OCTOBER · 1944

electronics

A McGRAW-HILL PUBLICATION

electronics

OCTOBER • 1944

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To ....

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Signed ....

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The war brought an avalanche of orders for K & E Slide Rules. We have done our utmost to keep pace with it and are rather proud of the job. But we are still prouder of the quality that makes the K & E Slide Rule reputation what it is.

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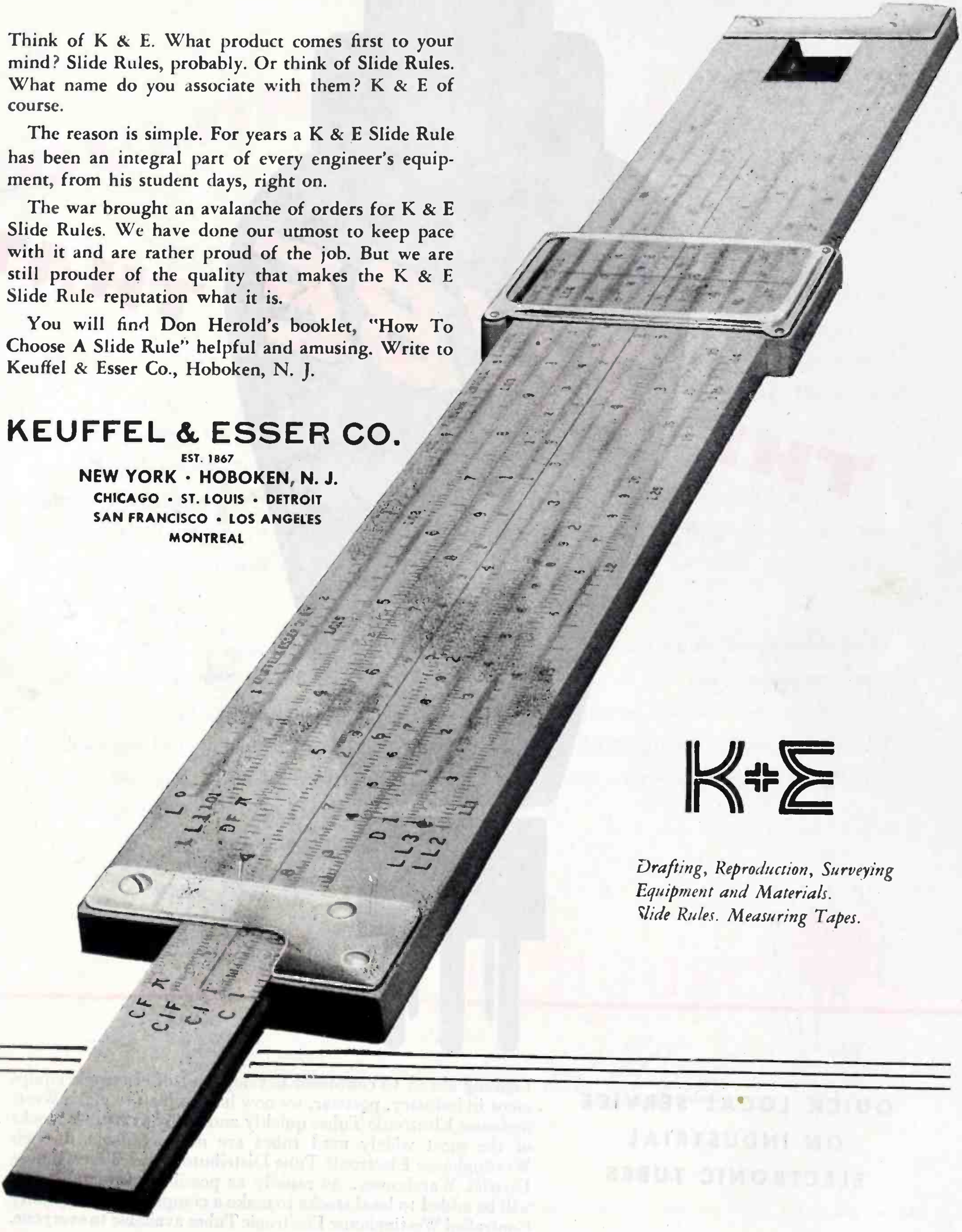

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Tobe Capacitors are *built* to last. From winding to shipping, each step is under rigid inspection to maintain the high standard set by twenty years' experience.

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RATINGS:

600 VDC	Single Units	.01 to 2.0 Mfd.
	Dual Units	.05 to 1.0 Mfd.
	Triple Units	.05 to 0.5 Mfd.
1,000 VDC	Single Units	.01 to 1.0 Mfd.
	Dual Units	.05 to 0.5 Mfd.
	Triple Units	0.1 and .25 Mfd.

STANDARD CAPACITANCE TOLERANCE—plus or minus 20%**

TEST VOLTAGE—twice D.C. rating

GROUND TEST—2,500 Volts D.C.

OPERATING TEMPERATURE—55° F. to 185° F.

SHUNT RESISTANCE—

.01 to 0.1 Mfd.	—20,000 Megohms
.25 to 0.5 Mfd.	—12,000 Megohms
1.0 Mfd.	—10,000 Megohms
2.0 Mfd.	— 5,000 Megohms

POWER FACTOR —1,000 cycles—.002 to .005

MOUNTING HOLE CENTERS: 2⅛" except for the following capacitance values which are made in containers having 2⅜" mounting centers:

600 VDC—	Single Units	1.0 and 2.0 Mfd.
	Dual Units	0.5 and 1.0 Mfd.
	Triple Units	.25 and 0.5 Mfd.
1,000 VDC—	Single Units	0.5 and 1.0 Mfd.
	Dual Units	.25 and 0.5 Mfd.
	Triple Units	0.1 and .25 Mfd.

*Data sheets showing complete code number for units having a specific capacitance value and voltage rating available on request.
**Other tolerances available.

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Photo Courtesy of Southern Pacific Lines


The Final Touch
THAT ASSURES
PERFECT CRAFTSMANSHIP
TEMCO
FINAL OK
Above: TEMCO Model 1000 AG-CW 1000 watt radio telegraph transmitter with pretuned tank circuits for 6-frequency operation with motor driven frequency selection.
Below: TEMCO Model 350 AG 350 watts output 6-frequency band switching mobile transmitter, designed for military service aboard trucks.
Hundreds of hand operations enter into the custom-style construction of every TEMCO unit.
Of all these, the last and simplest is the most important: the affixing of the TEMCO name plate, which sets our "hand and seal" to certify that the last detail of perfect workmanship has been patiently and skillfully built in . . . assuring years of dependable service.
Application of the name plate signifies that the job has passed the most exacting inspections and tests imposed by our own engineers . . . and now invites inspection by U. S. Government services, or any other users employing the most critical standards.
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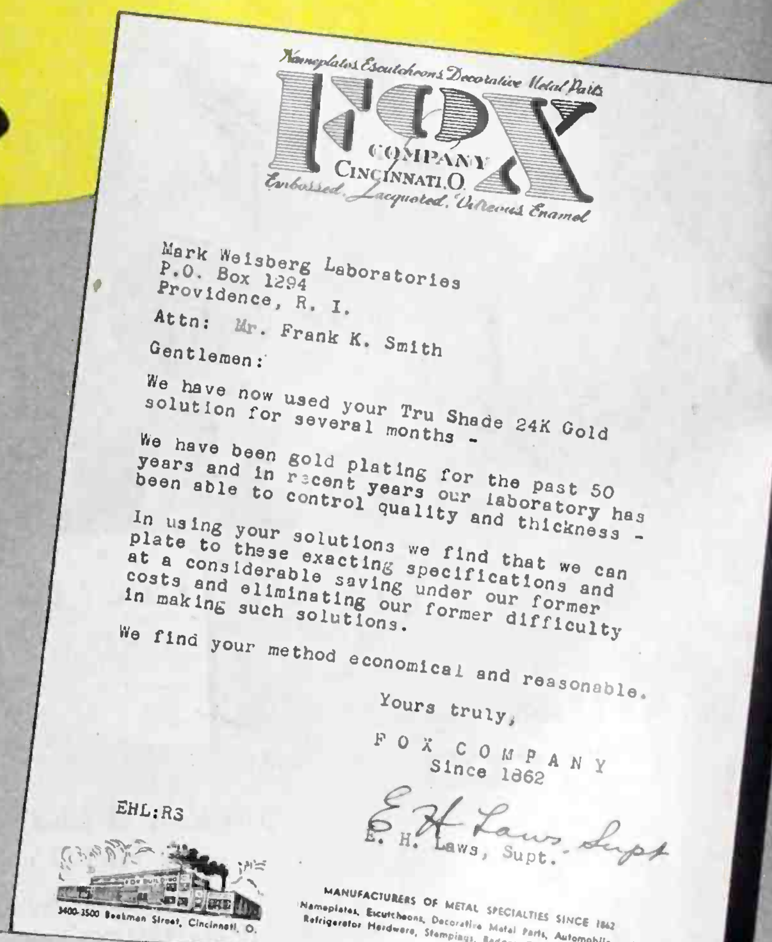
RADIO COMMUNICATION EQUIPMENT
TRANSMITTER EQUIPMENT MFG. CO., INC.
345 Hudson Street • New York 14, N. Y.

This TRUSHADE user's stamp of approval is indicative of the way in which leading industrialists everywhere are endorsing our radically different gold-plating procedure.

The TRUSHADE method of gold plating permits trouble-free HEAVY DEPOSITIONS of 24 kt. gold with less waste and with DEFINITE CONTROL and POSITIVE ANALYSIS of the gold and gold alloys solution — (100% ACCURATE ANALYSIS in less than 20 minutes).

In addition, TRUSHADE eliminates loss usually incurred by cutting down gold and it has a far higher efficiency than prepared salts. Also, it makes possible much greater flexibility of application and has an acid resistance up to 3 hours on a 60-second application. Tests relate that TRUSHADE saves over 50% ON GOLD COSTS and up to 300% on PRODUCTION TIME and also assures low current consumption. Gold content of TRUSHADE GOLD AND ALLOYS IS ALWAYS CERTIFIED.

Our Advisory Service will furnish any further facts on request.



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FOX COMPANY CINCINNATI, O.
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Providence, R. I.

Attn: Mr. Frank K. Smith

Gentlemen:

We have now used your Tru Shade 24K Gold solution for several months -

We have been gold plating for the past 50 years and in recent years our laboratory has been able to control quality and thickness -

In using your solutions we find that we can plate to these exacting specifications and at a considerable saving under our former costs and eliminating our former difficulty in making such solutions.

We find your method economical and reasonable.

Yours truly,

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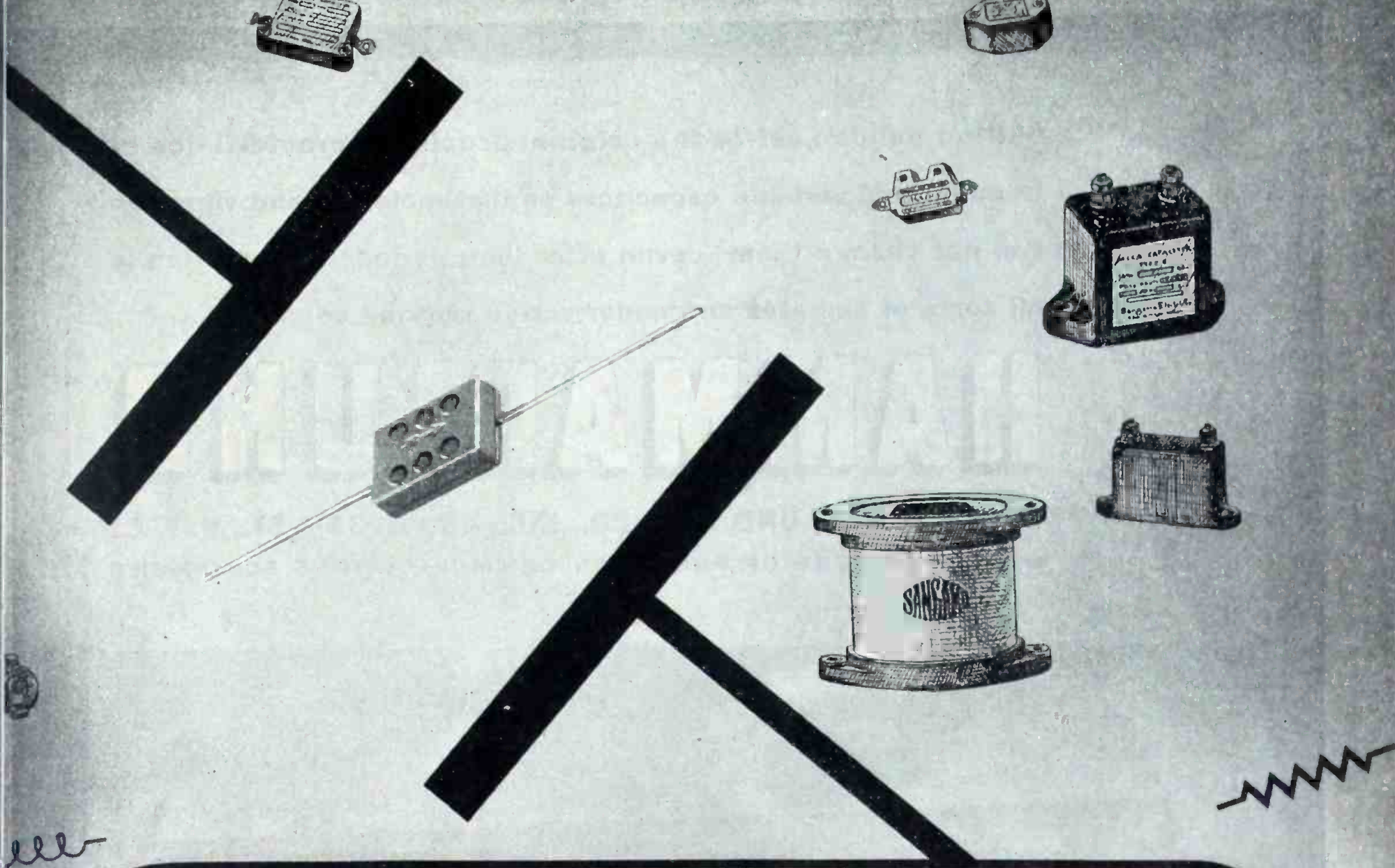
SANGAMO


Skilled hands seal-in the original precise characteristics of Hammarlund variable capacitors so that moisture and vibration can not change them — even after long periods of operation in all sorts of climates and under varied working conditions.
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ESTABLISHED 1910
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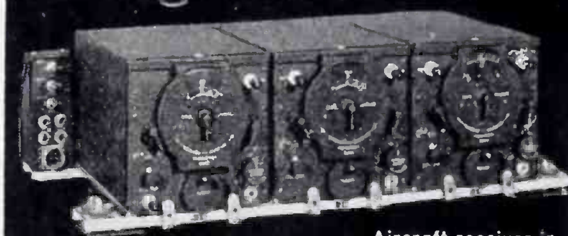
Television receiver
in table-model size

A lot of army-tank radio
equipment in a compact package



Aircraft receiver in
three compact band units

The tube that shields itself

another G·E electronic FIRST!

THE G-E development of the metal receiver tube represented a complete departure in the conception and manufacture of electronic receiver tubes and of parts assembly.

The G-E metal receiver tube not only serves as an "envelope" for the tube elements, but in itself provides the necessary "shielding" to prevent feed-back (the electrostatic or electromagnetic influences in circuits which interfere with operation). Thus, the elimination of separate, space-consuming shielding devices permitted circuits to be designed more compactly. This, in turn, made possible the simplification and the smaller size of receivers—not only for "consumer" uses, but importantly for aircraft, tank, lifeboat and other vital needs.

General Electric progress during all the years of radio history has been a succession of electronic-tube "firsts." You may be sure that *all* G-E tubes—transmitting or receiving—possess everything that electronic research and engineering have uncovered . . . and that they have the most exacting construction, highest efficiency, and longest serviceable life the world's finest tube factory can produce.

G-E TUBES ARE "FIRST" IN INDUSTRY, TOO! For example, General Electric pioneered in the application of the phototube in commercial talking moving pictures. G. E. has also contributed to the designing of sorting, inspection, registering, counting and other apparatus employing the light-sensitive characteristics of the phototube.

FREE BOOK, "HOW ELECTRONIC TUBES WORK." Address *Electronics Dept., General Electric, Schenectady, New York.*

• *Tune in "The World Today" 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.*

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

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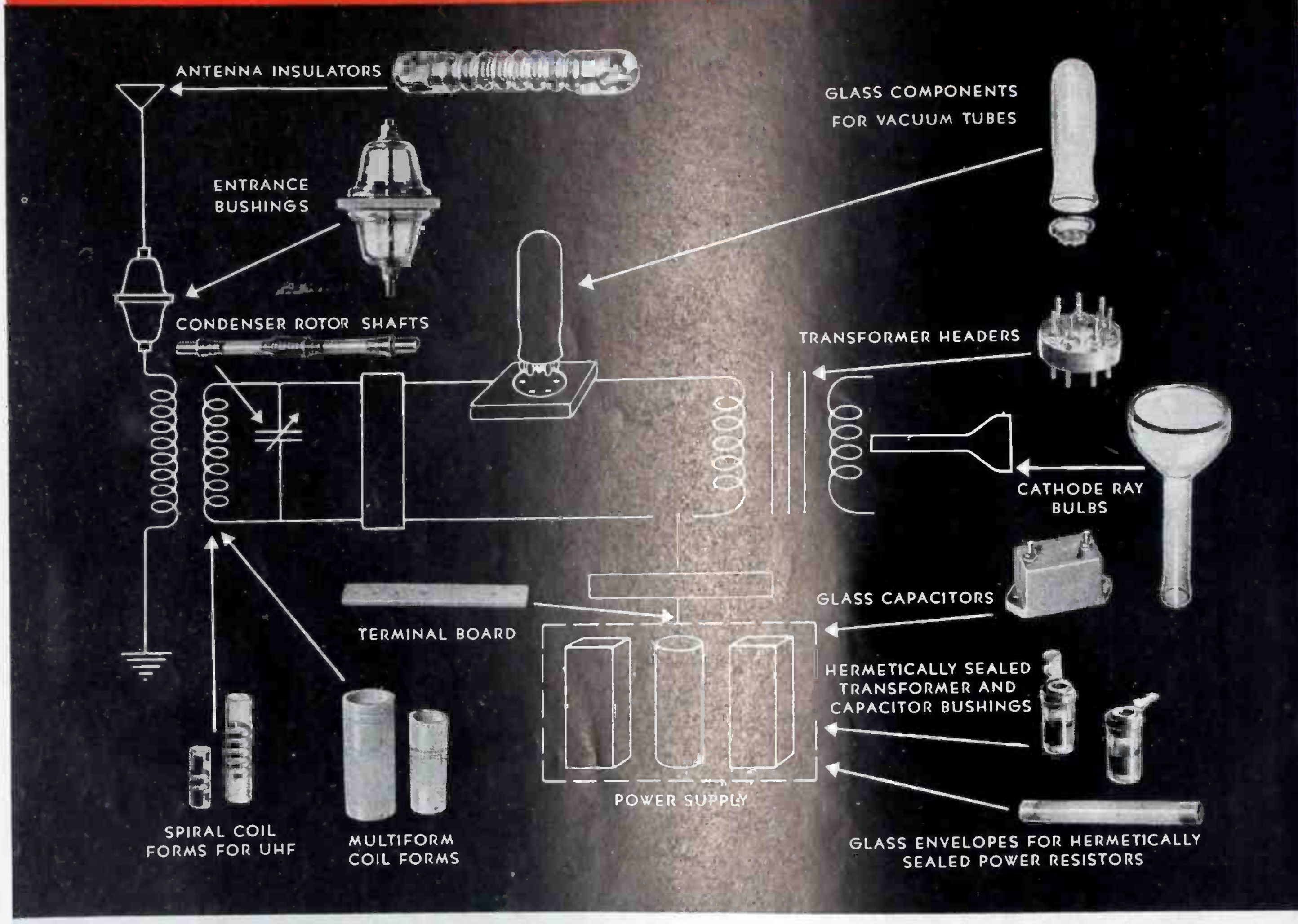
ARE YOU LETTING GLASS HELP YOU ALL IT CAN?



IT wouldn't be surprising if you aren't familiar with everything glass is doing in electronic equipment today. Progress has been rapid. In the above *"circuit"*, for example, you'll find it on the job in (twelve) vital places. At Corning right now we're making a lot of other electronic glassware that we can't show. After the war we'll tell you all about it.

It's no accident that a major part of the electronic glassware in use got its start at Corning. We've dug in on some tough ones and ferreted out solutions. They told us we couldn't solder metal to glass — they needed glasses with a coefficient of expansion practically equal to that of fused quartz —they needed something to take the place of mica in capacitors — Corning Research found the answers to these and many other electronic problems.

Our 250 glass experts—the men behind "Corning Research"— our facilities and all our knowledge of glass are at your service. Write for a copy of an informative new booklet "There Will Be More Glass Parts in Postwar Electrical Products." Address Electronic Sales Dept. E - 10, Bulb and Tubing Division, Corning Glass Works, Corning, N. Y.

CORNING means Research in Glass

Electronic Glassware

CORNING REG. U.S. PAT. OFF. — PYREX REG. U.S. PAT. OFF.

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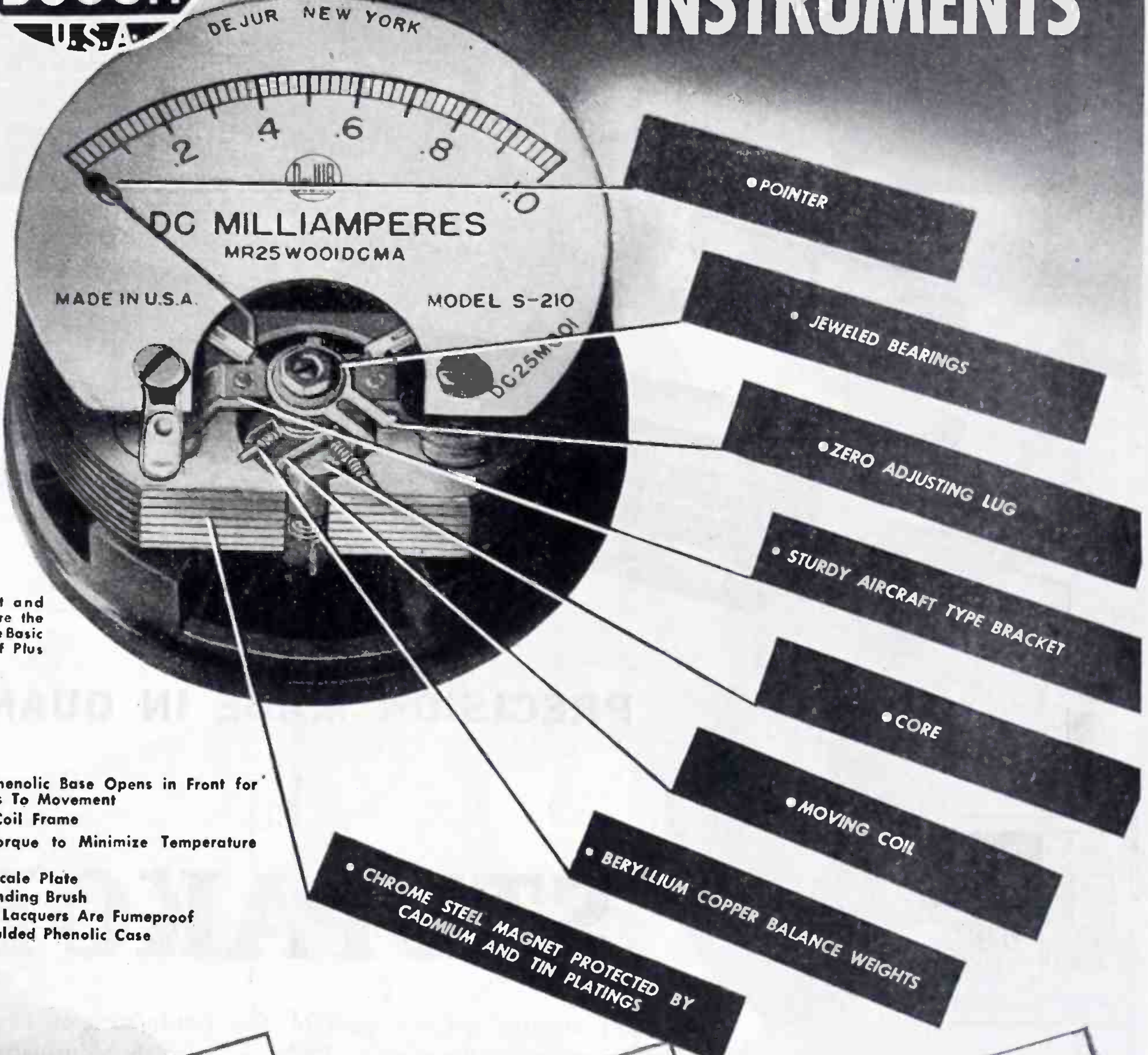
ELECTRICAL INDICATING INSTRUMENTS



Magnet Movement and Bracket Illustrated are the S-210 0-1 Milliampere Basic Design—Accuracy of Plus or Minus 2%.

- Moulded Phenolic Base Opens in Front for Easy Access To Movement
- Anodized Coil Frame
- Matched Torque to Minimize Temperature Effect
- All Brass Scale Plate
- Static Grounding Brush
- Scale Plate Lacquers Are Fumeproof
- Strong, Moulded Phenolic Case

Better Balancing
... and a uniform magnetic flux around the moving coil, eliminate possibility of calibration error.

Longer Pivot Axis
... permits a more accurate adjustment of jewels and pivot assembly. More easily accessible, too, in event of repair or servicing.

Superior Magnetic Materials
... Alnico and cobalt are used in conjunction with soft iron pole pieces, thus assuring high torque, fast response and improved performance.

Keep Buying War Bonds

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All DeJur Electrical Indicating Instruments are manufactured in strict conformance with American Standards Association specifications. Additional technical information will be supplied upon request.

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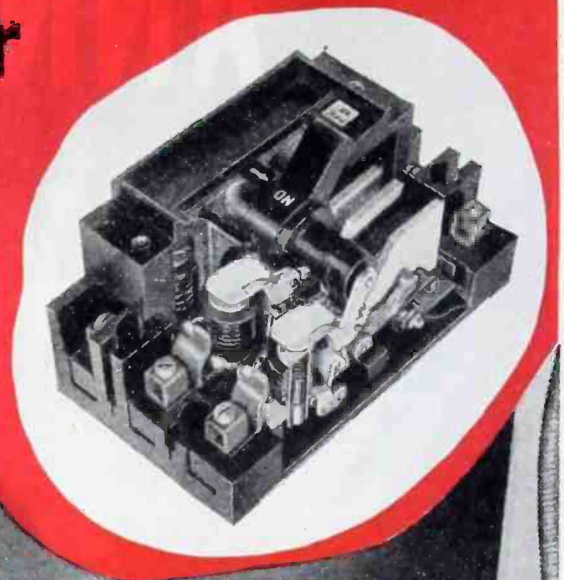
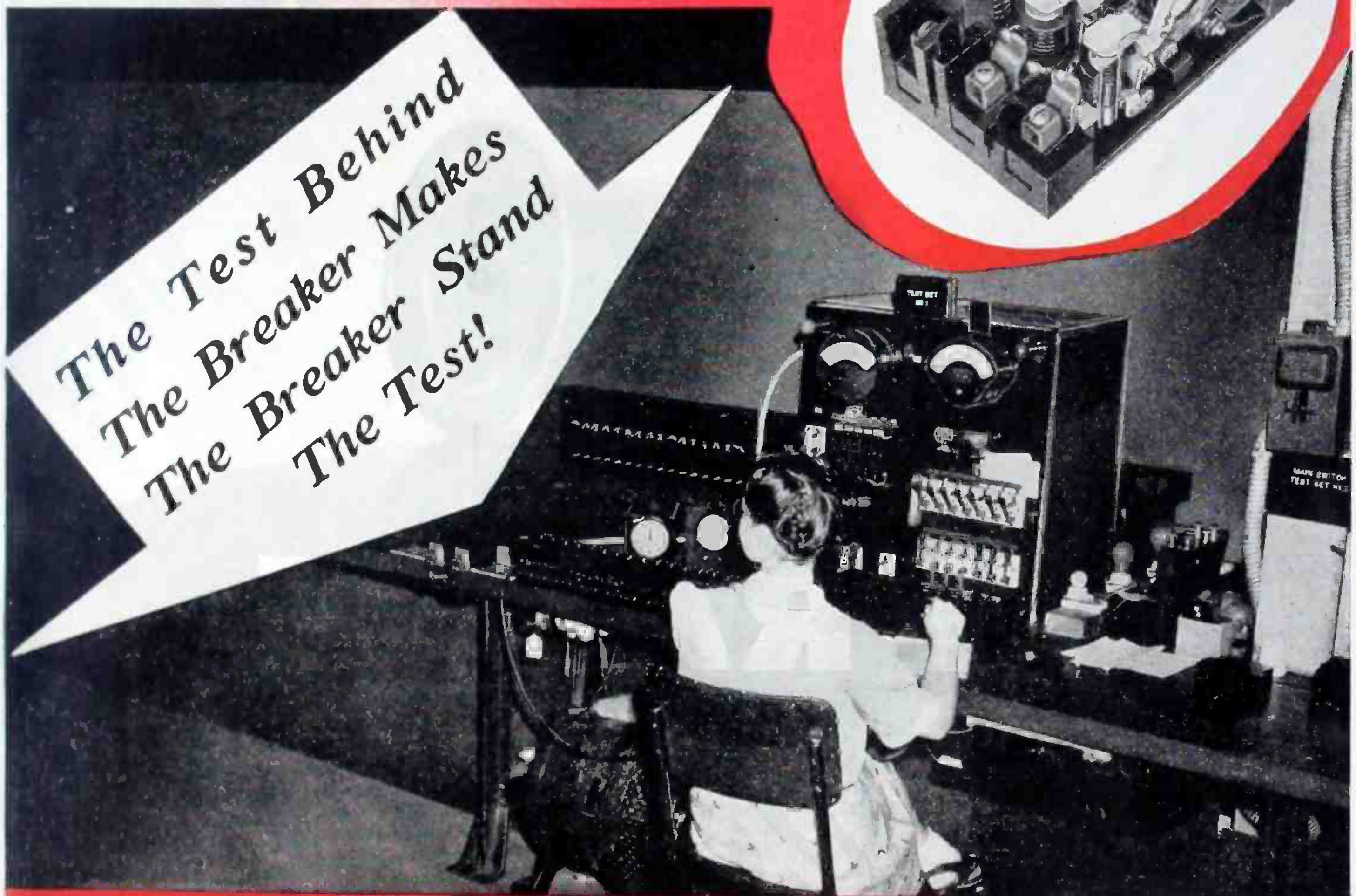
GENERAL OFFICE: NORTHERN BLVD. AT 45th ST., LONG ISLAND CITY 1, N. Y.

ACTUAL SERVICE
Is The Real Test For
HEINEMANN
MAGNETIC CIRCUIT BREAKERS





The above photograph shows Heinemann Circuit Breakers on the final time test. Breakers are manufactured with time delays closely matched to customer's specification. Each breaker is tested on at least three points of its time delay curve to insure that the time delay stays within the curve limits specified.

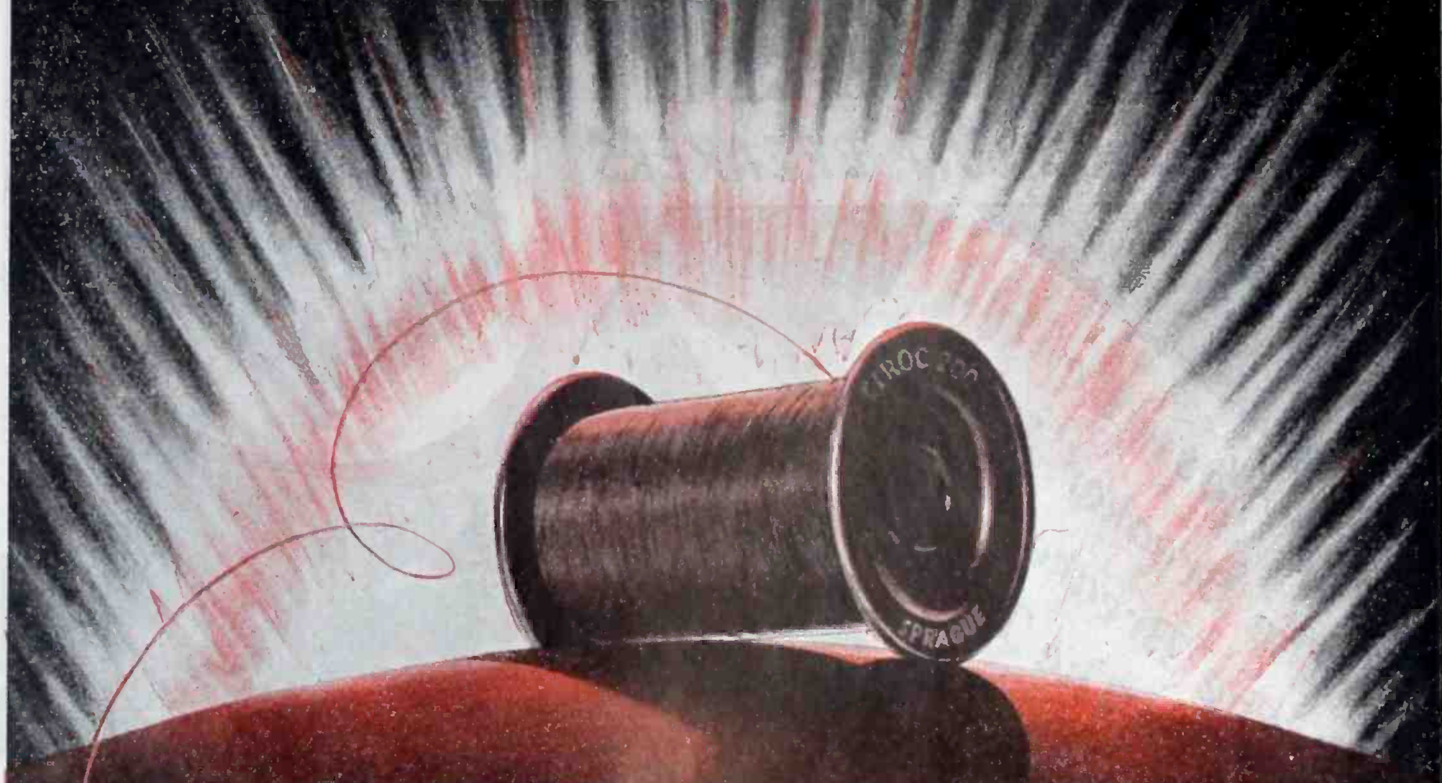
Other tests include high potential tests, trip point tests, time delay tests, vibration tests, etc. Breakers are designed to carry full load continuously and to trip at 8 to 10 times full load instantaneously regardless of ambient temperature. Send for bulletin giving time delay curve, mechanical details, and engineering data.

HEINEMANN CIRCUIT BREAKER CO.

Subsidiary Heinemann Electric Co., Est. 1888

97 PLUM STREET TRENTON, N. J.

ANNOUNCING*



SPRAGUE
Ceroc 200†

A high-temperature (200° C.) ceramic insulation for copper, nickel, and other wire

*We use the word "Announcing" advisedly. Although this is its first public announcement, Sprague CEROC 200 is by no means a new or untried development. Many engineers are already familiar with it. Many have long been using it on restricted war developments on which details cannot yet be announced. So far-reaching are its possibilities for such a wide variety of electrical products, however, and with our production facilities being steadily and materially expanded we take this means of bringing it to general trade attention.

† T. M. REG. U. S. PAT. OFF.

†Ceroc 200

INORGANIC INSULATION FOR COPPER AND OTHER WIRE

PERMITS 200° C. CONTINUOUS OPERATION

FOR MANY TYPES OF ELECTRICAL EQUIPMENT

A CLASS C INSULATION MATERIAL

CROSS SECTION The extreme uniformity of CEROC 200 makes for smooth, level winding. The thinness with which it may be deposited on the wire saves space.

Culminating seven years of continuous research and development by the Sprague engineering organization, CEROC 200 now paves the way for greatly increased efficiency, smaller sizes, and lighter weight for a wide variety of electrical equipment.

Sprague CEROC 200 is a ceramic (inorganic) insulating coating thinly deposited on copper, nickel, and other types of wire, and permitting much higher continuous operating temperatures than are possible with ordinary Class A insulations such as enamels, varnishes, and other organic materials. Applied to copper wire, it permits of a conservatively rated 200° C. continuous operating temperature as compared to the present limit of 105° C. for Class A materials. Thus, by designing electrical equipment to utilize the full maximum operating temperature of this new wire coating, a very substantial increase in volt-ampere rating can be obtained. We believe that CEROC 200 meets all requisites of a Class C insulating material under A. I. E. E. standards.

THERMAL CONDUCTIVITY: Coils wound with CEROC 200 dissipate heat rapidly. There is little or no tendency toward development of hot spots which might nullify a big percentage of the high-temperature gain that would otherwise be expected. Thus, the high-temperature advantages of CEROC 200 are real and not apparent.

SPACE FACTOR is extremely good. Typical percentages of copper area to total cross-sectional area of finished wire are 96% for AWG #21 wire, and 95% for #24 wire for CEROC 200 by comparison with only 69% and 59% respectively for other insulations that might be used for high-temperature applications. Moreover, CEROC 200 coating is extremely uniform, thus making for smooth, level winding. The preferred coating thickness is 1/4 mil., and the following characteristics are based on wire so coated:

MAXIMUM STABLE TEMPERATURE for continuous operation—200° C.

VOLTAGE BREAKDOWN between two wires of a twisted pair 4" long:

Standard condition (25° C.)—300 v. A.C.

Humid condition (95% relative humidity)—300 v. A.C.

Hot condition (200° C.)—300 v. A.C.

LEAKAGE between two wires of a twisted pair, 4" long, at 95% relative humidity is greater than 100,000 megohms.

FLEXIBILITY by bending: 16% elongation.

ABRASION RESISTANCE: Average 16-18 scrapes at 200 G. weight on G.E. abrasion tester for #25 AWG wire having the preferred 1/4 mil. coating thickness. On wire sizes smaller than #25, this average is slightly less, and on larger than #25 wire, it is somewhat more.

WIRE SIZES: Although CEROC 200 is constantly being adapted to new uses, the present preferred ranges for coated wire are as follows:

Copper wire—from 3 to 30 mils (#40 to #21 AWG).

Nickel wire—from 1½ to 12 mils (#46 to #28 AWG).

WINDING CHARACTERISTICS: CEROC 200 is sufficiently flexible to present no winding difficulties that will not be far more than compensated for by its tremendous high temperature and space advantages. In general, round coils can be wound satisfactorily by existing methods. Slight modifications in winding technique may prove necessary, however, in the case of rectangular coils or motor armatures.

Although costs on CEROC 200 are being steadily revised downward, as a result of greatly increased facilities, it should be borne in mind that this material was not designed to compete on applications where conventional organic insulations are giving satisfactory service. Rather, it is intended for those applications where a substantially higher temperature insulation combined with space- and weight-saving factors more than justify a somewhat higher price for the CEROC 200 insulation that makes them possible.

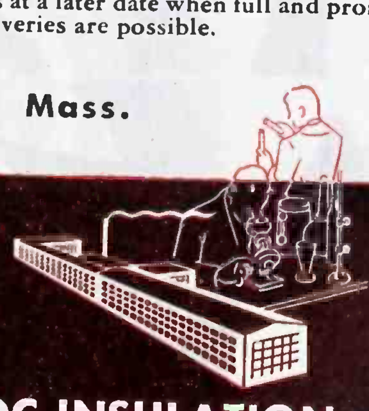
SAMPLES

CEROC 200 is by no means a new or untried development. For more than a year, large quantities of CEROC-insulated wire have been supplied for important war applications of the most exacting sort. Thus, although production facilities are being steadily increased, it is still difficult to supply generous samples of specific wire sizes to all who might be interested. As far as possible, however, we will gladly supply small quantities of available sizes to large users who want to test its far-reaching possibilities in connection with their products at a later date when full and prompt deliveries are possible.

SPRAGUE ELECTRIC COMPANY, North Adams, Mass.

