam angle at constant modulation potential will be an indication of the unknown anode voltage.

Though, theoretically, there ap-



Electron-optical voltmeter

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WIDE READING

pears to be no limit to the voltage which can be measured, the present range is limited to between 2 and 20 kv dc or ac.

Magnesium Alloy X-Ray Tests

R. Taylor (Iron Age, July 20, 1944)

X-ray inspection of magnesium alloy test bars is suited to detect shrinkage, gas blows, oxide or sand inclusions which are associated with low mechanical strength. Test bars should be inspected and sound specimens used for the subsequent tests of their mechanical properties, because only these are representative of the melt from which the castings will be poured.

Regulator for Arc Furnaces

J. E. Reilly and C. E. Valentine (Electrical Engineering, August, 1944)

The regulator controls the position of the electrode as determined by response to current in the electrode and voltage between the electrode and the furnace shell, the voltage increases with a decrease in arc current. The difference between the two derived voltages is amplified and regulates the conduction of thyratrons which provide more or less current for the

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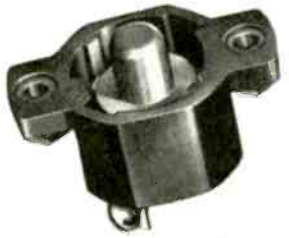

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WIDE READING

motor field. Apparatus and performance are described in detail.

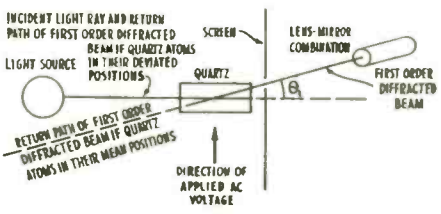
The Ultrasonic Diffraction Grating

R. A. Houston (Philosophical Magazine, London, March, 1944)

Standing ultrasonic waves in a quartz crystal produce layers of different density in the crystal, and, consequently, layers of different refractive index; a rarefication diminishes the refractive index and a condensation increases it. If a parallel beam of light traverses a quartz plate at right angles to the direction of the standing ultrasonic waves, the variations in the refractive index will produce periodic changes in the phase of the electromagnetic light waves and cause a diffraction spectrum. A quartz oscillating at its nth harmonic is equivalent to a diffraction grating of n rulings. The angular deviation of the first order diffraction band has been used to measure the wavelength of the oscillator driving the crystal.

Experimental results show that the overtones of the lengths resonance oscillations of a quartz plate are not exact multiples of the fundamental. However, when the thickness is small compared with the other dimensions, the harmonic law is obeyed very accurately by the thickness oscillations. Within the range of the harmonic law the velocity of the ultrasonic waves is constant, but it was established to vary from quartz to quartz, and, consequently, the grating constant is different for different quartzes.

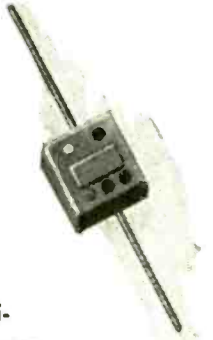
The apparatus shown in the figure has been used to measure the velocity of light. All light beams, except the first diffracted beam are stopped by the screen. The first diffracted beam is reflected back in its path by the lens-mirror combination. If the crystal grating is in action, (i.e., the crystal atoms are in their deviated positions), when the reflected beam passes through the crystal, the first order spectrum is diffracted back toward the light source; if the quartz atoms are in their mean positions, there is no diffraction and the beam proceeds in its originial direction as indicated by the dotted line. Consequently, when the lens-mirror combination is continuously moved away from the



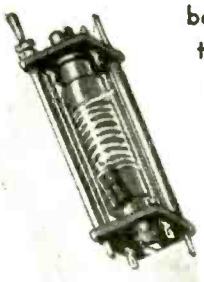
Measuring light velocity with ultrasonic diffraction grating

PRODUCTION TESTING WITH PANORAMIC

Any variation in magnitude which can be converted to a variation in frequency—quantities such as length, permeance, volume, and height—can be more quickly and accurately measured by the PANORAMIC COMPARISON TECHNIQUE. Capacitors, inductors, resistors, and crystals are "naturals" for PANORAMIC production testing. A simple jig and a PANORAMIC COMPARATOR will provide your tester with an unbeatable combination for speed and accuracy on the production line.



In application, the component under test is placed into the jig containing the standard. The chosen tolerance may be established quickly by means of the panel control on the PANORAMIC COMPARATOR. From the deflections which appear on the PANORAMIC screen, deviations from the standard become immediately apparent both as to percentage and type. The instrument is usually adjusted so that a visible deflection indicates that the production unit is within the predetermined tolerance range, while the absence of deflection indicates an error in excess of the permissible tolerance. Coincident deflections indicate zero error; displaced deflections tell their own story regarding the percentage of error. PANORAMIC COMPARISON TECHNIQUE is economical in time and energy . . . but extremely accurate in results.



Our engineers will gladly suggest simple jigs for use in any type of production testing.

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WIDE READING

quartz, so that the time interval during which the diffracted beam travels from the quartz to the lens-mirror combination and back increases, the return beam undergoes a periodic change in intensity; the positions of maximum intensity depend on the travel time of the beam to the lens-mirror combination and back, and the travel time is in turn a function of the light velocity to be measured.

The author measured the velocity of light in water by this method using a length of four meters of water. Three different colors of light were used. The accuracy obtained was one part in seven hundred. If the electric wave length is three meters, the positions of the reflector which give intensity are 37.5, 112.5, 187.5, 262.5 cm, etc.

Counter for Ionizing Particles

C. B. A. McCusker (Journal of Scientific Instruments, London, July, 1944)

Counters have been built where the cylindrical metal electrode of the conventional Geiger-Mueller counter is replaced by three metal rods arranged at the corners of an equilateral triangle or by six metal rods arranged at the corners of a regular hexagon. In this type of counter the ionizing particles do

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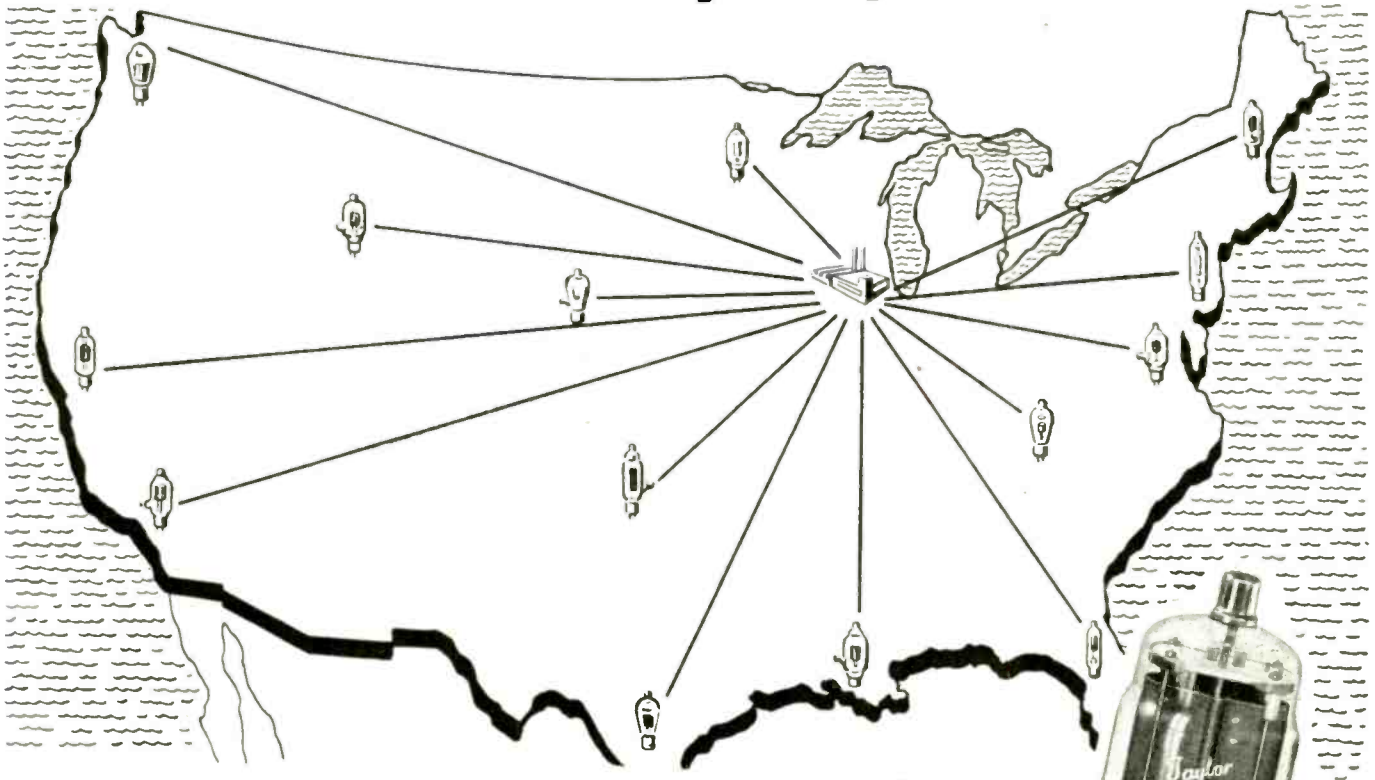

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WIDE READING

not have to traverse the metal electrode so that particles of less energy (1.5×10^6 eV as compared with a minimum of 3×10^6 eV for conventional Geiger-Mueller counters) will initiate a discharge and be registered. Further in coincidence counting, several counters can be placed with adjacent sides in parallel, which is not possible for the conventional cylindrical counters. The dimensions of the counters, the material used and the results obtained are discussed.

Resistance Furnace Control

H. J. Hague (Steel, August 14, 1944)

The ac line is connected to a saturated core reactor and hence to the heating element of the furnace to be controlled. A thermocouple is placed in a desired position in the furnace and its output terminated in a pyrometer. A motor in the pyrometer operates a sliding resistor contact so that its position corresponds to the furnace temperature as indicated by the thermocouple. Any deviation of this sliding resistor contact from a desired value will result in the unbalance of a circuit and in adjustment of the firing angle of two thyratrons which control the dc through the saturable reactor.

TRANSIENT RESPONSES

(*Continued from page 82*)

It is interesting to note the close formal relation between the definitions of W_A and W_T. One measures a time and the other a frequency and in exactly the same way. Thus the formula for $1/W_T$ is exactly like that for W_A with f replacing g and t replacing W.