(Formerly Sprague Specialties Company)

SPRAGUE

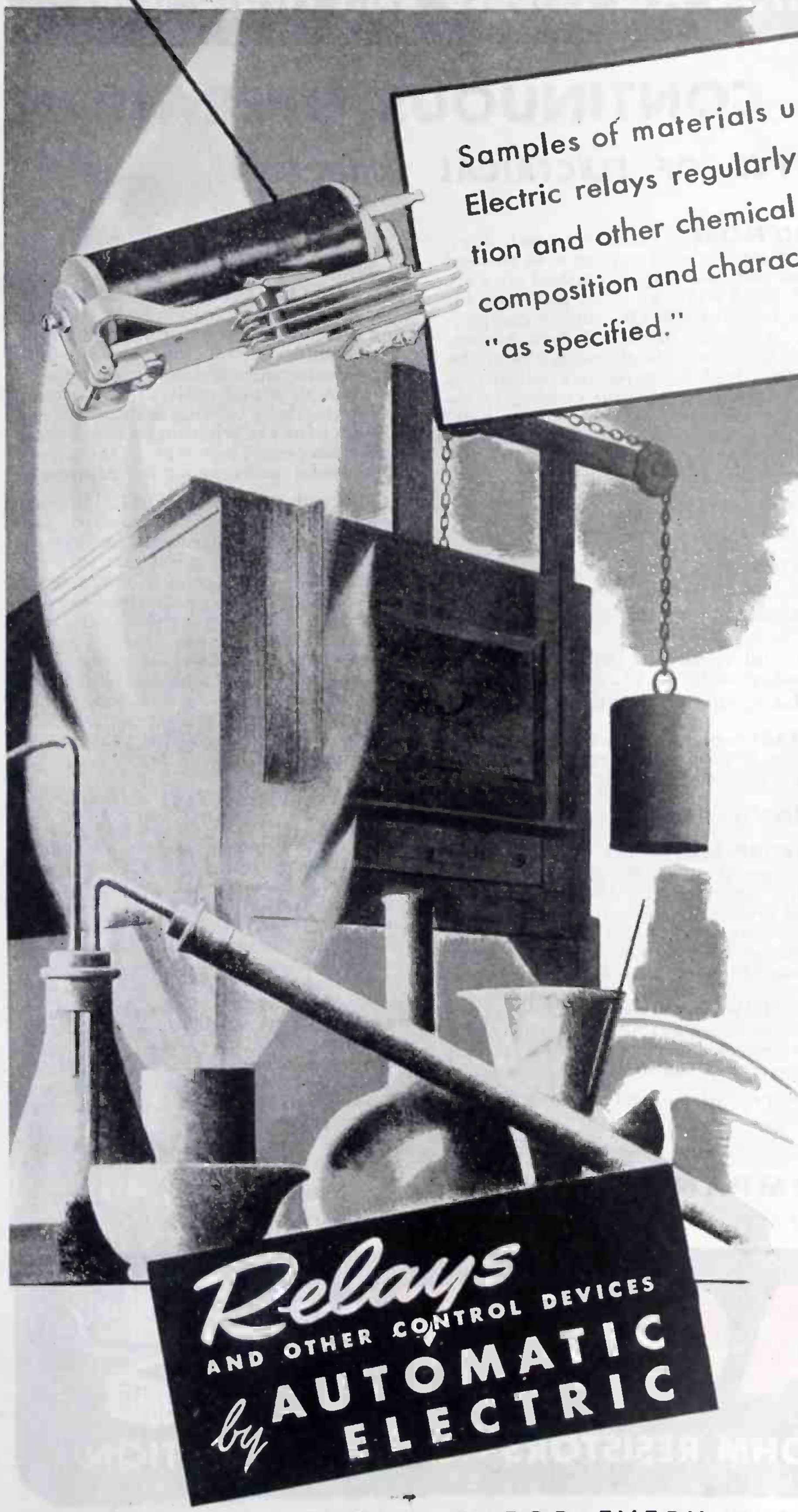


CAPACITORS • †KOOLOHM RESISTORS • †CEROC INSULATION

†TRADEMARKS REGISTERED U. S. PATENT OFFICE

"The Heat's On" To Verify Relay Material Composition

Samples of materials used in Automatic Electric relays regularly undergo combustion and other chemical tests to insure that composition and characteristics are exactly "as specified."



It may seem a simple matter—this job of selecting the right materials for making relays; but—

Automatic Electric designers know better. They know that correct design is only the beginning—that materials must also meet exacting standards, or performance will suffer. That is why they insist that quality control must begin in the laboratory.

When you need relays, call in the Automatic Electric field engineer. He can show you how quality pays, in longer life, better performance. In the meantime, for a preview of the Automatic Electric line, write for Catalog 4071.

★

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PARTS AND ASSEMBLIES FOR EVERY ELECTRICAL CONTROL NEED

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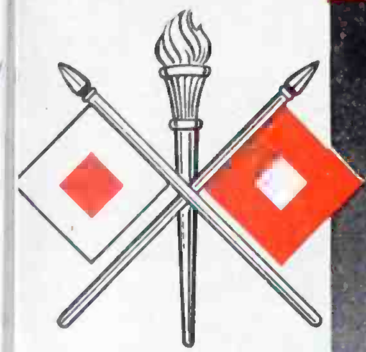
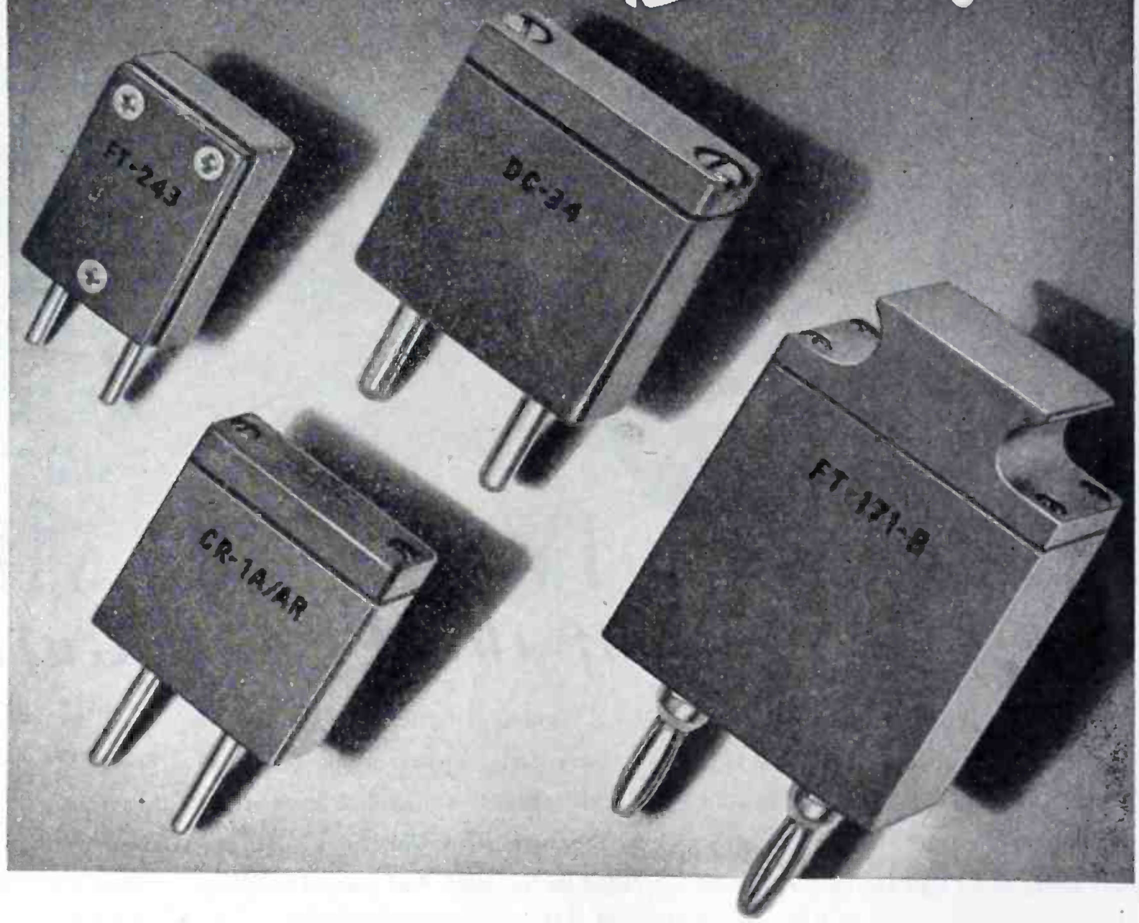


Four basic controls by *Bliley*



All helping to "get the message through"... all precision proved in the tradition of

BLILEY CRYSTALS

Bliley CRYSTALS

Do more than before... buy extra War Bonds

BLILEY ELECTRIC COMPANY • UNION STATION BUILDING • ERIE, PENNSYLVANIA

INCREDIBLE SALVAGE

The Case of the Flying Gull . . .

During the storm season of 1942, *The Flying Gull* ran into heavy seas in the Gulf of Mexico.* Running before a terrific wind, she all but made port. Then, just as she was putting about near Hunter's Point, she shipped a gigantic wave and foundered. All hands were saved. But *The Flying Gull* rested in eight fathoms of Gulf water.

Salvage operations were started. Later in 1942, when The Flying Gull was in the dock and her electrical equipment ripped out, an amazing thing occurred. George Long, of The Harris Salvage and Drydock Company of Galveston, put the Thermador transformer equipment on a shelf in the sunshine—mentally assigning it to the scrap metal drive. Three days later, out of curiosity, he hooked the transformers onto a testing bench and flipped on the current. To his amazement, they still showed signs of life. He then ran standard tests. To his further astonishment, all twelve of the transformers were not only working—they were working perfectly.

Harvy Stark, owner of the boat, had already ordered a complete new set of transformers from Thermador. He cancelled the re-order. And today The Flying Gull sails with her original Thermador transformers. Not designed for the briny deep—but they could take it!

Such stories of plus performance are not accidents, for Thermador transformers are built to perform beyond normal expectations. They are completely manufactured—not just assembled—under one roof on a vast array of modern precision equipment. They are made *only* from the finest materials, engineered by men of broad experience. The result is not alone quality but *quality in quantity*. If that meets your specifications, better discuss transformers with Thermador.

THERMADOR TRANSFORMERS
DEFEAT HEAT • COLD • HUMIDITY

An actual case history from Thermador files; however names, dates, and location have been altered.* **Buy MORE War Bonds.

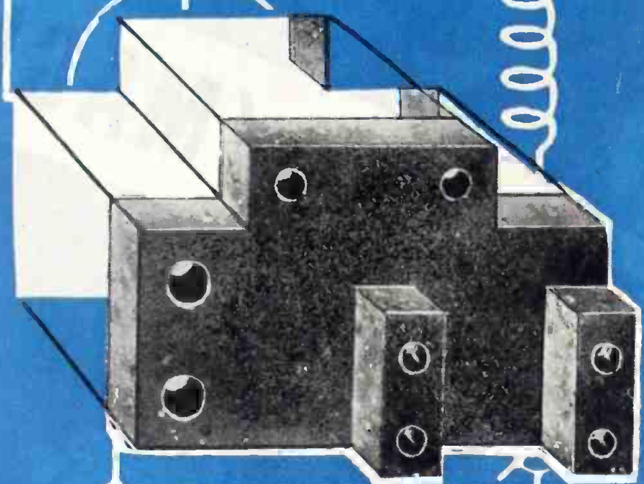
"SEVEN LEAGUES AHEAD"

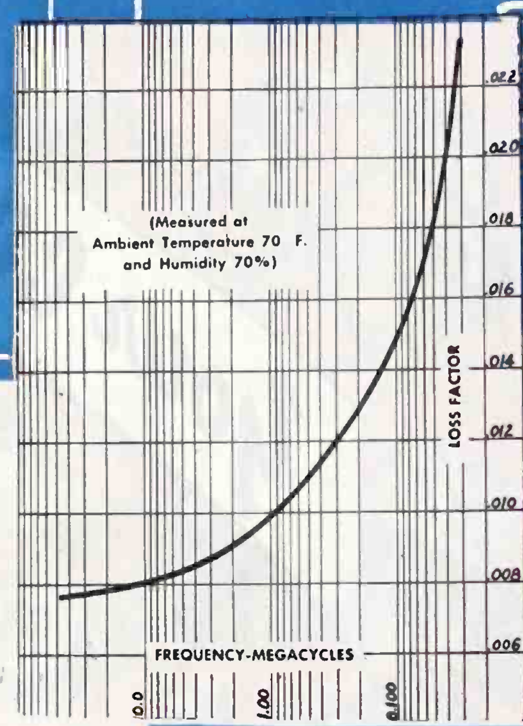
THERMADOR ELECTRICAL MANUFACTURING COMPANY
5119 SOUTH RIVERSIDE DRIVE • LOS ANGELES 22, CALIFORNIA

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. Write for full details and samples.

MYCALEX THE INSULATOR

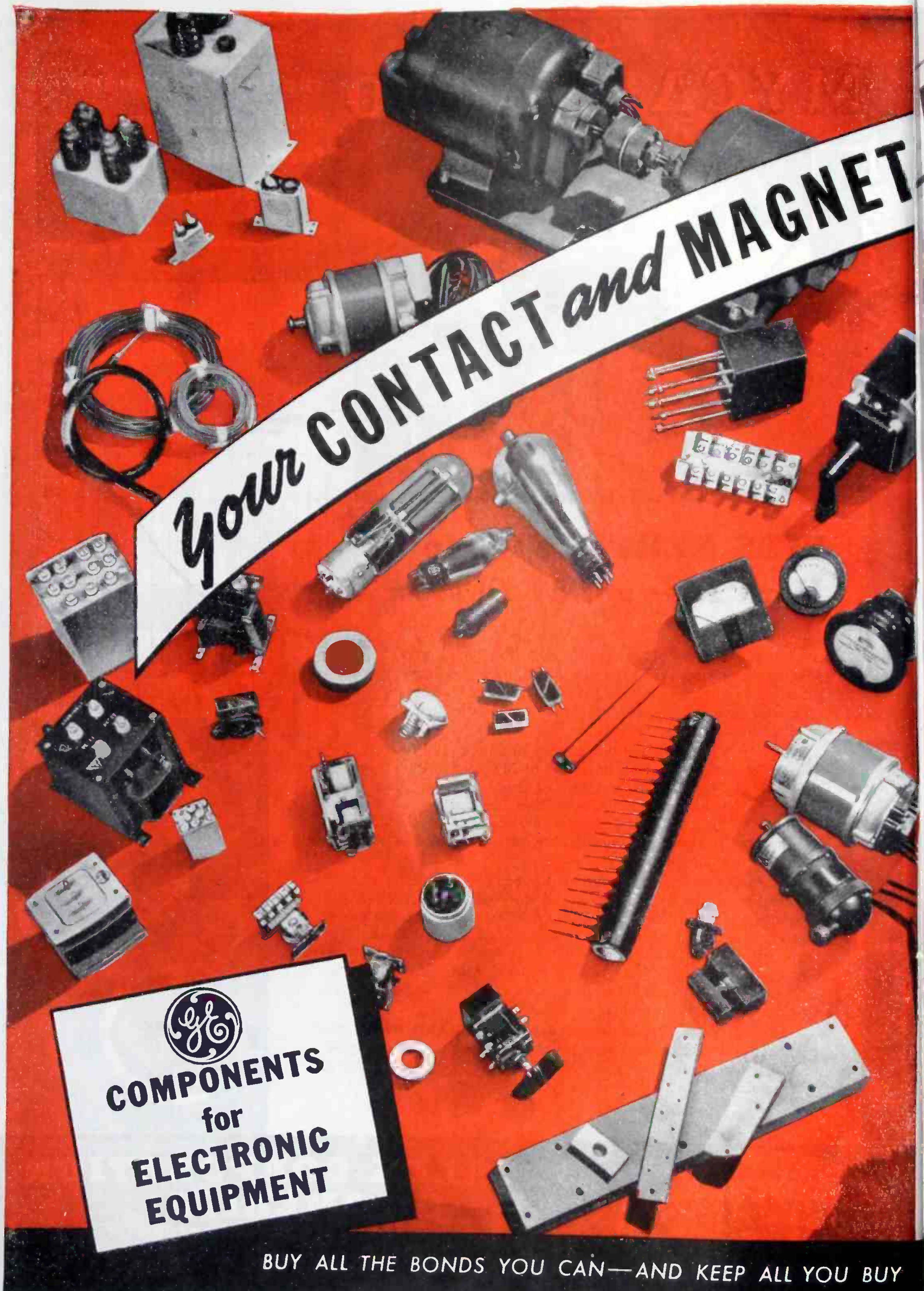
TRADE MARK REG. U. S. PAT. OFF.

MYCALEX CORPORATION OF AMERICA

"OWNERS OF 'MYCALEX' PATENTS"

CLIFTON, NEW JERSEY

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


Your CONTACT and MAGNET
COMPONENTS for ELECTRONIC EQUIPMENT
BUY ALL THE BONDS YOU CAN—AND KEEP ALL YOU BUY

PROBLEMS *pre-solved!*

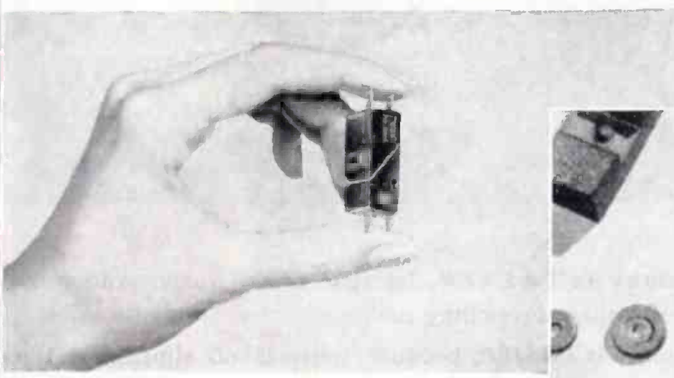
Switchettes and Alnico magnets afford examples of how G-E components save designers' time, make for better performance

If you're puzzling over how to get the switching functions you want into the limited space you'd ke to allow, the chances are that you'll find your nswer *ready-made*—in the G-E Switchette.

Again, if yours is the problem of applying permanent ıagnets (perhaps of intricate shapes) in restricted space, ou may find your problem *solved in advance*—by G-E lnico magnets.

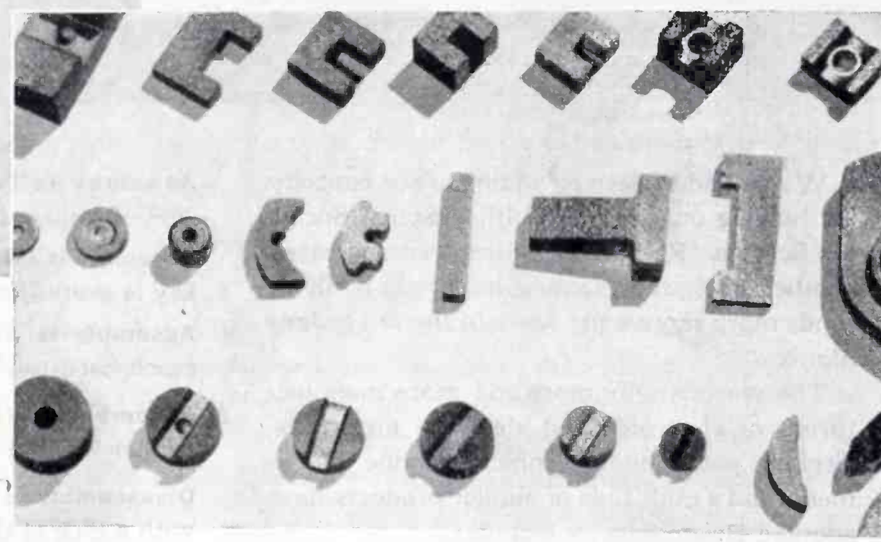
These are but two of many examples of G-E electronic omponents that lift a big burden of detail from designers' shoulders, and give greater latitude in the design of new equipment. Each of these components is the product of close co-operation between designers—at G.E. and in the electronics industries. Each is precision-built. Each has proved its ability to maintain specified performance characteristics under severe service conditions.

In selecting components from General Electric's extensive line, you can count on practical help from qualified G-E representatives. Located in principal U.S. cities, these men will gladly co-operate with you on both application and procurement problems. Call on them through the G-E office nearest you. *General Electric Company, Schenectady 5, N. Y.*



HE G-E SWITCHETTE

Smaller than a woman's thumb, the witchette shown weighs only 9 grams; et it can handle up to 10 amperes at 30 volts a-c, or 10 amperes at 24 volts c. Low-inertia moving parts, high conct force, and double-break construcon assure positive action, even in the ce of the severe vibration encountered n combat aircraft. Actuation can be anual or mechanical, as by a cam, ver arm, or bellows. Switchettes are ailable in such a variety of contact rms and terminal arrangements that any perplexing contact problems are terally "licked to start with." Bulletin EA-3818B describes more than 100 pes and arrangements. Ask for your opy.



SINTERED ALNICO MAGNETS

Alnico magnets, of which there are several types, provide more external energy for a given volume than any other permanent-magnet material, more stored energy per dollar. Alnico is also more resistant to stray magnetic fields, temperature extremes, and vibration. Sintered Alnico II, because of its compactness, stability, and uniform flux distribution, facilitates the design of precision devices of small size. The sintered-alnico process employed by G.E. is a "natural" for large-scale, close-tolerance manufacture of both simple and complex shapes—for hearing aids, electronic measuring equipment, microphones, etc., and for numerous applications in connection with electronic tubes. Ask for Bulletin GEA-3682A.

GENERAL ELECTRIC

642-4

THERE IS NOTHING TO DO ABOUT A WAR EXCEPT WIN IT!

The purpose of this advertisement is NOT to brag about Thordarson's part in the war effort. While patriotism in a person or company may be something to be proud of, our own feeling is that it should not be exploited. Expressing patriotism in America is not even a duty; rather, it is a privilege . . . happily one that is understood and appreciated by the majority.

That is why, for nearly 3 years, Thordarson has talked little about the war and war production . . . except to make the bare statement that we were busy supplying materials for the armed forces.

Regardless of all this, we do think the time is now propitious to give a few more details as to what we are thinking and doing.

When war came, we were one of the first companies to be chosen for front-line production duty. The need was urgent . . . the demands were great. As Americans, we were glad wholeheartedly to tackle the job assigned to us.

Early and late . . . day and night . . . Sundays and holidays, we have continued to devote all of our efforts, 100% to winning the war. We have kept "eyes front" on this one task. We have had to forget, for the moment, personal considerations of "good business" . . . on occasion we have even had to turn down old and good friends who needed this or that which, under ordinary conditions, we would have been tickled to death to supply.

The time will come . . . it's coming shortly, we feel . . . when we again can think first and foremost of supplying civilian needs. That will be a far happier day for us than it could possibly be for you, no matter how much you have needed material you were unable to secure.

But meantime, the war goes on . . . and we, in our small way, must continue to stand guard at our appointed post until the "at ease" command is given. As we said in the beginning: THERE IS NOTHING TO DO ABOUT A WAR EXCEPT *WIN* IT!

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

INSULATION HELPS for post-war salability

With numerous pre-war products, processes and techniques "going by the board" when so-called non-essential production lines start rolling again, receptance of new developments and creations will be dependent upon their capability to function satisfactorily from the customer point-of-view. Instrumental in electrical fields of endeavor, and the sustaining of the reputation for quality, will be insulation.

The diversified types of TURBO insulation—Saturated Sleeving, Varnished Tubing, Extruded Tubing, Varnished Glass Tubing, Cambrics, Composites, Mica Products, etc.—are best exemplified by their wide application in equipment in every theatre of World War II.

Electrical and mechanical advantages of TURBO are multiple, for there's a specific material to meet any of today's insulation problems—sub-zero temperatures, high heat conditions, moisture absorption, wear and abrasion, wiring perplexities, acids and alkalis, high dielectric strength, etc.

• • •

Engineers, designers and manufacturers—now engaged "in peering beyond the horizon" will find it a substantial "help" to carefully consider TURBO as a means of stepping-up product sales potentials. Write today on company letterhead for free Specimen Board; no obligation.

WILLIAM BRAND & COMPANY

276 FOURTH AVE. NEW YORK, N. Y.
325 W. HURON ST. CHICAGO, ILL.

IF IT'S TURBO IT SAFEGUARDS

FLEXIBLE VARNISHED OIL TUBING: this TURBO insulation meets the diversity of requirements necessary to stand up against breakdowns, impairment through moisture absorption, and the general deteriorating influences caused by acids, alkalis, fumes, corrosion, etc.

VARNISHED GLASS TUBING: the extensive use of this TURBO product is directly attributable to its excellent characteristics under high heat conditions. Heavy duty operating conditions, confined areas where ventilation is minimized and other similar problems are solved.

EXTRUDED TUBING: where the effects of temperatures are apt to induce insulation embrittlement, TURBO Extruded Tubing is especially suited. Sudden climatic changes, wide fluctuations in temperature, or refrigerant operating conditions will not affect its dependability.

WIRE IDENTIFICATION MARKERS: the facilitating of production and assembling operations, with corresponding increases in functional efficiency, are effected with this TURBO insulation product. Available in any size, length or color. TURBO markers meet UL requirements.

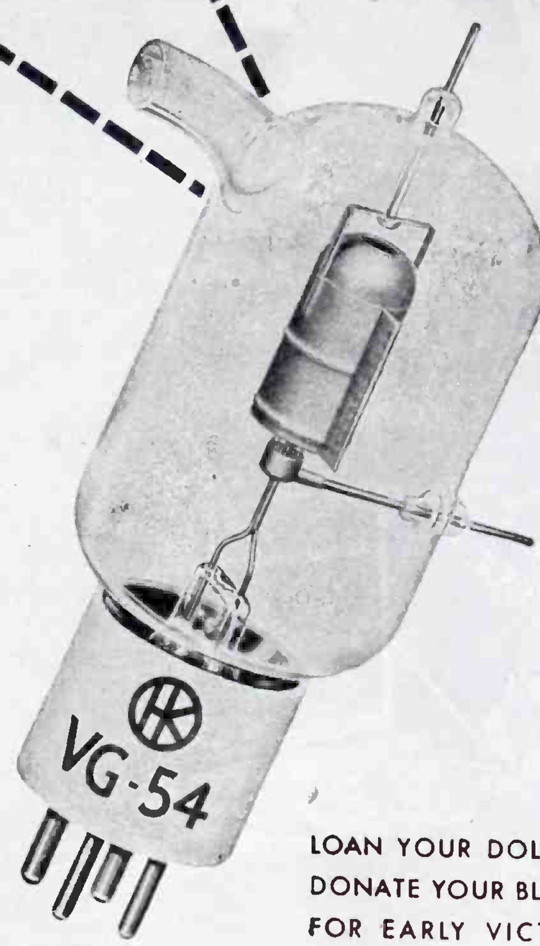
NEW GLASS COATING TECHNIQUE AIDED BY VG-54 IONIZATION GAUGES

A new technique for making glass transmit up to 50% more light through a lens system, and eliminating troublesome "ghost images", is being aided by a new Gammatron tube — the VG-54.

A transparent, microthin coating of magnesium fluoride is applied to the glass by a unit which produces the high vacuum necessary to vaporize this metallic salt in a few minutes, instead of the several hours previously required.

The VG-54 ionization gauge, a special type of triode which accurately measures vacuum pressure, is currently in use with units which are decreasing the surface and interior reflection of lenses and prisms in Norden bombsights.

Gammatron *ionization* gauges are now available for checking the operation of all types of vacuum equipment.

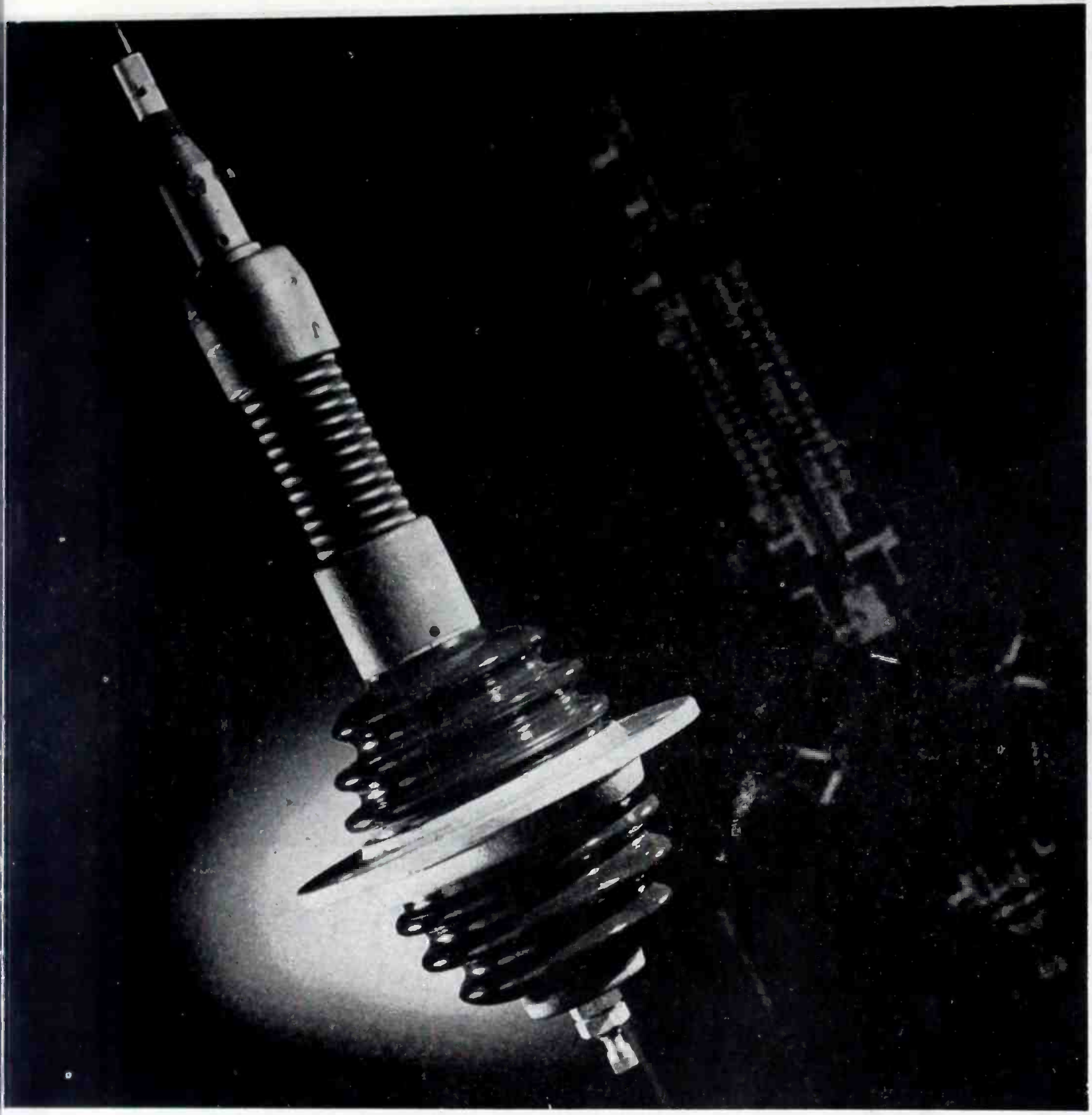


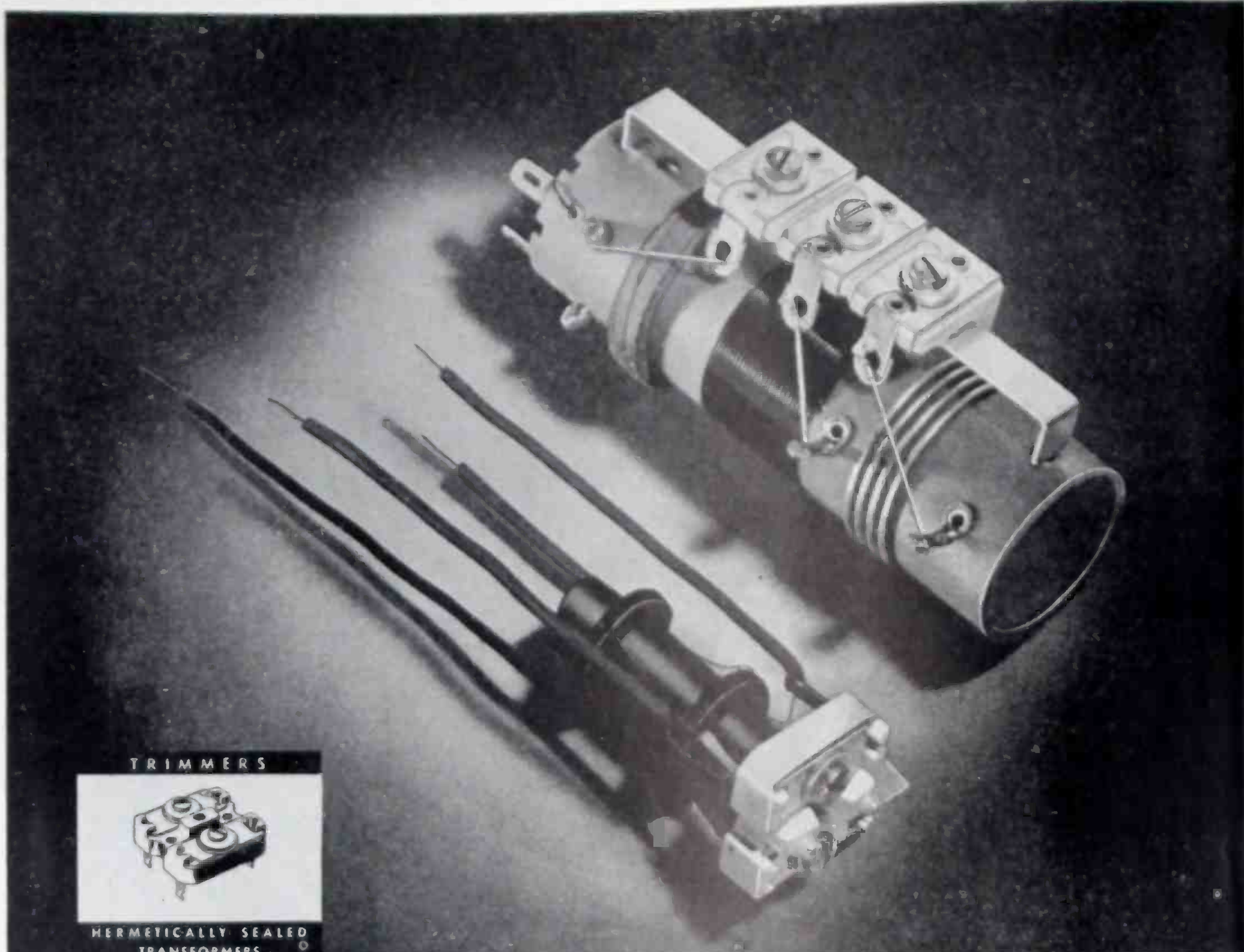
HEINTZ AND KAUFMAN LTD.
SOUTH SAN FRANCISCO • CALIFORNIA

Gammatron Tubes

LOAN YOUR DOLLARS
DONATE YOUR BLOOD
FOR EARLY VICTORY


The TINYMITE
SMALLEST PAPER CAPACITOR - - -
yet 100%
MOISTUREPROOF
TYPE P5N
TYPE P4N
FEATURES
1. Bakelite Resinoid Ends. Lead wire cannot pull out, even under hot conditions.
2. Non-Inductive.
3. Excellent Temperature Coefficient.
4. Very high leakage Resistance.
5. Fine Power-Factor.
6. Range from 20 MMFD to .25 MFD. From 150 volts to 600 volts.
7. Types P4N, P5N for 100% humidity operation.
8. Types P4, P5 for 95% humidity operation.
Samples and price list on Request
BUY EXTRA WAR BONDS . . .
. . . 'TIL THE WAR IS OVER.
Pat. Pend.
DUMONT
ELECTRIC CO.
MFR'S OF
CAPACITORS FOR EVERY REQUIREMENT
34 HUBERT STREET NEW YORK, N. Y.

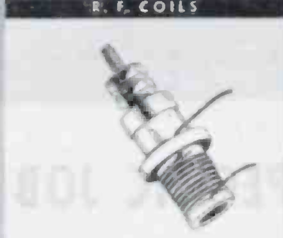




TRIMMERS

HERMETICALLY SEALED TRANSFORMERS

R. F. COILS



I. F. COILS

CHOKE COILS

INTANGIBLES

The Design of Radio Equipment has become an exact science. Yet, where tuned radio frequency circuits are concerned, many intangibles which cannot be reduced to rigid specifications can affect performance materially.

AUTOMATIC has a background of years of experience and *"know how"* which enable us to recognize and thereby control these possible sources of trouble.

Whether Coils or Trimmers, your requirements will be met more uniformly and reliably at no greater cost by *AUTOMATIC WINDING COMPANY* products.

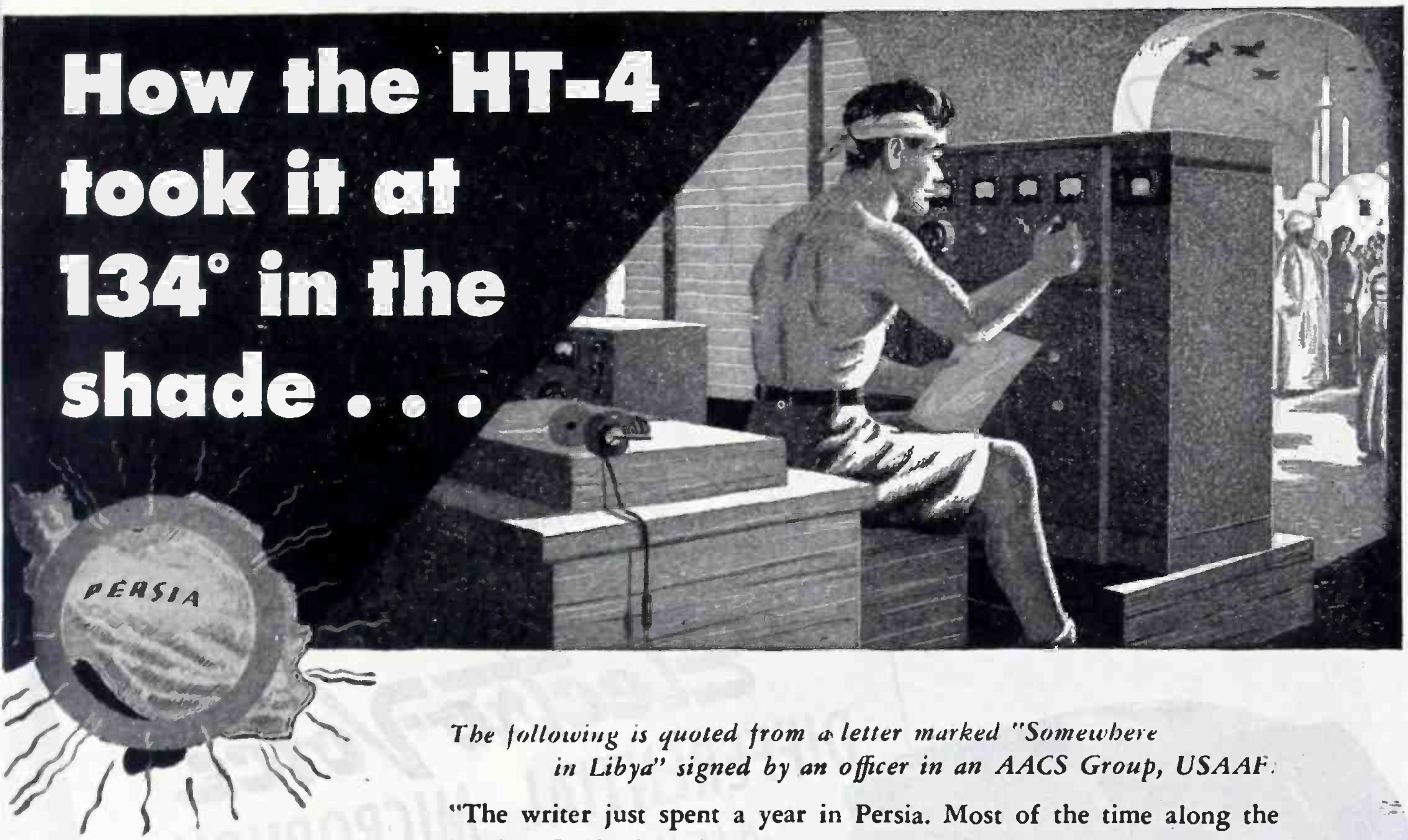
AUTOMATIC WINDING CO., INC.

KEEP BACKING THE ATTACK! BUY MORE WAR BONDS

COMPLETE ELECTRONIC ASSEMBLIES & COMPONENT PARTS

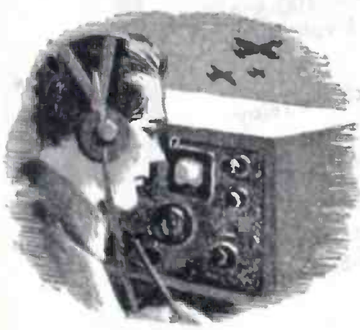
900 PASSAIC AVE. EAST NEWARK, N. J.

How the HT-4 took it at 134° in the shade . . .



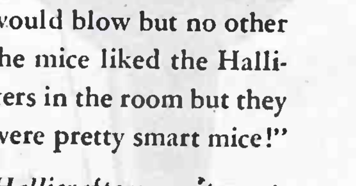
The following is quoted from a letter marked "Somewhere in Libya" signed by an officer in an AACS Group, USAAF.