Actually the above "derivation" which purports to show that (4) is a measure of the mean square error is fallacious. But a more detailed and refined procedure exists which shows that (4) really is such a measure.

In any case, it is obvious that (4) is a sensible measure of the response to a delta function, for it essentially says that the bigger the output, and the shorter the time it lasts, the better the transient response.

Examples

But perhaps the best way to show this is to introduce some typical examples. This is done in Table I. Here we consider the transient response of a number of possible amplifiers, most of which might well occur in practice. To give a common basis for comparison it has been assumed that all the amplifiers are so proportioned as to have the same amplitude bandwidth. The various amplifiers, and some of the relevant numbers, are tabulated in Table I.

The first case—a single stage only—is not likely in practice but has been introduced because of its simplicity. As one uses more stages the proportions are, of course, changed to keep the amplitude band constant. We give the results for two stages and a very large number. By a "perfect" band pass we mean a flat response out to band edge and zero thereafter, and with linear phase response. While not physically realizable this might be well approximated by a filter coupled amplifier with a phase correction network.

By a stagger-tuned amplifier we mean the sort introduced by Landon in which the various stages are tuned to different frequencies and have different loadings in such a way that the poles of the gain function are evenly spaced on a semicircle centered on the real ω axis. By filter coupling we mean an amplifier suggested by Wheeler in which each stage is coupled by the two terminal impedance presented by the input of an infinite filter.

It will be observed that the values of W_T, the transient bandwidth, vary over a considerable range. Whether or no this W_T is a suitable measure of the transient response may perhaps be decided by inspection of plotted curves of the response of the various amplifiers to

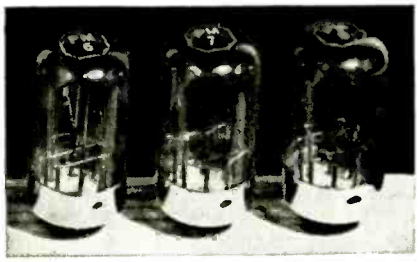
SYLVANIA NEWS

ELECTRONIC EQUIPMENT EDITION

NOVEMBER *Published in the Interests of Better Sight and Sound* 1944

PM Lamps Offer Easy Way of Measuring RF Power Output

The group of Power Measurement Lamps introduced by Sylvania a little over a year ago have fully demonstrated their merits as a simple, accurate means of measuring the high-frequency power output of radio equipment.



3 of the 6 Sylvania PM Lamps

The present series consist of 6 lamps, with which power outputs ranging from 0.05 to 25 watts can be measured directly, with the aid of ordinary meters. Accuracy of the measurements is within 5%, without any special calibration of the lamps.

Full information on the principle of operation of these lamps, and on their ratings and characteristics, is available from Sylvania.

DID YOU KNOW...

That fluorescent lights are now helping with the job of guiding Pan American Clippers to port? They illuminate seadrome landing strips which were developed by Sylvania in cooperation with Pan American.

* * *

That 7½-watt ruby lamps have been developed by Sylvania for use in Army photographic printing equipment? Smaller than most lamps of its type, the 7½-watt size is easily installed in portable printers.

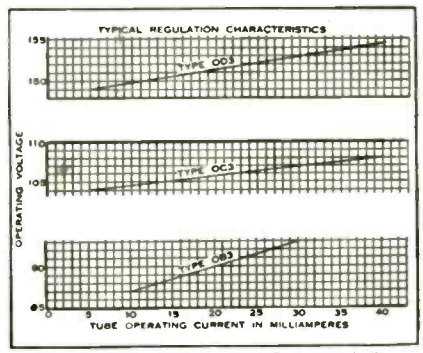
* * *

That the Army Medical Corps' new ten-car hospital train is fluorescent lighted throughout? Patients in the tropics will be more comfortable under these lights, which radiate little heat.

Regulator Tube Maintains Voltage within Narrow Limits

Maximum Regulation of Type OC3/VR105 Is 4 Volts over Operating Current Range

A voltage regulator tube, for applications where practically constant voltages must be delivered to a load, was recently placed on the market by Sylvania. Like previous tubes in the Sylvania line of voltage regulators, the new tube, designated as Type OC3/VR105, is of the gas filled, cold cathode type. It's outstanding difference from earlier types lies in its lower voltage regulation. With a design center operating voltage of 105, the OC3/VR105 has a maximum regulation of 4 volts over the operating current range from 5 milliamperes minimum to 40 milliamperes maximum. Characteristics of the new tube are compared with those of the OB3/VR90 and OD3/VR150 in the accompanying curves.



Comparative regulation characteristics of Sylvania voltage regulator tubes.

It should be noted that individual tubes may not deliver identical voltages to the load. However, the voltage will be within the specified operating limits of 105-112 volts, and the regulation 4 volts or less for any tube.

Base diagram of OC3/VR105

The tube is mounted in an ST-12 bulb with a standard small 6-pin octal base.

A current-limiting resistor should always be used in series with the OC3/VR105, to keep the operating current through the tube down to 40 milliamperes if the load should be disconnected.

28D7 USEFUL AS VOLTAGE BOOSTER

With 28-volt operation of radio equipment attracting increasing interest in its current aircraft applications, and in its commercial potentialities, the Sylvania Type 28D7 is finding new fields of usefulness.

The 28D7 is a Lock-In output tube specifically developed for operation direct from a 28-volt source. The 28D7 can be used as a convenient voltage booster. This feature is particularly important where the 28-volt supply may drop too low to operate tubes having a critical minimum voltage.

For voltage boosting, the 28D7 is coupled as an oscillator to a load coil of the required characteristics, and the output rectified by a diode. Output voltages up to 500 to 600 volts can be obtained in this way.

"Car 54 go to 8th and Main—Signal 17 and doesn't the transmitter sound swell since I put in those Sylvania tubes? That is all."

a delta function. After considerable study of these, and many other responses we have come to the conclusion that the criterion W_T certainly puts the various responses in the proper order and even that it is a suitable quantitative measure, though this last point is to a considerable extent a matter of personal taste. An exception must certainly be made for the single RC stage which, while good, is certainly not so good as is indicated by W_T. But a closer examination reveals that this really is a highly special case and that one need not worry about the possibility of other similar cases appearing.

Evaluation of transient responses

Even if we agree that W_T is a good measure of transient response, it will not be of much use unless it can be evaluated easily enough to make its use a practical matter rather than a mathematical exercise.

In the first place, it is quite obvious that W_T may be evaluated simply and directly from an oscillogram of the output of an amplifier subjected to a delta function input. Practically this should be simple and easy, except that suitable signal generators are not as common as one might wish. A suitable "delta function" is a pulse short compared to $1/W_T$. The pulse duration must be variable if a very wide range of amplifiers are to be tested as a pulse suitable for a wideband amplifier would overload a narrow band one before sufficient output was obtained. Also, W_T may be obtained, though with reduced accuracy, from the response to a square wave.

Second, we may say that we have devised mathematical methods which enable W_T to be evaluated without great difficulty for practically any coupling scheme and for any number of stages. If the possibility of this mathematics may be said to turn on any one thing, that thing is the fact that W_T is so defined that it can be found from W_A and a single point on the transient response—the maximum. Thus one need not compute the complete transient response.

Lastly, we present the final results for a series of coupling schemes believed to include most of those likely to be used in practice and for numbers of stages running from one to one hundred. These results are in the form of graphs which show each coupling scheme, W_A, W_T and W_T/W_A as a function of the number of stages.

WHAT WE'VE BEEN THROUGH!

1251200 TINNISWOOD. B. SGT.
ROYAL AIR FORCE.
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24/9/43.

DEAR SIRS. During a few quiet spare moments out here on the latest battle front, I thought that perhaps you would care to know the history of one of your model 8-K Recording Machines. Just what it has been through, just what it has done for thousands, perhaps millions of people all over the world, and just what it is doing at the present moment.

It was available in Cairo over two years ago, and the RAF purchased it for the Mobile Recording Unit for work on the front, recording everything and anything that would be interesting to the public of the world.

I am the engineer that has had the pleasure of operating this machine all this time, and being in the radio trade for fourteen years, should know when a set is well made or not.

It has travelled over 23,000 miles. Aproximatly 20,000 by road, track, or desert, in one of the hardest sprung trucks of the British Army, and 3,000 by air.

It has recorded bomb and shell explosion in slit trenches, covered with dust. Blown over on one occasion by blast.

Dropped on numerous occasions.

Has recorded in the air, and on sea rescue craft, with better results than expected.

2

Has travelled to:- Amman Transjordan, to Tripoli, back to Cairo, back to Tripoli, on to Tunis, Bizerte, on to Algiers, back to Tunis, on to Sicily, all through Sicily, on to Italy. All this way by truck, recording, reecording, recording. Never once, through all this bumping, buffetting, and banging about, has it let our little party down. Never in my opinion, has any radio apparatus stood up so well, for so long in such conditions.

Recordings from this machine have been broadcast from the following countries. England; America; Canada; New Zealand; Australia; Sth Africa; Egypt; Palestine; Algeria. Perhaps presently, from Italy itself.

Please thank your engineers and assembly workers for such an efficient and trouble free recorder, and may you continue to put such products on the market.

If you care to acknowledge this letter please address to my home in England. 110 Cardinal Avenue, Morden Park, Morden, Surrey, GB.

Yours truly,
B R Tinniswood

To:- The Managing Director,
Presto Recording Corp.
242 W. 55th St., New York; U.S.A.

Presto Recording Corporation, New York 19, N.Y., U.S.A.
World's Largest Manufacturers of Instantaneous Sound Recording Equipment and Discs
Walter P. Downs, Ltd. in Canada

ENGINEERING SUCCESS

(*Continued from page* 111)

And also do not hesitate to aspire to an executive position in the organization. Too few organizations, even though highly technical in character, have engineers in executive positions. Rather we find erstwhile bookkeepers or stenographers, salesmen or bench workers, bankers or clerks, or others of similar non-technical training, heading the destinies of such companies, while their engineers simply carry out their orders. But the fault lies with the technicians. They have failed to appreciate the importance of a business-mindedness.

High self esteem

Sixth and last, hold yourself in high esteem if you would have others appraise you at your true worth. In this regard I like the way the French refer sometimes to engineers. Their military engineers especially are called the "GENIE." And genie means the genie or supernatural spirit in Arabian folklore, capable of doing fantastic things at the bidding of their master. Remember Aladdin and his wonderful lamp? Precisely so with you engineers and technicians in the world of 1944.

You are invited to take your rightful place in the bigger brighter world now in the making.

What will you need...

IN THE FIRST SIX POST-WAR MONTHS

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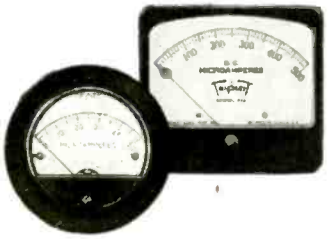
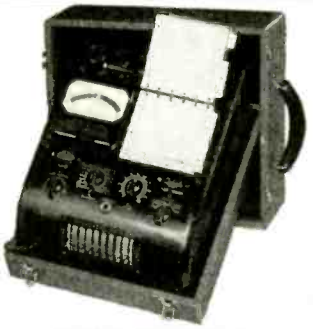


PANEL INSTRUMENTS

VOLT-OHM-MILLIAMMETERS

POCKET TESTERS



TUBE TESTERS

VOLT-OHM-MILLIAMMETERS

✓ CHECK THE TYPES AND QUANTITY

NOW—right now—is the time to protect your post-war business by estimating your future equipment needs. Check those needs, list them and place a *tentative post-war order* with your jobber now. This foresight will enable him to stock the Triplett instruments you will need, and will assure you quicker resumption of civilian business than you could expect if you wait till the last minute. Give best priority you can obtain to facilitate deliveries as production is available.

Newly perfected developments now being produced on important war contracts, and many other outstanding instruments, will be incorporated in Triplett offerings for the first time beginning with our initial civilian production. Be sure you get the complete list of Triplett instruments and radio test equipment.

Triplett

ELECTRICAL INSTRUMENT CO.

BLUFFTON OHIO ★★★

STANDARDS ARE SET BY TRIPLETT

CHEMICAL FUNCTIONS

(*Continued from page* 100)

cedure. For example, it is often of importance to know the stage of polymerization of resin impregnated material such as laminated bakelite, molded coil tube materials, impregnated paper, etc.

The acetone extraction method whereby the acetone extractable material has been used as a measure of non-polymerization is of some value with a given, known resin. However, when insulating materials of this type are submitted by different manufacturers, manufactured of resins, and perhaps plasticizers, not known to the user, the acetone extraction method becomes unreliable and other tests must be substituted. A. R. Dunton in the "Journal of the Institution of Electrical Engineers," Volume 90, Part 1, No. 35, November 1943, has described a piece of apparatus for the purpose of evaluating the degree of polymerization of synthetic resin varnish coated paper which may be said to be appropriate to many similar materials.

Basically, the apparatus "consists of a horizontal electrically-heated cylinder, 5¼ in. diameter by 4 in. wide, round the surface of which are wound two complete turns of a 2-in. ribbon of treated paper when subjected to a tension of 350 grammes. The heat produced by the electrically-heated cylinder causes the resin used on the paper first to soften, then to melt and finally to harden, at which stage adhesion occurs between layer and layer, so that when the cylinder is allowed to unwind slowly this adhesion reaches a stage where no further unwinding occurs. The number of degrees of rotation of the cylinder can be taken as the greenness number." Expressed differently, the number of degrees of rotation of the cylinder may be taken as a measure of the degree of polymerization.

Other special tests mentioned by Mr. Dunton include apparatus for testing moisture resisting properties of various varnishes, paints and enamels; a method and apparatus for determining plastic yield, etc.

The latter comprises essentially a bottle filled with water and inverted on the sheet of paper under test. The paper sample rests on a flat brass plate. "The bottle and the plate are connected in series to a low-voltage battery and a delicate milliammeter as illustrated. The test consists in noting the number of seconds that elapse before the current passing through this circuit reaches a selected figure. With absorbent papers this period may be 5-20 secs., whilst with a non-absorbent paper such as grease-proof the period may be as long as 600 secs."

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THE ENGINEER who helped design this special machine has a son in the South Pacific, the girl who feeds in the "nails" has a boy friend with General Patton. Like other Americans with a stake in Victory, these Remler workers take a personal interest in improving techniques to lower costs and speed up deliveries. • For complete sound transmitting systems; radio; plugs and connectors and other electronic components in metal and plastic, consult . . .

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58	65	108	125	354	No.
59	67	109	127		212938-1
60	68	112	149		

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

OTHER DESIGNS TO ORDER

X-RAY TUBE

(Continued from page 79)

problem of insulation for the cathode heating system is solved by the use of a generator driven by the moving belt and thus insulated from the ground end of the system. The 12 kv steps are obtained by a resistor bleeder network across the generator output.

The difficulties of producing such a tube were enormous. For example, there are 300 feet of glass-to-metal seal in each tube. This is more than in 1000 ordinary X-ray tubes. The seals must not only stand external atmospheric pressure but from 200 to 400 lb. of air pressure surrounding the outer surface for insulating purposes. The problem of sealing the metal rings between the glass rings is accomplished by a combination of gas fires and induction heating. The gas fires soften the glass while induction heating is used to bring the temperature of the metal ring to such a point that the correct oxide formation takes place to produce a strong seal. The tube is built on a vertical lathe and the column is so accurately aligned that a deviation of less than 0.020 in. occurs from top to bottom in spite of the number of junctions.

Most of the applications of this new tube are war secrets. However, many things are expected of it. For example, for deep therapy treatment of cancer it is almost twice as effective as a 200 kv X-ray tube for the same skin dose.

The greater penetrating power of super-high voltage X-rays makes it possible to produce a strong dose below the surface of the skin without subjecting the surface layers to the harmful dose.

Since the transmission type target used in this tube produced the major X-ray intensity along the same line that the electrons are traveling, the intensity distribution angle of the X-rays from the target decreases as the voltage increases and it is considered probable that for many applications about 4 million volts may be the upper practical limit for tubes of this type. Otherwise the X-ray beam angle becomes so sharp that it is difficult to cover a large enough area at close ranges.

Philco's Tele Boosters

Seven relay, or booster, stations for television are to be established by Philco Radio and Television Corp. Three of them are to be in Havre De Grace and Sappington, Md., and Honeybrook, Pa. They are to operate in channels 13 and 14, will be of 15 watts video and 10 watts audio. The other four to operate on channels 11 and 12 will operate from similar locations, with the same power.

Great Events in the History of...

COMMUNICATIONS!

The Telephone Talks! "Mr. Watson, come here, I want you!"—this sentence uttered by Alexander Graham Bell on the evening of March 10, 1876, was the first ever transmitted by telephone. This great event soon led to the beginnings of the Bell Telephone System—for which Western Electric has been the manufacturer ever since 1882.

The Telephone Spans the Continent! On January 25, 1915, Alexander Graham Bell talked once more to Thomas A. Watson on a momentous occasion—the first time a telephone message crossed America. This great advance was made possible by the use of Western Electric vacuum tube repeaters—the first of many millions we have produced for the Bell System.

EVEN BEFORE the first of these events Western Electric—founded on November 18, 1869—was making electrical communications equipment. Bell Telephone maker since '82—pioneer in radio since its beginning—the Company today is the nation's largest producer of electronic and communications apparatus for war. In the peace that's coming, count on Western Electric—with its unique 75-year experience—for continuing leadership.

During the 6th War Loan Drive, buy more Bonds than ever!

Radio Telephone Spans the Atlantic! Just before dawn on October 21, 1915, the first spoken words spanned the Atlantic—transmitted from Arlington, Va., and received in Paris by radio telephone apparatus designed and made by Western Electric. Out of this pioneering came world-wide telephony—broadcasting—aviation, marine and mobile radio.

75TH ANNIVERSARY

Western Electric

ARSENAL OF COMMUNICATIONS EQUIPMENT

SOUND AMPLIFICATION

(*Continued from page 87*)

associated coupling channels, and that of the amplifier. The latter can, of course, have modified characteristics to compensate to a degree, other deficiencies in the system since the low power requirements of 15-20 watts does not constitute an arrangement that is unwieldy, and simple compensated feedback circuits are quite effective.

The curves Fig. 5 show one sound pressure/frequency curve with the circuit set-up by which the measurements were made. A curve representing speaker input power at the same frequencies is also shown. This represents a combination selected for speech operation over wide areas. Variations in both the modulating unit and the associated equipment are applied to increase the output at higher frequencies when music is to be handled.

SUPER-FM USES

(*Continued from page 78*)

pensation will give the contact lock-in range beyond the knee of the curve.

The lock-in range depends upon the amount of quadrature current that can be developed by the tube. The tube should have a fairly high zero-bias plate current and a fairly high mutual conductance from the No. 1 grid to plate. This assures large pulses of plate current which produce the required reactive current.

The primary effect of IF selectivity is to attenuate the voltage on the No. 1 grid as the signal frequency moves down the side of the selectivity curve. This means that the band-width of the IF amplifier will affect the lock-in range. The range falls off very rapidly when the applied voltage falls below the knee of the curve, and the amplifier should be designed so it is broad enough to assure sufficient voltage to lock-in the oscillator at the maximum frequency swings encountered and also to provide for drift and mistuning.

The lock-in range will increase somewhat with increased mutual inductance from the tank coil to the feedback winding. Fairly tight coupling should be used for increased range. A method which can be used to increase the lock-in range is to tune the feedback winding to the second harmonic of the oscillator as shown in Fig. 2. Capacitor C is chosen to tune the grid circuit to 1720 kc. This builds up to the second harmonic which in turn causes an increase in the fourth and sixth harmonics because of the nonlinearity of the tube.

A modification of the frequency-dividing FM receiver has been developed by which its ability to select between desired signals and

Perfection is Our Aim!

In every industry there are various methods of turning out products for similar use requirements. Usually there is *one best way* — a way based on developing and following certain tested techniques — proved processes that in themselves guarantee uniform quality every step of the way.

James Knights owes its reputation for unquestioned dependability to a steadfast determination of finding the *one best way* of carrying out every manufacturing operation. The culmination is a certainty — the positive assurance of better operating performance for every James Knights Crystal.

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undesired signals or noise is further extended. Fig. 5 is a block diagram of this modification.

The locked-in oscillator used in this arrangement is likewise designed to operate at one-fifth of the intermediate frequency. The normal lock-in range of the oscillator, however, is restricted to only 20 to 35 per cent of the frequency variation range required for received signals. This very restricted lock-in range is extended by means of a reactance tube arrangement so that the oscillator will follow the maximum frequency variations of received signals.

The audio frequency potential developed at the discriminator-rectifier combination is applied through a phase correcting network to the reactance tube to cause the reactance tube to shift the oscillator resonant frequency so that at any instant its frequency is such that the limited lock-in range will permit it to lock in with the received signal. The amplitude of the control potential applied to the reactance tube is normally kept slightly below the value which would shift the oscillator to the correct frequency, assuming that the oscillator had no lock-in range. In other words, for 100 per cent modulation the reactance tube shifts the oscillator frequency by slightly less than ± 15 kc.