"The writer just spent a year in Persia. Most of the time along the Persian Gulf where it really gets HOT! We operated one of your HT-4-B Transmitters near a place called Abadan. The transmitter performed very satisfactorily under the most unfavorable conditions. I doubt that your engineers ever dreamed that one of your rigs would be called upon to perform in a place where for 5 days and nights the temperature never dropped below 117 degrees and in fact it got up to 134 degrees during the daytime, that is "in the shade" temperature, the humidity was high and the air salty. Actually the transmitter got much hotter than that as it was installed in a brick building and no air conditioning, not even an exhaust fan. The HT-4-B was used on voice and gave very little trouble. One day the piece of bakelite under the phone/cw switch caught on fire but this was easily repaired. During the so called winter season, the temperature actually got as low as 36 degrees one day, we had a little trouble with mice crawling under the rig, which was set up on two 4x4 wooden sleepers. It seems the mice liked the heat and they would crawl up under the transmitter and get lodged in between the rectifier sockets and the frame when the operator switched on the transmitter the mice would fry, usually a fuse would blow but no other damage was done We never did figure why the mice liked the Hallicrafters best. There were several other transmitters in the room but they always seemed to pick the HT-4-B; guess they were pretty smart mice!"



Just one of hundreds of real life experiences of Hallicrafters equipment. Out of this valuable experience will come your peace time short wave radio.

★**BUY A WAR BOND TODAY!**

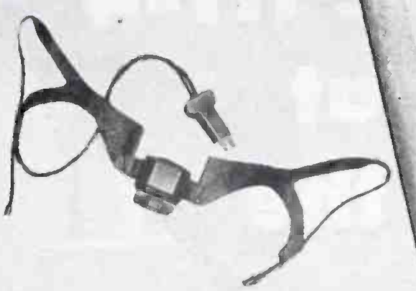


ARMY E NAVY

hallicrafters RADIO

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

This is the now-famous Electro-Voice "Lip Mike" which began a new era in transmission of voice and the cancellation of ambient noises.



. . . and this marks the second step in the development of a full line of Electro-Voice Differential (noise-cancelling) Microphones.

Electro-Voice DIFFERENTIAL MICROPHONE

NEW MODEL 205-S

Designed, developed and built by E-V engineers and technicians

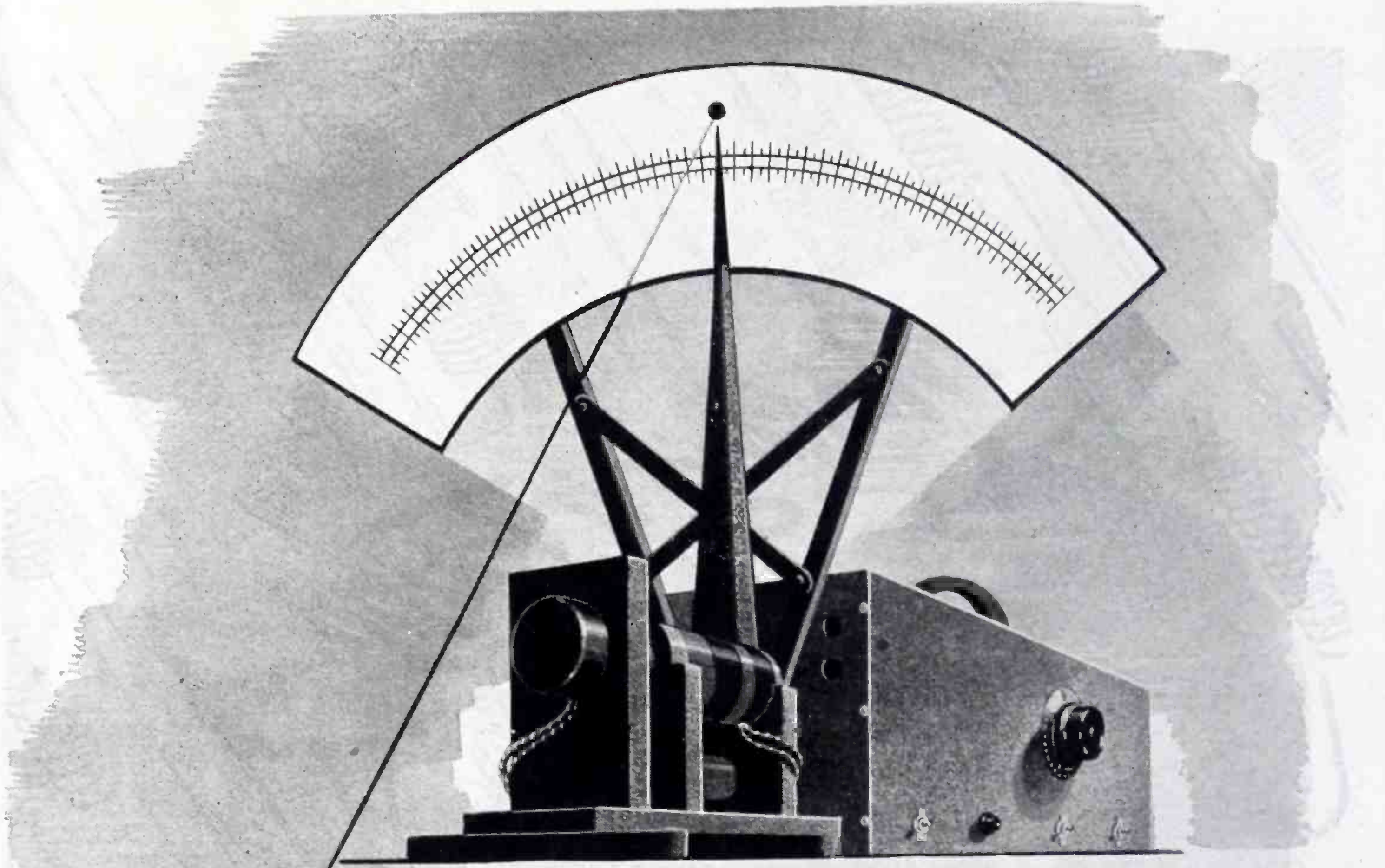
- Provides extremely high intelligibility even under intense surrounding noises
- A most efficient microphone for aircraft, factories, railroads, police and emergency services
- May be used in all temperatures from −40 to +185 degrees, and is interchangeable with conventional carbon microphones
- Close-talking, blast proof, waterproof and shock-resistant
- Operates satisfactorily in all positions
- Frequency response substantially flat from 100-5000 c.p.s.: high output level: −20 DB (0 DB = 1 volt/dyne-/cm²); internal noise level below .001 volt.
- Press-to-talk switch opens microphone and closes relay simultaneously, if desired
- High impact phenolic case, 4" x 2-5/16"; Fiberglas wind noise filter; weighs less than 8 ounces
- Cable length, 5 ft.; panel mounting on the back; available in two models: Model 205-S, and 205-SL with switch lock.

If your present limited quantity needs can be filled by any of our Standard Model Microphones, with or without minor modifications, please contact your nearest Electro-Voice distributor.

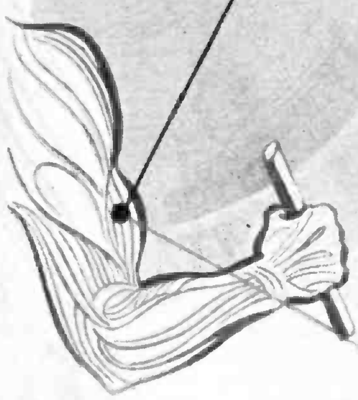
Electro-Voice MICROPHONES

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



measuring mighty muscles of midget motors

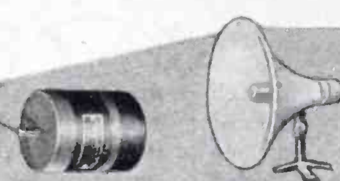


● The might of this midget motor is no secret to this special dynamometer used in the Utah laboratory. It accurately measures the horsepower; actually predetermines the successful performance of this Utah motor in its many vital functions in actual use.

Utah's complete testing service is playing an important part in the war effort today, and is scheduled for an equally important role tomorrow . . . in adapting war-born electronic and radio developments to commercial and consumer needs.

★ ★ ★

Every Product Made for the Trade, by Utah, Is Thoroughly Tested and Approved



Keyed to "tomorrow's" demands: Utah transformers, speakers, vibrators, vitreous enamel resistors, wirewound controls, plugs, jacks, switches and small electric motors.

utah

Utah Radio Products Company, 857 Orleans Street, Chicago 10, Ill.

. . . for callite tube components

Heavy duty oscillator tubes for high frequency heating are specially designed to withstand widely varying conditions of load and frequency. The United Electronics Company of Newark, N. J., one of the leading producers of such tubes, has long relied on Callite for high quality components — especially tungsten kulgrid welds, a Callite development.

An important requirement in the manufacture of vacuum tubes has been a stranded wire which does not oxidize readily at the high temperatures required in the successful steps of production such as beading, stem-making, sealing-in and exhaust. Kulgrid has the necessary high-heat and electrical conductivity for efficient operation when used in conjunction with Callite tungsten in the manufacture of hard glass electronic tubes. Callite Tungsten Corporation, 544 39th St., Union City, N. J. Branch Offices: Chicago and Cleveland.

United Electronics Tube KU-23 for r. f. heating, contains Callite tungsten kulgrid welds.

℞ FOR R* DAY
***RECONVERSION**

Discuss your post-war plans with our engineers. Our accumulated knowledge and experience is worth having —Now. We can help you on the design and selection of materials.

CALLITE TUNGSTEN CORPORATION CT

Callite tube components

ENDLESSLY *the Improvement goes on.*

● Since 1913, in the Formica Laboratories, a consi able force of competent research men has been b every day seeking new ways to improve Formica and usefulness to industry.

They have worked out a long line of improveme which have been additions to the art. During these years they have been exceptionally busy, and product

Among the important recent developments have b glass cloth and glass mat grades for high mechani strength, and improved insulation of high freqe currents; Pregwood for airplane propeller blades other mechanical uses; alkali resistant grades for ch ical processes, better laminated translucent sheet, sturd and more decorative Formica finishes.

There are others which will soon be unveiled. the knowledge of this laboratory is at your disposal w you have a problem in the use of laminated plastics solve. Ask for it

"The Formica Story" is a moving picture in co showing the qualities of Formica, how it is made, h it is used. Available for meetings of business grou

ARMY E NAVY

FORMICA

THE FORMICA INSULATION COMPANY, 4661 Spring Grove Avenue, Cincinnati 32, Oh

making mountains out of molehills

Dependability is a lot of little things that add up—it's the end result of paying due homage to all the molehills of production so that the finished product will give a mountain of service. Like paying strict attention to seemingly unimportant details of workmanship. Like emphasizing the work of skilled technicians who are experts in their special field of building finer capacitors.

That's the way we've been making capacitors since 1910. Many of our men and women have been working on C-D capacitors for nearly 34 years. Others have been with us for five—ten—twenty years of loyal, devoted service.

Dependability is a C-D tradition. Every C-D capacitor has built into it the dependability . . . the skill, experience and research . . . that belong only to the leader, Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

TYPE YAT—*A compact, low capacity Dykanol "G" bypass capacitor—hermetically sealed in specially-treated drawn metal container. Range at 600V.—.05 mfd. to 1 mfd. at 100V.—.05 mfd. to .5 mfd.*

CORNELL-DUBILIER CAPACITORS

1910 1944

MICA · DYKANOL · PAPER · WET AND DRY ELECTROLYTICS

ALSO AT NEW BEDFORD, BROOKLINE, WORCESTER, MASS.; PROVIDENCE, R. I.


Federal
Low Frequency Transmitters Used
Inside the
FEDERAL TELEPHONE & RADIO
FTR

Arctic Circle

To maintain unfailing communication between airports and from field to plane inside the Arctic Circle, requires the use of low frequency transmitters that will operate reliably far from service facilities.

Federal, pioneer in both low and high frequency radio communication, provides the solution with its 10 KW low frequency transmitter, consisting of an exciter, rectifier, RF transmitter and antenna tuning equipment, housed as separate units. Compact, light in weight, they may be transported in a cargo plane without dismantling.

Through blinding storms and almost perpetual night, pilots in the Far North stake their lives on the dependability of these Federal radio transmitters.

Your transmitting equipment may never be called upon to meet such rigorous demands. But, whatever your requirements are in low or high frequency transmission, Federal, with its technical experience and leadership in radio communication, is prepared to solve your problem.

Intelin High Frequency Power and Coaxial Cables manufactured by Federal, meet every construction and performance requirement of the most exacting specifications.

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark 1, N. J.

"Ham" Radio and HYTRON

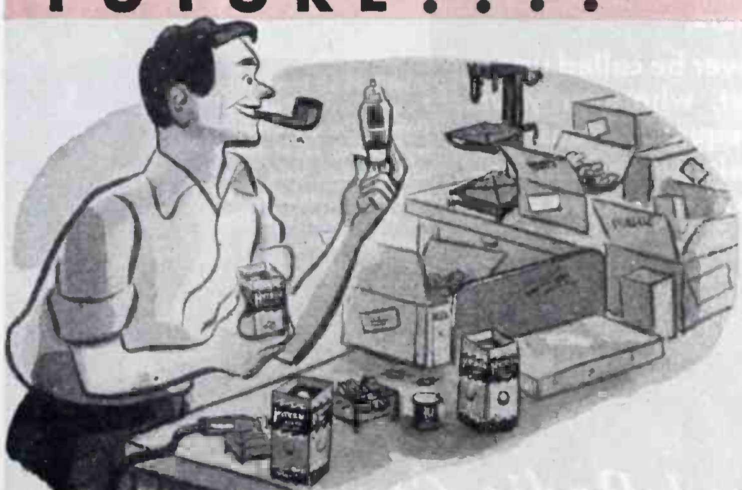
PAST . . . .

THE radio amateur trained himself during peac
to be invaluable to the Nation during war. Special
izing on tubes exclusively designed for ham radic
Hytron when war began was prepared for immediat
and direct conversion to war production. Hytro
transmitting and special purpose tubes proved by th
ham were ideally suited—with little or no changes—
to military applications. Years of practical experi
ence made Army and Navy specialists of radi
amateurs overnight. Peacetime tools of these sam
hams, Hytron tubes joined immediately this new
fighting team.

. . . . PRESENT

HAMS with the Services in all parts of the world know the war job Hytron is doing. High-speed receiving tube techniques plus know-how derived from special purpose engineering of tubes for the amateur, make possible a flood of dependable Hytron radar and radio tubes to these fighting ex-hams and potential hams. Proud of winning the Army-Navy "E" for its performance on a huge production job, Hytron is also proud of its ham friends who are transforming innocent-appearing Hytron tubes into deadly weapons.

FUTURE . . . .



THERE should be no concern about adequate post-war amateur frequencies. Excellent wartime performance on far-flung battle fronts has made for ham radio many enthusiastic and influential friends. The ARRL reports that it looks forward with absolute confidence to the opening of new frontiers in expanded frequency ranges to be made available to the post-war amateur. Hosts of hams will return to their old friend, Hytron. For the more familiar lower frequency bands—the very high frequencies—or the new superhighs—their choice will be Hytron.

OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

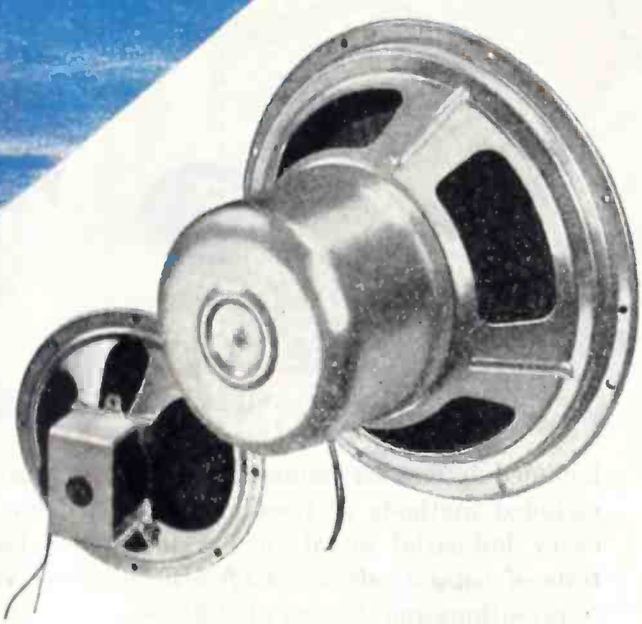
HYTRON CORPORATION ELECTRONIC AND RADIO TUBES

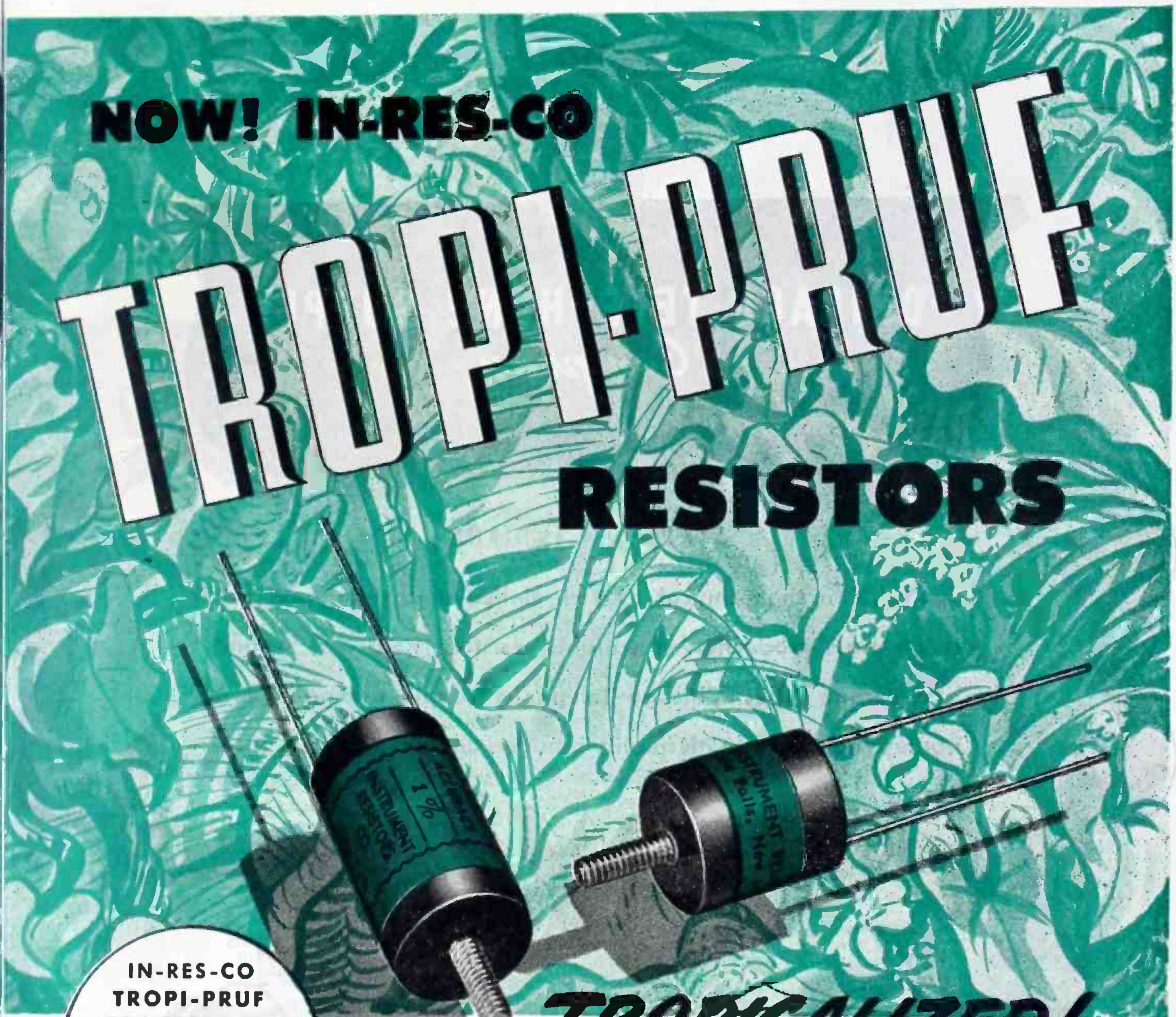
SALEM AND NEWBURYPORT, MASS.

ARMY NAVY

HYTRON RADIO TUBES

BUY ANOTHER WAR BOND





TROPICALIZED!

IN-RES-CO TROPI-PRUF RESISTORS have all these features

1. Specially - engineered cap design for tight, penetration-proof fit.
2. Terminal leads bonded to cap for hermetic seal.
3. Special IN-RES-CO banding material for lasting protection.
4. Special IN-RES-CO fungus-proof coating.
5. One-piece molded bakelite shell, with cap, assuring rugged durability and dependability.
6. #6-32 mounting screw, an integral permanent part of the shell.

A new conception of resistor performance

IN-RES-CO

Present day application of electrical equipment under drastic climatic variations, demands new considerations and requisites in engineering. In tropical climates, absorption and adsorption of humid spore-bearing atmosphere is not uncommon, and subsequent fungus growth plays havoc with delicate components and adjustments. Product failure—complete and irreparable in a matter of only two days—is the usual result. Thus, fungicidal protection becomes a foregone conclusion.

IN-RES-CO engineers — responsive to the new requirements, offer the complete TROPI-PRUF line of tropicalized resistors. New, proved and accepted, each wire-wound unit —itself carefully protected against corrosion, moisture and deteriorating influences —is permanently sealed in a hermetically-tight bakelite case. Terminal leads are brought through close-tolerance openings, and sealed to prevent creepage of moisture or fungus growth.

After dehydration, the complete piece receives several carefully controlled coatings of fungicidal finish. Signal Corps #71-2202-A approved, this protective film is non-toxic, resistant to thermal shock, mold and mildew, and possesses high dielectric strength. It is designed to withstand Navy Salt Spray tests, electrolytic action, condensation and corrosive influences.

All IN-RES-CO wire-wound resistor units are available in TROPI-PRUF. Included are a wide diversity of components for both general and high accuracy applications.

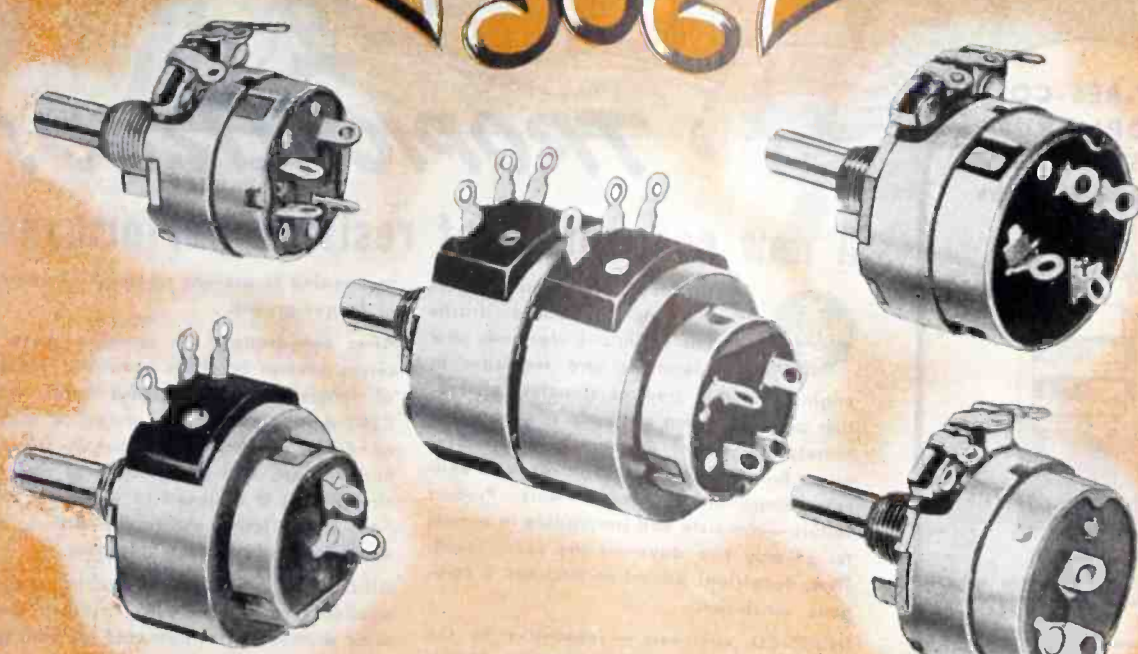
WRITE FOR CATALOG.
The complete IN-RES-CO line of high-accuracy units, includes meter multipliers, shunts, choke coils, solenoids and special coils. Write for your copy of this 16-page data compilation; there is no obligation.

INSTRUMENT RESISTORS CO.
25 AMITY STREET, LITTLE FALLS, NEW JERSEY

CHICAGO TELEPHONE SUPPLY *Company*

ELKHART ★ INDIANA

Specialists in the technical research, skilled engineering and precision mass production of variable resistors, both wire wound and carbon types, Chicago Telephone Supply Company is a name synonymous with quality products and unexcelled service.



VARIABLE RESISTORS, PLUGS, JACKS, SWITCHES, TELEPHONE GENERATORS, RINGERS

REPRESENTATIVES

R. W. Farris
2600 Grand Avenue
Kansas City 8, Missouri
Phone: Victory 3070

Frank A. Emmet Co.
2837 West Pico Boulevard
Los Angeles 6, California
Phone: Rochester 9111

BRANCH OFFICES

S. J. Hutchinson, Jr.
401 North Broad Street
Philadelphia 8, Pennsylvania
Phone: Walnut 5369

IN CANADA
C. C. Meredith & Co.
Streetsville, Ontario

Manufacturers of Quality Electro Mechanical Components Since 1896

NO SWEATER GIRLS, *Please*

Electronic tubes are as sensitive to lint, dust and minute particles of foreign matter, as a hay fever sufferer is to pollen. Unless the most stringent precautions are taken to keep tube parts free from impurities, trouble is sure to follow. Trouble—such as noisy receivers . . . discoloration or spots on the screen in cathode-ray tubes . . . power failure in transmitting tubes.

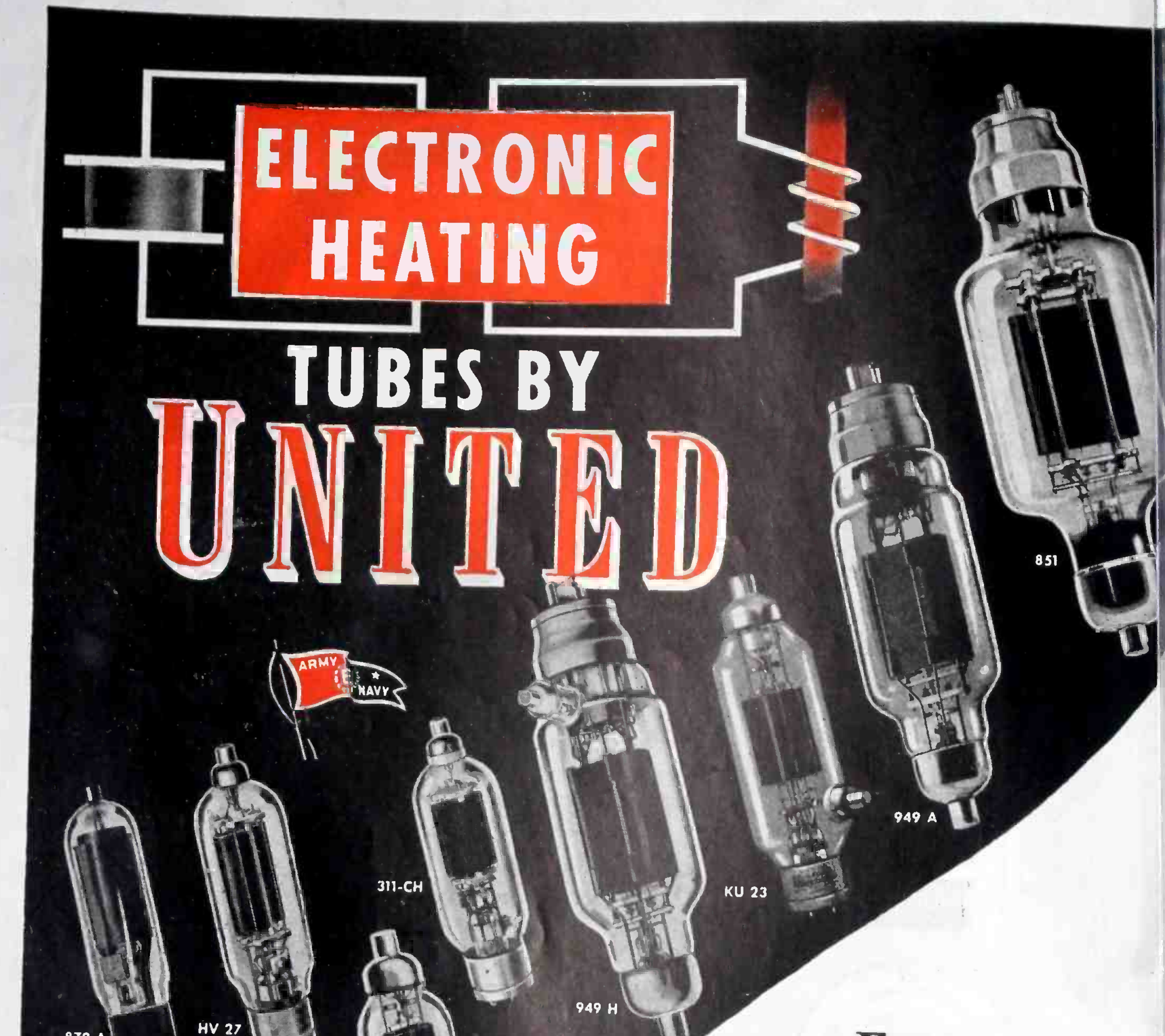
That is why National Union engineers go the limit to assure absolute cleanliness all along the production line. As an example, the model N. U. cathode spray room, pictured above, is not only clean—it's *hospital clean.* No fuzzy sweaters or lint-shedding dresses are worn here. There is no dust, no dirt, because it's air-conditioned. Humidity and temperature are precisely controlled. The whole room is washed from ceiling to floor once a week. Then, to make sure, the individual parts are sterilized—some in boiling water—others in special solvents—still others by hydrogen firing.

Even should other factors be equal, the cleaner tube is the better tube. Remember this—and *count on* National Union.

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

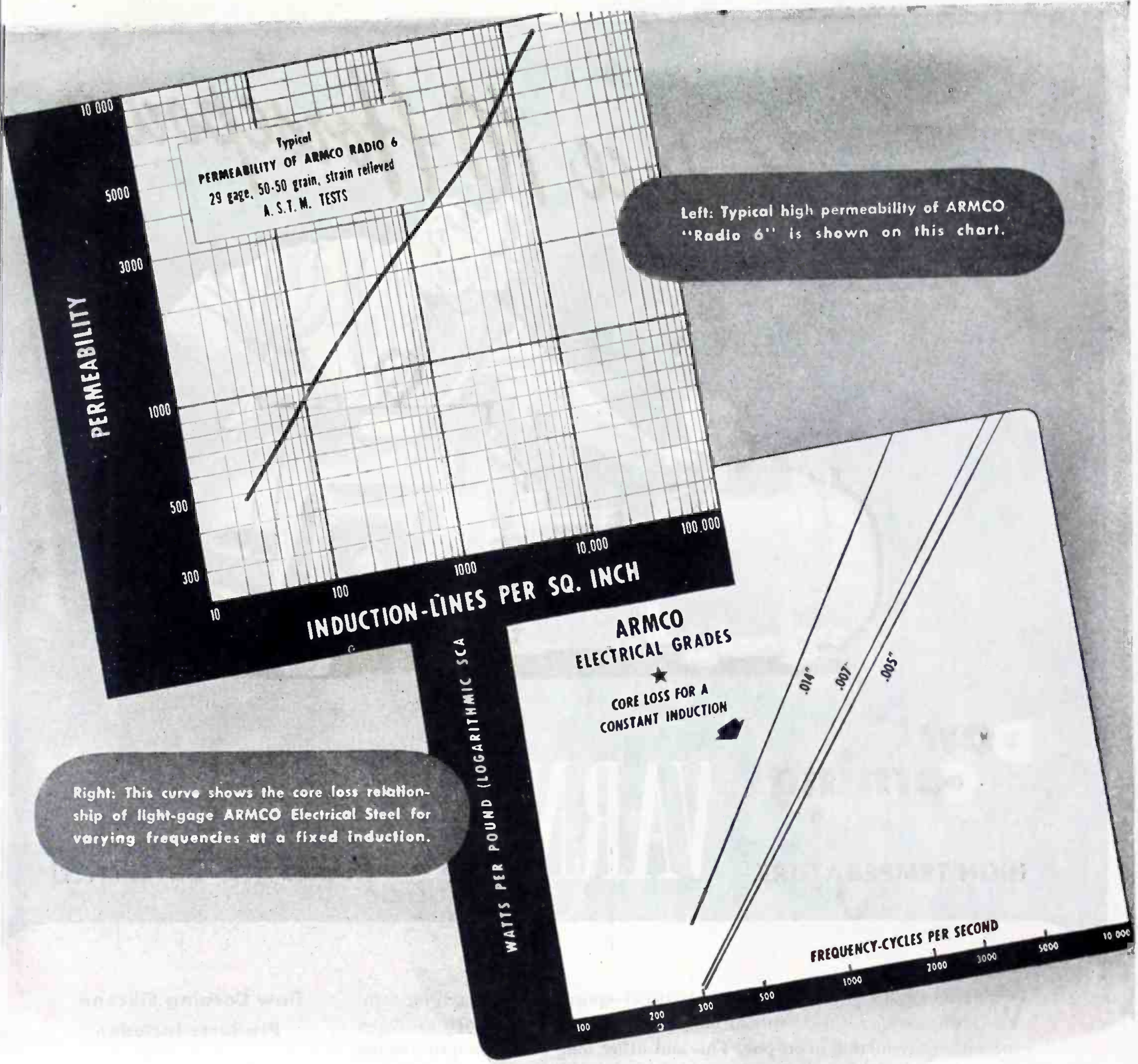
NATIONAL UNION
RADIO AND ELECTRONIC TUBES

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

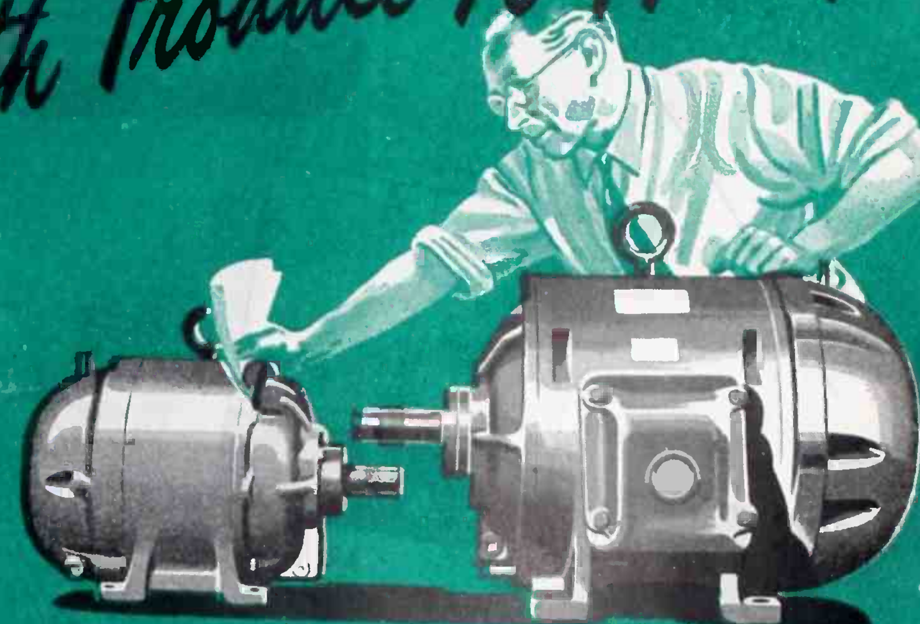


ELECTRONIC
HEATING
TUBES BY
UNITED
ARMY
NAVY
851
949 A
KU 23
311-CH
949 H
872 A
HV 27

HV 18
872
975 A
UX-973
967


Typical
PERMEABILITY OF ARMCO RADIO 6
29 gage, 50-50 grain, strain relieved
A. S. T. M. TESTS
PERMEABILITY
10 000
5000
3000
1000
500
300
10
100
1000
10,000
100,000
INDUCTION-LINES PER SQ. INCH
Left: Typical high permeability of ARMCO "Radio 6" is shown on this chart.
ARMCO
ELECTRICAL GRADES
CORE LOSS FOR A CONSTANT INDUCTION
.014"
.007"
.005"
WATTS PER POUND (LOGARITHMIC SCA
FREQUENCY-CYCLES PER SECOND
100
200
300
500
1000
2000
3000
5000
10 000
Right: This curve shows the core loss relationship of light-gage ARMCO Electrical Steel for varying frequencies at a fixed induction.

Both Produce 10 Horsepower



Dow Corning HIGH TEMPERATURE **VARNISH** MAKES THE DIFFERENCE!

WHEREVER design limitations of electrical equipment are based on insulating temperature, you can now reduce weight by as much as 50 per cent without reduction in output. This and other long desired improvements are accomplished by utilizing the recently developed Dow Corning Silicone Varnishes. These totally new products make possible high temperature insulation of such remarkable thermal endurance that, in addition to weight reduction, the following advantages are attained:

Increased operating temperatures
Increased life under severe service conditions
Increased output

Motors of present design for use under severe service conditions of temperature and humidity may also take advantage of Dow Corning High Temperature Varnish. Dow Corning Silicone Varnished Fiberglas magnet wire, Fiberglas tapes and sleevings, and Fiberglas cloth, alone or laminated with mica, are available for use in this type of construction. We invite consultation.

Dow Corning Silicone Products Include:

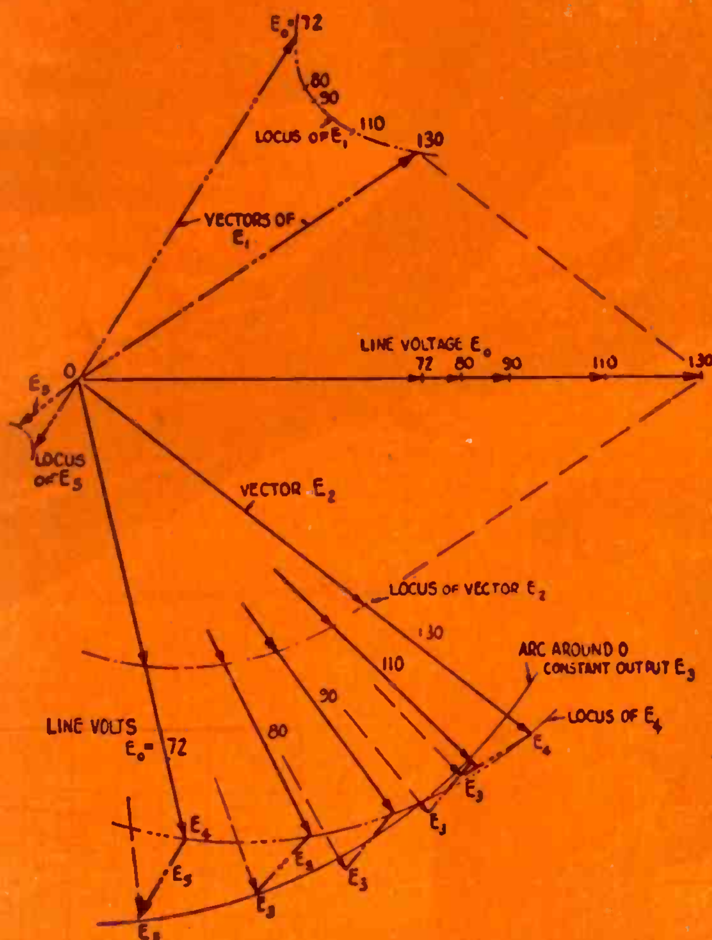
Fluids—Inert liquids, with viscosity little affected by temperature changes; for operation at sub-zero as well as elevated temperatures.

Greases—For lubrication of valves in high temperature or corrosive chemical services. Plug Cock Grease — for metal valves. Stopcock Grease — for glass and ceramic valves.

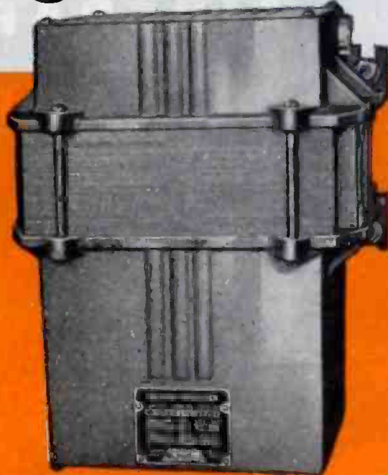
DOW CORNING

DOW CORNING CORPORATION, BOX 592, MIDLAND, MICHIGAN

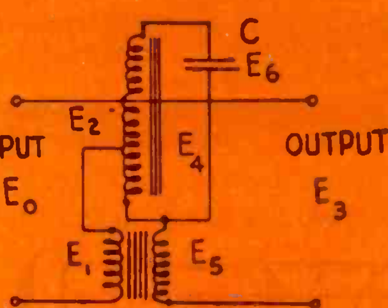
Raytheon Voltage Stabilizers CONTROL Output Voltage to ± ½%



VECTOR RELATIONS FOR FULL LOAD AND VARIABLE LINE VOLTAGE



Endbell Model



PRINCIPLES OF OPERATION

The stabilizer consists of two transformers with the primaries in series. One of these transformers operates at high magnetic density. This transformer with the higher saturation is partially resonated by means of a condenser. The secondary of the two transformers are connected in series opposed. Careful design results in the various voltages adding up vectorially producing the desired output changes compensating for differences of individual voltages. The resultant is a constant output voltage. This action is illustrated above in the chart of vector relations of voltage.

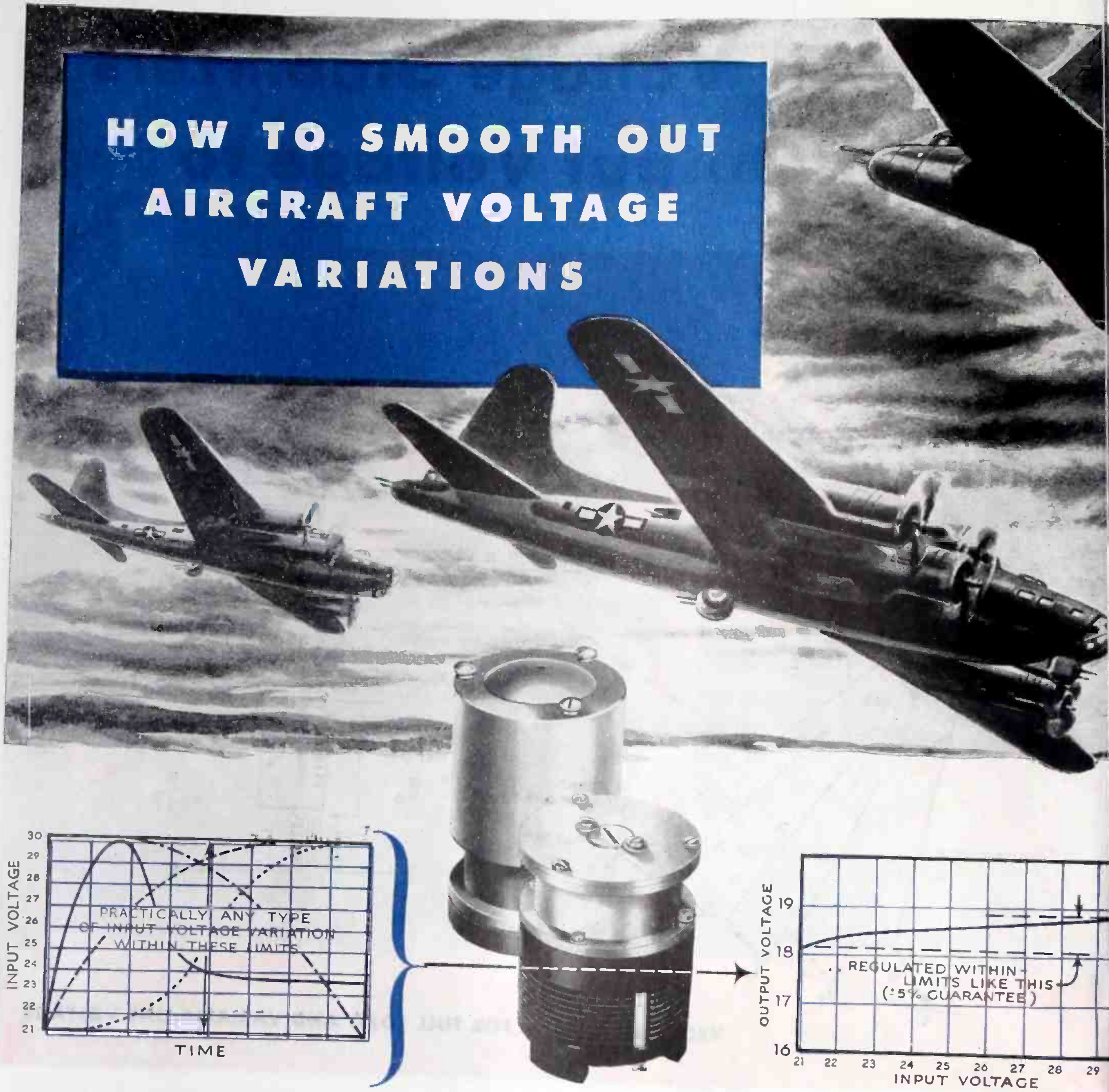
A Raytheon Voltage Stabilizer . . . built into new equipment or incorporated into apparatus not having voltage regulation . . . improves the performance and assures reliable, accurate operation of the equipment. It stabilizes varying line voltages from 95 to 130 volts to plus or minus ½ %. Entirely automatic in operation, the Raytheon Voltage Stabilizer has no moving parts, nothing to wear out. Simply connect it and forget it. Write for Bulletin DL48-537.

RAYTHEON
MANUFACTURING COMPANY
190 WILLOW STREET, WALTHAM, MASS.

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.

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

HOW TO SMOOTH OUT AIRCRAFT VOLTAGE VARIATIONS



VOLTAGE variations inherent in aircraft electrical systems may handicap the performance of precision electronic or other electrically powered devices you manufacture. If so, a Webster Voltage Regulator may solve the problem for you as it has for other manufacturers of airborne equipment. Tell us about your problem—we will be glad to analyze it for the applicability of Webster Voltage Regulators. No obligation, of course.

LOOK TO WEBSTER PRODUCTS

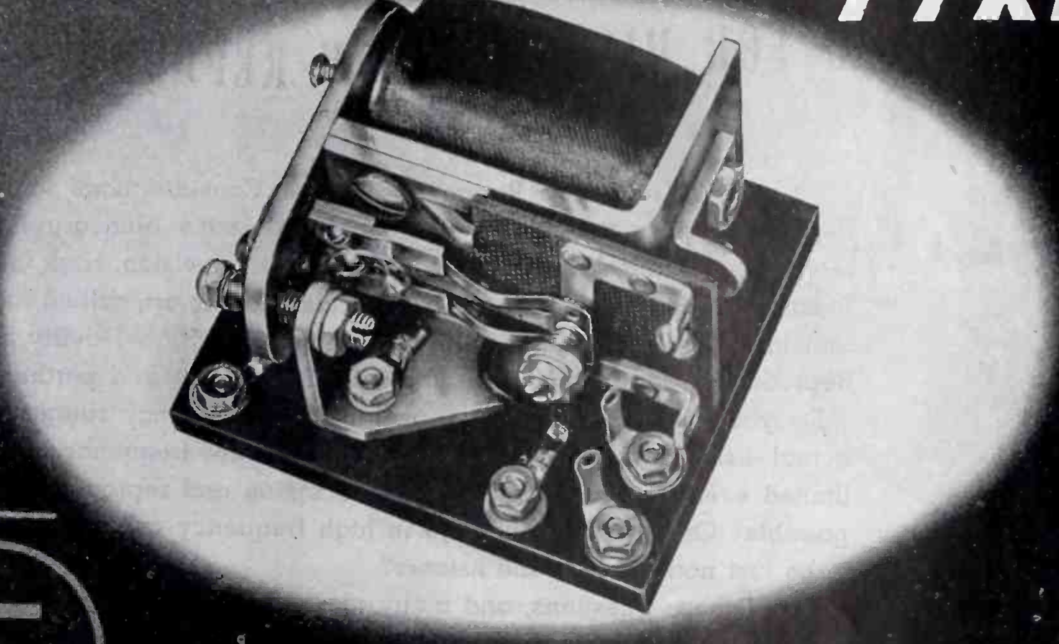
TODAY	*TOMORROW*
Dynamotors and Voltage Regulators	World-Acclaimed Record Changers

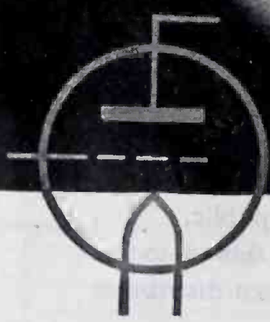
WEBSTER PRODUCTS

3825 W. ARMITAGE AVE. CHICAGO 47, ILLINOIS

STRUTHERS-DUNN

RELAY TYPE 79XAX





Sensitive, Snap-Action Operation

FOR USE ON SLOWLY-VARYING COIL CURRENTS

EXTREMELY CLOSE DIFFERENTIAL

. . . between pick-up and drop-out for either current or potential operation may be obtained by use of a resistor across the coil of the 79XAX, thus reducing coil current to a value just sufficient to hold the contacts closed. Any further decrease in current or voltage will operate the contacts.

Extreme sensitivity can also be obtained by use of a resistor, and the addition of a special coil to the 79XAX. These maintain the relay in a balanced condition. Any slight unbalance of the bridge or other power source will, through the upper coil, buck or boost the lower coil and cause the contacts to snap-operate.

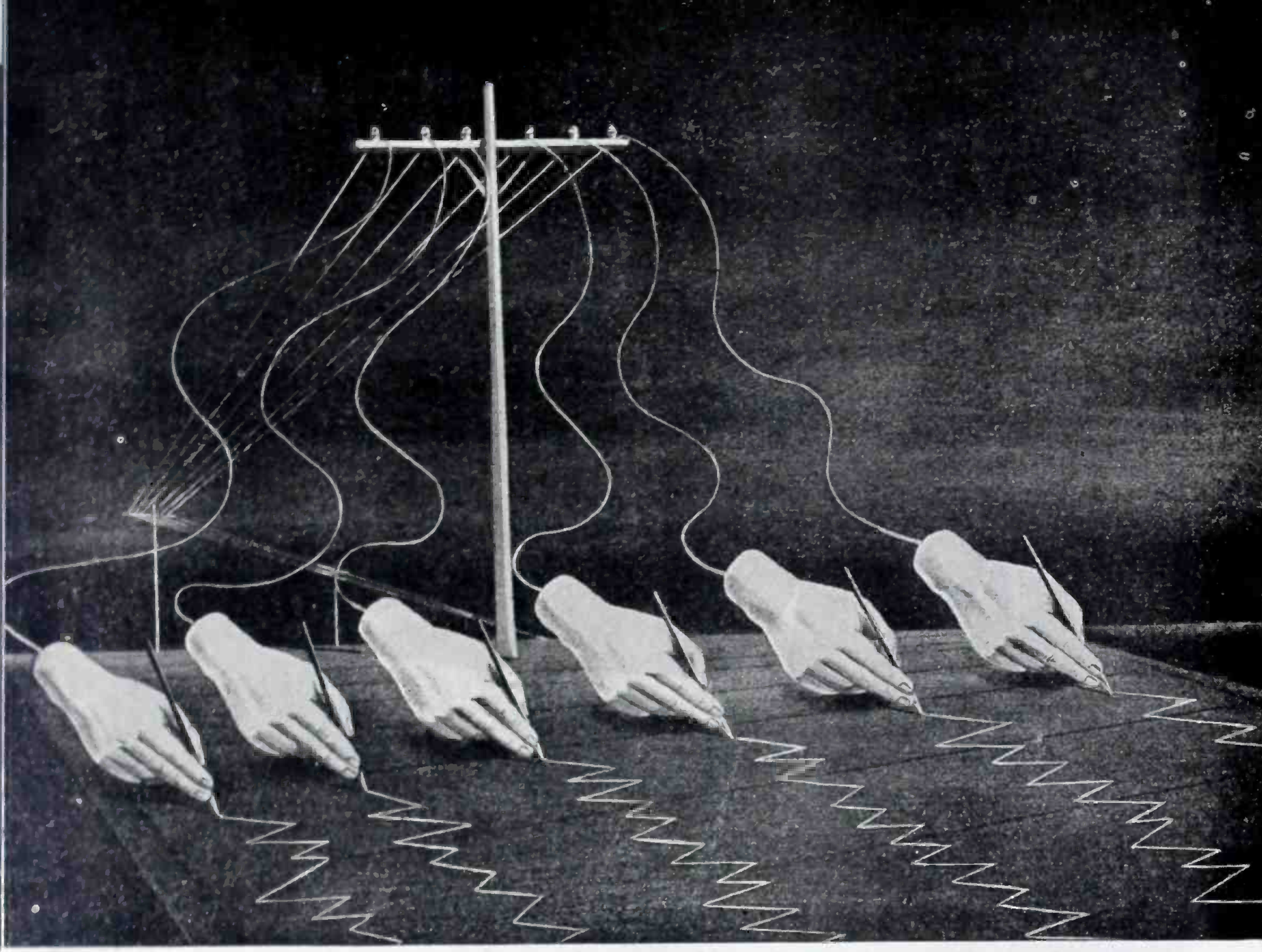
In addition to all of the advantages of conventional sensitive relays, Struthers-Dunn Type 79XAX is designed so that its armature practically completes its travel *before* the contacts snap-operate to the corresponding position. This, plus the fact that contacts remain closed *with full pressure* up to the instant of transfer, permit this relay to be used in a number of unusual ways. Such applications include overcurrent protection particularly in the range of 1 to 100 milliamperes, or in connection with shunts furnishing potentials in the range of 1 to 100 millivolts; pulsing circuits where the relay must "pump" or "scratch its own back"; sensitive vacuum tube circuits, and various others.

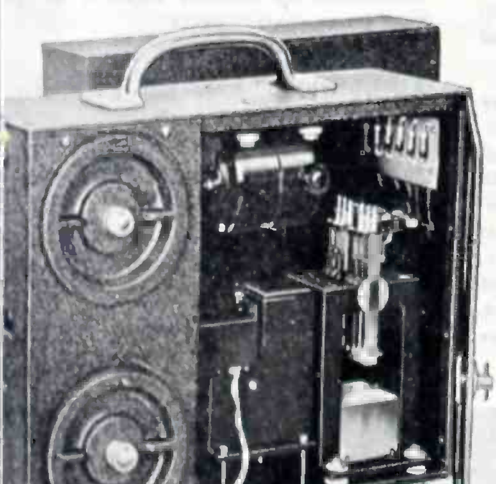
Normal sensitivity is 0.01 watt, although this sensitivity can be heightened by means of various circuit arrangements. Contact arrangement is S.P.D.T., and contact rating 10 amps. 110-V a.c., and 10 amps. 24-V d.c. Balanced construction withstands 10 G vibration and shock. Write for Data Bulletin describing this relay and giving circuit diagrams.

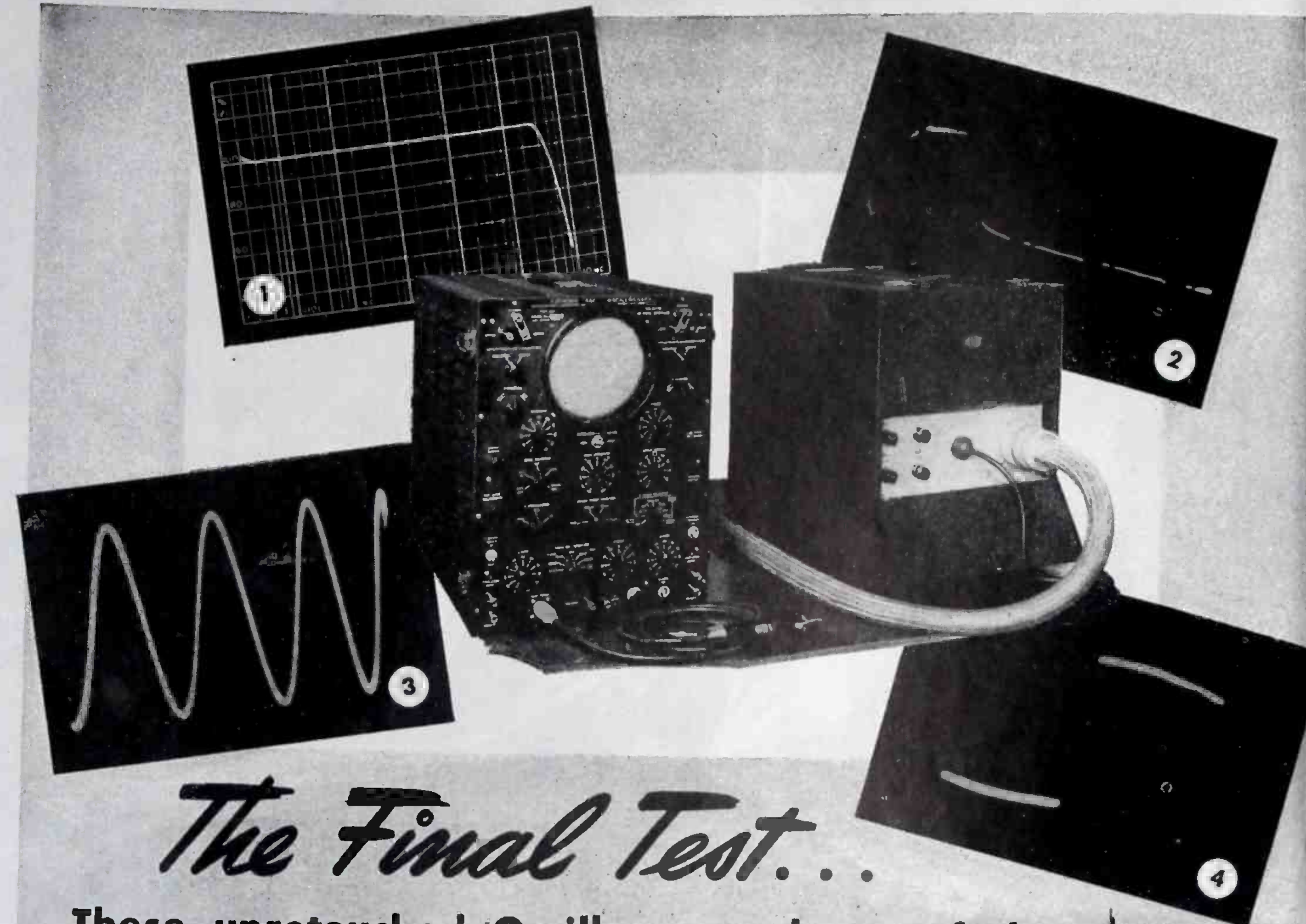
STRUTHERS-DUNN, INC., 1321 ARCH STREET, PHILADELPHIA 7, PA.

ONE OF THE STRUTHERS-DUNN 5,288 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







The Final Test...

These unretouched Oscillogram photos of the DuMont 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.

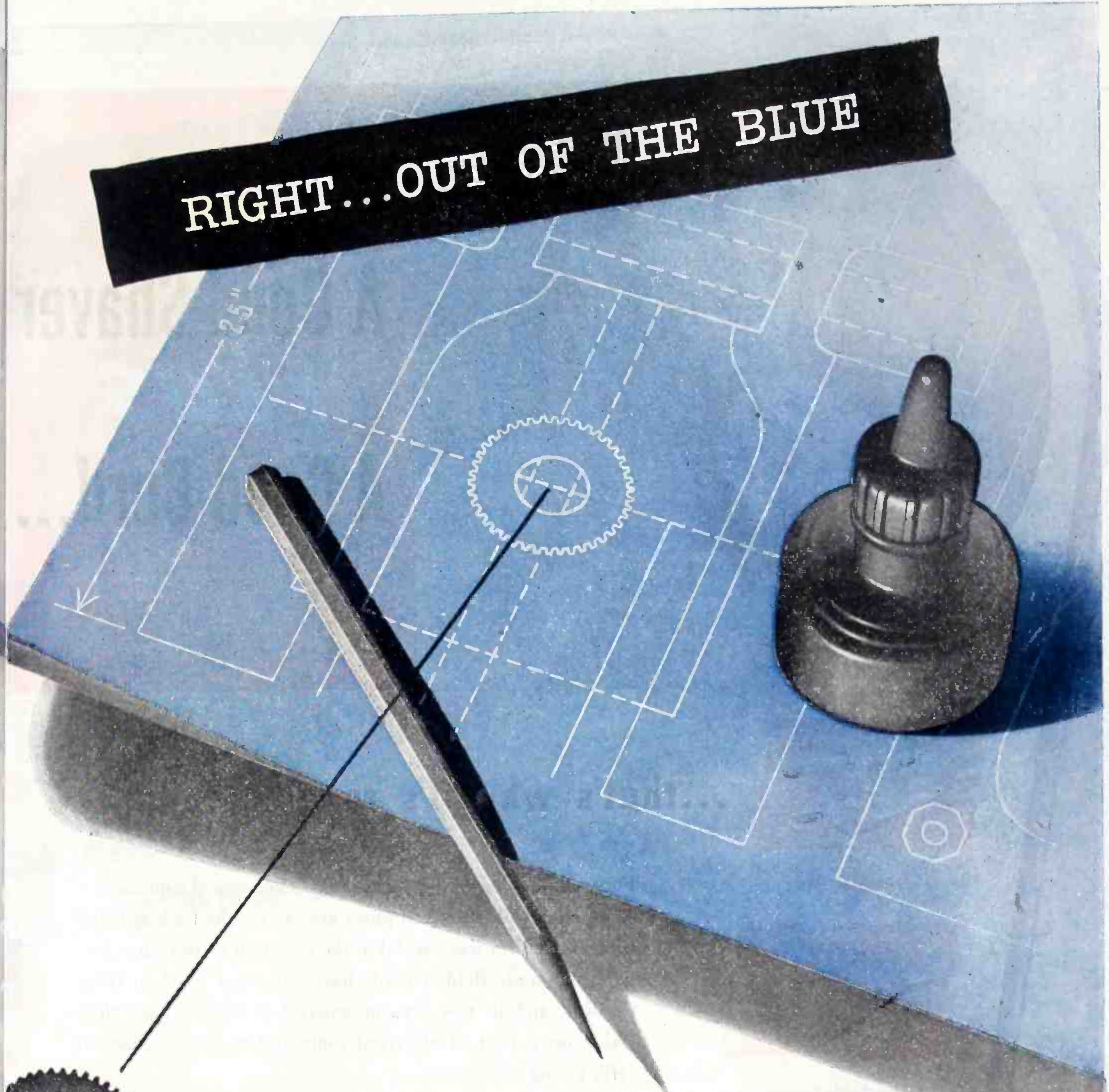
• • •

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



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

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

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

A Good Shaver PLUS A Good Cord...

Unbreakable Plugs

Unbreakable Connectors

Unbreakable Strain Relief

...that's why it's running today

For years an identifying mark of a good electrical appliance, Belden electrical cords and plugs are an accepted token that the manufacturer was careful in the selection of the parts for his equipment. Belden cords have promised freedom from Corditis, and in this present emergency have proved their value on a host of electrical tools and appliances that are still giving service.

After the war, customers will again look for nationally advertised Belden cords and plugs as a guide in purchasing electrical equipment. Take advantage of the plus value of Belden materials when designing your post-war products; specify Belden Corditis-free cords.

BELDEN MANUFACTURING COMPANY
4625 W. Van Buren Street, Chicago 44, Illinois

Belden

Corditis-free CORDS

MOISTURE

he enemy of radio insulators

CAN'T PENETRATE STEATITE

Moisture in hot steaming jungles and in cold foggy climates is a life-shortening enemy of radio equipment.

Steatite is absolutely impervious to moisture. The American Society of Testing Materials porosity test (Steatite placed in a chamber with fuchsine dye under five tons of pressure for six hours) has proved that General Ceramics and Steatite insulators are not porous and therefore do not absorb moisture.

ARMY E NAVY

The low loss factor, the high physical strength, the stability of shape of Steatite is not affected by age or climatic changes. For a long trouble-free life of your equipment specify Steatite Insulators made by General Ceramics & Steatite Corporation.

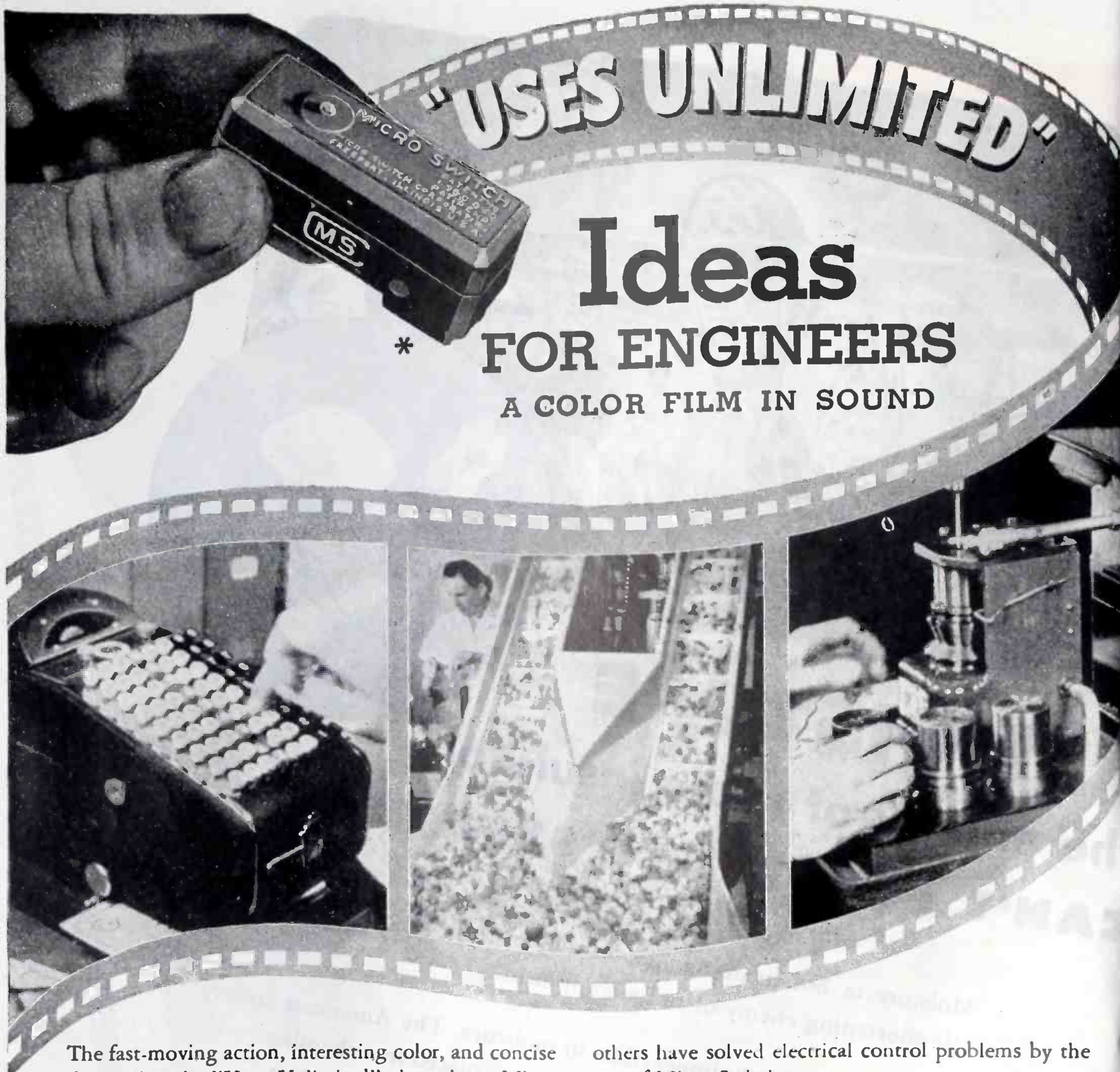
General Ceramics

AND STEATITE CORP.

GENERAL CERAMICS AND STEATITE CORPORATION STEATITE INSULATORS

KEASBEY NEW JERSEY

6398



The fast-moving action, interesting color, and concise description in "Uses Unlimited" show how Micro Switches are made, and how they are being used by production and design engineers throughout industry to control everything from sensitive, precise instruments and office equipment to heavy duty machinery.

This film is packed with examples of tried and proven applications of Micro Switches. It will stimulate the thinking of your engineers by showing them how others have solved electrical control problems by the use of Micro Switches.

"Uses Unlimited" is available to industrial groups, technical societies, training classes, schools and colleges. Size: 16 mm. Length: 40 minutes.

Contact the Y. M. C. A. Motion Picture Bureau: 347 Madison Ave., New York, N. Y.; 19 So. La Salle St., Chicago, Ill.; 351 Turk St., San Francisco, Calif.

* 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.

MICRO SWITCH

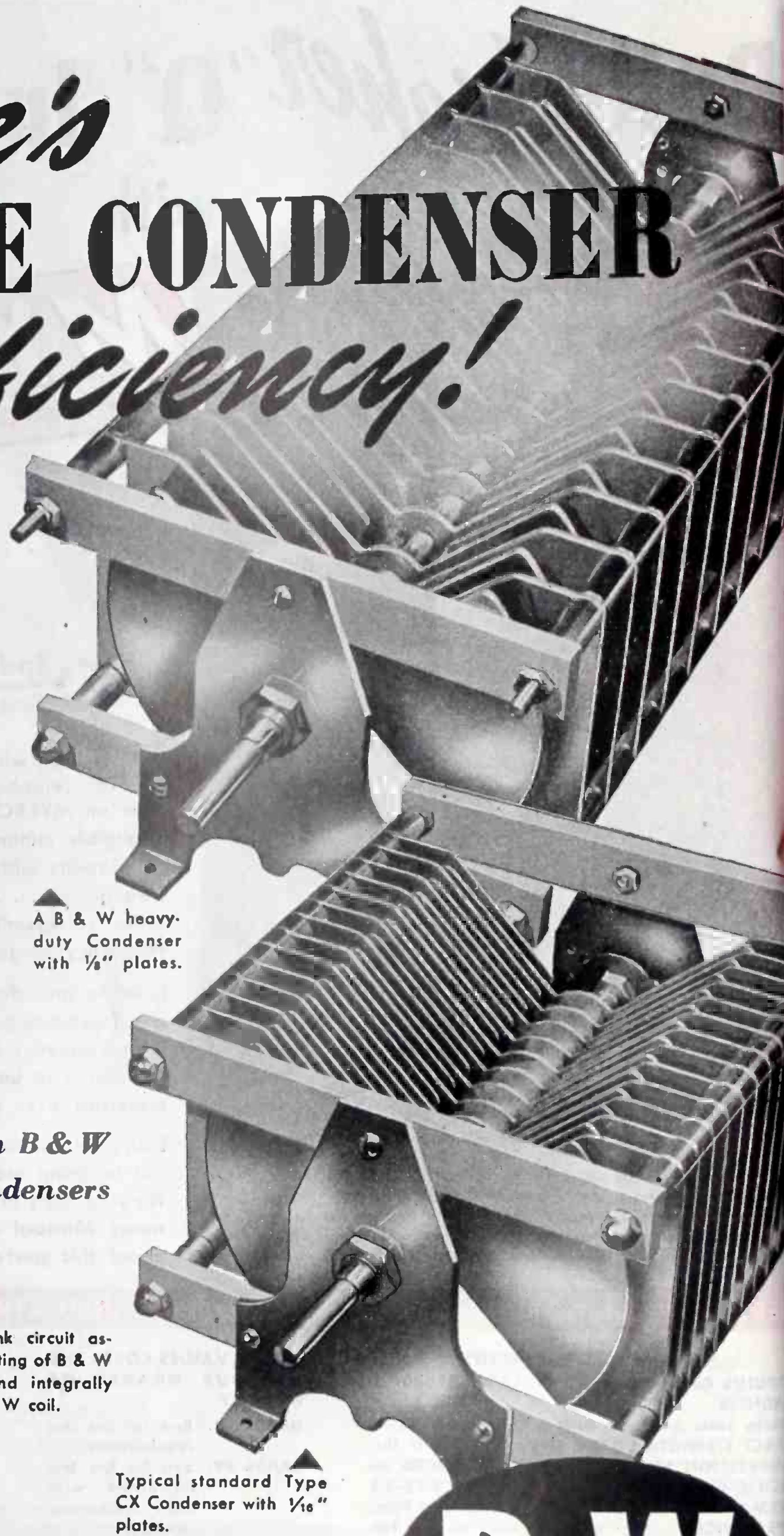
TRADE MARK

A DIVISION OF FIRST INDUSTRIAL CORPORATION

FREEPORT, ILL., U.S.A., Sales Offices in New York, Chicago, Cleveland, Los Angeles, Boston, Dallas, Portland, (Ore.)

Let's All Back the Attack—Buy EXTRA War Bonds

Here's VARIABLE CONDENSER *Efficiency!*

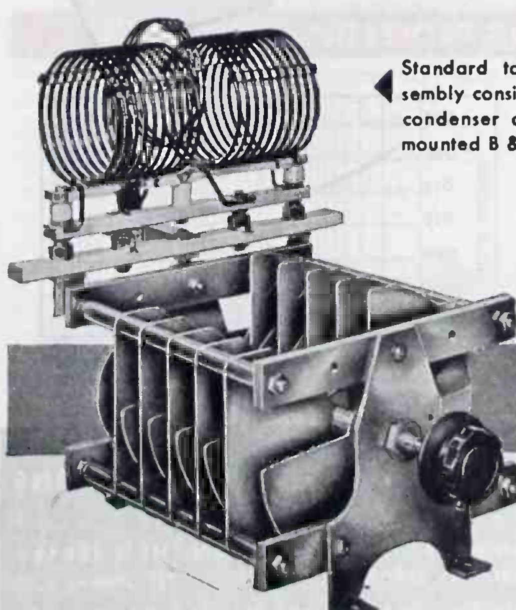


- Perfect electrical design symmetry.
- Built-in neutralization.
- Unexcelled mechanical construction.
- Built-in coil mountings with lead lengths at an absolute minimum.
- Half the length of conventional dual condensers.
- Unexcelled for use in balanced single-ended or push-pull circuits.

Write for new Catalog 75-C on B & W Type CX heavy duty variable condensers

▲ A B & W heavy-duty Condenser with 1/8" plates.

▲ Typical standard Type CX Condenser with 1/16" plates.



◀ Standard tank circuit assembly consisting of B & W condenser and integrally mounted B & W coil.

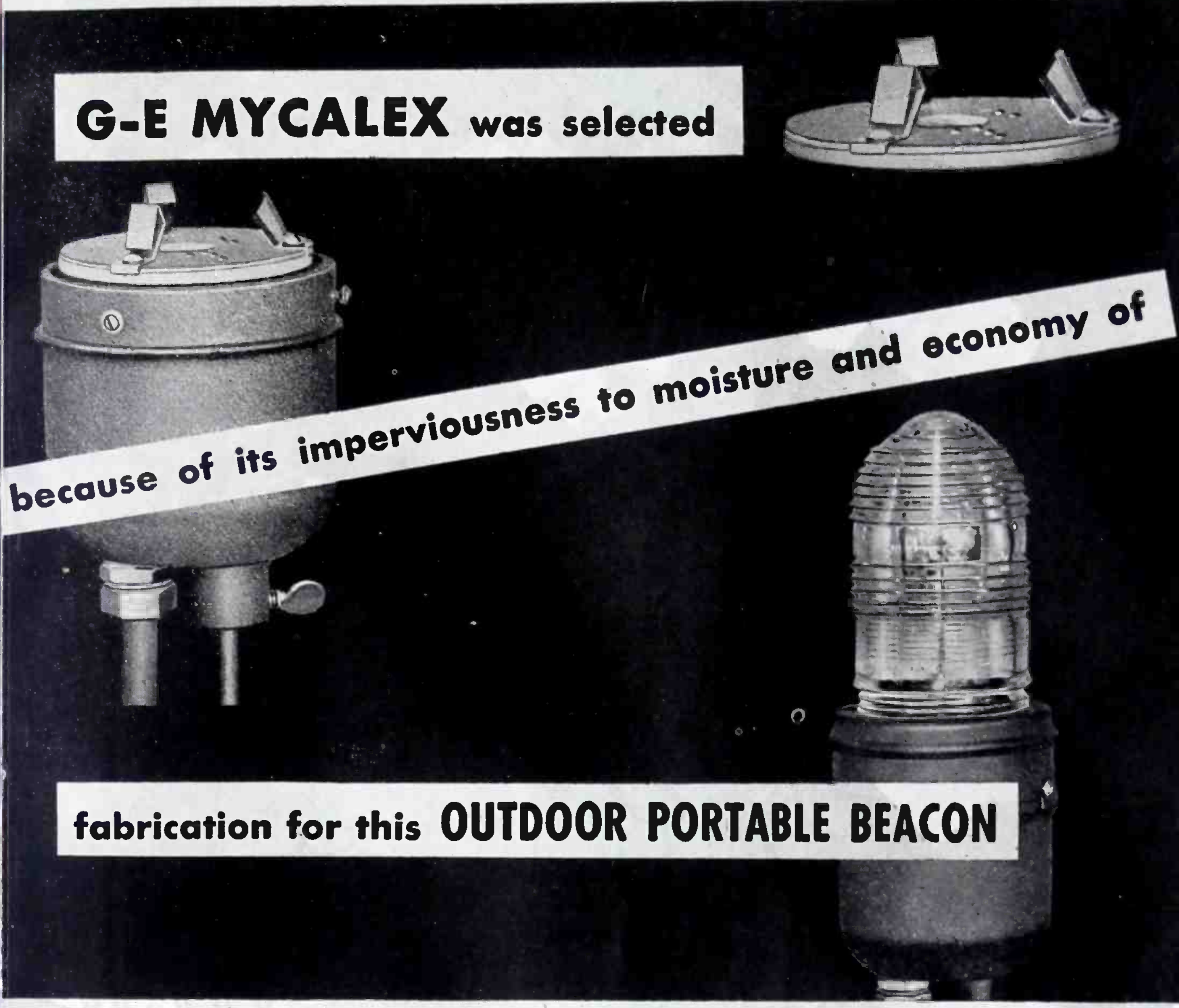
AIR INDUCTORS • VARIABLE CONDENSERS
ELECTRONIC EQUIPMENT ASSEMBLIES

B&W

BARKER & WILLIAMSON

Dept. A104, 235 Fairfield Ave., Upper Darby, P

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



G-E MYCALEX was chosen for the socket of the G-E Novalux Portable Flashing Beacon for three reasons: First—the performance of this amazing material under high humidity conditions; second, because of guaranteed high mechanical strength of at least 14,000 lbs. per square inch; third, it eliminates expensive molds. G-E mycalex can be fabricated from sheets with common machining operations.

In addition, G-E mycalex has chemical and dimensional stability. It does not deteriorate with age and is free from warpage and shrinkage. It offers high resistance to sudden temperature changes.

Whatever your specialized insulation needs may be, it will pay you to investigate this all-purpose insulating material. For a list of specialists in the fabrication of G-E mycalex — for a free sample and a copy of the data bulletin, "G-E Compression-Molded Mycalex"—please fill out the coupon. . . . *General Electric, Schenectady, N. Y.*

• *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.*

FREE—
G-E MYCALEX BULLETIN

ELECTRONICS DEPARTMENT
GENERAL ELECTRIC CO.
Schenectady, N. Y.

Please send me a free sample of G-E mycalex and your descriptive bulletin explaining the methods and tools to use in machining G-E mycalex.

(If you wish a list of fabricators of G-E mycalex, check here_______.)

*Name*____________________

*Company*____________________

*Address*____________________

____

Or 21 Years of Mycalex Experience—Your Assurance of Quality

GENERAL ELECTRIC

177-M-C6-99


Connect
WITH DICO
CO-AXIAL CONNECTORS TO "AN" SPECIFICATIONS
Performance-proved in specialized high-frequency applications — where only the finest is acceptable — DICO co-axial connectors are now available for additional service to the electronic industry. A catalog will be furnished at your request; please give type designations of the connectors you require.
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PLATING • ASSEMBLING
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NORTH AVENUE • WAKEFIELD, MASSACHUSETTS

BAKELITE

TRADE-MARK

MOLDABILITY...

HIGH FREQUENCY RESISTIVITY...

STRUCTURAL STABILITY OF COMPLEX FORMS...

INVISIBLE FIRST WINDINGS

The low power factor of coil forms molded from BAKELITE low-loss phenolic material (.015—.025 at 60 cycles; .010—.014 at 10^3 cycles; and .007—.009 at 10^6 cycles) is practically unchanged after a day's immersion in water. Their dielectric constant at all frequencies is 4.7—5.2. The high volume resistivity inherent in this plastic (above 10^6 megohm centimeters) drops but slightly with increased temperature.

Modern high-frequency radio coil forms are molded from BAKELITE low-loss phenolic plastic. Ribbed spheroids—4 x 5 inches in size, and 13 ounces in weight—these forms have electrical characteristics ideal for use in high frequency circuits below 30 mc. They are also dimensionally stable, resistant to high humidity, and are unharmed by the heat generated in the operation of some equipment.

These radio coil forms show that BAKELITE low-loss phenolic material can be readily molded into complicated shapes. It offers many possibilities for the fabrication of insulating parts designed for high frequency apparatus—always contributing, in addition to its other properties, the advantages of compactness, strength, and light weight.

Investigate this BAKELITE material now—for today's essential requirements and for consideration in your postwar planning. Write Department 7.

TRADE (B) MARK

BAKELITE CORPORATION, 30 E. 42 St., New York 17, N.Y.