Superaudible frequency modulation noise components applied to the input circuit of the lock-in oscillator may appear in the oscillator output circuit. The phase correcting network, however, may be designed so that these components either are not fed back to the reactance tube at all or are not fed back in such phase and amplitude as to permit the oscillator to follow them.

The effect of the reactance tube arrangement on adjacent channel selectivity is also of interest. As the output potential of the discriminator-rectifier and hence the potential applied to the reactance tube varies over the useful portion of the discriminator characteristic (the linear portion of the characteristic) the effect of the reactance tube is to shift the oscillator frequency in the same direction as the frequency changes which give rise to the demodulator potentials.

If, on the other hand, a signal on the adjacent channel could reach the discriminator circuits and produce potentials caused by frequency variations over the side of the discriminator characteristic, the phase of the potentials applied to the reactance tube would be such that the effect of the reactance tube on the oscillator would be to reverse the direction of the oscillator frequency change.

That is, the reactance tube cannot shift the oscillator frequency

108 SERIES *Amplifiers*

WITH MOUNTING ACCESSORIES

TYPE 108-B two-stage Amplifier provides transformer input impedances for either 30 or 250 ohms with nominal output impedance 500 or 8 ohms. Variable gain 65/105 db. with electronic volume control. Frequency response better than ±1 db. 30/16,000 c.p.s. Power output +43 V.U. (20 watts) with less than 5% RMS harmonic content. Noise level full gain 56 db. below full output.

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TYPE 108-A two-stage Amplifier provides transformer input for either 600 ohm or bridging. 600 ohm input fixed gain 61 db. Bridging input variable gain 6/46 db. Noise level 68 db. below full output.

TYPE 108-B as illustrated and described above.

TYPE 108-C combines the input channels of the 108-A and 108-B Amplifiers. Channel 1—600 ohm input variable gain 20/60 db. Bridging input variable gain 2/42 db. Channel 2—high gain 30/250 ohm input variable gain 62/102 db. with electronic volume control. Noise level 56 db. below full output.

TYPE 108-D two-channel each 30/250 ohm input. Either channel variable gain 62/102 db. with electronic volume control. Noise level 56 db. below full output.

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TYPE 202-A Wall Mounting Cabinet permits universal installation of 108 Series Amplifiers to any flat surface. Well ventilated and designed for maximum accessibility, servicing and convenience of installation. Standard aluminum gray finish.

TYPE 9-A Modification Group permits 108 Series Amplifiers to mount on standard 19" telephone relay racks. Occupies 7" rack space. Allows servicing from front of rack. Standard aluminum gray finish.

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so that it will lock in with the signal on an adjacent channel because the circuit elements are so designed that if a frequency of the oscillator were to change beyond the useful range of the discriminator and towards the adjacent channel, the phase and magnitude of the potential applied to the reactance tube would shift in such a manner that the oscillator frequency would be shifted away from the adjacent channel frequencies.

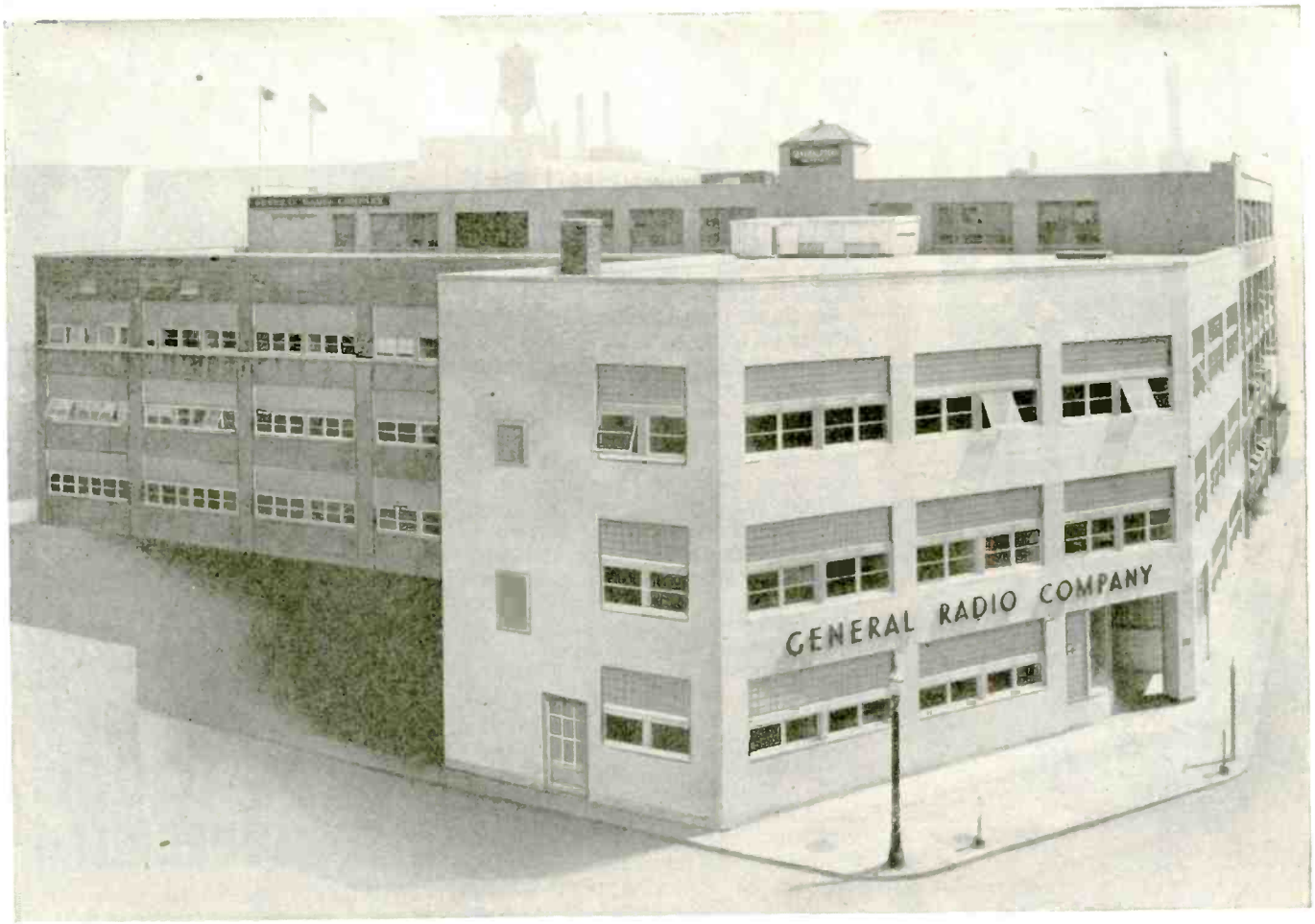
As a part of an experimental investigation of the new receiving system, work was carried on with two identical commercial receivers. One was modified by incorporating the locked-in oscillator and reduced range discriminator, shown in Fig. 2, in place of the two-tube cascade limiter and the discriminator used in the original construction. The other receiver was used for comparative tests in the laboratory and field. This procedure was repeated with two identical laboratory receivers constructed along conventional lines.

It should be noted that the locked-in oscillator circuit shown in Fig. 2 is representative of the receiving system illustrated by the block diagram in Fig. 1. This arrangement was used in preference to the modification illustrated by the block diagram in Fig. 5 because it was less complicated and, therefore, considered more suitable for commercial receivers.

Lock-in requirement

With the arrangement shown in Fig. 2 an IF signal of about one volt on the No. 1 grid of the oscillator tube was required to provide the desired lock-in range of approximately ± 110 kc. The frequency range in excess of the ± 75 kc required for the normal modulation of a received signal is provided to take care of the mistuning by the user, frequency drift of the heterodyne oscillator and overmodulation at the transmitter. The oscillator voltage developed at the discriminator was between 20 and 30 volts. From the foregoing, it is apparent that the receiver should be sufficiently sensitive to produce one volt on the No. 1 grid of the oscillator to provide satisfactory reception of a desired signal.

The results of selectivity measurements, made by the two signal method, are shown in the chart. In these tests, the receivers were tuned to a desired signal of 100 μv, with 400 cycle modulation and a deviation of ± 25 kc. An interfering signal, modulated with 1000 cycles, and a deviation of ± 25 kc, was adjusted in signal strength and frequency to give an interference output 30 db below the 400 cycle output. A considerable improvement in selectivity, especially for the entire adjacent channel, is shown with the receiver employ-



JUST AROUND THE CORNER

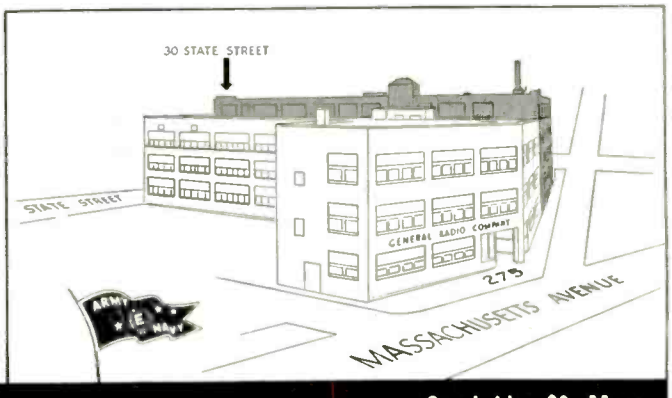
• LATELY, persons corresponding with us have noted a new address . . . 275 Massachusetts Avenue. We've moved our engineering and general business offices into a remodeled building at this location. It's just around the corner from 30 State Street, which is still ours, and which is now devoted exclusively to manufacturing.

For a long time we have felt the need for rearranging our space; for one thing we have been badly cramped in the shop; and our engineering department has been spread over several floors and mixed up with many other activities.

The new building, which is connected by ramps on two floors with the older one, provides about 30 per cent more manufacturing space, and allows all of the engineering department to be on one floor.

Under pressure of the war we have expanded our output in several ways. We have let out the manufacture of several instruments to subcontractors; we have turned over the designs, drawings and models of several instruments to other manufacturers for their exclusive use; we have rented considerable extra space in two outside buildings, in one of which we have contracted for a large number of war-time workers under our own foremen.

After the war when the armed guards have left us, we hope that you will come to see our new laboratories and offices. In the meantime we continue to devote our energies to filling war orders for electronic laboratory test equipment.



ing the frequency dividing locked-in oscillator system.