Unit of Union Carbide and Carbon Corporation

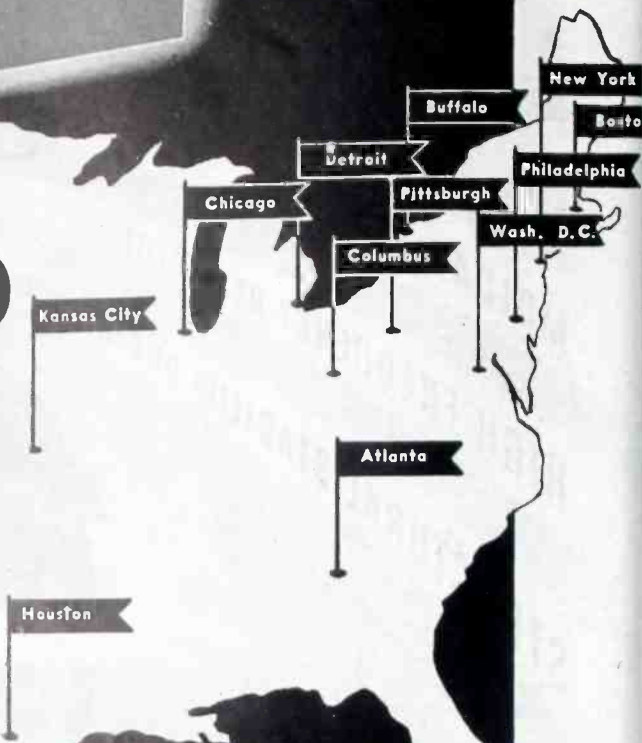
UCC

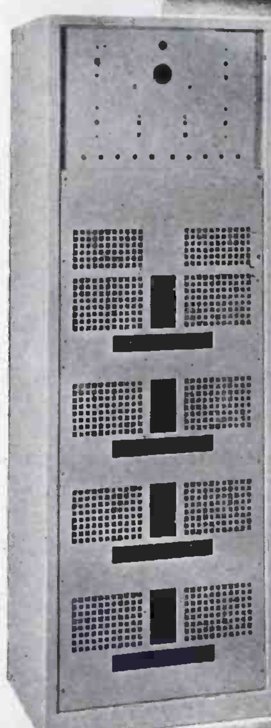
Molding Plastics

BY POPULAR REQUEST

KARP

RAISES ITS BANNER OVER NEW TERRITORY





Demands for KARP quality, service, and deliveries have made it necessary for us to establish KARP sales representatives in many different parts of the country. If you are looking for:

- sheet-metal specialists capable of handling highly intricate as well as simple construction jobs.
- engineers with the experience and knowledge for complete redesign problems.
- made-to-order products at competitive prices with fast deliveries.

. . . consult our sales representatives wherever the KARP flag flies on this map . . . your request addressed to our home office will bring him to you. We create to your individual order:

Cabinets	*Boxes*	*Frames*
Panels	*Cases*	*Mounts*
Chassis	*Racks*	*Enclosures*

See us at the October Electronic Conference, Stevens Hotel, Chicago, Booth 57.

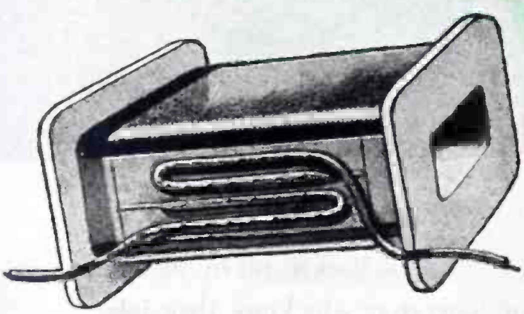
KARP METAL PRODUCTS CO., INC.

124 30th STREET • BROOKLYN 31, N. Y.

KEEP BACKING THE ATTACK ALL THE WAY TO BERLIN...BUY WAR BONDS

Lumarith*

Electrical Insulation



resists the

BLACK HAND OF CORROSION

The logic behind the growing use of Lumarith insulation is extremely simple: The primary cause of the free-acids associated with electro-chemical corrosion is moisture. Lumarith resists moisture, and contains no materials which combine with moisture to form free acids.

Besides, Lumarith doesn't promote that built-in hazard common to much electrical insulation—organic decomposition.

Even where corrosion ordinarily is severe—as with coils on positive D.C. under moisture conditions—Lumarith is dependable. It is outstanding for high dielectric strength and its high softening point (146–177° C. depending on formulation) makes it applicable in many types of coils.

How is Lumarith available? Films, sheets, rods, tubes and molding materials. Films are furnished plain or with special mat finish, easy to see and slippage-resistant—advantages winders appreciate.

You'll want a copy of "Lumarith for the Electrical Industry." Send for it now. Celanese Celluloid Corporation, *a division of Celanese Corporation of America*, 180 Madison Avenue, New York 16, N. Y.

Data—	Softening Point	volts/mil. Dielectric Strength
P903	146° C.	2800—3300
P904	177° C.	2800—3300

P904 can be baked 8 hours at 140° C. in a coil.

Lumarith*

A CELANESE PLASTIC

*Reg. U. S. Pat. Off.

WE READ BETWEEN THE BLUEPRINT LINES

PLASTIC MOLDERS can look at a prospective job from two angles. They can take the blueprint you supply, figure their methods, materials, costs and deliveries exactly as indicated. That is, they can read just the lines on the blueprints.

AT GENERAL INDUSTRIES, we do more. Naturally, you know the functions of the plastic part better than we do, so we don't attempt any major design changes. *But we do know plastics,* and from our wide experience can make suggestions which come from reading between the lines of the blueprint.

QUITE OFTEN, our customers have found that our ideas result in a product improved in utility or appearance, delivered quicker and at a lower final cost.

THIS METHOD calls for wide experience in the plastic industry. It requires a real knowledge of mold making and of the characteristics of the many different plastic compounds. And, of course, it must be backed up by modern equipment and operators who know their jobs.

SO, when you are thinking of postwar plastic parts, we suggest that you ask us to "read between the blueprint lines." Right now, we're 100% on war work, but when that job is done, we'll have engineers and facilities to take on your peacetime plastic molding. We'd like to have you call on us.

ARMY E NAVY

THE GENERAL INDUSTRIES COMPANY

MOLDED PLASTICS

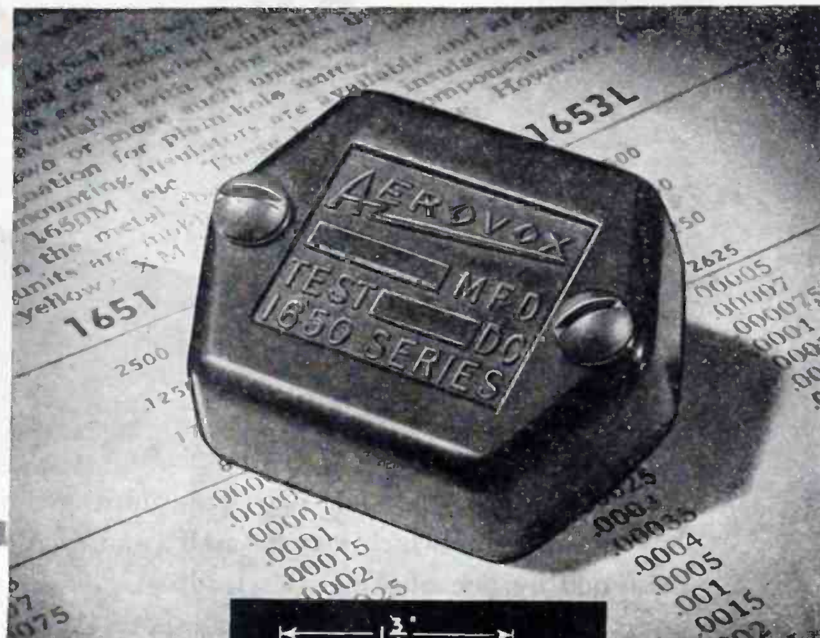
Molded Plastics Division • Elyria, Ohio

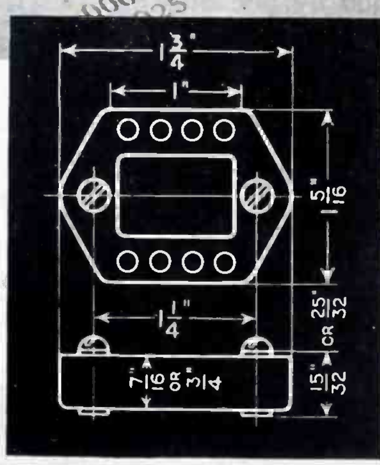
Chicago: Phone Central 8431
Detroit: Phone Madison 2146
Milwaukee: Phone Daly 6818
Philadelphia: Phone Camden 2215

In ratings from 1000 volts to 10,000 volts test . . .

Molded-in-Bakelite

MICA CAPACITORS





● The 1650 Series is the most rugged of the heavy-duty molded-in-bakelite mica capacitors of the extensive Aerovox line. These high-voltage units are intended for the most critical service of low-powered transmitting circuits, buffer stages, power amplifiers, laboratory equipment, etc. Also recommended for use in ultra-high-frequency circuits, and accordingly their r.f. current ratings are given in the Aerovox Capacitor Catalog.

The extra-generous use of high-grade dielectric material provides that greater factor of safety for longer service under severest operating conditions.

Standard units with tapped holes take 6/32 screws which serve for terminals. Also available with clearance holes through which screws or rods may be slipped, so that two or more units can be stack-mounted. Low-loss ceramic mounting insulators are available for mounting on metal surfaces. Standard units molded in brown bakelite. Also available in low-loss (yellow) XM bakelite.

In 1000, 2500, 5000, 7500 and 10,000 volts D.C. test. Capacitance ratings from .00005 mfd. to .06 mfd. in Type 1650 at 1000 v. D.C. test; .00005 mfd. to .001 mfd. in Type 1654L at 10,000 v. D.C. test.

● Literature on request . . .

AEROVOX *Capacitors*

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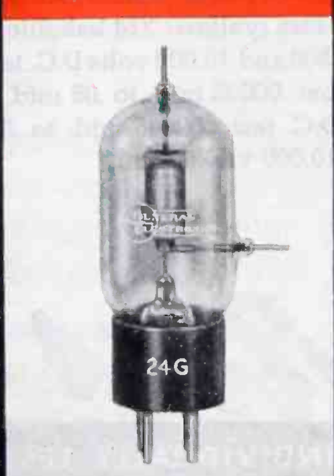
...another new tube Ready for Delivery!

GENERAL ELECTRONICS' new Transmitting Triode is a medium power tube which may be used as an oscillator or modulator. Designed by one of America's leading, pioneer tube engineers, it offers many unusual qualities—operates up to 30 megacycles; exceptionally rugged design; three pillar grid support; anode almost totally encloses grid and filament—an essential feature for operation at ultra-high frequencies; grid terminal at side reduces inter-electrode capacitances—important in high frequency circuits.

Available now—get top performance in the 808 through General Electronics' superior engineering!

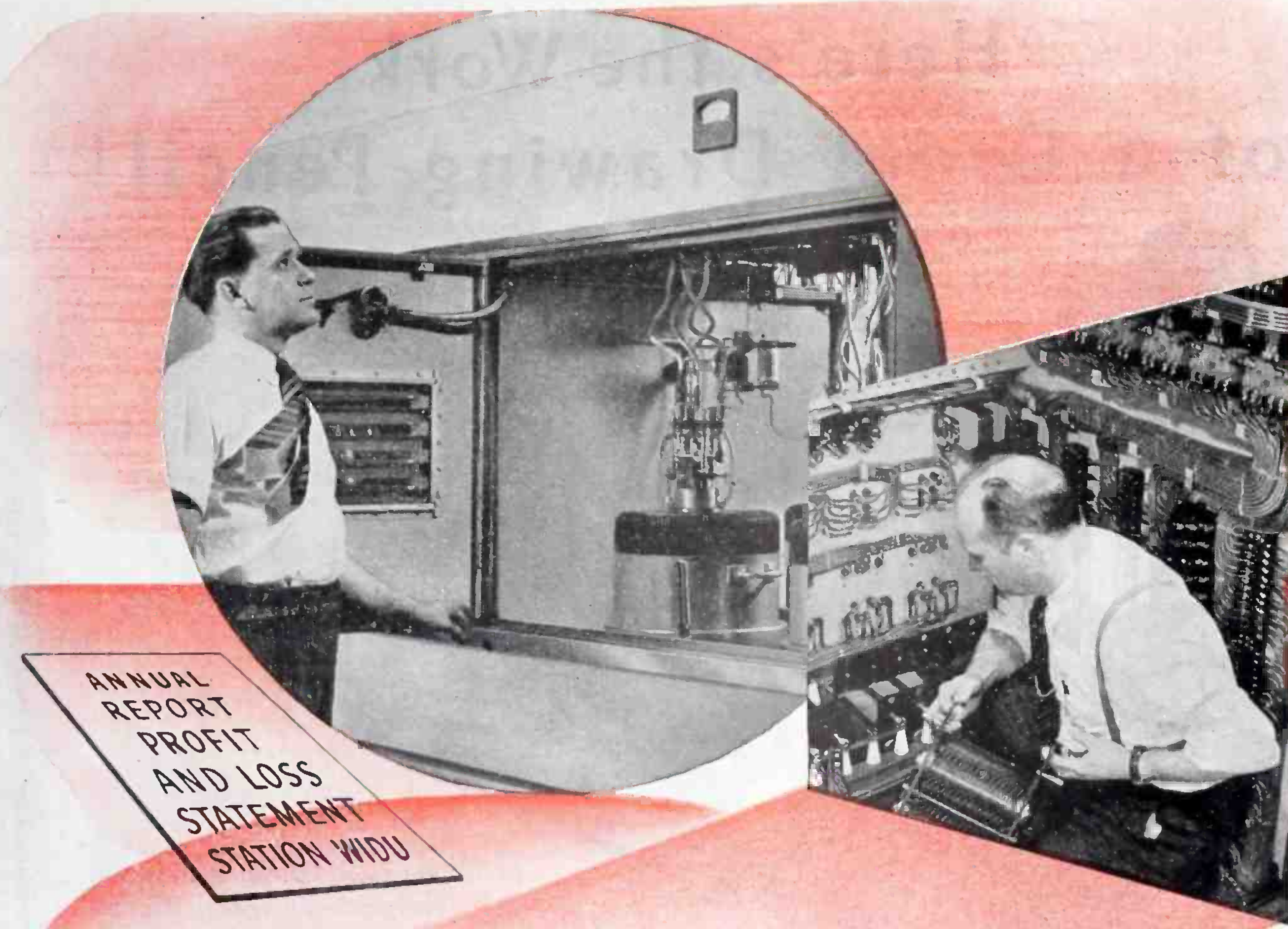
GET HIGH WATT-VALUE PER OUNCE IN GENERAL ELECTRONICS' 24 G



90 watts continuous output (as a Class C, unmodulated UHF amplifier) from this amazing tube that weighs only 1.5 ounces . . . and at 3 meters! Output of 65 watts even at 1.5 meters (200 Mc). No insulators or supports to evolve gas on the first overload; no exposed filament to spray envelope with energy-wasting electrons; tantalum plate and grid eliminate flashed-film type getter, allowing tube to run cooler; well adapted for pulse operation where very high voltages are applied in instantaneous pulses . . . all these are features that recommend General Electronics' 24 G to your consideration.

GENERAL ELECTRONICS INC.

Sales: 1819 Broadway, N.Y. 23, N.Y. • Factory: 101 Hazel St., Paterson, N.J. • Export: 89 Broad St., N.Y. 4, N.Y.



CONSIDER *Low Operating Cost*

WHEN YOU SELECT A NEW TRANSMITTER

In selecting a new transmitter, naturally you will take a good, hard look at operating costs. They have an embarrassing way of turning up every month where they *have* to be considered.

Westinghouse Transmitters are designed to keep operating costs at a very low minimum. For example:

1. Air-Cooled Tubes—featured by Westinghouse, eliminate the expense of water cooling. Air which cools the tubes can be used to heat the building.
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3. Conservative Operation of All Tubes—results in long life and low upkeep cost.
4. Class C Operation—of all radio frequencies provides higher efficiencies and lower power consumption than any other type of circuit.

These are only a few of the advantages Westinghouse Transmitters offer. Others include: ***Simplicity of Control, Continuity of Operation, High Fidelity Signals, Ease of Maintenance.***

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FOR YOUR POSTWAR TRANSMITTER**

By placing your order today for a Westinghouse transmitter, you assure yourself of the fastest possible delivery following the lifting of wartime manufacturing restrictions. We are scheduling deliveries in the sequence in which orders are received. For details, write Westinghouse Electric & Mfg. Company, Dept. 1NB, P. O. Box 868, Pittsburgh 30, Pa.

J-080

Westinghouse RADIO DIVISION
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

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Eloquent evidence of DuMont leadership is provided in the design and construction of 3 of the nation's 9 television stations in service today . . . and in the operation (for more than 3 years) of Television Station WABD, New York. Just as DuMont's development of the DuMont Cathode-ray Tube made television commercially practical, so DuMont pioneering in station design and operation has set a pattern for profitable station management. This pattern is available to you.

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Leading designers and builders of rugged electronic recording devices ally their products with TURNER applications for sure-fire performance under varying acoustic and climatic conditions. Today these recorders play an important role in essential war communication activities. In the world tomorrow, they will open new horizons in the fields of radio, entertainment, education and business.
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GENERAL SILENTBLOC

Rubber Mountings and Bearings

Absorb Vibration... Allow Torque Action ...Correct for Misalignment

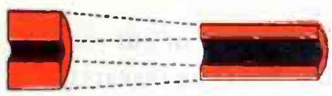
ENTBLOC MOUNTING to ·rol vibration from motor, ion shock loads, isolate vi- on between parts of equipment sulate delicate instruments and rols from foreign vibration. neered design determines rate flection in any plane.

ILENTBLOC TORQUE BEAR- NG lasts as long as the machine, ever needs lubrication, makes no oise, cannot slip. Degree of torque engineered into the bearing by xperienced General designers.

YOUR customers expect improvements in your new products—and General Silentbloc can help you deliver them. These shear-type mountings, bearings and couplings are engineered to:

1. Control vibration and cushion shock-loads.
2. Give trouble-free torque action.
3. Correct for misalignment in hinges, bearings and shaft mountings.

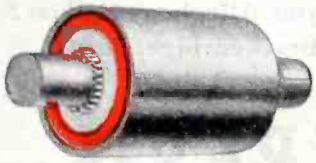
Silentbloc are simple in construction, easy to install and practically indestructible.



They consist of an outer metal tube into which a rubber ring is inserted under pressure, with a sleeve or shaft "shot" through the ring. This patented process *elongates* and *confines* the rubber, the extreme tension giving a cohesion of rubber-to-metal which cannot rupture. The stretched rubber stays *alive* and resilient.

Silentbloc mountings and bearings can be engineered by General to solve *your* exact problem. They are made any size, to carry loads of ounces to tons. Any metal—steel, bronze, aluminum, magnesium—can be used. By variation of size and design, elongation and distortion of rubber and kind of rubber, Silentbloc can be made to give *predictable performance* under axial, radial, conical or torque loads.

Silentbloc efficiency has been proved in automotive products, aircraft, industrial machinery, home equipment, electrical products, marine equipment, and war mechanisms. To learn how it can improve your product, write now for factual booklet. The General Tire & Rubber Company, Dept. 93, Wabash, Indiana.

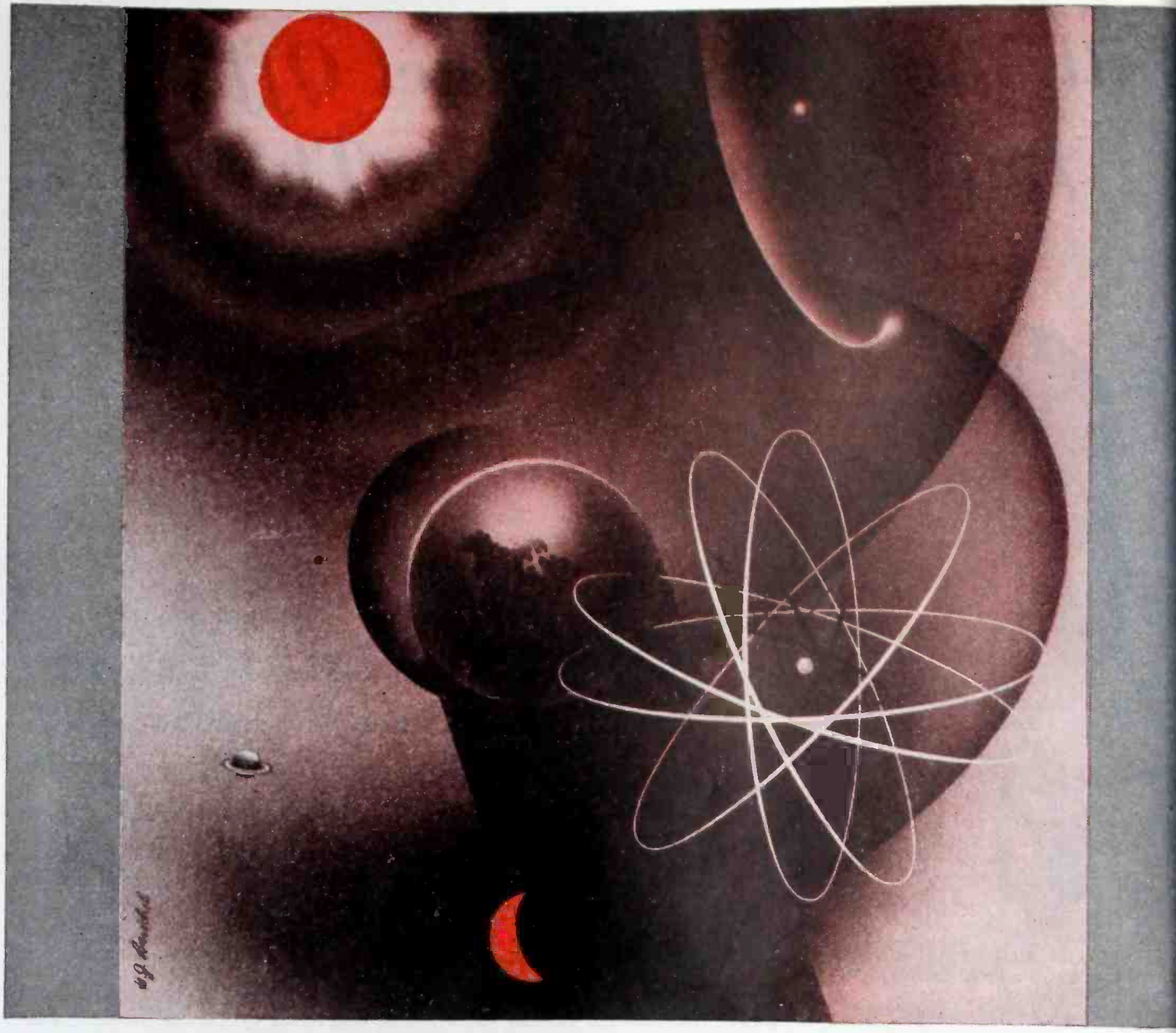


SILENTBLOC BEARING provides a cushion for needle or ball bearings, shaft supports in series, and hinges, which corrects for misalignment. Saves time and money in production, gives longer life and lower upkeep.

The GENERAL SILENTBLOC
MOUNTINGS... BEARINGS COUPLINGS

THE GENERAL TIRE & RUBBER CO.

Mechanical Products Division, Wabash, Indiana



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 w ght, its lightning-fast snap action, and its long life, t G-E Switchette is becoming more and more popular w h designers for circuit control where space is at a p mium.

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

More than 200 modifications have already been de-v oped to meet special circuit requirements and to fit i o special mechanical arrangements. Dimensions, oper-a ng characteristics, and ordering directions for standard S itchettes and many typical modifications are given in o new catalog, No. GEA-3818C. For your copy, mail t coupon. If you don't find the forms you need in the c alog, our engineers will be glad to work with you in a apting Switchettes to meet your requirements.

SWITCHETTES

GENERAL ELECTRIC COMPANY, SECTION A676-141
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Please send me Bulletin GEA-3818C giving dimensions, ratings, and operating characteristics of Switchettes

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The world of tomorrow will be one of electronics. Pioneer for that world is the electronic engineer. His vitally important effort during this wartime period in devising electronic equipment is helping to defeat the enemy. Tomorrow, he devotes his specialized scientific knowledge to aid peacetime industries.
Raytheon is applying its efforts to the development of advanced electronic tubes and equipment for the war effort. When that job is done, the knowledge that has been gained will be used to guarantee that post-war radio, industrial and electronic equipment manufacturers will receive Raytheon tubes and equipment with even greater "Plus-Extra" quality.
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The Economic Reconstruction of Europe

THE time is fast approaching when allied and enemy populations alike will demand a blueprint for the economic reconstruction of Europe. The ace plans following this World War will be writ-a piecemeal, and by experts, at a series of con-tuing conferences, such as Hot Springs, Bretton oods, Dumbarton Oaks and Quebec, each tracing new pattern for negotiation and each dealing with single, specific problem. In the drawing of these ans, the United States, as owner of more than lf of the world's industrial capacity, controller of le only great credit reservoir, and possessor of the rgest force of highly skilled technicians and man-gement engineers, has heavy responsibilities which s industrial, financial, agricultural and labor leaders nnot evade.

☆ ☆ ☆

Just what is the problem which the world's busi-ess leaders must help solve in Europe?

The best safeguard of peace is economic oppor-nity—a good chance for all peoples to raise their andard of living by their own ingenuity, foresight d industry.

Frustrated and disappointed peoples, who view e future with misgiving rather than hope, breed natical demagogues who seek to divert nations om their ills and disappointments by promising ilitary glory and conquests.

Consequently, an important step in building a cure and lasting peace is to open the doors of pportunity to the peoples of Europe.

The greatest obstacle to opportunity in Europe as been economic nationalism.

The economic tradition of the Continent always as been highly nationalistic. The national feeling nerated by the first World War, and the political tonomy conferred upon many peoples by the peace eaties, led to a great growth of economic restric-ons. This trend was accentuated by the depression d by the military plans of the Fascists and Nazis. itler had to show his people they could be fed en if a blockade was imposed again. The inevita-le result of these influences was to carry self-fficiency to tragic extremes.

Economic nationalism holds down the standard of ving of Europe in two ways:

It prevents the rise in most European countries of low-cost mass production.

It operates against an efficient geographical division of labor, preventing nations from doing what each can do best.

Great machines require great markets. One great machine of which the United States has many and Europe few is the continuous strip steel mill. At the outbreak of the war we had twenty-eight such mills of various sizes, England but one, and Continental Europe one. A building containing one of these machines is more than a quarter of a mile long and the minimum cost of the mill is almost $25,000,000. Only the prospect of a mass market justifies production on this vast, but highly economic basis.

The wasteful geographical distribution of production is shown by the agricultural policies of Italy, France and Germany.

In the 1930's, when lard sold for less than 8¢ a lb. in the United States, it cost 32¢ a lb. in Germany. In Italy and Germany imports of wheat were banned and its production at home was heavily subsidized. By the middle of the 1930's, wheat sold for $1.55 a bushel in France, $1.97 in Czechoslovakia, $2.29 in Germany, and $2.47 in Italy. At the same time the United States and the other efficient world producers and exporters (Canada, Australia and Argentina) were *restricting* production and were unable to average more than about 75¢ a bushel for their wheat.

Economic unity in Europe must ultimately mean a freedom to trade not greatly different from what we have within the United States. Given economic unity and the large markets which go with it, efficient mass production will develop. With Europe receiving cheap supplies of such staple foods as wheat, pork, lard and dried fruits from overseas, European farmers can prosper by specializing in producing fresh foods—butter, cheese, eggs, fruits, vegetables.

Then European agriculture will be more prosperous producing its specialties, and our agriculture (and that of the other great efficient surplus-producing countries as well) will have greatly expanded markets for our staples.

With a cheaper food supply for Europe—yet one yielding a better price for our agriculture—European labor will live better. Labor now used uneconomically for agricultural production will be released for industry. With big machines and semi-automatic processes European labor can produce more steel, automobiles, furnaces, plumbing and electrical appliances to advance its standard of living in coming decades, as the United States has done in past decades.

A rising standard of living in Europe will bring

Europeans to view peace with optimism and hope. And world trade grows as confidence and prosperity widen.

How would a Europe which possesses economic unity appear to us on this side of the Atlantic?

It would be a prosperous Europe that would have strength in its advancing industries, but as the single great agricultural deficit area of the world, it would be dependent upon overseas supplies for vital agricultural staples. This dependence upon overseas agricultural supplies would be greatest for industrial Germany. Some people believe that a strong Europe would be a threat to world peace. More important, however, is the fact that a strong and prosperous Europe would not be a frustrated Europe. It would have found a way to achieve a rising standard of living. Furthermore, a prosperous Europe would, economically, be a dependent Europe because, although the European industrial worker would use more and cheaper food, he would have it only as long as he maintained the peace.

A prosperous Europe would be of special advantage to American agriculture (if we do not keep on pricing ourselves out of the market) and of great advantage to American industry.

The British policy of buying agricultural staples from abroad, for example, made her, a nation of only 45,000,000, the purchaser, in 1937, of $250,000,000 of all kinds of agricultural products from the United States. In the same year the rest of Europe (exclusive of Russia), with a population of 325,000,000 purchased only $300,000,000 of our agricultural products. But with more sensible organization of its agriculture, Europe could be expected to buy more than one billion dollars of agricultural products from us.

By far the greatest market for an expanded European industry will be Europe itself.

For American industry, there will be growing markets in Europe as industry expands. Experience shows that the trade between different highly industrialized areas is large. This country's biggest export markets have been with its keenest competitors—Britain, Canada, Japan, France and Germany.

Before the war, Europe, with two and one-half times the population of the United States, had only one-sixth as many automobiles.

If Europe (exclusive of Britain and Russia) were to motorize proportionately, it would need 75,000,000 automobiles. With normal depreciation this would ultimately mean 10,000,000 cars to be produced annually to replace worn out cars.

If one still wonders about the immense number of things Europe might produce *for herself,* let him calculate the highway expenditures, the filling and repair station businesses that must be equipped and maintained; and the doubling of the steel production that would be required to make the automobiles themselves and to reinforce with steel even a moderate amount of additional concrete highways.

Another example is the electrification of Europe. With two and one-half times our population Europe's consumption of electrical energy would be 175 million electrical H.P., if the European worker were to have the advantage of as many H.P. as the American. Yet, just prior to the war, Europe's installed operating capacity was only about 40 per cent of this figure.

What has been sketched for Europe is actually much more nearly a page from the economic history of the United States than it is mere prophecy about a desirable future for a Europe at peace. But how can it be achieved? And what is our part to be in helping to bring it about?

Economic unity can be provided for the sovereign states of Western Europe by the peace treaty or treaties adopted at the end of the war. The provisions for securing *economic unity* in Europe should specifically cover:

1. Substantial freedom for persons and enterprises to do business anywhere in Europe.
2. Reasonably free movement throughout Europe of persons for employment, recreation and education.
3. Greatly increased freedom of trade:
   a. Within Europe—through the application of a Europe-wide agreement reducing the tariffs among all European countries to a maximum of 10 or 15 per cent.
   b. With the rest of the world—through reduction of European tariffs on goods bought from overseas. This would call for generally lower levels on manufactured goods, and for the removal (after a reasonable period of progressive reduction) of tariffs on all agricultural foodstuffs and most industrial raw materials.
4. A special currency provision requiring as nearly as practicable complete currency stabilization for all countries of Western Europe among each other.
5. Creation of an agency (with adequate revenues) through which all Europe-wide business and other affairs affected by these agreements would be administered for a minimum period of twenty-five years.

This would permit the economic unity of Europe to be substantially achieved. During this period, assistance in administering the provisions would be given by officials of the United Nations.

Near the end of such a period arrangements could be made for a vote in the European countries on whether or not to continue the "unification provisions." If the vote were in the negative, the United Nations would have proper warning that additional safeguards would be necessary to prevent war.

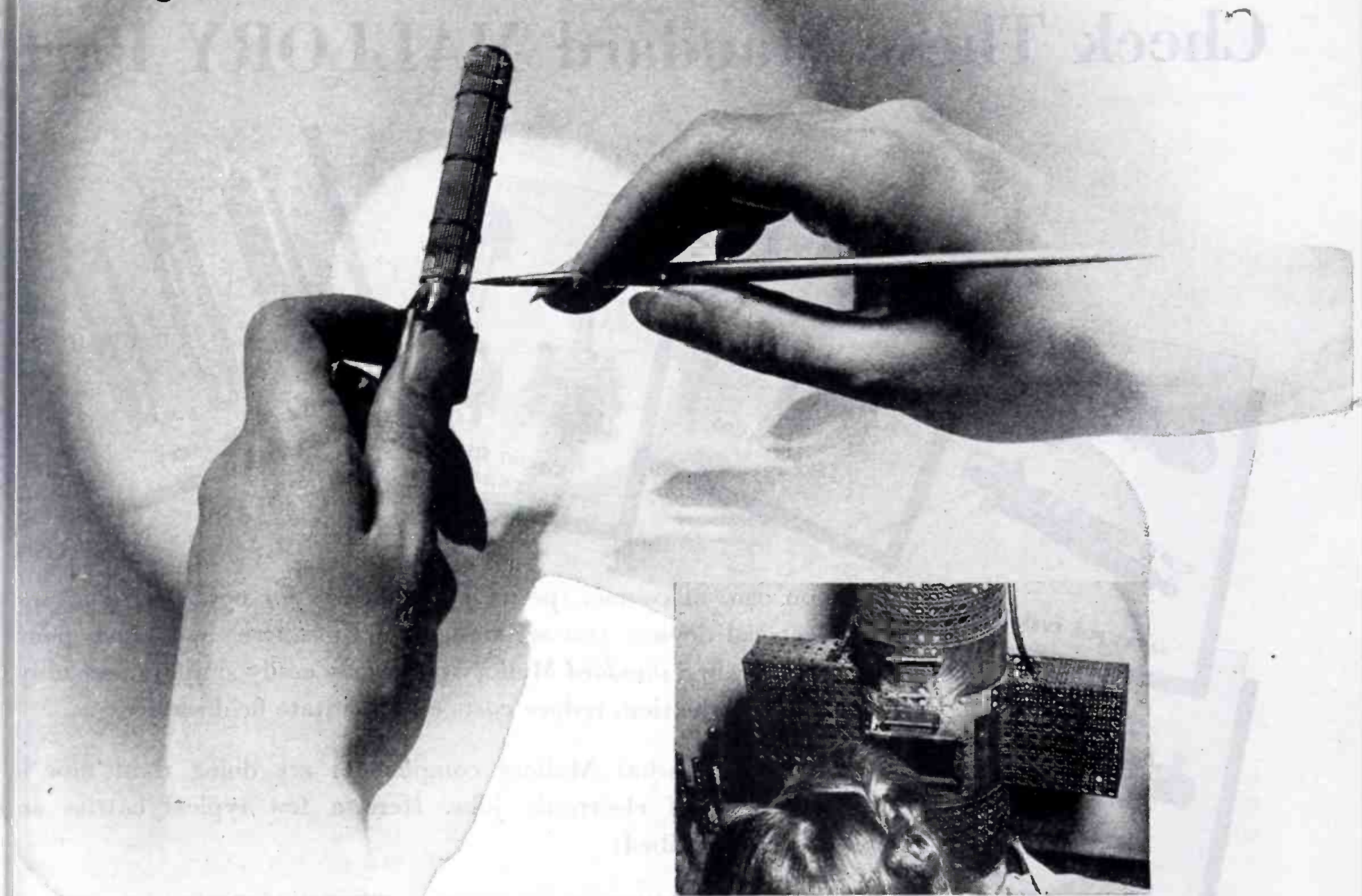
The suggestions made in this statement aim at securing economic unification of Europe and thereby promoting the possibilities of permanent peace in Europe.

The realization of these possibilities throughout the postwar years requires a freely expressed public opinion in Europe to guide all who share the responsibility for bringing peace to Europe and to the world.

James H. McGraw, Jr.

President McGraw-Hill Publishing Company, Inc.

lding with a paint brush?



Alloy flows easily and weld is quickly completed under arc.

The Science Behind the Science of Electronics

is the focusing of all branches of science upon the development and improvement of electron vacuum tubes.

***Spectrograph**... Analysis determines exact characteristics of metals to be joined.*

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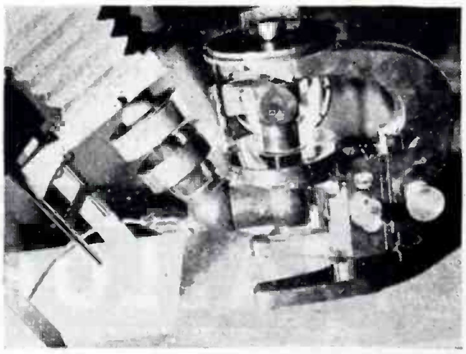
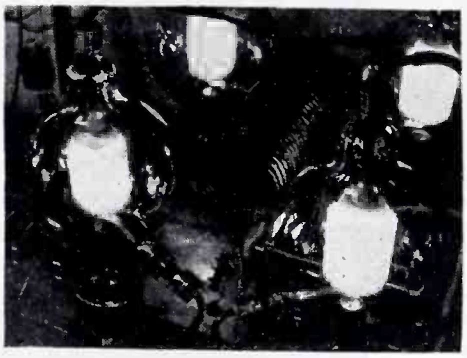


***OPTICS**... For studying the effects of processing.*



***ELECTRONICS**... Welded elements in electron vacuum tubes withstand tremendous heat.*

...e a difficult welding problem, Eimac laboratory ...cians compounded a welding alloy that could be ... with a paint brush. The alloy flows easily under ...o complete the weld, yet subsequent heating to ...atures as high as 2900 degrees Centigrade will ...troy the weld.

...h is but an example of the application of the ... of metallurgy in the "science behind the science ...ronics." The extent to which Eimac Engineers ... solve this relatively small problem reveals two ...ant facts:—(1.) The thoroughness of Eimac Engi...g, and (2.) The completeness of their engineering ...ies. The leadership which Eimac tubes enjoy ...out the world in all phases of electronics is ...able to the soundness of this engineering.

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CROSS TALK

EGITIMATE . . . For the first time in many ns, the editor has been sandbagged into going to th theater. It was quite an experience, and not alto- ier to be recommended to anyone out of practice. the first place, in the legitimate theater, in case yo have forgot, the orchestra is right down in front, ween the audience and the singers or actors. There is nly limited volume control, apparently, so that the time the orchestra drowns out the singers. In second place, the singers and actors are only ural size, not blown up real big as in a movie, and th are located down in front instead of up in front. Theater seats are so arranged that you can see und nearly everyone except the people in the row t in front of you, and these people always want to right when you look right and vice versa. The ult is, you seldom see much but the edges of the ge. There is also a fairly unsatisfactory acoustical angement so that it is difficult to make out the ds without a libretto or something.

Some steady radio listeners and movie-goers com- in that the drums and violins always seem to come m a certain part of the pit in the regular theater, we didn't mind this so much—although it did und strange. Others complain that the bass isn't d or boomy enough but, on this score, maybe the low who plays the bass viol will, in time, make it und like a radio. People do like bass, you know.

BONANZA . . . Disappointment stares into the es of members of the legal profession who look to end of the war as a time to make their fortunes hting patent infringement suits based on every- ly's use of everybody else's patents. With the after- th of the last World War in mind, when claims to tune of some two billion dollars arose, Government s acted early and wisely this time to circumvent dif- ulties of this nature.

In a few cases exorbitant sums were asked for the ivilege of using patents or inventions to aid in the r. These offers were flatly refused and the claimants n had the opportunity of taking the matter to the urt of Claims. As a result, most of these get-rich ers have been scaled down so that the Government t the use of the inventions at a reasonable cost.

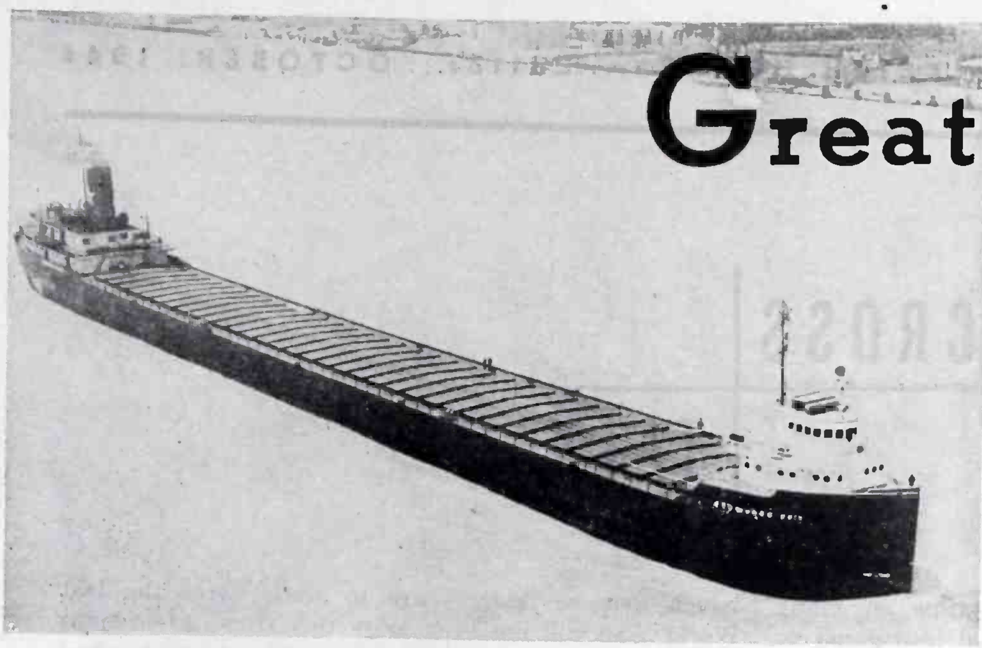
It looks, then, as though the infringement suits which took so many years to settle after the last World War will not even arise this time. Lieutenant Colonel Lippincott of the War Department, who has had a lot to do with the happy sharing of inventions and patents for prosecution of the war, says: "Even we patent attorneys will not suffer in the long run" from the amicable arrangements between inventors and Government that have been worked out."