It should be noted that with an increase in interfering signal, a point of oscillator break-out may always be reached. The level of interfering signal at which break-out occurs is higher than the —30 db interference level. The improvement in adjacent channel selectivity, shown by these curves, is equivalent to the addition of two IF stages in the receiver.

Oscilloscopic investigations of the effects of impulse interference with both modulated and unmodulated signals were made with the four receivers. The results indicated a general superiority in noise reduction for the frequency dividing locked-in oscillator system.

Field tests showed the receivers using the new receiving system to be considerably more selective with respect to adjacent channel interference than conventional commercial receivers. More distortion was, however, encountered when the locked-in oscillator receivers were tuned so that the signal was received at the edges of the receiver response characteristic than was obtained with the conventional units. This is due to the oscillator break-out characteristic and the fact that the voltage at the discriminator remains fixed irrespective of the signal applied to the oscillator. In general, it can be

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stated that an increase in distortion, when tuned to one side of a desired signal, goes hand-in-hand with increased adjacent channel selectivity in any type of radio receiver. Some observers felt that this effect assisted in properly tuning the receiver.

An experimental receiver was also constructed incorporating the modified arrangement illustrated by Fig. 5. Although the tests on this receiver were not as extensive as those on the receivers in which the Fig. 1 arrangement was used, they did indicate that the modified circuit possessed superior noise reducing and adjacent channel selectivity characteristics.

[Mr. Beers' paper, presented first at the National Electronic Conference in Chicago and later at the IRE New York Chapter meeting Nov. 1, is to be published in full in the IRE Proceedings for December.—Editor.]

CONFERENCE

(Continued from page 93)

lowed by an amplifier and a cathode-ray oscilloscope. The bridge circuit most frequently used is essentially a modulator and the signal applied to the cathode-ray oscilloscope is an amplitude modulated wave. Several methods for determining whether the bridge unbalance is due to tension or compression were described in the paper.

Industrial high frequency heating

High Frequency Heating of Conductors and Non-Conductors—C. J. Madsen and R. M. Baker (Westinghouse): The theoretical concepts of the phenomena of heating conducting materials and non-conducting materials were presented which permit hf heating problems to be calculated and the economic factors determined from a study on paper. Inductive heating applications frequently require considerable development work with the parts to be heated, mainly the details of the coil design, which cannot be determined from calculation alone.

The Use of Radio Frequencies to Obtain High Power Concentrations—Wesley Roberds (Radio Corp. of America): The use of radio frequencies makes possible the application of power to metal objects in concentrations up to 100 kw per sq. inch or 20,000 kw per cu. in. under favorable conditions, together with ability to control temperature and temperature gradients accurately. This paper discussed the optimum performance of electronic heating units.

New Methods and Techniques in High Frequency Heating—Eugene Mittelmann (Illinois Tool Works): Increased efficiency and greater effectiveness can be obtained if generators are designed which are able to deliver a constant rated power to a varying load. This paper described means for achieving that end by appropriate impedance matching methods. Both induction heating and dielectric heating generators, up to 20 kw useful high frequency output, were described. In the induction heating generator the rematching takes place automatically at the magnetic point of transformation. In dielectric heating units, where the heating cycle is considerably longer than the one used in induction heating, the rematching is continuous.

Typical Industrial Electronic Applications—R. M. Serota (Allis-Chalmers Mfg. Co.): This paper surveyed electronic applications in three fields: (1) Instrumentation: Including discussion of counters, frequency rate and speed indicators, turbidity meters, shock measurements, and thermal indicators and alarms. (2) Control: Current, voltage, frequency and speed

Official U. S. Marine Corps Photo

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TECHNICAL NOTES

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

Circuit Equivalents

The November issue of CREI NEWS continues with a discussion of Circuit Equivalents.

First the meaning of physical realizability is taken up and examples of circuits are given that are physically realizable in one form of configuration and not in another. Then the general problem of network synthesis and analysis is discussed so that the reader will be able to appreciate what is meant when it is desired to have one circuit equivalent to the other on a two-terminal basis or on a four-terminal basis.

Part II together with Part I which appeared in last month's issue will enable the reader to understand more completely the significance of the practical examples that are to follow in subsequent issues.

In case you are not aware, these articles, which appear in the CREI NEWS, monthly house organ of the Capitol Radio Engineering Institute, are examples of the material appearing in our advanced lesson section that we believe will be of interest to practicing engineers and students alike. If you have not already written for a free copy, do so now and become better acquainted with our activities.

These articles are available free of charge. Simply write to the Institute and request the November issue of "The CREI NEWS" containing the article on "Circuit Equivalents."

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

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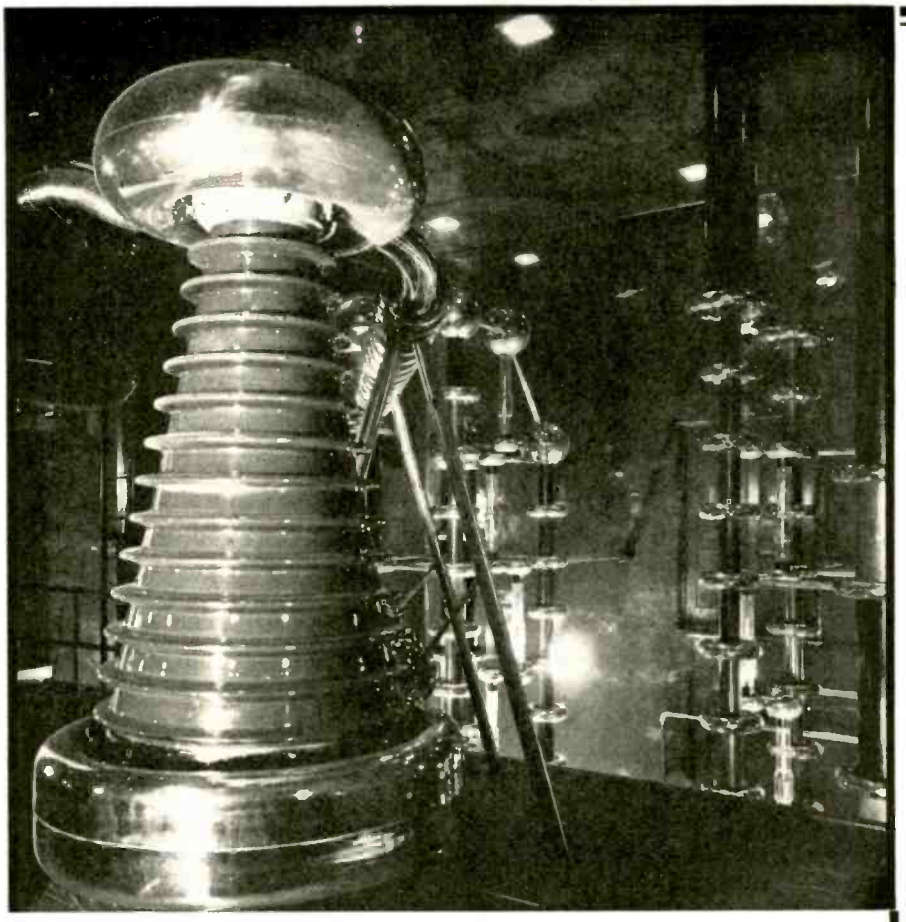

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(7) Core Casting
(8) Drain Casting
(9) Throwing

and certain other methods which at the present have only limited application.

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regulators for motors and generators, electronic timers, limit switches, and safety devices. (3) Power: High frequency induction heating of metals.

Theoretical electronics

Recent Researches and Postwar Radio—G. C. Southworth (Bell): This paper reviewed briefly the work of pioneering physicists and described some of the expedients and changes of technique used to overcome difficulties as this work progressed to higher and higher frequencies. The wave-guide or hollow pipe technic provides a simple and efficient way of propagating micro-wave power from one point to another. There have also grown from it some interesting counterparts of the tuned circuits, the matching transformers, and the filters that have been in common use for some time at the lower frequencies. The possible bearing of this new technic on the future of electrical communications was pointed out.

Beginnings of Nuclear Physics—K. K. Darrow (Bell): This discussion of the highly theoretical subject of nuclei physics was presented in a simple manner. Each chemical element has at least one type of nucleus, and most have several. The art of transmution consists in bringing two nuclei together in such a way that they merge momentarily and then break apart into two new clusters in which the original protons and neutrons are redistributed. As a rule this requires the application of very high voltages produced by very special types of apparatus. Every known element has in this way been obtained from other elements. Many of the nuclei thus provided are radioactive, so that radioactive forms of all known element are now available.

A Theorem of Larmor and Its Importance In Magnetic Fields—Leon Brillouin (Columbia University and Federal Radio Laboratories): The author emphasizes the importance of a well known theorem, originally due to Larmor. It enables a definition of "momentum" and "moment of momentum" for electrons in a magnetic field, hence the possibllity of writing the conservation of these quantities, when the geometry of the structure is convenient. As typical examples of the method, two special cases were discussed: a plane electron beam and a cylindrical electron beam with longitudinal magnetic field. In both cases it is found that the space charge density of the beam is entirely controlled by the magnetic field, and that the maximum current is obtained for a suitable optimum magnetic field.

Microwave Oscillation Generators Using Velocity Modulated Beams—E. U. Condon, (Westinghouse): This paper gave an elementary discussion of the way in which slowness of electron motion appears as a limitation on Class C oscillators intended for use at micro-wave frequencies. It then presented the main results of the elementary theory of three kinds of velocity-modulated tubes, namely, the Monotron, the Klystron and the reflex Klystron.

Some Considerations Concerning the Internal Impedance of the Cathode Follower—H. Goldberg (Stromberg-Carlson Telephone Mfg. Co.): For rectangular and sine wave input, the internal impedance of the cathode follower working into a load consisting of R and C in parallel is not bilateral except under special conditions. These conditions are not too restricted for sine wave input but are very restricted for rectangular wave input. For all other conditions, the internal impedance is unilateral.

Tube developments

The Lighthouse Tube—E. F. Peterson and E. D. McArthur (G.E.): A discussion was presented of the disk-seal tube development in general and the lighthouse tubes in particular. The mechanical design features and constructional details of the GL-2C40 and GL-2C43 were discussed. The electrical characteristics were given together with some of the operational precaution and limits.

Development of Electron Tubes—I. E. Mouromtseff (Westinghouse): The main types of modern electronic tubes were briefly surveyed, together with their general uses. Tubes were

classified according to electronic mechanism, and their origin traced to three independent sources and several independent lines of development.

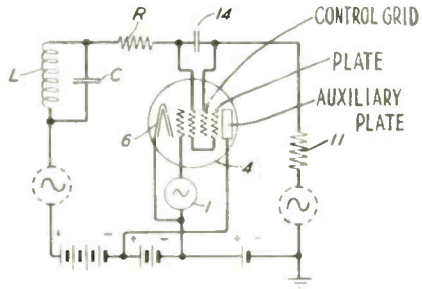
Some Notes on the Design of Electron Guns —A. L. Samuel (Bell Telephone Labs.): A method was outlined for the design of electron guns based on the theory published by J. R. Pierce. This method assumes that the electrons are moving in a beam according to a known solution of the space charge equation and requires that electrodes exterior to the region of space charge be shaped so as to match the boundary conditions at the edge of the beam. Attention is given to some of the complications ignored by the simple theory and to some of the practical difficulties which are encountered in constructing guns according to these principles. An experimental check on the theory was described together with some information as to the actual current distribution in a beam produced by a gun based on this design procedure.

Ultra-high frequencies

Principles of Klystron Amplifiers — R. O. Haxby (Sperry Gyroscope Co.): A description of a representative form of Klystron amplifier was given and its operation discussed. A graphical method was used to picture the bunching process used in this type of velocity modulated tube. The results of a mathematical calculation were used in the remainder of the paper in a discussion of the gain and modulation properties of the Klystron.

NEW PATENTS

(*Continued from page* 122)



tor 14 and will cause it to be less negative; plate current will decrease to a minimum. The tube will then discharge the electric charge on capacitor C and another cycle will start.

If resistor R is inserted in the plate lead, the circuit tends to become a relaxation oscillator were it not for the high impedance of the LC circuit. If the resistance of resistor R is too high, the circuit will cease oscillations. The point of maximum coercion is just before oscillations cease. The arrangement permits the coercion of an oscillator having a signal output of large amplitude by a coercing signal of a much smaller amplitude; the frequencies of the two oscillations must have an integral common divisor. The frequency of the coerced oscillator is determined by the LC circuit.

J. L. Roemisch, Western Electric Co., Inc., (F) February 7, 1942, (I) June 27, 1944, No. 2,352,451.

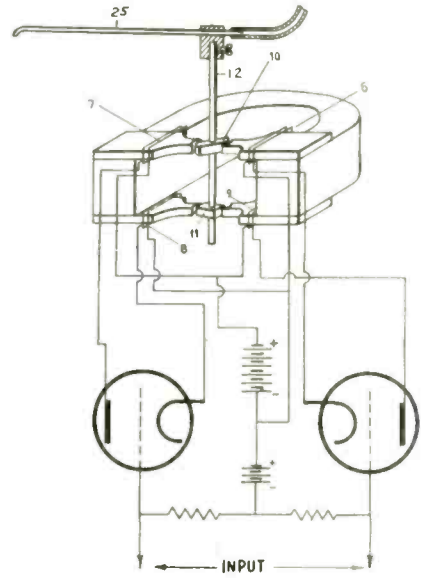
Voltage Recorder

The magneto-motive apparatus is designed to deliver sufficiently large amplitudes so that little or no mechanical amplification is required, and to have a sufficiently high impedance to be directly coupled to a vacuum tube amplifier.

With no current through coils 6, 7, 8, 9, the magnetic flux in the gaps tends to draw both armatures 10, 11, wholly into the gaps, resulting in a clockwise torque on the upper armature 10 and an equal counterclockwise torque on the lower armature 11. Shaft 12, which carries pen 25, will take a position of equilibrium, such that each armature is halfway in and halfway out of its respective gap.

The input voltage to be recorded con-

NEW PATENTS

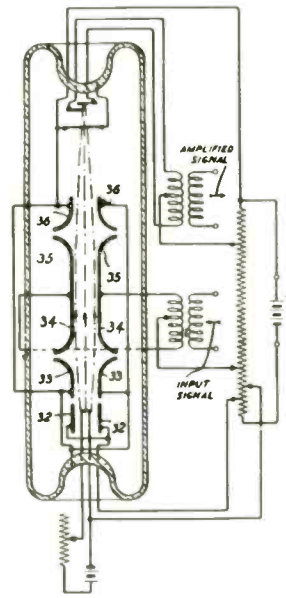


trols the current through coils 6, 7, 8, 9 which in turn modifies the magnetic flux in the gaps. Consequently, if an alternating voltage is applied, the shaft 12 will oscillate back and forth at a frequency equal to the applied frequency and at an amplitude proportional to the amplitude of the applied voltage.

M. Apstein, (F) February 14, 1941, (I) June 27, 1944, No. 2,352,242.

Electron Lens

To reduce the aberration in electron lens systems consisting of parallel plates or of a rectangular tube, it is proposed to shape



the plates as shown in the drawing. The adjacent portions of each pair of plates 33, 34 and 35, 36, respectively, are flared outwardly; an abrupt flare is required.

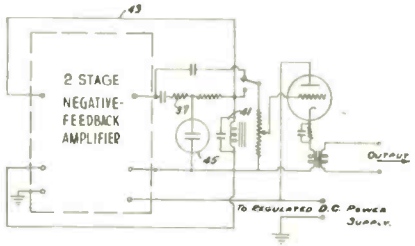
F. Gray, Bell Telephone Laboratories, (F) May 31, 1941, (I) June 13, 1944, No. 2,351,501.

Amplitude-Stabilized Oscillator

The oscillator circuit is primarily intended for vibration measurements by the carrier modulation method. For these measurements it is essential that the carrier amplitude be extremely constant. To improve the stability of the oscillation ampli-

NEW PATENTS

tude, glow tube 45 is inserted. It is stated that, as a result of the peak limiting action of the glow discharge tube 45, the amplitude of the component of fundamental frequency varies only an extremely small amount, even when the amplitude of the applied sinusoidal voltage varies a large amount. The desired fundamental frequency component is selected by circuit 41 tuned to this frequency, and undesired harmonics present or generated by the distortion due to the action of glow tube 45 are filtered out.



Lead 43 provides positive feedback for the oscillator. Current limiting resistance 37 is made sufficiently large compared to the low output impedance of the amplifier so that any variation in the resistance of the glow discharge tube during the cycle of operation does not affect the amplifier gain. R. C. Olrdrn, Consolidated Engineering Corp., (F) October 7, 1941, (I) June 27, 1944, No. 2,352,219.

Frequency Meter

The frequency to be measured is caused to produce electric impulses which are limited in amplitude by electron tube circuits, multiplied in frequency and integrated into a constant average current proportional to the frequency of the input. High and low frequencies can be measured with equal accuracy.

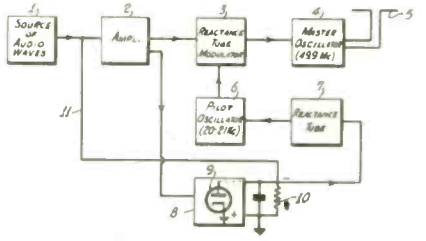
L. A. de Rosa, The National Cash Register Co., (F) July 23, 1941, (I) June 20, 1944, No. 2,352,082.

FM System

A super-audible control signal is used to secure the benefits of high devlation modulation, while utilizing a receiver having selector circuits of relatively narrow pass band width prior to the demodulator. The frequency deviation of the carrier is increased with audio signal amplitude up to a maximum value of about 25 kc; a super-audible control tone whose frequency is a function of the audio amplitude is simultaneously transmitted and used at the receiver to expand the dynamic range of the audio network for audio signals of high amplitude.

In the transmitter shown, rectifier 8, reactance tube network 7 and pilot oscillator 6 are provided so that up to a predetermined value of modulation input level, for which the voltage applied to diode 9 exceeds the delay bias, no effect on the pilot frequency takes place; for greater values the pilot frequency increases up to 21 kc with increasing amplitude. From the same value of modulation input level, the frequency of the master oscillator will remain constant with increasing signal amplitude because the voltage developed across resistor 10 reduces the gain of amplifier 2.

The receiver includes a filter for the control tone frequency, and the gain of the



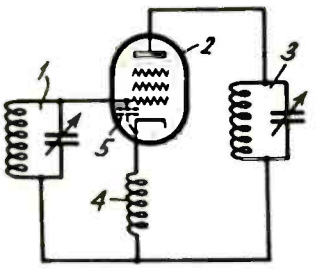
NEW PATENTS

audio frequency amplifier is regulated by the detected output of this filter, securing higher receiver output for the higher amplitude audio notes.

W. R. Koch, RCA (F) May 27, 1942. (I) May 30, 1944, No. 2,349,870.

Compensating Noise Voltages

It is proposed to compensate for circuit noise and/or tube noise by a negative feedback for the noise output. Obviously, the noise component can not be fed back without, at the same time, feeding back signal voltages. The conditions for various noise components originating in the input circuit, in the cathode emission, during passage of the electrons through the tube, or through the action of additional grids or secondary emission grids are investigated; circuits for each particular case are given and their merits in reducing the signal-to-noise ratio discussed.



The embodiment shown, which is claimed in the patent, has a self-inductance coil 4 in the cathode lead. A noise voltage correlated with the cathode noise occurs across this coil and leads 90 deg. relative to the cathode noise current. This noise voltage brings about a current through capacity 5 which current leads 90 deg. relative to the voltage across coil 4 and is consequently in anti-phase with the cathode noise-current, setting up a compensating noise voltage across circuit 1 which is applied to the control grid. It is shown that the simultaneous reduction in signal due to coil 4 is of such magnitude that the signal-to-noise ratio in the output circuit remains constant; additional damping of the input circuit has been achieved without a corresponding decrease of the signal-to-noise ratio.

M. J. O. Strutt and C. J. Bakker, Alien Property Custodian, (F) January 16, 1941. (I) July 4, 1944, No. 2,352,956.

Recording Frequency Differences

The beat frequency between a known and an unknown frequency is recorded in a conventional manner. However, a resistance-capacitance network is inserted between one of the frequency sources and the cooperating grid of the mixer tube. By varying the value of a resistance, a phase shift of associated frequency is introduced which causes a frequency variation the direction of which is known and a simultaneous variation in amplitude. As it is known whether the frequency of the source is increased or decreased, and it can be established from the record whether this results in an increase or decrease in the beat frequency, it can be concluded which of the two frequencies is the higher one, which is the problem to be solved by the device.

Also the amplitude of the record trace is changed during the interval in which the phase is shifted so as to set off in the record an easily identifiable block which contains the distinctive markings to be examined.