► **SYMBOLS** . . . To the first engineer who submits an acceptable paper containing circuit diagrams *using the ASA component-part symbols* printed on page 93 of our July issue the editors of ELECTRONICS offer a free lunch, with all the trimmings. We'll buy it here in New York, adding our own personal charms in the event that the lucky man is in this neck of the woods. Or we'll forward sufficient cash to cover a meal in the ritziest restaurant in his home town.

ELECTRONICS is now using the standard symbols in all circuit diagrams. Converting old symbols to the new ones on every single circuit diagram accompanying every manuscript is a tough, time-consuming job, with possibilities of making errors. The editors don't like this kind of work—thus the free-meal offer!

► **SHORT BUT SWEET** . . . Following the 50 to 60 pages of featured papers appearing in the average issue of ELECTRONICS there is nearly as much material again in back-of-book "Departments," indexed on the Contents page. Items handled in brief style usually get that way for one good reason or another. For example, perhaps censorship prevents the editors from immediately securing sufficient data to justify a feature article, yet they wish to keep readers as fully informed as circumstances permit. In no sense does departmental handling imply lack of importance. There is no room in our columns these days for unimportant material.

Discerning readers tell us that they frequently pick up just the ideas they need from the following departments: *Industrial Control* . . . covering the use of tubes in industry; *Tubes At Work* . . . devoted to immediately useful communication applications; *Electron Art* . . . discussing laboratory work pointing to applications just around the corner; *New Products* . . . describing commercially available gear; *New Books* . . . *News of the Industry* . . . *Backtalk*.



Great Lakes

TO FACILITATE the movement in the Great Lakes of nearly 200 million tons of bulk freight a year by some 600 cargo steamers, the Lorain County Radio Corporation has developed over the past decade a highly efficient radiophone service.

Ships can be routed while under way, thereby completely coordinating dock and rail facilities. As a result, an estimated 2000 freight cars are saved each day. In addition, the system provides ships with instantaneous contact with the outside world in case of emergency.

Regular weather reports are broadcast over the system, and ships can call one another for additional information.

Completely Automatic

Ship personnel require a communication system for the operation of which no training beyond that necessary for an FCC restricted radiotelephone operator's permit is needed. Therefore, the Lorain company has developed a completely automatic dial-controlled installation for use in the area shown in Fig. 1.

The dial phone shown in Fig. 2 can be mounted aboard ship wherever it will be most convenient. Usually one hand set is mounted in the pilot house, and one in the captain's cabin. Lifting the hand set from its cradle puts remote transmitting and receiving equipment into operation.

One of six two-way crystal-controlled channels is selected by dialing. A lock-out feature prevents dialing the transmitter onto the air on a frequency already in use, except on general calling and ship-to-ship channels. Once the connection is established, conversation is carried on as in usual telephone installations. Voice-operated relays switch the ship's transmitter on and off the air, eliminating the need for a press-to-talk button. At the shore station a voice-controlled relay switches the land line from receiver to transmitter in accordance with the conversation. A noise discriminator prevents operation of the relay by atmospherics.

The main station at Lorain, shown in Fig. 3, is 30 miles west of Cleveland and communicates with ships on all of the Great Lakes. Two other shore stations, one at Duluth and one at Port Washington, cover local traffic in their respective areas. In addition to the Lorain-operated shore stations there are stations operated by other companies in the United States and Canada which handle traffic. About 95 percent of the ship installations were, however, made by the Lorain Company.

Marine Communication Network

Communication is handled on ship-to-shore frequencies in the 2, 4, 6, and 8 Mc bands; a ship-to-ship channel in the 2 Mc band; and an emergency channel in this latter band. The frequencies used were chosen to give complete coverage on the Great Lakes. Calls are routed over channels which will give the best service at the particular season of year, time of day, and distance to be covered. From the shore stations connection is made to shipping offices, weather bureau and elsewhere over telephone land lines.

Equipment Aboard Ship

The ship equipment comprises a six-frequency crystal-controlled transmitter, six crystal-controlled

FIG. 1—Location of Lorain County Radio Corporation's shore stations in the Great Lakes marine communication network, showing relation to shipping lanes

Ship Radio System

)etailed description of Lorain County Radio Corporation's automatic service employ-ng dial operation, selective ringing, six crystal-controlled two-way channels, relay-perated transmitters, and voice-controlled terminal equipment with noise discrimination

ɛceivers, power supply and control quipment all in a metal cabinet as ı Fig. 4, a transmitting and a re-ɛiving antenna, and one or more ɛlephone instruments installed at ıitable locations on the ship.

The equipment in the cabinet is ssembled on sliding chassis, re-ovable for inspection and servic-ıg. Automatic plug-in arrange-ents complete all connections hen the chassis are slid home. nly the connecting wiring and ugs are attached to the cabinet roper, thus providing complete ccessibility of equipment and mak-g it possible to install the cabinet ith its rear and side faces against ılkheads or lockers. This feature of considerable importance on ipboard.

The equipment is completely ɪsed. A main power switch at the p of the cabinet disconnects the ɪwer or connects an emergency ɪwer supply. The cabinet door is uipped with a tumbler lock to pro-ɪct the equipment against unauthorized manipulation. In installations where the antenna lead-in wires can not be placed beyond reach, they are insulated in heavy hose.

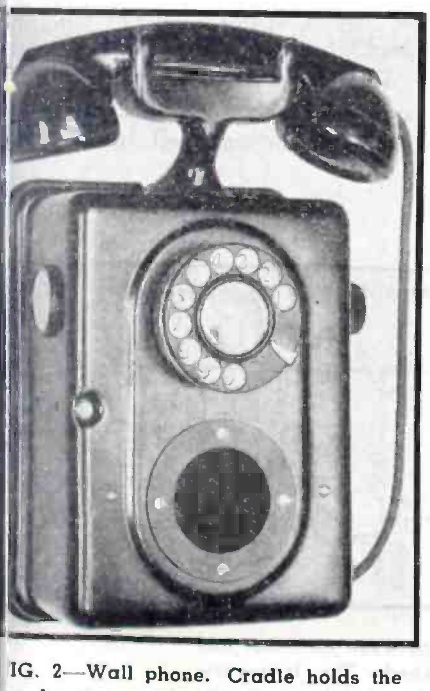
The transmitter operates directly into a single-wire antenna 50 to 100 feet long, carried as high as possible. The receiving antenna is usually installed on the opposite side of the ship from the transmitting antenna and is connected to the cabinet through a shielded low-capacity rubber-covered lead-in cable.

The equipment operates from 90-115 volts d.c. (the usual electric power aboard ships). The stand-by demand is approximately three amperes; under full operation the installation draws nine amperes. The 500 volts of plate power for the transmitter are supplied by a dynamotor in the base of cabinet. Filters in the ship's power line and in the dynamotor control-unit absorb interference. A rheostat adjusts the dynamotor for operation at the ship's average voltage. The receivers, which are in constant operation, operate directly from the ship's power mains, eliminating the need for a continuously-running converter.

Features of Ship Transmitter

The 50-watt ship transmitter consists of a crystal-controlled 6L6G oscillator and a plate-modulated final amplifier with three RK39's in parallel, shown in Fig. 5 and 6. The three tubes in parallel in the final r-f amplifier permit transmission at somewhat reduced power if one tube fails. Frequency stability is within 0.02 percent.

Individual crystals are provided for operation in the 2, 4, and 6 Mc bands; operation in the 8 Mc band is obtained by doubling from the 4 Mc crystal. Selection of the desired frequency is accomplished under control of the remote telephone dial by means of relays. The relays for the final stage use Isolantite supports for the contact members to



IG. 2—Wall phone. Cradle holds the and set securely in heavy weather

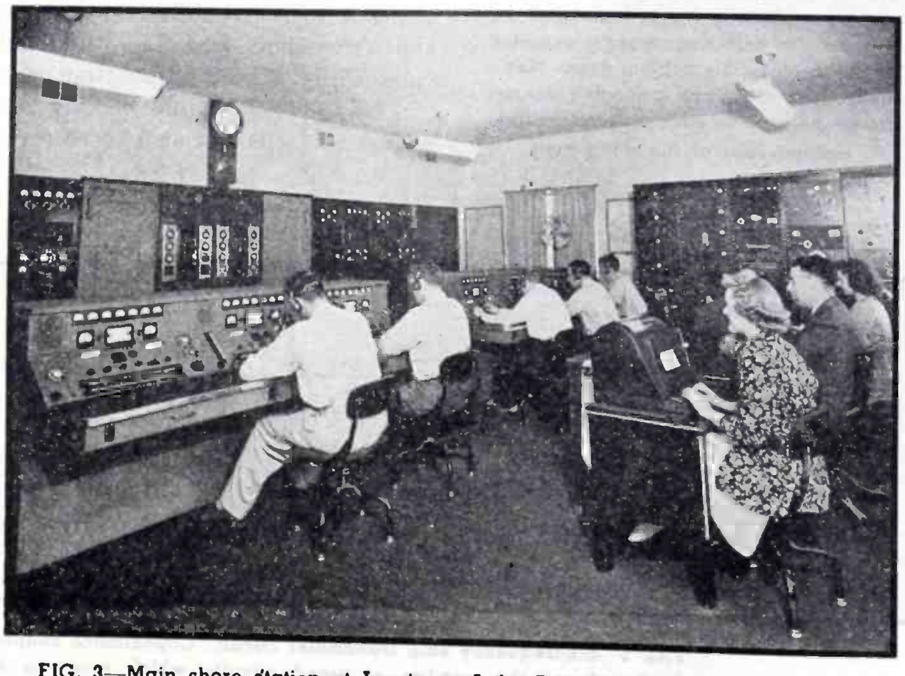


FIG. 3—Main shore station at Lorain on Lake Erie. Each of the six operator positions has push-button selection controlling six transmitters and receivers

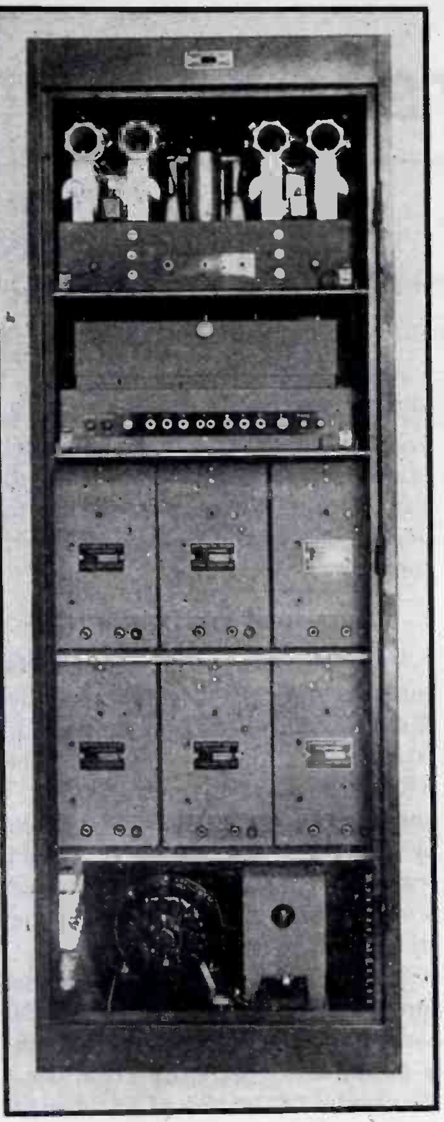


FIG. 4—Ship radio equipment, shown with the front door removed. The six-frequency crystal-controlled transmitter is at the top. Immediately below is the modulator and relay assembly. Occupying most of the space in the cabinet are six receivers. The transmitter voltage is supplied by the dynamotor at the bottom. The selective ringer is mounted on the inside of the cabinet door. Meter jacks, fuse clips and adjusting screws are at the front of each unit to facilitate maintenance of the equipment

reduce losses. Complete shielding is provided between the oscillator and final stages. Capacitance-coupling between oscillator and final reduces the number of tuned circuits which must be switched.

The modulator and audio-frequency stages, together with the control equipment, are mounted on a second chassis, shown in Fig. 7 and 8. Carbon microphones in the hand sets and the two stages of speech amplification provide sufficient power for 100 percent modulation of the carrier. All tubes in the transmitter are heated during standby periods so that the transmitter may be started instantly.

Features of Ship Receivers

Six separate complete and self-contained superheterodyne receivers constitute the receiving system. To insure the frequency stability necessary for permanent tuning, the local oscillator of each receiver is crystal controlled.

The use of six complete receivers insures signal reception on all frequencies, obviating the necessity for switching receiver frequencies as the ship passes from the area served by a shore station on one frequency into that of another. This assurance that calls will be received at all times on any of the frequencies employed is of the utmost importance where the distance range of these different frequencies varies with time of day and season of year. Moreover, separate receivers for each frequency make it possible to receive distress calls on the frequency assigned for such calls while at the same time calls can be received on the working frequencies. Calls can also be received on other frequencies if one of the receivers should fail.

Operation of Shipboard Equipment

In making a call the ship operator removes the hand set from the cradle, thereby closing the microphone circuit and also starting the dynamotor. To change the ship's equipment over from the normal standby condition to the calling condition the ship operator dials a two digit number. This number determines which of the six available channels will be used for the call. The channel to be used is chosen on the basis of the type of service desired (ship-to-shore or ship-to-ship), the particular shore station being called, and the prevailing atmospheric conditions.

The dial in the telephone unit transmits a number of pulses corresponding to the digit dialed. These pulses actuate a counting-chain relay system. The first digit is recorded by the counting system, which then locks itself so that further dialing will not change this first count. This prepares the transmitter for operation on the particular channel selected.

In addition to locking itself at the end of the first series of dial pulses, corresponding to the first digit of the channel number, the counting system also switches the common outputs of the receivers from the standby loudspeaker in the hand set units, connects them to the hand set ear-phones, and disconnects the plate voltages from all the receivers except the one associated with the dialed channel.

With the proper channel receiver connected to the ear-phone the operator can tell by listening

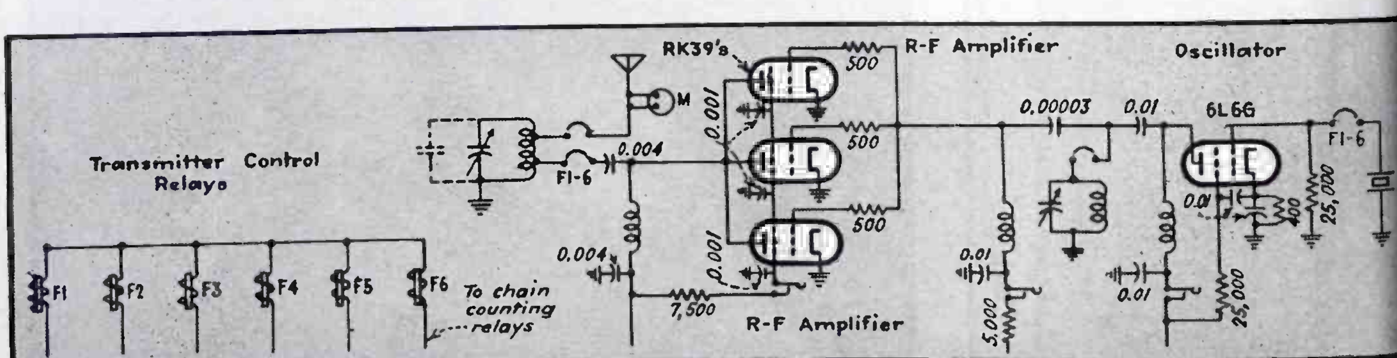
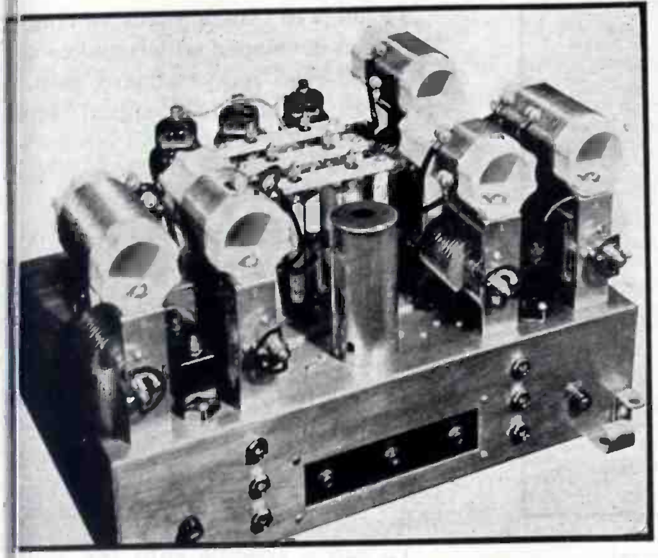


FIG. 5—Six-frequency ship transmitter circuit. Capacitance coupling between oscillator and final reduces the number of tuned circuits which must be switched. The frequency-selector relays are actuated from the chain-counting relays on the modulator chassis



IG. 6—Ship transmitter chassis with band-changing relays

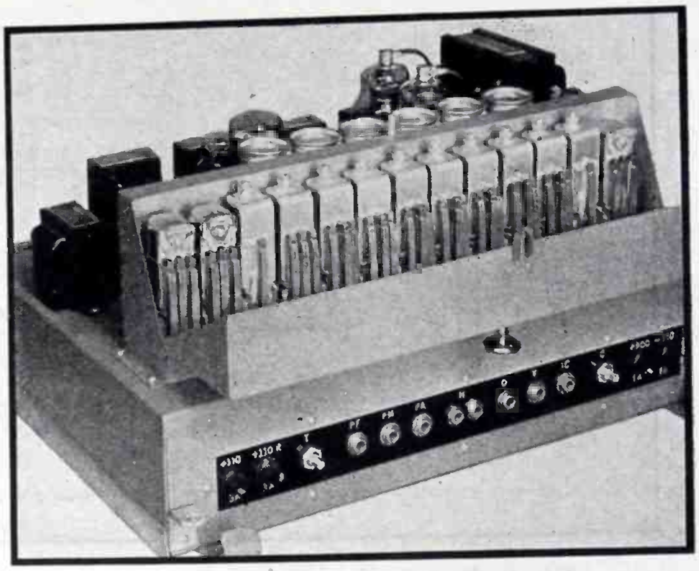


FIG. 7—Modulator and a-f stages, with chain-counting relays

hether or not that channel is in ıe. If it is, he hangs up and ıals another channel; if it is clear ı dials the second digit of the ıannel number. To prevent putng the transmitter into operation ı a busy channel, dialing the secıd digit of the channel number ıuses avc voltage from the reıiver to be applied to a 6C6 "carer-tube" grid. Should the sected receiver receive a radio carer, the avc voltage developed ıereby and impressed on the carer tube prevents the flow of plate ırrent through this tube and ence through the transmitter ate voltage relay which is in its ate circuit. The transmitter is ıus locked out in the event that ıe channel dialed is already in use.

If no signal is received, the late-voltage relay operates, aplying plate voltage to the transıitter and closing the circuit to ıe transmitter channel-selector elay which has already been preared for operation by the dialing ction of the first digit. The ransmitter channel-relay acts, lacing the crystal and tuned ciruits for the selected channel into he transmitter circuit.

The plate voltage relay has nother set of contacts which close o apply screen voltage to the 6L6G irst audio tube, putting that tube nto operation, and also closing a eedback circuit in this stage which onverts it from an amplifier to a 300-cps oscillator to generate an atention tone.

The 300-cps tone operates a slowrelease voice-relay through copperoxide rectifiers (used to keep the number of tubes whose heaters must be kept hot to a minimum) which relay closes the oscillator plate circuit of the transmitter, and shunts out 2000 ohms in the grid circuits of the modulator and r-f final stages, thereby reducing the grid bias of these tubes and putting the stages into operation. The transmitter goes on the air modulated at 300 cps.

In operating, the voice relay also inserts 25,000 ohms in the plate supply of the selected receiver to prevent its operation during transmission. Although transmission and reception are on slightly different frequencies in a given channel, the proximity of the ship's transmitting and receiving antennas makes this precaution necessary.

Shortly after the completion of the dialing operation, the feedback circuit in the first audio stage opens. As a result, the slow-release voice-relay takes the transmitter off the air, and returns the receiver to operation.

Speaking into the hand set microphone produces voice signals which, after amplification by the first stage of the audio amplifier, operate the voice relay as did the 300-cps attention tone. The voice relay does not clip words between syllables because of its slow-releas-

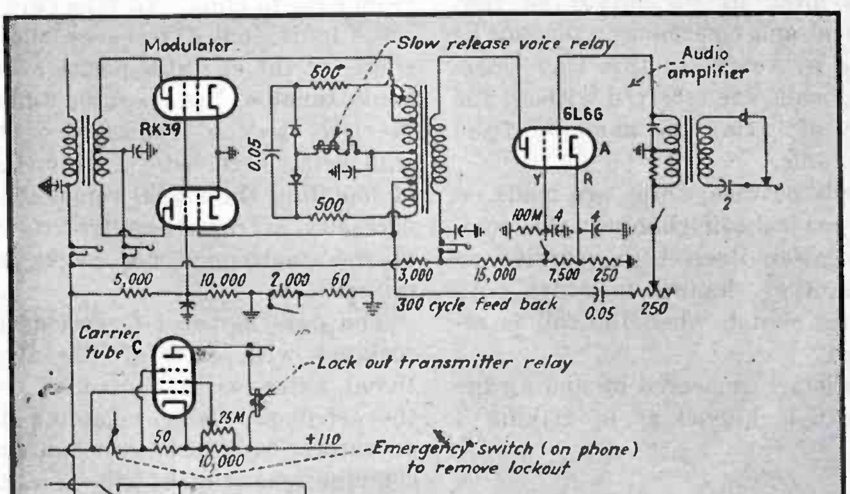


FIG. 8—Ship transmitter modulator circuit and audio amplifier circuits

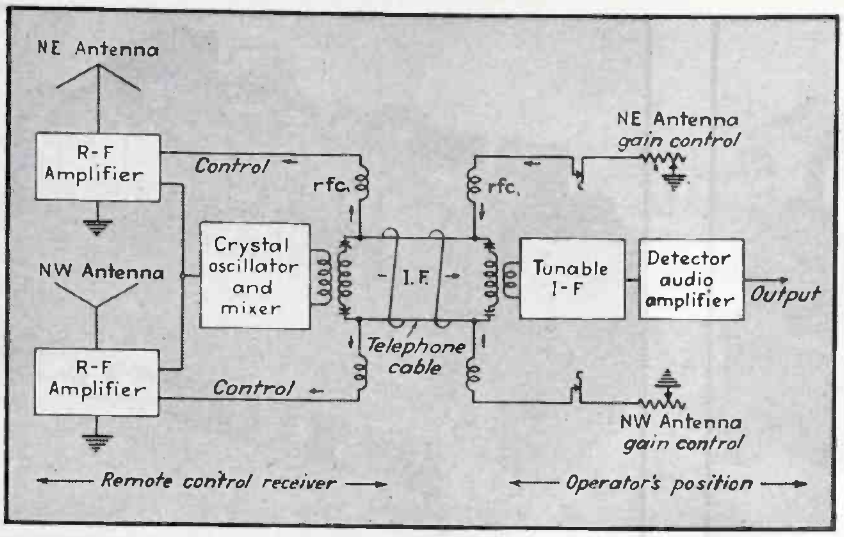


FIG. 9—Block diagram of shore station remote-control receiver.

ing action. When the operator stops speaking, the transmitter is made non-operating, and full voltage is applied to the receiver.

When a call is received aboard ship the signal from the shore station or another ship passes through a low-pass filter whose cut-off is 300 cps, thereby eliminating noise and voice signals from succeeding equipment. In the case of calls from shore stations, selective ringing is employed (as outlined in later paragraphs). The receivers of the channels reserved for shore-to-ship calls have their outputs connected to the selective-ringing equipment through the low pass filter.

The emergency and general-call channel receiver is wired directly to a separate speaker without a low pass filter in its output so that general and emergency calls can be made by voice. In this way emergency calls are received without the delay of lifting the hand set from its cradle.

Calls between ships are made on the general-call channel; the communication itself being carried on on another channel to which both parties switch when the call is received.

Calls are answered by dialing the indicated channel as in making a call.

Shore Installations

A typical shore installation consists of six operator-positions, each position having access to all of the six channels. Each operator position has its own direct line to the nearest long-distance tollboard, from which connection is made to or from the desired land party.

To eliminate interference from the 500-watt shore station transmitters, the shore receivers are located several miles away in unattended remote-control stations.

Each receiver has two directional antennas, one pointing to the northeast, one to the northwest. Each receiver antenna has its own r-f stage. The r-f stages feed to a common mixer with a crystal controlled oscillator. The resulting i-f is fed over telephone cable pairs to i-f stages at the shore station, as shown in Fig. 9.

Because the transmitter frequencies of different ships vary within the permissible tolerances of the channel, the i-f's developed by the crystal-controlled oscillator differ from ship to ship. To take care of these individual differences, the i-f stages at the operator positions are made tunable, the operator tuning precisely to the frequency of the ship being received. This method of handling the signal removes the necessity of remote-control tuning of the unattended r-f stages and mixers.

The gain of the r-f sections associated with each of the directional antennas is controlled over the telephone cable, enabling the operators to choose the antenna combinations which will give the clearest signal. Since all channels must be continuously available for communication the shore stations have duplicate transmitters, one for each channel handled by that station, and an emergency transmitter.

When calling, the shore station should signal only the ship called. To achieve this, a selective ringer has been developed which makes use of tuned-reed relays aboard ship to distinguish one call signal from another.

Selective Ringing

The shore station can modulate its carrier at any one of seven frequencies lying between 120 cps and 300 cps by dialing digits one to seven at the operator position. Four reed-relays tuned to four different frequencies in the available seven-frequency series are used in the selective ringer on board each ship.

To call a specific ship the shore station transmits five tone pulses without intervening pauses. This means that successive pulses must be of different frequencies to be distinguished. Also, since there are but four tuned-relays aboard ship, one of the reed frequencies must be repeated. This arrangement gives slightly over 5000 possible combinations, so that 5000 ships may be called.

The shore operator dials the call number of the ship to be reached. At the ship the audio impulses are delivered by the shore-to-ship receiver, through the low-pass filter which prevents operation of the selective circuit by noise or voice, to a type 41 amplifier tube and thence to the selective ringer. If the first pulse is of the frequency to which the first reed-relay is tuned, the relay operates, connecting the receiver to the next relay in the series. The process is repeated as long as the pulses are of the required frequencies to operate the relays. If at any time the frequency is not that of the next reed, the circuit is opened so that the next pulse can not operate a relay. After all five pulses have been properly received, the selective ringer rings a bell at the hand set location.

Voice-Controlled Terminal Relays

Terminal connection to the shore-party land-line is voice-operated and has an anti-noise feature. Several terminal systems have been tried; the present system, developed from these earlier systems, takes two forms, both of which provide the required operating characteristics.

The chief problem in terminatn the land line arises from the re- rement that the land line handle fic in both directions. This two- traffic must be divided, the ısmission going to the shore ısmitter, reception coming from shore receiver. The transmis- ı loss over the land line is about 5lb, with the result that there is ifferential of 30 db between re- ver output and transmitter in- ı under the operating conditions ch provide the land party with quate signal strength at the phone receiver.

f the receiver output, transmit- e input and land line were paral- ed, the shore transmitter would iate that half of the conversa- ı received from the ship by the re receiver, as well as that from shore party. This means that eceiver tuned to the shore trans- ter would receive both halves of conversation.

n addition to this undesirable k of privacy, and since the ship nsmitter is off the air while the re party is speaking, the shore eiver—which employs avc—is at maximum sensitivity when the re party is talking. Were the ect connection mentioned above d, the noise in the output of the re receiver would be added to t already present on the land e and fed out over the shore nsmitter, with the result that re would be an abnormally high se-level in the transmission of shore party.

Both to add to the privacy of the versation and to reduce the se in the shore party's transmis- n, it is desirable to switch the land line to shore receiver or transmitter as the conversation demands. Since the ship transmitter goes off the air when that party has finished talking, it seemed possible to operate a switching relay from either rectified voice in the shore receiver output or the avc voltage developed by the receiver in the presence of a signal, either being an indication that the ship party is speaking. However, noise, especially in the summer on the 2 Mc band in the latitude of the Great Lakes, is so severe as to operate a relay so controlled.

To eliminate the effects of noise, a noise-balancing circuit was developed. As shown in Fig. 10, i-f energy from the receiver is converted by means of an afc oscillator to 55 and 50 kc. Noise in the receiver i-f produces voltages of equal strength at these two frequencies. The two frequencies so produced are rectified and applied in opposition to a d-c amplifier which operates the land-line switching-relay. Regardless of the noise level in the receiver there is no effective voltage applied to the relay amplifier unless a modulated carrier is present. Then the voltage developed in the 55-kc amplifier will increase, unbalancing the system and operating the land-line relay.

As a further precaution to avoid transfer of the land line from the transmitter to the receiver by random carriers crossing the receiver frequency and momentarily interrupting the shore party's transmission, some voice signal from the shore party is amplified and rectified and used to lock the land-line relay to the transmitter position.

The second system in use at present, shown in Fig. 11, is one which (because of its greater simplicity) is displacing the previously described system. It works on the same principle of balancing out two noise-voltages.

In this system one noise-voltage is taken from the superaudible noises present in the receiver; the other is taken from the audible noise voltages. As in the earlier system, these two noise-voltages are balanced, rectified and applied to the d-c amplifier of the land-line switching-relay. When a modulated carrier is present, the audible frequencies predominate, unbalancing the system. If there is no voice-voltage on the land line from which the relay is locked to the transmitter, the presence of a modulated carrier in the receiver switches the line to the shore receiver output.

This automatic ship-radiotelephone system serves the ships of over 30 different companies operating on the Great Lakes. The concentration of shipping in this area, the cooperation of many shipping companies, the spirit of mutual assistance against spring fog and storms on the part of the ship captains, and the absence of international antagonism has made it economically feasible to develop this communication network.

Regular inspection and servicing of the marine equipment, even to the extent of dispatching a serviceman by airplane in case of faulty operation, has assured the reliable operation of the system.—F.R.

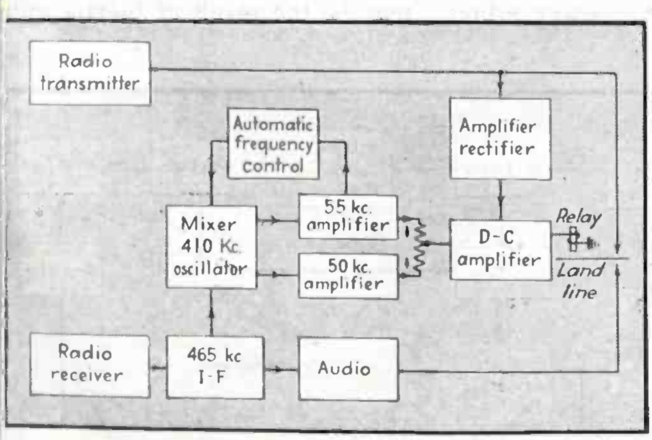


FIG. 10—Frequency-controlled heterodyne oscillator produces two signals, equal in the presence of noise, unequal in the presence of a modulated carrier in this noise-discriminating voice-controlled terminal-relay used in shore stations

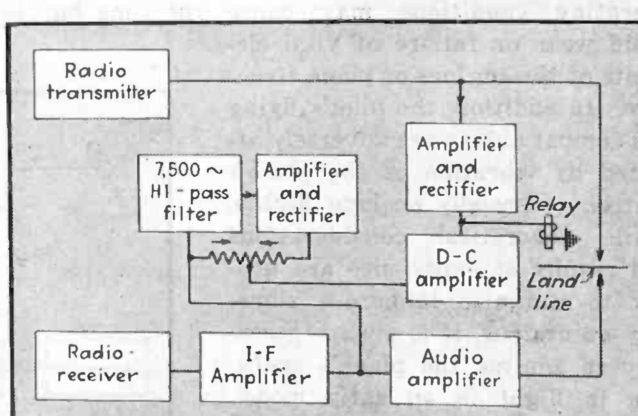


FIG. 11—Noise-discriminating voice-controlled terminal-relay using superaudible noise to balance the audible noise. The presence of voice voltages in the receiver's output unbalances the system

Aircraft Vibration Analyzer

Installed in an airplane for tests during flight, this electronic device provides an instantaneous indication and a graphical record of the amplitude of vibration of the power plant, structural members and controls at certain fixed frequencies related to engine speed

By F. G. MARBLE

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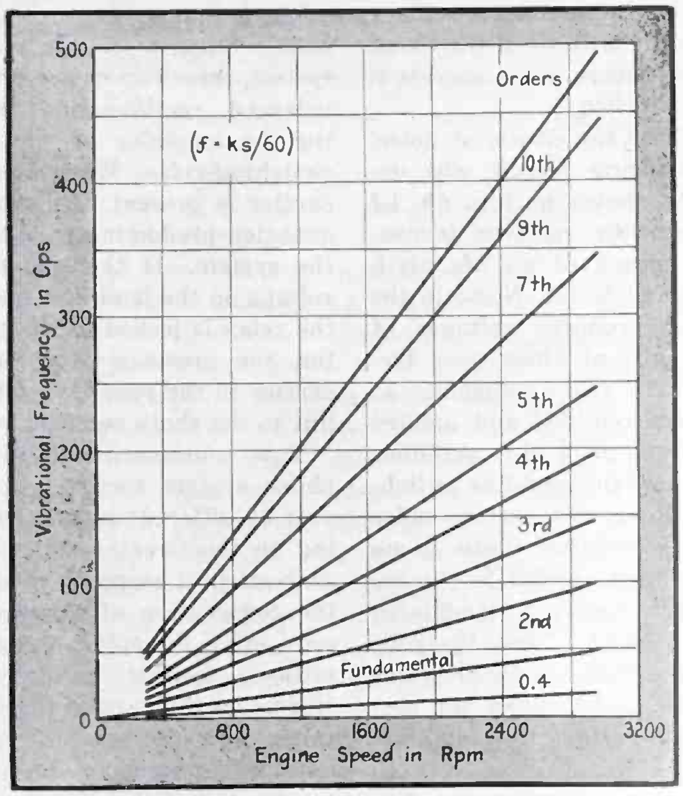

FIG. 1—Curves showing vibration frequency for various "orders" discussed in the text as engine speed varies

One important element of aircraft design is the elimination of excessive vibration of the power plant and plane structure during operation. The appearance of excessive vibration at various operating conditions may cause rapid wear or failure of vital elements of the engines or plane structure. In addition, the pilot's flying and combat ability are adversely affected by vibration of the plane's controls, especially on long flights. While theoretical considerations and results of experience are utilized to minimize dangerous vibratory excursions, it is always necessary to analyze the plane's operation in flight in an early model. This necessity results from the incorporation of modifications whose effect cannot be foreseen, such as greater power, higher speeds, lowered weight, new propellers, etc.

Methods of measuring vibrations in planes in flight have been under development for a number of years. Each of these has possessed advantages but all have suffered from the fact that a considerable expenditure of time has been necessary either during flight or while analyzing the data. In addition, some methods have been liable to errors resulting from the fact that data must be recorded and plotted by an observer. To overcome these defects, general requirements were formulated for an automatic system by the Pratt & Whitney Aircraft Division of the United Aircraft Corp. The automatic vibration analyzer was designed to these requirements by the Bell Telephone Laboratories and manufactured by the Western Electric Co. This analyzer in conjunction with an electrical vibration pickup and a recorder produces a curve of the amplitude of vibratory velocity at a given multiple or order of engine speed versus engine rpm.

Nature of Vibrations

Engineers, in their studies of aircraft vibration, have discovered that for the most part power plant exciting forces originate as a result of one or more of the three following conditions: First, they may be the result of inertia unbal-

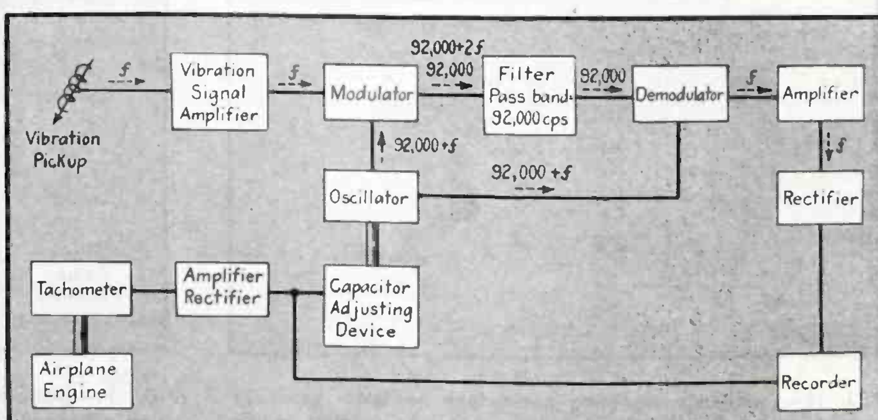

FIG. 2—Block diagram of the analyzer circuit

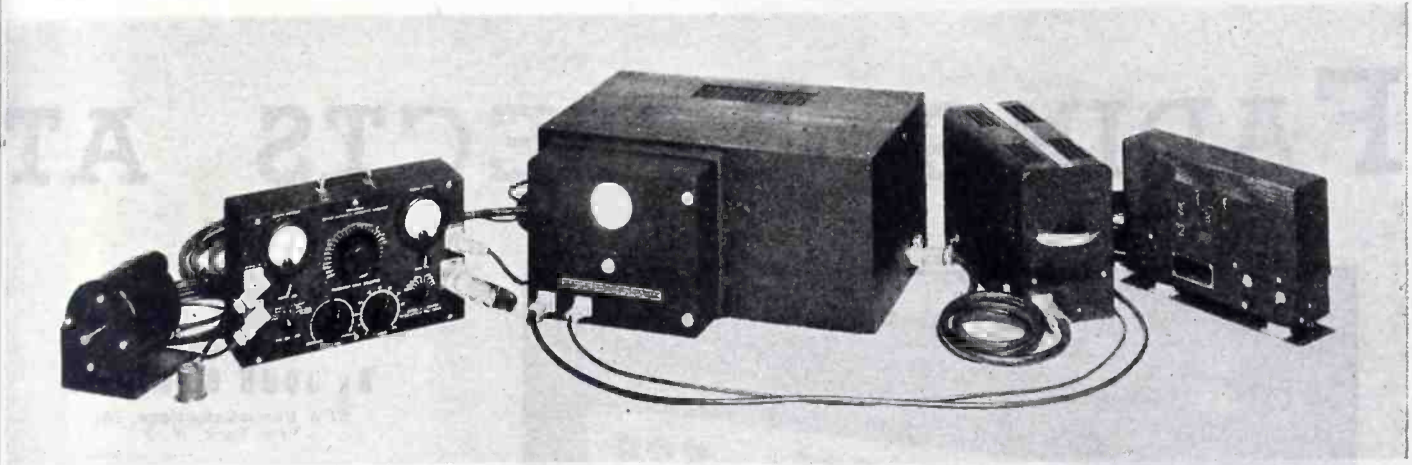

FIG. 3—The test setup, complete except for the recording-pen unit. Left to right: tachometer; control unit for analyzer and recorder; capacitor-drive mechanism and associated amplifier made by the Brown Instrument Co., analyzer power supply and control unit for capacitor drive

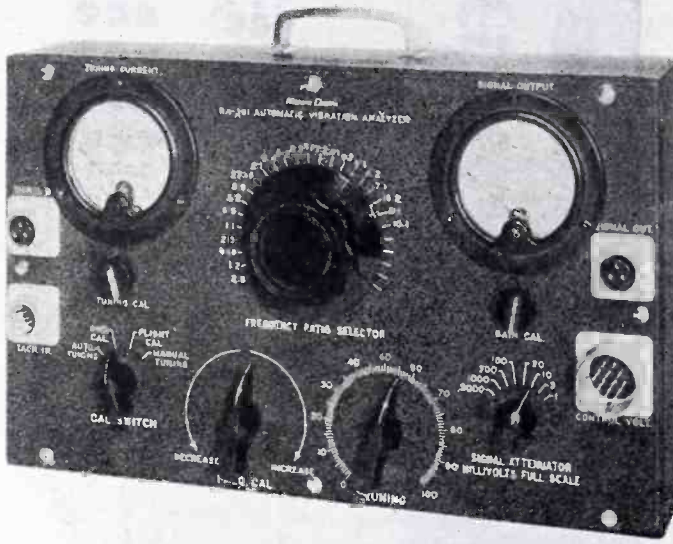

FIG. 4—Close-up of the analyzer-recorder control unit

ances in the engine or propeller; second, they may result from forces generated by burning gases in the engine cylinders; and third, they may emanate from aerodynamic forces acting on the propeller. Further, they have found that these vibration-exciting forces occur at frequencies corresponding to definite multiples of engine rpm.

To measure and analyze engine vibrations successfully, it is important to obtain the amplitude of vibration at each of several frequencies for each of a number of engine speeds in the operating range of the standard airplane motor. Consequently, twenty-three frequencies expressed in terms of multiples of engine speed, commonly referred to as "orders," were specified for which analyzer tuning would be required. (In addition, it was requested that provisions be made for five subsequent orders to be specified at a later date.) The final selection of orders was based on possible exciting forces resulting from a number of different engine-propeller combinations. These orders are listed in Table I.

Since the speed range of the standard airplane motor is assumed to be between 500 and 3000 rpm (8.33 and 50 rps), the actual frequencies involved cover a range from the lowest of the twenty-three orders at the lowest engine speed to the highest order at the highest engine speed. Thus the frequencies, being definite multiples of engine rps, will range from 3.33 to 500 cps. Because of the difficulty of separating the low frequencies, however, the full accuracy of the analyzer is not realized below 5.5 cps.

To illustrate the relation between vibrational frequencies and engine speed, several typical curves are provided in Fig. 1. These curves are plots of the relationship $f = ks/60$ where f is the frequency in cps at which the vibration occurs, s is the motor speed in rpm, and k is one of the 23 pre-selected orders.

TABLE I. ORDERS (Multiples of engine speed)

2/5	8/3
1/2	3/1
9/16	7/2
2/3	4/1
1/1	9/2
6/5	5/1
3/2	11/2
8/5	7/1
27/16	8/1
2/1	9/1
9/4	10/1
5/2	

In locating the source of the vibration the key to the source is not the actual frequency at which it occurs but the particular order of vibration, k. Knowing the value of k, the possible sources of the excitation are considerably narrowed down. Although it would be possible to measure the frequency f at which the vibration occurs and determine the engine speed s, then substitute these values in the above equation and solve for k, this is not desirable due to the fact it would require searching for vibration at all frequencies within the band from 3.33 to 500 cps.

Analyzer Circuit Design

The automatic analyzer plots a curve showing the relationship between the amplitude of the vibration and the engine speed for one particular order at a time. The actual frequency of vibration, f, may be readily determined from the previously mentioned frequency equation.

In order to more fully understand

(Continued on page 180)

FADING EFFECTS AT

By JOHN B. MOORE
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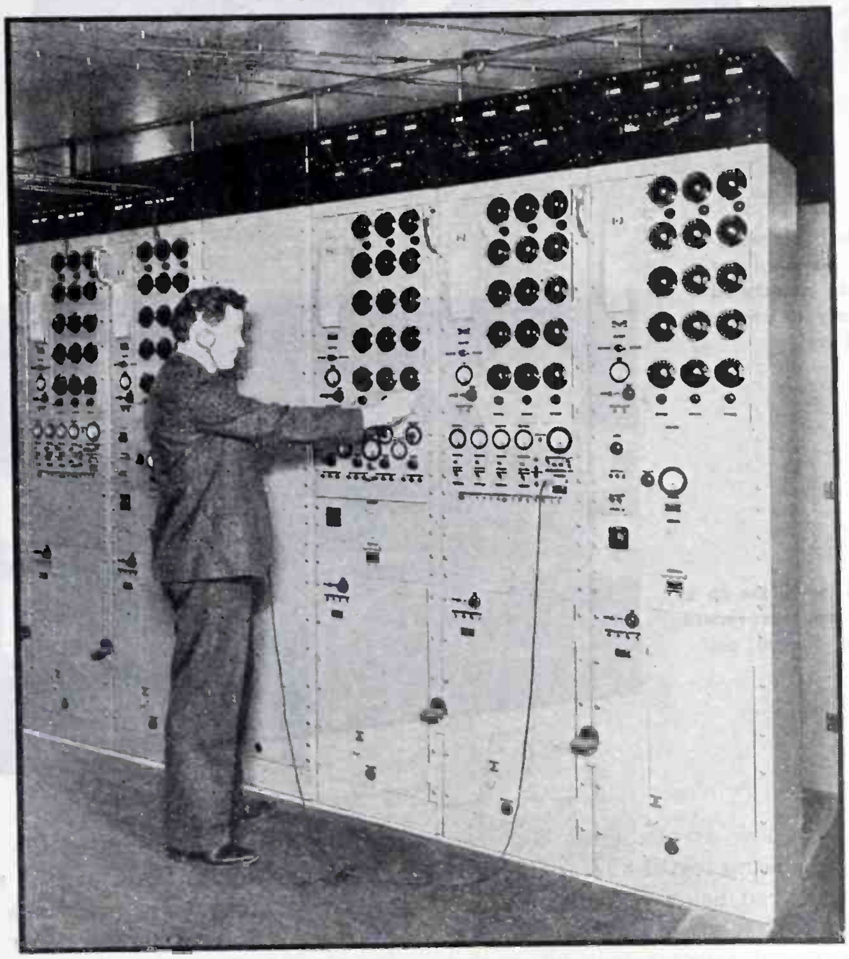

Racks of receivers used for diversity reception at high frequencies in the RCA receiving station at Riverhead, N. Y.

THE FIELD STRENGTH of a distant transmitter operating at frequencies between 4 and 24 Mc may vary over a wide range. Diurnal and seasonal variations, and slow shifts with the sunspot cycle, may be largely if not entirely overcome by the proper choice of carrier frequencies. There remains, however, the problem of insuring satisfactory reception during short-period variations, commonly called fading.

This problem is of particular importance to the commercial communications services, including telegraph, printing telegraph, picture transmission and facsimile, telephone and program services. All are adversely affected in one way or another by fading. No single solution for all types of fading and services has yet been disclosed or put into commercial use.

It is the purpose of this paper to give a coordinated picture of the general problem, the methods of attack employed so far, and the advantages or disadvantages of each method. Violent interruptions or drop-outs lasting from several minutes to several hours or days, caused by terrestrial magnetic disturbances or sun spot activity, will not be dealt with.

Types of Fading

Short-period variations in the signal delivered by the receiving antenna may be of several kinds. The term *fading* will be taken to include any such variation which has a time duration—from normal to subnormal or abnormal and back to normal—of less than one minute roughly speaking, and generally less than one second. The various types will be identified by their outstanding characteristics and effects.

The simplest case is that in which the carrier and all modulation sidebands vary in intensity simultaneously and in the same proportion. This may be a 20 db drop (10 to 1 in field intensity), or considerably greater. Regardless of the depth to which the signal fades, carrier and sidebands retain their original relative strengths. The signal becomes weak, and may even drop below the noise level, but there is no noticeable distortion.

Theoretically at least, this simple type of fading—in amplitude or depth only—may be caused either by: (1) a change in the reflection or refraction of a single ray by the ionized layer then effective in propagating the signal to the receiving point; or (2) out-of-phase addition, and thereby partial cancellation, of two or more rays arriving over paths of slightly different apparent lengths. Such out-of-phase arrival of two or more rays at the receiving antenna gives rise to a number of different effects.

The interference pattern resulting from the out-of-phase arrival of two or more rays sweeps across any given point at which a receiving antenna may be located. At a given instant, and for any specific and discrete frequency, areas or bands of maximum and minimum field intensity just above the surface of the earth (at an-

HIGH FREQUENCIES

Commercial communications services operating between 4 and 24 Mc are adversely affected by field-strength variations of less than one minute duration. The precise nature of the problem depends upon the type of service. Practical methods of minimizing drop-outs, distortion and errors are reviewed.

tenna height) will occur along the direction of propagation as shown in Fig. 1. Generally, the slower the fading the greater the area covered by any one such maximum or minimum.

The interference pattern also sweeps across the frequency spectrum, the frequency separation between maxima and minima varying greatly. Here again, the slower the fading the more widely separated the maxima and minima.

In view of the statements just made, we may say that slow fading generally covers a large geographical area and a wide band of frequencies.

As the fading becomes more rapid, due to the interference patterns — space and frequency — sweeping across the surface of the earth and across the frequency spectrum, the areas of maxima and minima apparently become smaller and the separations between frequencies having simultaneous maximum and minimum field strengths also become less. Under such conditions not only are there rapid variations in field strength of all frequencies within a particular band, but also different discrete frequencies, or very narrow bands of frequencies, do not fade in unison. The result is so-called *selective fading*.

Another effect resulting from simultaneous arrival of two or more rays over paths of appreciably different length is encountered when the time-of-arrival of the rays differs by an amount—measured in milli-seconds—which is appreciable compared to the time of duration of a telegraph dot or of a small element in material being transmitted by radio-photo (facsimile). This is commonly referred to as the *multi-path* effect.

Effects of Fading

The practical effects of the various type of fading shown in Fig. 2 can best be discussed in relation to specific types of radio-communication service. A convenient classification, for this purpose, is:

(1) Slow-speed telegraphy
(2) High-speed telegraphy and multiplex
(3) Radio-photo or facsimile

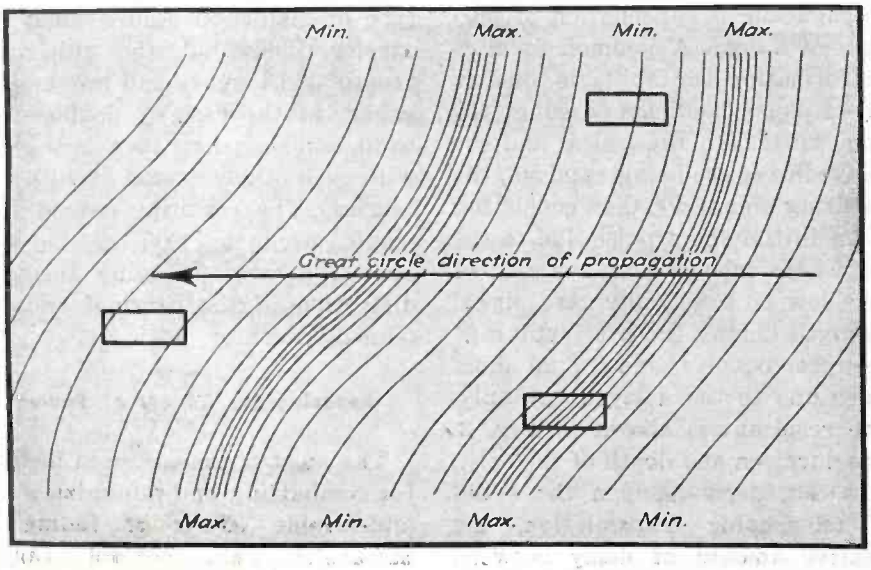

FIG. 1—A typical interference pattern, showing areas or bands of maximum and minimum field intensity. Antennas arranged for space diversity reception are shown as boxes

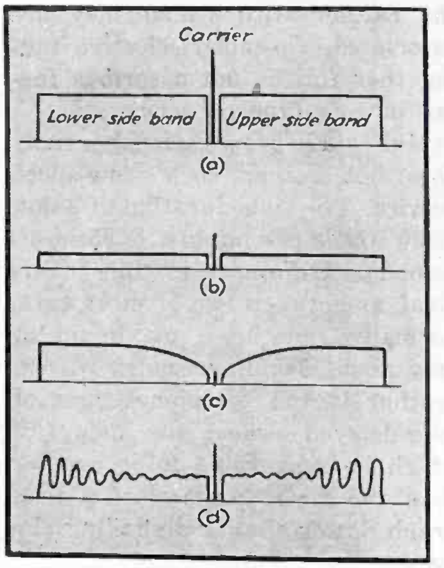

FIG. 2—General types of fading: (a) normal signal; (b) distortionless and non-selective fade; (c) selective fading of a carrier; (d) selective fading of sidebands

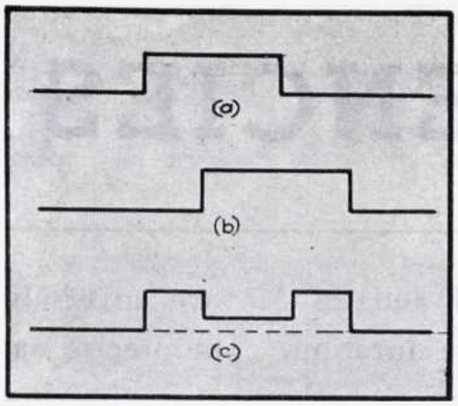

FIG. 3—A "split", showing the effect of multi-path propagation on the formation of a high-speed telegraph dot. (a) The first signal received; (b) the delayed ray signal; (c) the resultant

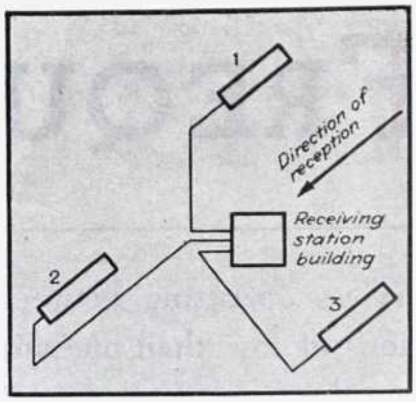

FIG. 4—A space diversity antenna layout. Three directive antennas (shown as rectangles) are placed a number of wavelengths apart, at the corners of an isoeceles triangle

(4) Telephone and program services

This classification is based on speeds, or band widths, required.

(1) Slow-speed telegraphy is affected chiefly by the slower type of fading, in which the predominant factor is simultaneous variation of the received field strength of the carrier and all necessary sidebands.

Taking the arbitrary upper limit of 20 dots or square cycles per second for this class of service, and considering that the third harmonic of the fundamental keying frequency is all that is needed for reasonably good envelope formation of the dots and dashes, we see that the total band width involves only 3 x 20, or 60 cps. Observation has shown that such sidebands seldom, if ever, fade differently than the carrier with which they are associated. So-called selective fading therefore is not a serious factor in this type of service.

Multi-path propagation normally does not bother such slow-speed service. The time duration of a dot, at 50 words per minute, is 25 milli-seconds. Difference in time of arrival, as between two or more rays, normally runs to a maximum of only about 3 milli-seconds. An exception is the occasional case of long-delayed *echos*, the delay of which is comparable to or greater than the time duration of a telegraph dot or similar signalling element.

(2) High-speed telegraphy includes high-speed Morse or printer operations and multiplex services in which keying speeds may run to 200 dots per second (square cycles per second). At such speed the time duration of a telegraph dot or multiplex keying element amounts to only 2.5 milli-seconds.

It will be apparent, from statements made in preceding paragraphs, that multi-path propagation can seriously interfere with such high-speed telegraphic transmissions. A delayed signal, arriving over a longer path, will result in a dot being elongated, the overall effect being to make the mark/space ratio not 50/50 but perhaps as heavy as 90/10 or even 100/0. Satisfactory reception and transcription then becomes extremely difficult or impossible.

Another effect, due to multi-path propagation, is cancellation of portions of a dot. A common form of malformation, or *split*, is due to out-of-phase addition during the time when both the initial and the delayed rays are being received, the resulting signal dot then consisting of an initial short pulse due to the ray which arrived first, a period of very low or practically zero signal strength during the overlapping of the received rays, and a final short pulse due to the delayed ray only. The resultant is shown in Fig. 3. The duration and depth of the split, in a dot, depends upon the speed of telegraphic transmission, the relative amount of delay between rays arriving, and relative phases and amplitudes of the arriving rays.

Selective fading may affect envelope formation when the fundamental and necessary harmonics of the keying frequency run to 200 x 3 or 600 cps or higher. That is, sidebands removed this far from the carrier may, under conditions of extreme selective fading, fade differently than does the carrier, and an originally rectangular envelope shape will suffer malformation.

(3) Radio-photo and facsimile keying speeds and sideband frequencies generally run considerably higher than for high-speed telegraphic service. Roughly, we may set an upper limit of 3000 cps for systems now in use. Such transmissions obviously will be adversely affected by general fading in depth, by multi-path propagation, and by selective fading. The effects, as observed in the recorded picture, may be streaks, widened or elongated elements of the picture subject matter, and loss of detail.

(4) Telephone and program service sidebands require some 3000 or 5000 cps, respectively. General fading, in depth only, reduces the modulation/noise ratio. Depending upon the action of the receiving system and equipment, this may produce a falling and rising level of modulation output (from the loudspeaker) or a rising and falling noise level.

Selective fading produces distortion having characteristics which depend both on the nature of the selective fading and on the type of receiving system and equipment used. One particularly bothersome type of distortion occurs when the carrier fades but the sidebands remain. The upper and lower sidebands, in the case of double-sideband transmission, then beat only with each other instead of with the carrier. The resulting second-harmonic products are, as is well known, a very annoying form of distortion of the original and intended speech or music.

Reducing the Effects of Fading

The most commonly used method for combatting and minimizing the undesirable effects of fading is automatic gain control (agc), known in some types of equipment as automatic volume control (avc).

s method maintains a reason- ly constant reference level for speech or music modulation. It ffective against the slower, gen- l fading in which the carrier and l sidebands fade essentially in son and in the same proportion. f the agc system is designed to too rapidly, it will follow the er modulation frequencies and ually, to a considerable degree, nove these modulation compon- s from the final output signal livered to a loud speaker or other lization device or circuit. This ion is sometimes referred to as modulation of the carrier. (This of the term *demodulation* should t be confused with final rectifica- tin, or detection, to which the term nodulation often and unfortu- ely is applied.)

Automatic gain control to take e of general fading of the slower pe, is usually used in combination h other methods that are de- ibed in following sections. For venience, these methods are ed here:

- Frequency diversity
- Space diversity
- Polarization diversity
- Ray selection and diversity
- Limiting
- Frequency and phase modulation
- Exalted-carrier receivers
- Single-side-band.

These general methods will be ken up, separately, in following tions.

Frequency Diversity

This general method derives its me from the diversity, or differ- ce, of fading that often exists on quencies which may be separ- ed by as little as 500 cps or less. hile the basic principle has rather de possibilities, its practical ap- ication has, for various reasons, en pretty much limited to tele- aphic services in which the trans- ssion of intelligence is accom- shed by keying an r-f carrier on d off. The simplest and probably st widely used system or method s as its purpose the improvement radio-telegraphic communication thout resort to elaborate and ex- nsive receiving systems and uipment. This particular method will be described, by way of illustration.

In the radio transmitter, the carrier frequency is varied or modulated in any manner which will produce sidebands extending roughly 1 kc each side of the carrier. A common method of accomplishing this is to phase-modulate the master oscillator by means of a tone frequency in the neighborhood of 600 cps. The resulting distribution of energy, in sideband frequencies on each side of the carrier, is determined by the degree of modulation. A limited number of sidebands, spaced 600 cps, is a practical compromise between the wide separation desirable for obtaining the maximum benefits of diversity of fading on the one hand, and the disadvantages of interference to signals on adjacent channels on the other. However, distribution of the total available power between the carrier and a large number of discrete sideband frequencies means less power, and therefore less field intensity, on any one frequency.

Rapid fading which would chop or split characters, in the case of a pure c-w carrier, also manifests itself as selective fading which sweeps across the frequency spectrum. At the receiving station, therefore, the adverse effects of such fading are minimized by the employment of frequency diversity—the reception of a number of separate frequencies instead of a pure carrier.

Space Diversity

This system makes use of the diversity of fading existing at geographically separated points, specifically at receiving antennas which are spaced a number of wavelengths from one another. Due to the fact that the system does not depend upon or require any special type of signal, but may be used for reception of all types of high-frequency signals and services, it has been widely adopted.

Three antennas generally are used, as shown in Fig. 4. They may be of any type, directional or not, and are placed at the corners of an isosceles triangle. The exact shape and orientation of this base triangle with respect to the desired direction of reception is not critical.

Generally speaking, spacing between the several antennas should be greater for use at the lower frequencies than at the higher fre-

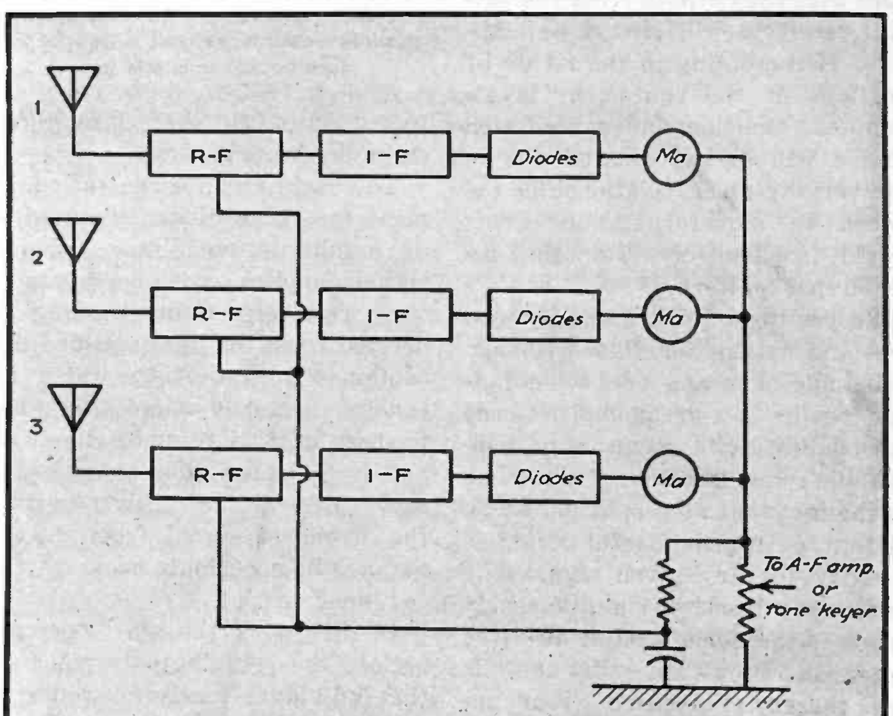

FIG. 5—In this space diversity reception system the rectified output of three receivers is combined, operating the keyer and also supplying bias for automatic gain control

quencies for good diversity performance. A figure of about ten wavelengths or a compromise of about 1000 feet is generally to be recommended, although diversity of fading can be observed between antennas spaced much less than this. However, the greater the spacing, the slower the fading on which diversity action can be expected to be obtained.

In such systems a transmission line of a type having low inherent pickup conducts the r-f signal voltages from each antenna to a separate receiver. The outputs from these three receivers then are either combined or switched, the object being to insure that the utilized output signal will at any and every instant be derived either wholly or chiefly from the antenna at which the best signal-to-noise ratio exists at that instant.

In telegraph service, and others that similarly employ on-off keying of the carrier, general practice is to combine the rectified outputs from the final detectors of the several receivers. This combined, rectified output controls a keying tube or tubes and also supplies bias voltage for automatic gain control as shown in Fig. 5. The purpose of combining after final rectification is to insure that the outputs from the several receivers will always be additive. If combining in the r-f or i-f portions of the equipment is attempted, addition and cancellation effects will be experienced due to the varying phase relationships between the several signals. This would, in effect, create another interference pattern.

Proper use of this diversity system and action, together with agc to handle slow and area-wide fading, results in a great improvement in reliability and accuracy of telegraphic communication. This is due to the fact that at practically every instant, during the useful period of the day for any given signal, the field strength seldom simultaneously drops to the noise level at all three antennas. Drop-outs, splits and fills are thereby prevented from appearing in the final output signal delivered by the system and equipment.

In telephone and program services, and in others which employ variable depth of amplitude modulation rather than on-off keying, application and use of the space diversity principle is attended by certain complications not met in the case of telegraph service. This is due to the fact that the audio-frequency modulation envelopes of the several signals, delivered by the separate antennas and their receivers, vary in phase. That is, their phases vary with relation to each other as the field-interference pattern sweeps across the antenna locations. Combining two or more such rectified, modulated outputs of approximately equal strengths but out of phase results in a distorted output if the phase differences are very great.

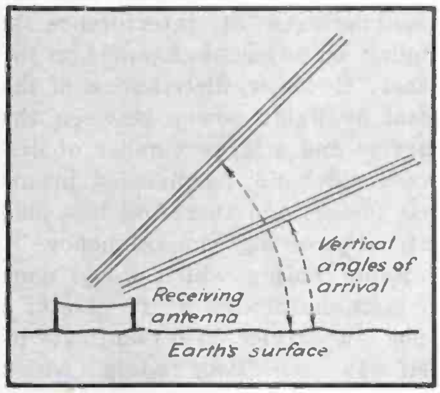

FIG. 6—"Bundles" or groups of rays frequently arrive at the receiving point at different angles. Antenna systems having variable vertical selectivity reduce trouble from this source

The usual arrangement of equipment for space diversity reception of amplitude modulated (phone) signals, applies a common agc to all three receivers. Control voltage is derived from the final rectified and combined output of the three receivers normally employed. The purpose of this common agc voltage is to insure that at each and every moment the receiver getting the strongest signal from its antenna will contribute most to the combined output.

If this were the only selecting action, the contributions made by the individual receivers would be proportional to their input signals received, at the moment, from their respective antennas. Actually, however, there is also a considerable degree of inherent switching action caused by operation of the final diodes of the several receivers into their common load circuit in which the combining of outputs is accomplished. This action is to completely cut off the output or contribution from the diodes of one or two receivers when the output from another rises appreciably above them. As a result of the common agc, and also of the diode action described, a ratio of antenna voltages of as little as two to one (or less) may result in the entire output signal, in the combining circuit, being supplied by the one receiver momentarily having the strongest antenna signal.

The result of this switching action is that distortion occurs only at those instants when the signal delivered by one antenna is increasing in strength and that delivered by another antenna is decreasing in strength and the two momentarily are about equal in amplitude but differ in phase. This effect is minimized by reducing the value of the differential, between the two signals, required to effectively switch; that is, by cutting off the weaker and permitting the stronger to contribute the entire output current present in the combining circuit. Reduction of the required differential results in more rapid switching, and thereby reduces the time duration of the distortion that is experienced.

Proper use of space diversity action, together with agc, insures the best possible signal-to-noise ratio at every instant, and maintains that ratio at a more nearly constant value than is possible by the use of a single receiver. On very rapid fading, which may also be quite deep, the second and third receivers fill in during those very brief but rapidly occurring instants when the signal from the first antenna is practically zero.

Polarization Diversity

Where space is not available for the erection of antennas separated by some hundreds of feet, use can be made of polarization diversity reception. The fact that the polarization of a received wave does not remain constant, but varies from horizontal to vertical and to other skew angles, makes it possible to obtain the benefits of diversity of fading by using one horizontal doublet and one vertical doublet (or other type antenna), both antennas being located at the same spot. Two separate receivers are used, in the same manner as for space diversity reception. The improvement to be expected is, however, considerably less.

Ray Selection and Diversity

As has been pointed out, long-distance propagation of high-frequency signals does not take place over but a single path at any given instant. Angle of incidence of two or more rays, or bundles of rays, can be observed and measured, as shown in Fig. 6. By selecting only one of these rays, or small bundles of rays, the effects of ray interference can be greatly reduced.

The so-called *Musa* (multiple-unit steerable antenna) system, developed by the Bell Telephone Laboratories, accomplishes this. The antenna system and its associated equipment are designed to effectively pick out any one ray, or small bundle of rays, by means of extremely sharp vertical directivity which can be adjusted to the desired angle. When it is thus possible to pick out only a single ray, the field-interference pattern previously discussed is no longer such a source of trouble. Large variations in the vertical angle of arrival must, of course, be followed by adjustment of the vertical directivity of the system. Where the signal is arriving simultaneously over two paths that differ sufficiently in their vertical angle of arrival, each can be selected separately and the two combined or switched for obtaining what may be termed ray diversity or path diversity.

A detailed description of the antenna system, and of the receiving equipment, is given in a reference cited at the end of this paper. Briefly, the antenna system consists of some twelve separate antennas of the rhombic type, erected in a straight line pointing in the direction of the desired reception. Rather elaborate provisions are made in the receiving building for properly phasing the signals received from the separate antennas. Adjustment of this phasing is the means employed to produce the sharply directive and adjustable vertical pattern desired.

Limiting

Limiting, by means of non-linear circuit elements such as biased or over-driven vacuum tubes, has relatively little value as a means of reducing the effects of fading except when used in combination with other methods.

In receivers used for telegraph service, employing on-off keying of the carrier, limiting may be used to handle small variations still remaining after the use of agc and diversity reception of any type. Care must be taken, however, not to depend on limiting to such an extent that preceding stages of amplification and frequency conversion are overloaded. If this is not guarded against, various types of spurious interference are apt to be experienced.

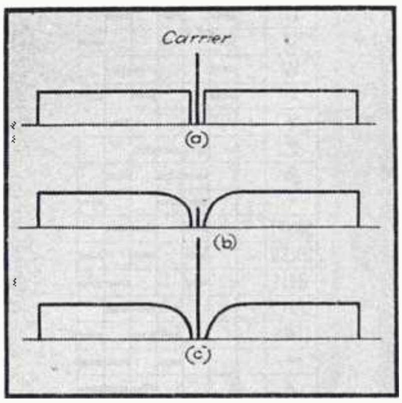

FIG. 7—Principle of exalted carrier receiving system. (a) normal signal; (b) selective fade of carrier; (c) carrier exalted or reinforced at the receiver

In the reception of signals employing variable depth of amplitude modulation, such as telephone signals, limiting obviously can not be used.

In systems employing frequency or phase modulation rather than variable depth of amplitude modulation, limiting is used to eliminate or minimize amplitude variations still existing after the use of agc.

Frequency or Phase Modulation

The use of frequency, or phase modulation as a means of reducing the effects of fading has as its purpose the elimination of amplitude variations in the received r-f signal. Since intelligence is transmitted by varying the frequency or phase, and not the amplitude, it is obvious that limiting can be made use of in the receiving equipment. Some of the variations still existing after the use of agc can thus be eliminated.

Selective fading, due to its random effects on the numerous sidebands that make up a frequency or phase-modulated signal, results in rather serious distortion of modulation such as speech or music. The system therefore does not improve reception which is bothered primarily by selective fading.

It is of interest to note, in dealing with frequency modulation and phase modulation, that certain conditions of propagation partially convert these types of modulation into amplitude variations. One very annoying manifestation of this is the conversion of frequency or phase modulation at power-supply frequencies (hum) into what is effectively amplitude modulation of the received signal. This results in a rising and falling hum level in the a-f output of the receiver. This resultant level of hum may be considerably higher than that measured at the transmitter.

Radio-photo or facsimile services nowadays use some form of frequency modulation almost exclusively. This is applied either to the r-f carrier or to a tone-frequency sub-carrier which then is used to modulate the r-f carrier of a telephone-type transmitter employing any desired system—amplitude, frequency or phase—for modulating its r-f carrier. Advantages of this application lie in the fact that limiting may be applied, in the radio receiving equipment in one case and in the radio-photo terminal equipment in the other case, to eliminate streaks caused by amplitude fading.

The frequency-modulated sub-carrier system permits the use of standard phone transmitters and receivers.

Frequency or phase modulation of the r-f carrier itself simplifies the modulation problem in the transmitter, particularly in those cases in which a given transmitter must be used for either telegraph or telephone services, or their equivalents, on short notice. It also, however, complicates the design of the receiving equipment.

Exalted-Carrier Receivers

Selective fading often reduces the amplitude of the carrier, yet at the same time leaves most of the sidebands at their normal amplitudes. The result is second-harmonic distortion due to the absence of a carrier and the resultant beating of one set of sidebands against the other. The exalted-carrier type of receiver prevents this sort of distortion, by maintaining the carrier at a high level at all times as shown in Fig. 7. Carrier voltage at the final rectifier or detector is maintained at such a high level that the effective percentage of modulation can not exceed 100 percent. Actually, the figure is more like 50 percent or even 30 percent maximum.

In general, two different methods may be employed for obtaining the desired result. In one, the frequency of a local oscillator is automatically held to within plus or minus a few cps, or less, of the frequency of the incoming carrier signal. In the other general method, the incoming signal itself supplies the required carrier which is filtered, amplified, and then re-combined with the sidebands. The same net result may be obtained by the use of a sharply selective i-f system which emphasizes or exalts the carrier and at the same time uniformly reduces the relative amplitude of all sidebands.

The use of a single receiver of this type for reception of amplitude modulated phone signals results in virtually complete elimination of the second-harmonic distortion that otherwise is caused by selective fading of the carrier. To take care of the slower, general fading, it is necessary to supplement the exalted-carrier method with some other system such as space-diversity reception.

Single-side-band System

Complete suppression or elimination of one set of sidebands (upper or lower) and partial suppression of the transmitted carrier, as employed in some phone services, is not intended primarily for reduction of fading effects. Since the system necessarily employs an exalted-carrier receiver, however, it gives the improvement described above.

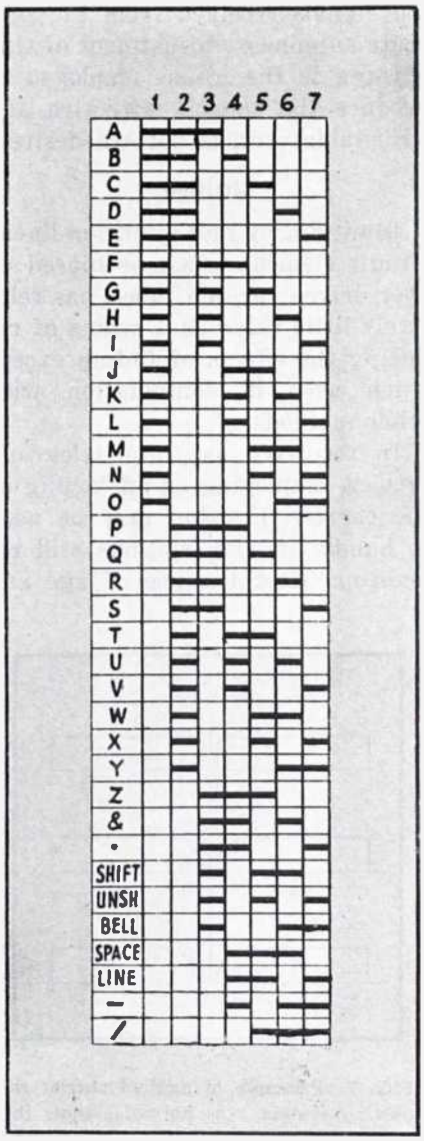

FIG. 8—Seven-unit telegraph code used to prevent printing of wrong letters due signal malformation

Special Code Systems

In view of the apparent impossibility of completely overcoming all types of fading at all times, the problem of providing reliable telegraphic communication has been attacked from another angle. This is to develop a code or system of communication which will tolerate any reasonable malformation of the signal, yet which will not cause an incorrect letter or character to be recorded on the received copy.

This attack has been primarily aimed at development of printing telegraph services. The so-called 5-unit code, for printer service, is so constituted and arranged that the dropping out of one or more impulses (marking bauds) by fading, or the accidental filling-in of spaces by static or interference, will result in the printing of an incorrect letter or character. To prevent such errors, or *transpositions*, there has been developed a code and system which will print a special error indicator sign when the incoming signal has suffered mutilation.

A printing-telegraph code in which each selecting combination consists of only three marking elements, out of a total of seven available per character, provides the required performance. This code is shown in Fig. 8. If either fewer or more than three marking or selecting impulses are received, the receiving machine prints the special error indicator sign. Fading can not, therefore, result in errors or transpositions,—only the special error indicator sign being recorded in such cases.

Summary

It is apparent, from the data given in the preceding sections, that no one method constitutes a complete solution to the problem of fading and its undesirable effects on signals. It also will be apparent that different combinations of the basic methods must be used for different types of service. The particular combination best suited to any given service and circuit depends upon the type and quality of service required and also upon the total cost justified by the business to be handled.

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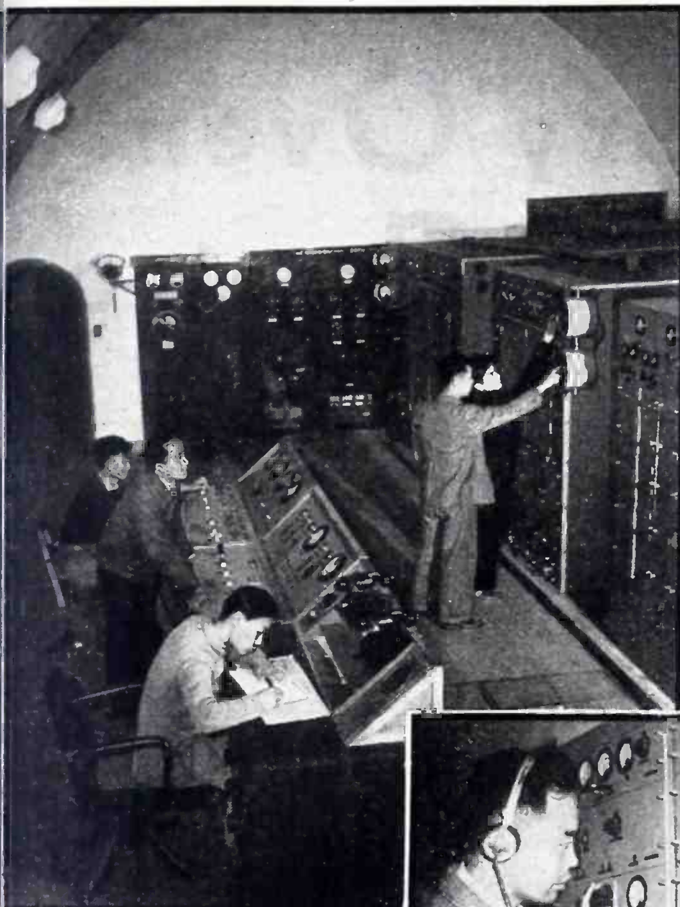
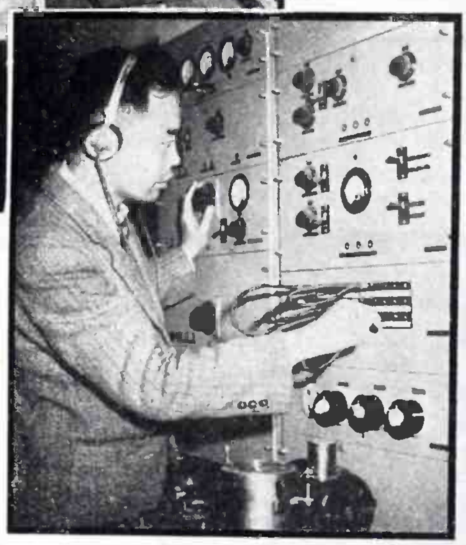
This is XGOY



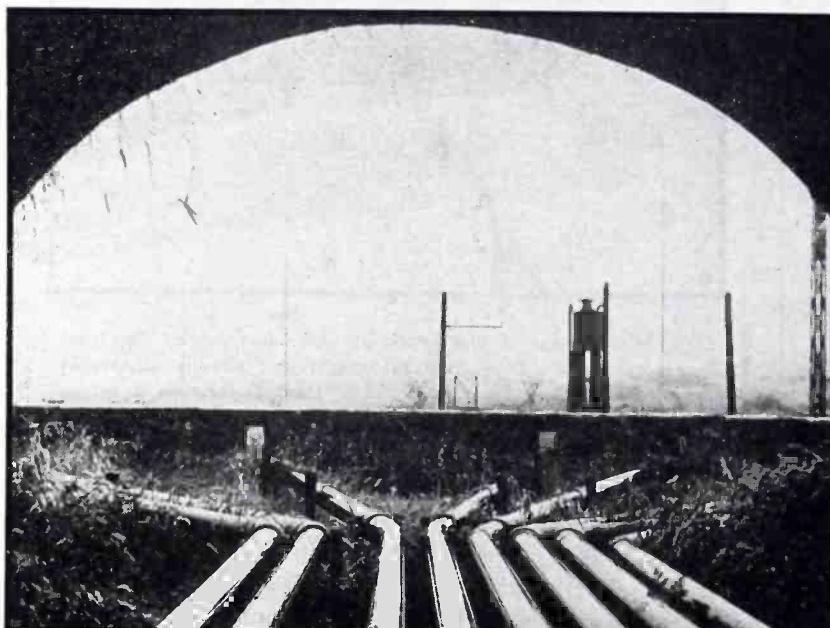
LEFT—Manned by Chinese technicians and located in a deep cavern at Chungking, this Marconi-built transmitting equipment carries the voice of free China to the world. Even direct bomb hits by the Japs have not been able to put it off the air

BELOW, RIGHT—Director of XGOY is Professor Feng Chien, authority on electro-magnetic waves and dean of the college of engineering of the University of Chungking. His training includes time with General Electric Co. at Schenectady and with German AEG



HT — Speech-input tests are made by Wang Shan-wei, engineer in ge of the transmitter operated by International Broadcasting Adminis- on. American reception of the sta- signal goes to networks through Ventura, Calif., ham rig of Charles E. Stuart

er source for the Chungking transmitter is prac- ly spoon-fed to keep within skimpy ration of coal. power is too undependable for functional appa- ratus and is used mainly for lights



Beam antennas at XGOY are powered through this series of coaxial cables emerging through cave mouth. American troops in China depend on the station for entertainment and news of home. Other broadcasts are in Burmese, Russian, Dutch, Spanish, Japanese, and Mandarin, each beamed to the appropriate area

Laboratory Oven Temperature Control

Rise and fall of the mercury column in an oven thermometer tunes and detunes a high frequency oscillator. The resulting variation in oscillator plate current operates relays which turn oven heater current on and off

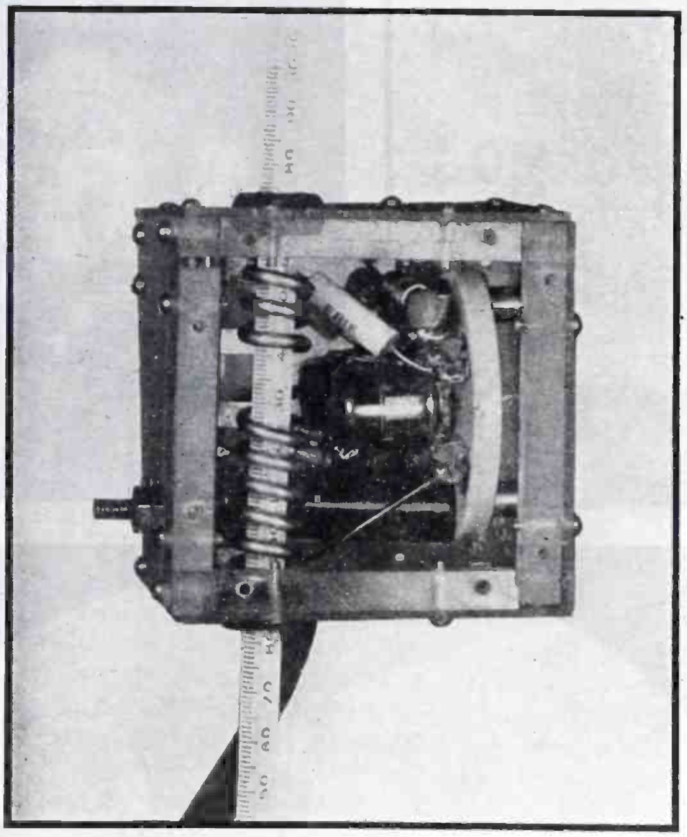


FIG. 2—Close-up of the oscillator unit, shown with the front cover removed. It is light in weight and readily supported by the thermometer which passes through it

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THE TEMPERATURE of laboratory ovens may be automatically maintained within ±0.5 deg C by means of the electronic control to be described, the precise accuracy being dependent upon the character of the thermometer used to indicate oven temperature.