L. H. Schwartz, and H. A. Tooker, Western Electric Co., Inc., (F) December 24, 1942, (I) June 13, 1944, No. 2,351,548.

Will Make Home Radios

Following is a list of manufacturers which, Electronic Industries has reason to believe, will produce home radio sets after Germany collapses. Besides the many familiar names of pre-Pearl Harbor recollection, there are included a number of new names of companies which have announced plans to enter the home-radio field, as verified by your editors. Those newcomers which did not make home radios in 1941-42 are indicated by an asterisk, thus*:

Admiral Corp., 3800 W. Cortland St., Chicago 47, Ill.
Air-King Products Co., Inc., 1523 63rd St., Brooklyn 19, N. Y.
Andrea Radio Corp., 43-20 34th St., Long Island City, N. Y.
Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Arvin—see Noblitt-Sparks Industries, Inc.
Automatic Radio Mfg. Co., 124 Brookline Ave., Boston, Mass.
Belmont Radio Corp., 5921 W. Dickens Ave., Chicago 39, Ill.
*Bendix Radio, Div. of Bendix Aviation Corp., East Joppa Rd., Baltimore 4, Md.
Browning Laboratories, Inc., 750 Main St., Winchester, Mass.
Brunswick—see Radio & Television, Inc.
Clarion—see Warwick Mfg. Corp.
Colonial Radio Corp., 254 Rano St., Buffalo, N. Y.
*Columbia Associates, 141 W. 24th Street, New York, N. Y.
Crosley Corp., 1329 Arlington St., Cincinnati.
Delco Radio, Div. General Motors Corp., Kokomo, Ind.
DeWald Radio Mfg. Corp., 444 Lafayette St., New York, N. Y.
Allen B. Dumont Labs., Inc., 2 Main Ave., Passaic, N. J.
Eckstein Radio & Telev. Co., 914 La Salle Ave. Minneapolis, Minn.
Electrical Research Labs., Inc., 2020 Ridge Ave., Evanston, Ill., "Sentinel"
*Electronic Corp. of America, 45 W. 18th St., New York, N. Y.
Emerson Radio & Phono. Corp., 111 8th Ave., New York, N. Y.
Empire Radio Mfg. Co., 114 E. 47th St., New York 17, N. Y.
Espey Mfg. Co., 305 E. 63rd St., New York.
Fada Radio & Elec. Mfg. Co., 3020 Thomson Ave., Long Island City, N. Y.
Farnsworth Telev. & Radio Corp., 3700 Pontiac St., Ft. Wayne, Ind.
Freed Radio Corp., 200 Houston St., New York.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill., "Motorola"
Garod Radio Corp., 70 Washington St., Brooklyn, N. Y.
General Electric Co., 1287 Boston Ave., Bridgeport, Conn.
General Television & Radio Corp., 1240 N. Homan Ave., Chicago, Ill.
Gilfillan Bros., 1815 Venice Blvd., Los Angeles, Calif.
Hamilton Radio Corp., 510 Sixth Ave., New York, N. Y., "Olympic"
*Herbach & Rademan Co., 522 Market St., Philadelphia, Pa.
*Hoffman Radio Corp., 3430 S. Hill St., Los Angeles, Calif.
Howard Radio Co., 1735 Belmont Ave., Chicago, Ill.
*Industrial Tool & Die Works, Inc., 2824 University Ave., S.E., Minneapolis, Minn.
International Detrola Corp., 1501 Beard St., Detroit, Mich.
*Keith Radio Products, Bedford, Ind.
Kingston Radio Co., Inc., Kokomo, Ind.
*Lear Avia, Inc., Piqua, Ohio
The Magnavox Co., Ltd., 2131 Bueter Rd., Ft. Wayne, Ind.
*Maguire Industries, Inc., 342 West Putnam Ave., Greenwich, Conn.

(*Continued on page* 252)

Will Make Home Radios

(*Continued from page 250*)

Majestic Radio & Telev. Corp., 2600 W. 55th St., Chicago, Ill.
*Mason Radio Products Co., Kingston, N. Y.
*John Meck Industries, Plymouth, Ind.
*Megard Corp., 1601 S. Burlington Ave., Los Angeles, Calif.
*Meissner Mfg. Co., Mt. Carmel, Ill.
Midwest Radio Corp., 909 Broadway, Cincinnati, Ohio
Motorola—see Galvin Mfg. Corp.
National Co., 61 Sherman St., Malden, Mass.
Noblitt-Sparks Industries, Columbus, Ind., "Arvin"
Olympic—see Hamilton Radio Corp.
*Pacific Electronics, Sprague at Jefferson, Spokane 5, Wash.
Packard Bell Co., 1115 S. Hope St., Los Angeles, Calif.
*Packard Mfg. Co., Kentucky & Morris Ave., Indianapolis, Ind.
Philco Corp., Ontario & C Sts., Philadelphia, Pa.
Philharmonic Radio Corp., 216 William St., New York, N. Y.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Pilot Radio Corp., 37-06 36th St., Long Island City, N. Y.
*Precision Specialties, 210-220 N. Western Ave., Los Angeles, Cal.
Radio & Television, Inc., 244 Madison Ave., New York, N. Y., "Brunswick"
Radiola—see RCA Victor Div., Radio Corp. of America
RCA Victor Div., Radio Corp. of America, Camden, N. J.
*Regal Electronics Corp., 20 W. 20th St., New York, N. Y.
Remler Co., Ltd., 19th at Bryant, San Francisco, Calif.
E. H. Scott Radio Labs., Inc., 4450 Ravenswood Ave., Chicago, Ill.
*Searle Aero Industries, Inc., Orange, Cal.
Sentinel Radio Corp., 2020 Ridge Ave., Evanston, Ill.
Setchell-Carlson, Inc., 2233 University Ave., St. Paul, Minn.
*Sheridan Electronics Corp., 2850 S. Michigan Ave., Chicago, Ill.
*Signal Electronic & Mfg. Co., 114 E. 16th St., New York, N. Y.
Sonora Radio & Telev. Corp., 325 N. Hoyne Ave., Chicago, Ill.
Sparks-Withington Co., 2400 E. Ganson Ave., Jackson, Mich., "Sparton"
*Sperti, Inc., Beech & Kentucky Ave., Norwood Sta., Cincinnati, Ohio
*Spokane Radio Co., Inc., P. O. Box 16, Spokane, Wash.
Stewart-Warner Corp., 228 N. LaSalle St., Chicago, Ill.
Stromberg-Carlson Co., 100 Carlson Rd., Rochester, N. Y.
Templetone Radio Co., Mystic, Conn.
Transitone—see Philco Corp.
Trav-Ler Karenola Radio & Tel. Corp., 1028 W. Van Buren St., Chicago, Ill.
Troubador—see Warwick Mfg. Corp.
*Viewtone Co., 203 E. 18th St., New York, N. Y.
Warwick Mfg. Corp., 4640 W. Harrison St., Chicago, Ill., "Troubador," "Warwick"
Watterson Radio Co., P.O. Box 54, Dallas, Texas
Wells Gardner & Co., 2701 N. Kildare Ave., Chicago, Ill.
*Westinghouse Elec. & Mfg. Co., 200 W. Baltimore Ave., Baltimore, Md.
Wilcox-Gay Corp., Charlotte, Mich.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

Poncher Heads NEDA

Sam Poncher of Newark Electric Co., Chicago, was elected president of the Chicago chapter of the National Electronic Distributors Assn. at a meeting held late September. Ralph E. Walker, Walker-Jimieson, Inc., was elected secretary and treasurer.

Chatten Replaces Ellis

The task of balancing the still most important assignment of military production requirements against the implementing of civilian reconversion after victory in Europe confronts Louis J. Chatten who became the new Director of the WPB Radio and Radar Division after the retirement of Ray C. Ellis to return to his former industrial organization, General Motors.

Reconversion to civilian production is still some time off and the Army and Navy are calling upon the electronics industry for the final sprint of war production. Even when VE-Day comes, there will be some bad bottlenecks in shortages of critical parts before home broadcast receiving sets will be ready for distribution to the public. These bottlenecks are tubes, electrolytics and loud speakers. In the case of tubes, even though the present output is 10,000,000 a month with military requirements consuming that entire amount, it is estimated that the combined military and civilian requirements for receiving tubes after Germany's defeat will be about 60 to 70 per cent above the present maximum production rates. Because of military demands the limited amount of civilian home receiver tube replacements is not being fully produced during the last quarter of 1944.

Mr. Ellis will continue as a special consultant to the Division. He returned to General Motors after 3¼ years with WPB and its predecessors, OPM, with the stipulation that he will not be associated in any way with any electronic operations and planning. Because he had conducted the supervision of his Radio and Radar Division, ever since it was established in early 1942, with such notable accomplishments and success, he has been kept in complete touch with the Army and Navy procurement programs and the secret developments in radio and electronics. In returning to General Motors where he had been General Manager of the Delco-Remy Division before going with OPM, he stipulated that because of this knowledge he did not desire to be linked with radio and electronic operations. He is to be stationed in New York City on general reconversion planning.

A highlight of Mr. Ellis' governmental career was his survey of the Soviet electronic industry and its requirements in a three-months trip in Russia. He was the first man in the OPM to handle radio production matters, starting in June, 1941, and he continued in the government with WPB, arranging for the coordination of the radio-electronic manufacturing industry in meeting the military production load and in the termination of civilian radio production on April 22, 1942.

(*Continued from page 253*)

His successor, Mr. Chatten, has had nearly a quarter-century in engineering and sales work in the radio and electrical equipment fields before he came to the WPB in July, 1943. One of his posts was with the Fada Radioelectric Corp. in charge of all administrative and engineering work in production from 1922-37 and another position was with the Diolograph Products Corp. as an engineering official on intercommunicating telephone systems. He also was successively sales manager with Bendix Home Appliance Inc., South Bend, and the National Electric Supply Co., Trenton.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933

Of ELECTRONIC INDUSTRIES, published monthly at New York, N. Y., for Oct. 1, 1944, State of New York, N. Y., County of New York, N. Y.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Orestes H. Caldwell, who, having been duly sworn according to law, deposes and says that he is the Editor of ELECTRONIC INDUSTRIES and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, M. Clements, Rumson, N. J. Editor, Orestes H. Caldwell, Catrock Road and Bible St., Cos Cob, Conn. Managing Editor, Stanley P. McMinn, 92 Adams St., Garden City, L. I., N. Y. Business Manager, M. H. Newton, 583 W. 215th St., New York, N. Y.

2. That the owner is (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) Caldwell-Clements, Inc., 480 Lexington Avenue, New York, N. Y. M. Clements, O. H. Caldwell, Charles Schatvet, Trustees, 480 Lexington Ave., N. Y. C. M. Clements, Trustee, Rumson, N. J. O. H. Caldwell, Trustee, Catrock Rd. and Bible St., Cos Cob, Conn. Charles Schatvet, Trustee, Darien, Conn. McGraw-Hill Publ. Co.,* 330 W. Forty-second St., New York, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security-holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds or other securities than as so stated by him.

(Signed) Orestes H. Caldwell

Sworn to and subscribed before me this 26th day of September, 1944.

R. M. Phillips

Notary Public Westchester County.
Notary Public N. Y. County Clerk's No. 452.
Notary Public N. Y. County Register's No. 280P.6.
(My commission expires March 30, 1946.)

*Represents minority stock interest which was purchase price for Radio & Television Retailing. Majority stock and control continue in hands of O. H. Caldwell and M. Clements.

ELECTRONIC INDUSTRIES

Advertisers — November, 1944

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

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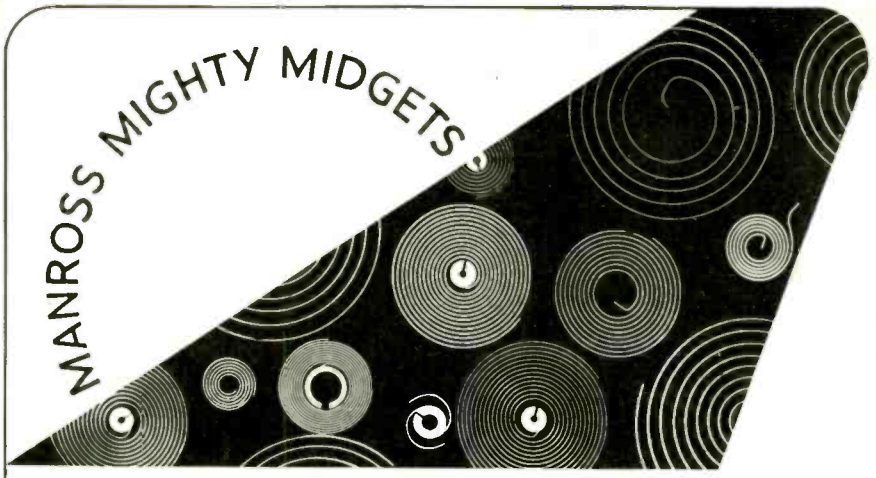

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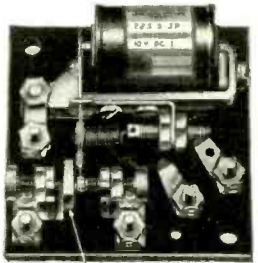
Now . . . Chatterless operation is added to the known sensitivity of our "Old Timer" (200 Series) . . . The new feature consists of an energy absorbing material sealed within a contact carrying cage. The compound used is *not affected by age, oil, or moisture.*



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No Bounce! No Chatter! . . . in the new Kurman 200S Flat Keying Relay

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2. Input 50 Milliwatts.
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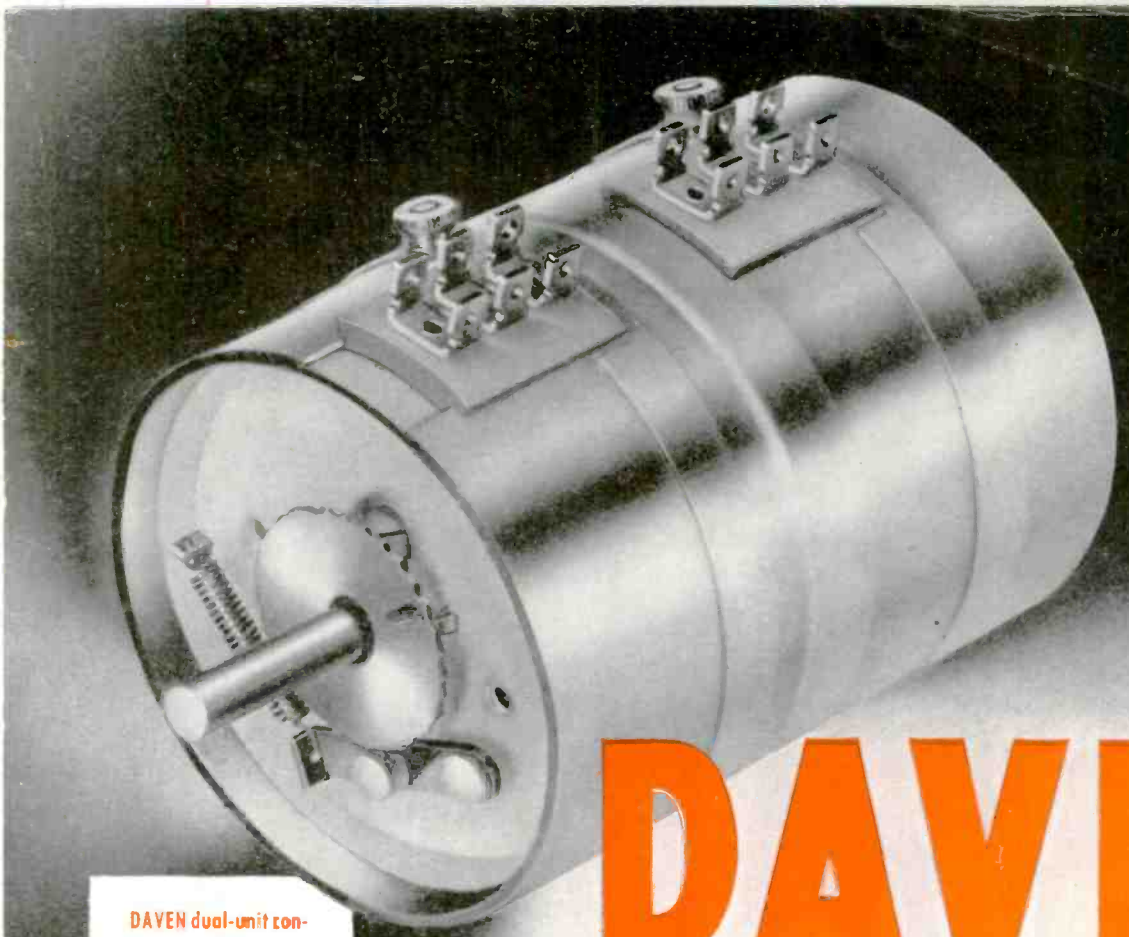
Oscilloscopic wave form looks like this

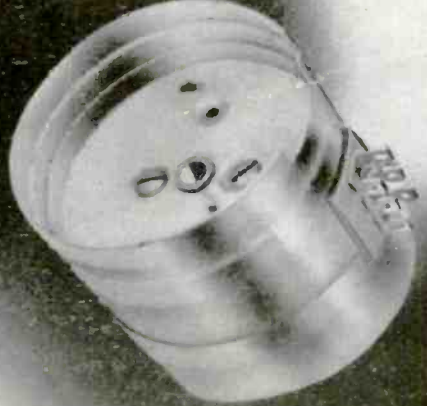
NOT like this

Send also for complete information on the new line of KURMAN vibration-proof RELAYS.

KURMAN ELECTRIC CO.
35-18 37th STREET • LONG ISLAND CITY 1, N. Y.



DAVEN dual-unit construction finds most important application in Balanced "H" attenuators, as well as in special multiple-circuit controls of the Potentiometer, "T", Ladder, "L" and Rheostat types.



DAVEN

ANNOUNCES A NEWLY-IMPROVED MODEL for DUAL-UNIT* ATTENUATORS

DAVEN engineers have incorporated into the improved dual-unit all the important new features recently announced for DAVEN standard single-unit attenuators. A noteworthy addition in the dual-unit is the improved method of coupling front and rear attenuators. The respective shafts of each meet in a lap joint within a long, snug collar, providing quick and complete access to either unit. By loosening a knurled nut and releasing a snap-on fitting, the front or rear switch may be reached without dismounting the front unit from the instrument panel.

*Patent Pending

Features of DAVEN Dual-Unit Attenuators

SEPARABLE COUPLING—Front and rear units now easily separated: gives quick access to either unit. Simple, durable, foolproof construction illustrated at left.

IMPROVED SHIELDING—Sturdy, snug fitting, 3 piece steel cover affords superb electrical and dust shielding, as well as greater all around ruggedness.

NEW DETENT DEVICE—Large gear and roller mounted in recessed front end of front unit, separate from resistive network, gives accurate indexing. (Illustrated.)

GREATER COMPACTNESS — Rear - of - panel depth only 3⅞"; 9/16" less than former models.

CERTAIN STOP—Extrusion of detent gear and steel attenuator cover form sturdy stop to rotation, eliminating rotor-hub strain of previous method.

CAPTIVE TERMINAL BOARD—Solder-lugs eyeletted to bakelite boards, which are grooved to fit securely into slots in their respective can sectors.

ANTI-FUNGUS TREATED—Bakelite parts and resistive windings treated to resist fungus and mildew.

SILVER ALLOY—Contacts, switch arms and returns of tarnish-resisting silver alloy lower internal resistance. Other metals optional.

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The Preferred-Type Idea makes sense. And, it works!

Introduced by RCA in January, 1940, the Preferred-Type Program aimed at concentrating a larger demand and production on fewer tube types. This would allow greater manufacturing efficiency, because of longer runs, and would mean higher-quality, lower-cost tubes for you.

Even before civilian radio manufacturing was suspended by war, the program paid off. By November, 1940, the average cost to you of tubes on the RCA preferred list was lower by 13% than the average cost of the same tubes in November, 1939 . . . before the program started.

Yet all the time their cost was being lowered, the tubes improved in quality and performance. And the way was being cleared for simplified tube warehousing and stocking.

Since Pearl Harbor, the value of the "preferred-type" idea has been proved beyond a doubt on the world's battlefields. Most military electronic equipment has been designed around an Army/Navy Preferred List of Vacuum Tubes . . . and our fighting men on every continent are assured speedy replacements of high-performance tubes as a result.

Will RCA continue the Preferred-Type Program after the war? You bet it will! If you already have specific tube complements in mind for postwar and would like to know if the tubes you need will be on the preferred list, let us know what they are. Write to Radio Corporation of America, Commercial Engineering Section, Dept. 62-12I, Harrison, New Jersey.

The Magic Brain of all electronic equipment is a Tube . . . and the fountain-head of modern Tube development is RCA.

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