The control may also be used as a safety device to cut off heater current in the event that standard controls supplied with stock ovens fail. In this case it is adjusted to operate at a temperature slightly higher than the critical value and takes over control of heater current at that point.

Referring to Fig. 1, it will be seen that the control is built in two separate units, connected together by means of a flexible cable.

Description of Circuit

The oscillator unit, which operates at a non-critical high frequency, is designed around a type 955 "acorn" triode tube and is contained in a plastic case measuring 2½ x 2½ x 2½ in. It is constructed in such a manner that the exposed end of the oven thermometer may pass through the tank coil. Tight rubber grommets hold the unit in place on the thermometer at any position along its length, as shown in Fig. 2. Rise and fall of the column of mercury in the thermometer tunes and detunes the oscillator, altering its plate current.

The other unit contains the power supply and control relays, and is contained within a metal cabinet. The two units may be seen on top of the typical oven pictured in Fig. 3.

Adjustment and Operation

To place the electronic control in operation the power supply unit is connected to the 110-v a-c line and the oven input control leads inserted in the plug on the side of this unit. The oscillator unit is then slid

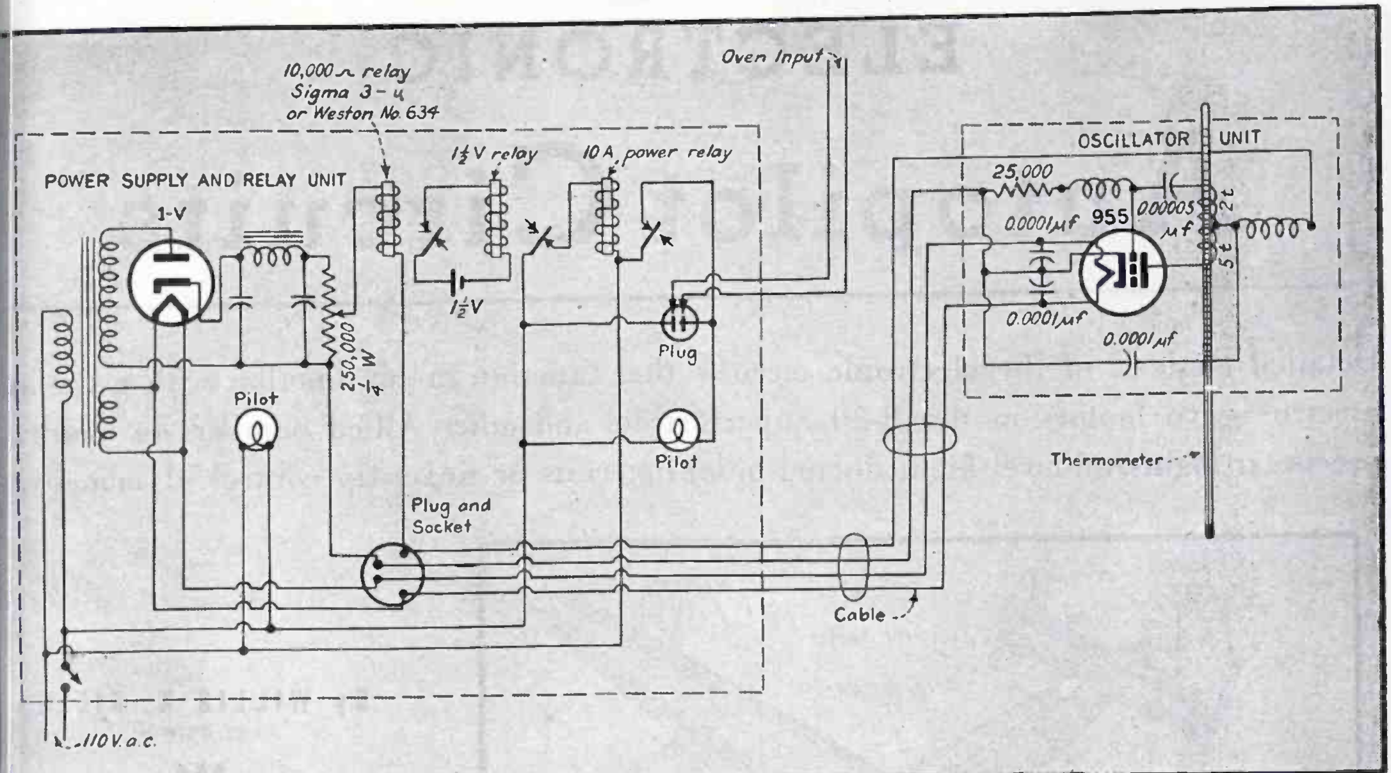

FIG. 1—Circuit diagram of the electronic control device. It is readily constructed from parts available in most laboratories and is relatively simple to adjust

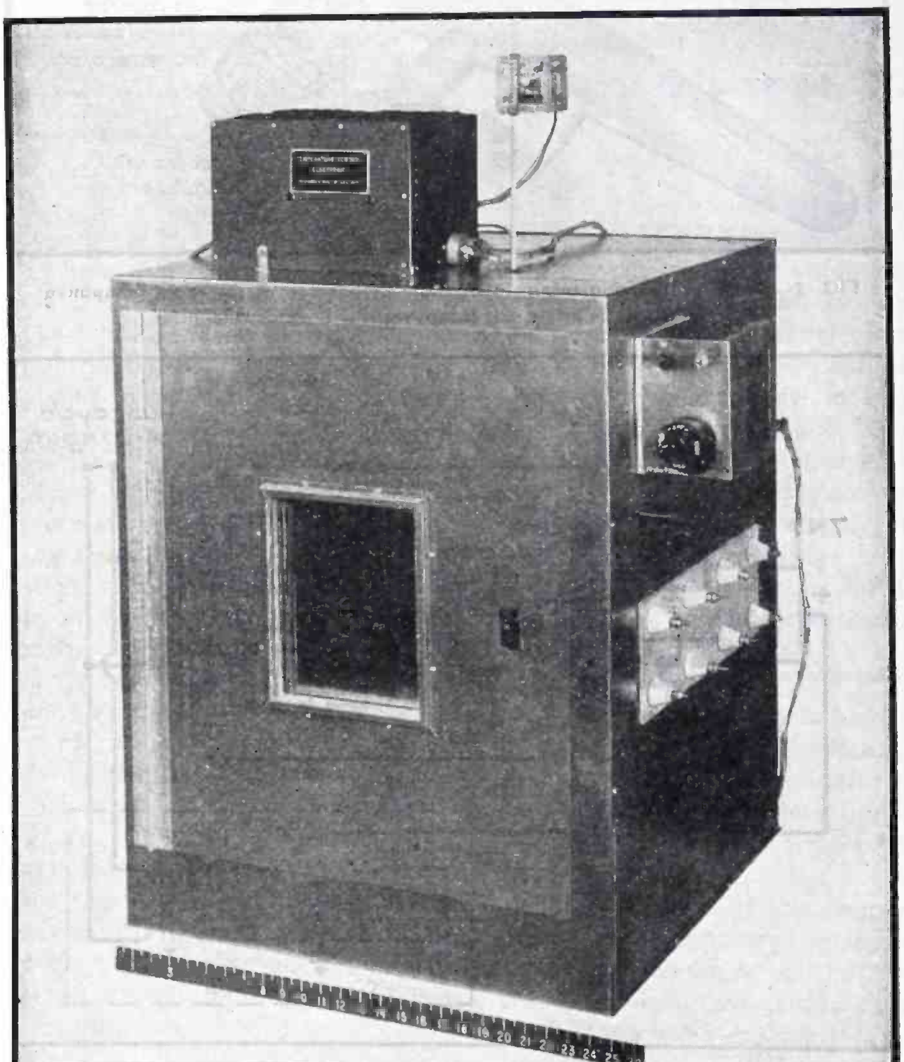

FIG. 3—A typical laboratory oven, showing the two-unit electronic control in position on the top, operating in this instance as a safety control supplementing standard controls

er the oven thermometer and iented so that the mercury column level with the plate end of the nk coil at the desired oven operting temperature. Oscillator plate ltage is then adjusted by means the 250,000-ohm potentiometer that the 10,000-ohm plate circuit lay just barely closes. Voltage is duced and the relay opens.

Increase in oven temperature bove the desired value causes the ercury column in the thermometer rise. Inasmuch as the mercury lumn rises inside the oscillator nk coil the oscillator is detuned, s plate current rises and the plate rcuit relay closes. Closing of the late circuit relay energizes the ½-v battery-operated relay, openg its contacts. The 10-ampere ower relay is de-energized and ven current is cut off. Oven current remains cut off until the merury column falls to the critical alue, at which time inverse relay peration takes place and heater urrent is restored.

Satisfactory action of the electronic control is largely dependent pon the adjustment of the 10,000-hm relay. The limiting factors with respect to speed as well as acuracy are, however, the characteristics of the thermometer.

ELECTRONIC Autopilot Circuits

Detailed analysis of the electronic circuits that function in conjunction with gyros an electric servo motors in the B-29 Superfortress and other Allied bombers to maintai precise straight-and-level flight during bombing runs or finger-tip control of maneuver

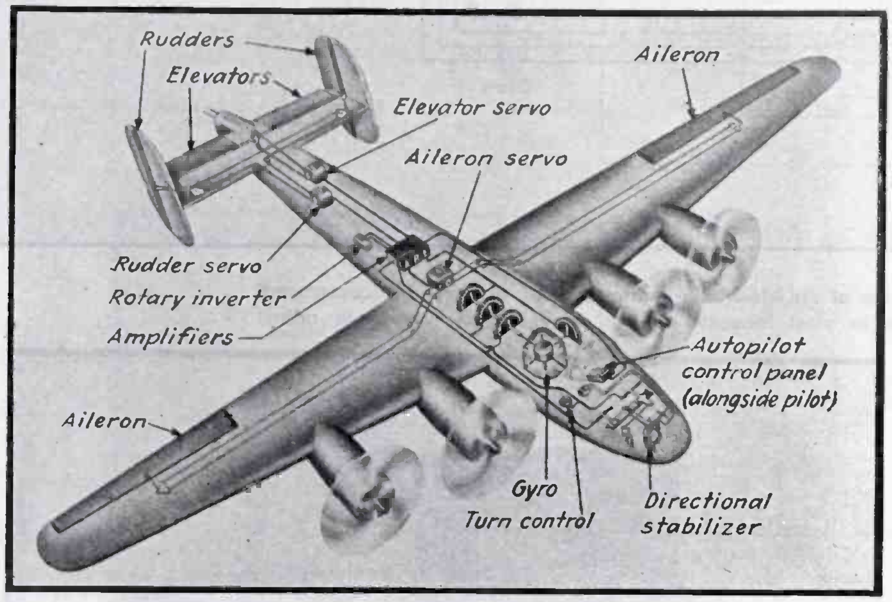

FIG. 1—Drawing showing interrelation but not position of the main component units in the Minneapolis-Honeywell C-1 automatic pilot

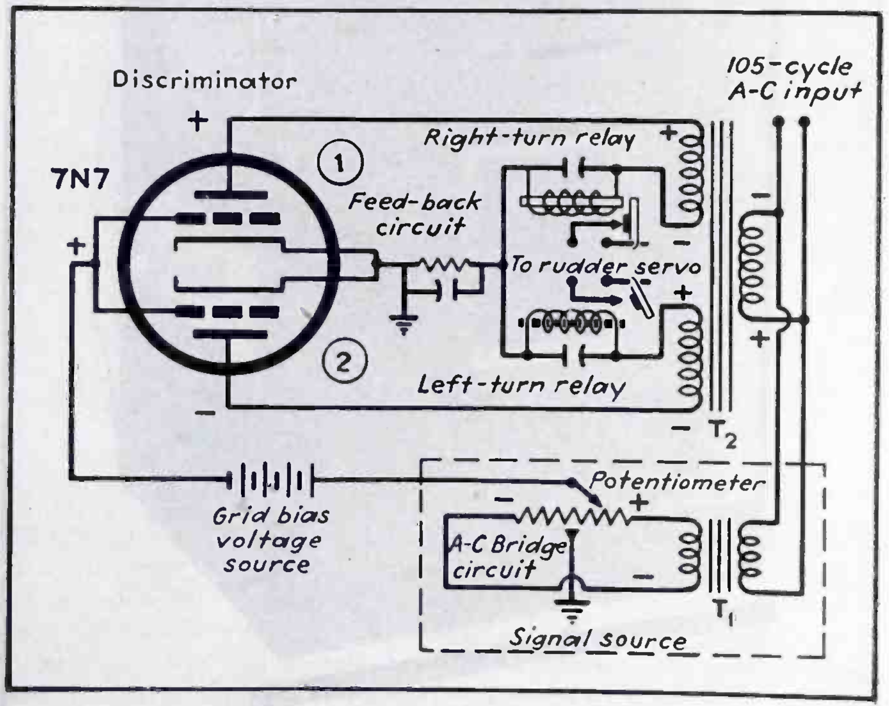

FIG. 2—Simplified schematic diagram of the discriminator circuit used in a single channel of the autopilot amplifier. Two signals, differing in phase by 180 degrees, may enter this stage from the a-c bridge circuit; one makes the right-turn relay operate, and the other makes the left-turn relay operate

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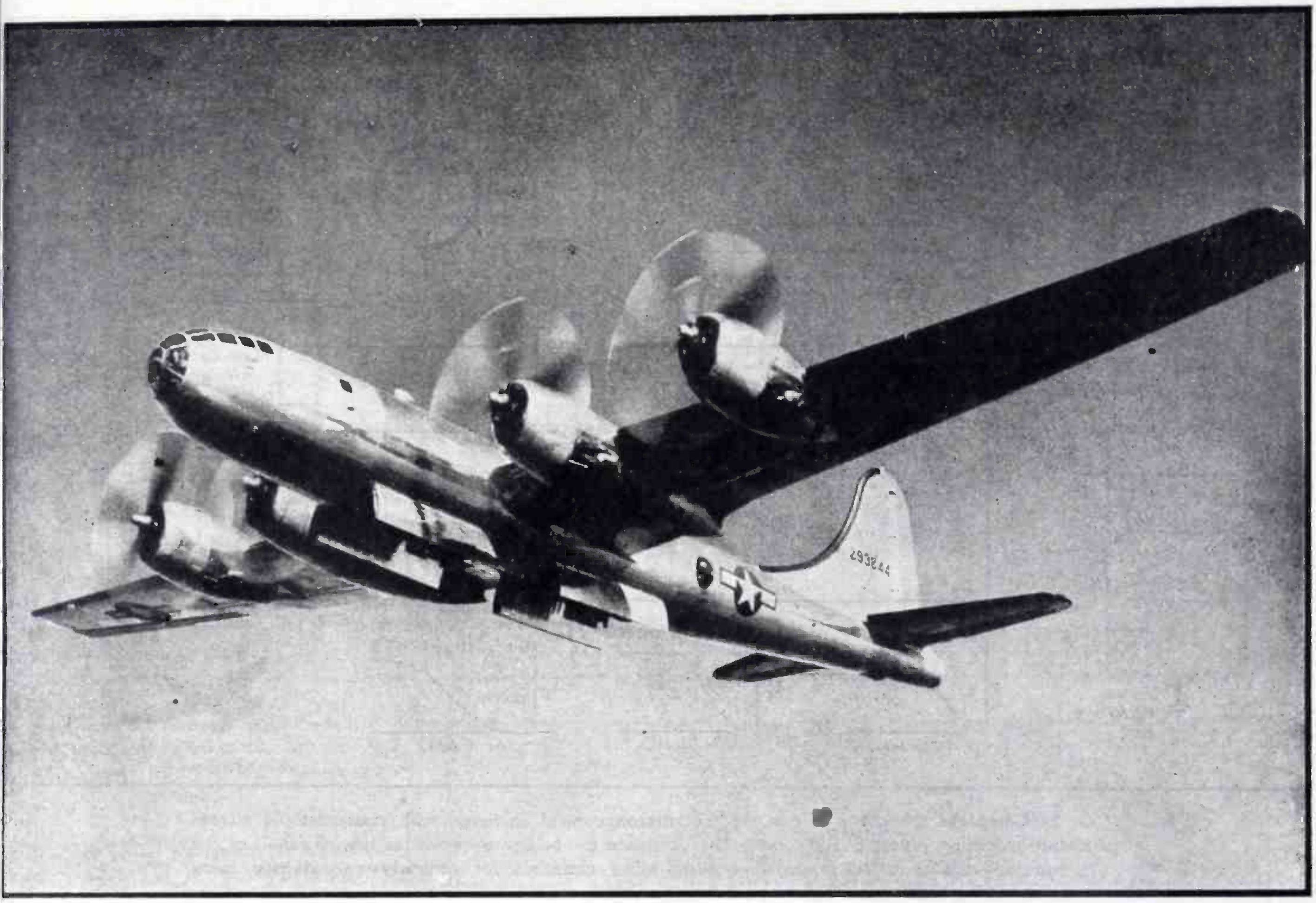
During the few seconds of a high-altitude precision bombing run, an airplane must not deviate appreciably in any direction from its set course. To provide a stable platform for such operations, the Minneapolis - Honeywell C-1 electronic automatic pilot is standard equipment on many AAF bombers, including Fortresses, Liberators and the new Boeing B-29 Superfortress.

The electronic control of the autopilot, developed by company engineers cooperating with the Materiel Command at Wright Field, offard equipment on many AAF bombers, including Fortresses, Liberators and the new Boeing B-29 Superfortress.

The autopilot works in much the same way as a human pilot. Gyroscopes act as the eyes and the electronic amplifier as the brain of the autopilot in detecting flight deviations. Potentiometers in the gyro housings respond to these deviations and transmit appropriate signals to amplifiers that control the operation of servo units, which are special electric motors that act di-



The C-1 electronic autopilot is used on the Boeing B-29 Superfortress

rectly on the control cables of the airplane.

The precision of even the most skillful human pilot is limited by such factors as his reaction time, susceptibility to fatigue, inability to detect slight variations the instant they occur, errors in judgment and errors in muscle coordination. The autopilot, on the other hand, detects flight deviations the instant they occur and makes the required correction of the airplane's controls quickly. When properly adjusted, the autopilot will smoothly return plane to straight-and-level flight after an off-course deviation, without over-control or under-control.

Acts on Rudder, Ailerons, and Elevator

An airplane is maneuvered by displacing three controls: (1) The rudder, for turns; (2) The ailerons, for selecting rolls and banks during turns; (3) The elevator, for making the plane ascend or descend. Thus for automatic flight three separate control channels are required, each consisting of a servo motor acting on one set of control cables, a gyro-controlled amplifier channel to make the servo rotate in the correct direction for the correct length of time, and the adjusting potentiometers in the autopilot control panel. These features of an autopilot installation are shown in simplified form in Fig. 1.

A pitch-axis deviation (such as sudden dropping of the nose of the plane) calls for corrective action by one control channel only, that serving the elevators. All other deviations necessitate corrective action by all three channels. Thus, if the right wing drops, correction is made by moving the right aileron downward and the left aileron upward. However, since the air under a wing is at higher pressure than air above a wing, the right aileron causes more drag than the left, and the plane tends to deviate to the right. Therefore, both the rudder and the elevator must be moved with the ailerons to correct the original deviation and to prevent loss of altitude.

In the autopilot, ingenious use of potentiometers in balanced a-c bridge circuits provides the required inter-relation of control actions in an automatic manner.

The electronic features of the three channels of a C-1 autopilot are essentially identical, and hence only the circuit of one channel need be analyzed in detail. By considering the turn-control channel in simplified form as shown in Fig. 2, with amplifier and control stages omitted and with the multitudinous potentiometers lumped as a single potentiometer in an a-c bridge circuit, the action of the entire autopilot can be more readily understood.

Analysis of Autopilot Circuit

When the a-c bridge is balanced, no a-c signal is applied to the two grids of the 7N7 discriminator tube and no plate current flows since the d-c bias is fixed at cutoff by a d-c bias source.

The two plates of the discriminator tube are connected to separate secondary windings of the power transformer in such a way that at the instant when one plate is positive with respect to the cathodes, the other plate is negative. The other ends of these secondary windings are connected through the two

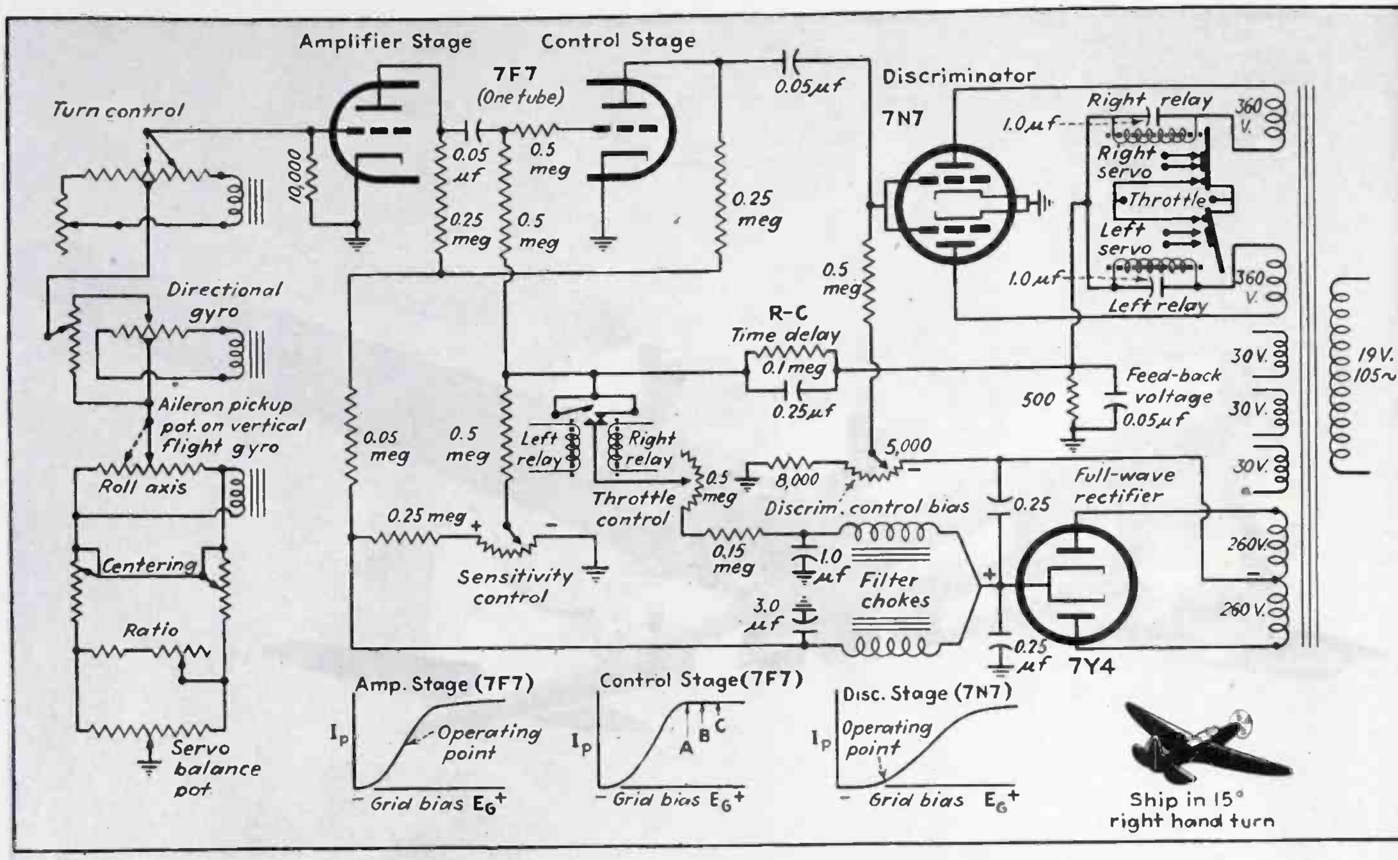


FIG. 3—Complete schematic circuit for the aileron control channel, with characteristic curves showing operating points of the tubes. The complete a-c bridge network for this channel, at the left, provides the required interlocking with other channels for properly co-ordinated turns

relay coils and a feedback circuit to the grounded cathodes of the tube. The bridge circuit is energized by another power transformer, in such a way that when plate No. 1 is positive, the right end of the potentiometer (pot) is positive as shown in Fig. 2, and when plate No. 2 is positive the left end of the pot is positive.

With the tube biased to cutoff, the positive half of any a-c signal applied to the grids will cause plate current to flow through the tube section having a positive plate at that instant. On the succeeding negative half of the signal, the plate current of the tube drops to zero because a swing beyond cutoff cannot cause variations in plate current.

Assume that a deviation of the airplane or operation of the turn-control knob by the pilot causes an unbalance in the bridge circuit, represented by movement of the wiper on the pot toward the right in Fig. 2 as shown. The signal produced by this bridge unbalance is fed through the amplifier and control stage (not shown in Fig. 2) to the grids of the discriminator tube. At the instant when the right end of the pot is positive, polarities in the circuit will be as indicated on the diagram. The grids are both positive with respect to the cathodes, but only plate No. 1 is positive. Therefore, electrons are attracted by plate No. 1 and current flows through the right relay coil, simultaneously charging the capacitor connected across the relay. Operation of the right relay closes the circuit through one operating solenoid in the corresponding servo unit, producing the required correcting movement of the rudder. Plate No. 2 is negative and hence passes no current at this time.

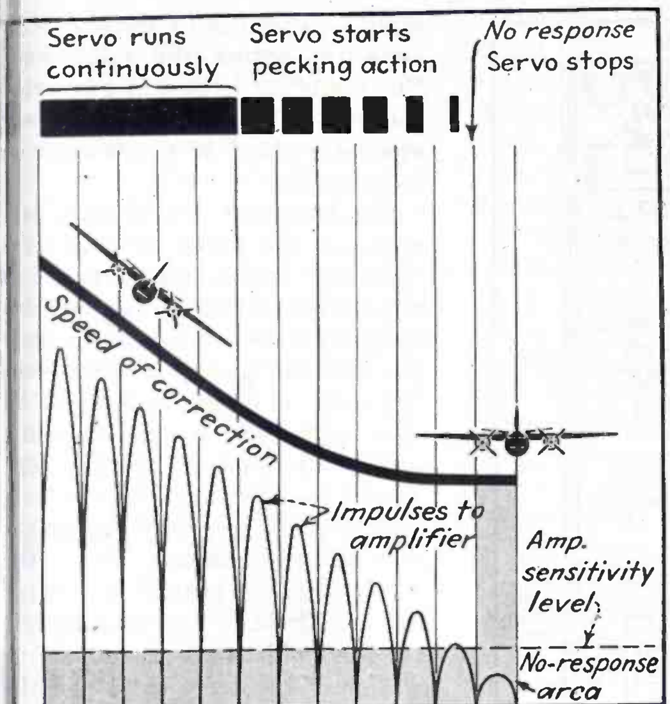
One-half cycle later, the right end of the pot and both grids are negative, hence no plate current flows even though plate No. 2 is positive. The righ-turn relay remains closed, however, because the capacitor connected across the relay coil discharges its stored-up energy through the coil. Thus, the right-turn relay is kept closed all the time the pot wiper is toward the right and calling for a right turn.

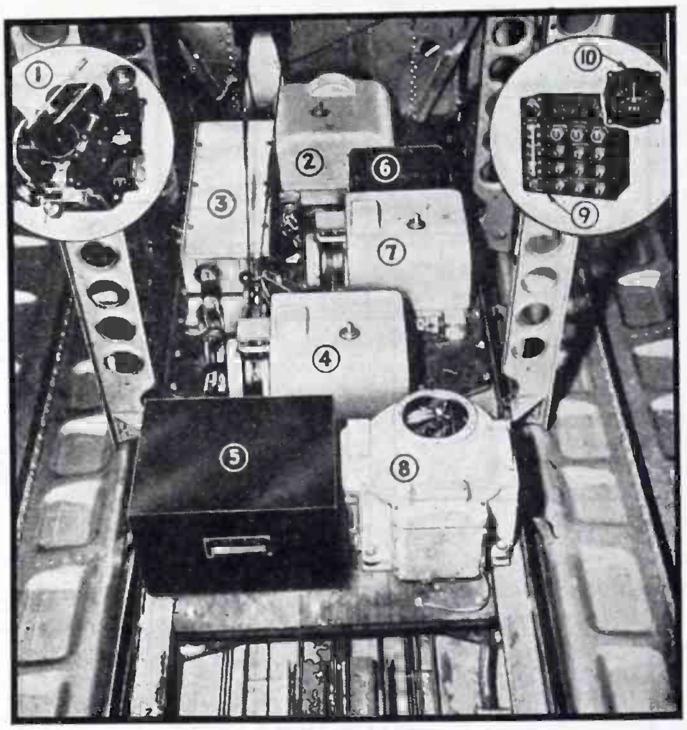
When airplane deviation causes the wiper on the pot to move to the left of center, exactly opposite conditions prevail. Plate No. 2 is positive at the instant when both grids are positive, hence current flows through the left-turn relay coil and charges its holding capacitor. This actuates the other solenoid in the servo unit, causing opposite movement of the rudder.

The bridge circuit in Fig. 2 is represented by a single pot for simplicity of explanation, with the center-tap serving as the balance point. Actually, the balance point of the bridge circuit is not fixed, but will shift from side to side depending upon the relative positions of all the wipers in the bridge circuit of the channel.

Complete Circuit for Aileron Channel

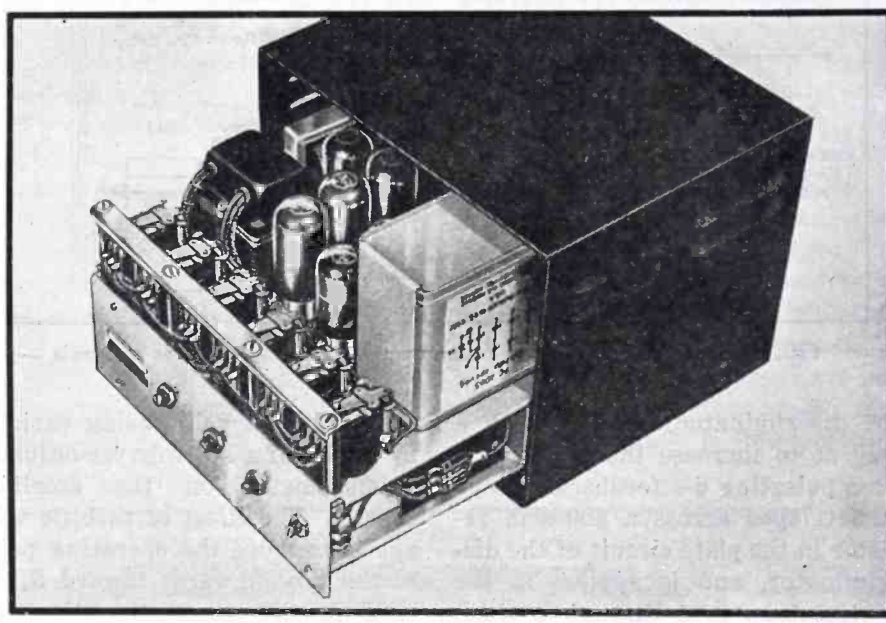
The complete circuit for one channel is given in Fig. 3, including the various potentiometers that make up the three a-c bridge circuits feeding this particular channel. The a-c voltage produced by bridge unbalance is amplified by the first section of a 7F7 double-triode, then fed to the control stage where the signals are sorted according to strength. Very small signals are rejected, weak signals are strengthened, medium signals are passed intermittently, and strong signals are





ᵢ. 4—Curve showing how speed-of-rection decreases as plane returns to aight-and-level flight after an extreme deviation

OVE RIGHT: C-1 autopilot as normally talled in an AT-11 airplane, with insets wing the three remotely located units. other types of aircraft the units are not nerally arranged as compactly as here. ntified parts are: 1—directional stabi-r in nose of airplane; 2—rudder servo t; 3—junction box; 4—aileron servo t; 5—amplifier unit; 6—rotary inverter; elevator servo unit; 8 vertical flight ro; 9—autopilot control panel; 10—pilot irection indicator on instrument panel



HT: Amplifier unit of autopilot, with ver removed and chassis pulled out to w the relays and some of the seven es making up the three amplifier channels

ssed continuously to the discrim-tor tube.

To accomplish this sorting action, ree separate control voltages are plied to the grid of the control be in the form of a composite d-c as acting in series with the a-c gnal coming from the amplifier ge. By inserting a 0.5-megohm sistor in the grid lead of the tube, characteristic curve like that at e bottom center in Fig. 3 is obtained for the control tube. When e combined grid voltage is negative this resistor has no effect; hen the grid swings positive, however, the resulting grid-current w through the resistor develops ross it a voltage drop that leaves ly a fraction of the applied positive voltage actually on the grid. Positive voltage swings thereby have no appreciable effect on plate current, and the characteristic curve levels off sharply at point A on the curve. The three control voltages, called sensitivity voltage, feedback voltage and throttling voltage, serve to shift the operating point of the control tube along section A-B-C of the curve.

Effects of Control Voltages

The first control voltage, which eliminates small signals, is called *sensitivity voltage* because it controls the sensitivity or "alertness" of the autopilot control system. This voltage is obtained from a variable voltage-divider connected in the power-pack circuit of the amplifier, with the control knob being located on the autopilot control panel alongside the pilot. Operation of this control regulates the grid voltage between *A* and *C* (Fig. 3). At *A*, sensitivity is high because the negative peaks of even very small signals will cause the plate current to fluctuate and transmit a signal to the discriminator tube. Normal setting is at *B*, except when extreme accuracy of flight control is required during bombing runs.

The second control voltage, which prevents chattering of the relays when signals are just barely strong enough to offset the positive sensitivity voltage, is called *feedback voltage* because it is fed back from

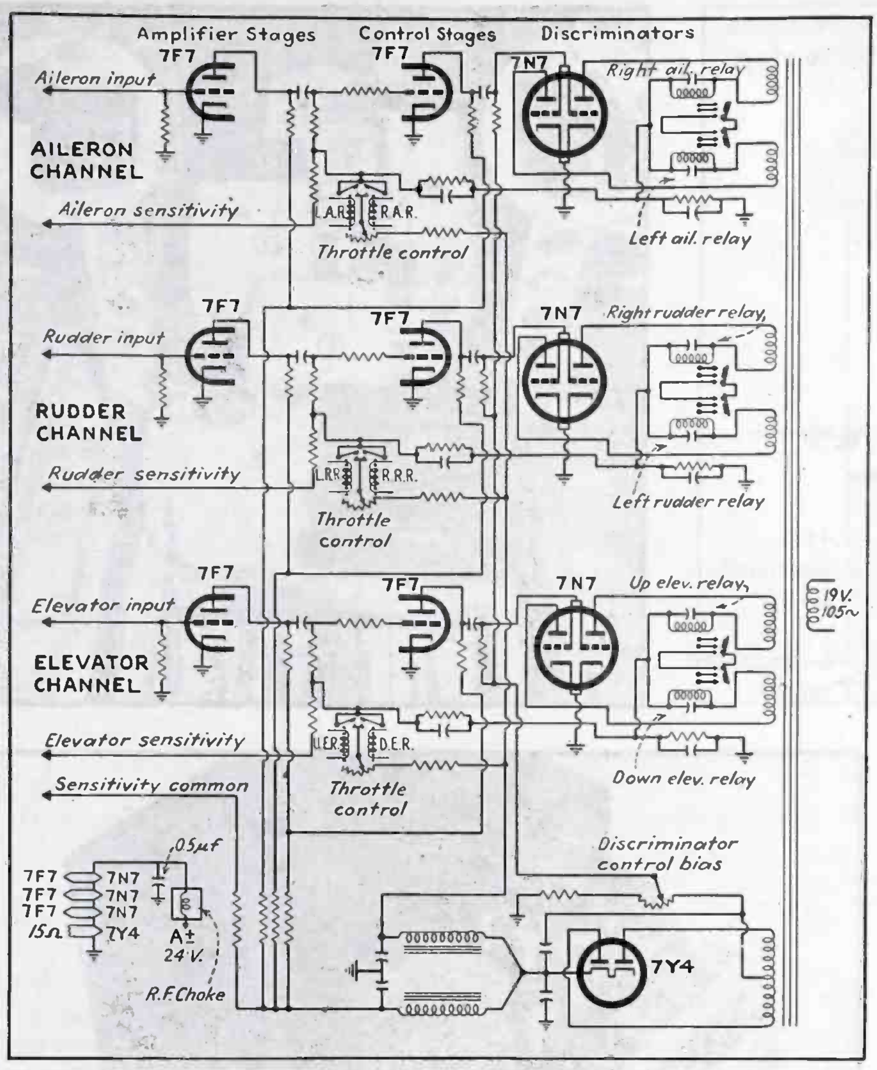


FIG. 5—Schematic diagram of 7-tube amplifier serving all three channels

the discriminator stage in such a way as to increase the sensitivity. This pulsating d-c feedback voltage is developed across a 500-ohm resistor in the plate circuit of the discriminator, and is applied to the control tube grid through a time-delay network that acts in conjunction with the third control voltage. When the sensitivity control is set at *A* and a weak a-c signal arrives, the feed-back voltage serves to increase the sensitivity of the control stage still more by shifting the bias point slightly to the left of *A*. This increases the amplifying effect of the tube, producing strong, firm closing of the proper relay in the discriminator plate circuit.

Pecking Action

The instant that a relay closes in the discriminator circuit, extra contacts on the relay apply the third control voltage, called *throttle voltage*, to the grid of the control tube. This throttle voltage is a positive d-c voltage obtained from the power pack, with its value being variable by means of a screwdriver-adjusted potentiometer on the amplifier chassis. The effect of throttle voltage is to move the operating point of the tube upwards toward *B*, decreasing the size of the plate current variations resulting from the given input signal. The tube continues to operate here until, as the servo unit gradually balances the bridge circuit, the a-c signal diminishes to the point where the discriminator relay opens. This removes the throttle voltage and the operating point moves back toward *A*. Now the signal is strong enough to close the relay again, but this time only for an instant because the throttle voltage is again applied to the tube to block the signal. Thus, the relay is made to open and close repeatedly, causing intermittent servo operation as the balance point is approached.

The rate at which the relay opens and closes is determined by the R-C time-delay network in the feedback circuit, as well as by the size of the capacitor across the relay itself. The net effect is that of preventing the signal from closing the relay again for about 15 cycles after the relay opens.

The resulting intermittent operation of the servo unit is called "pecking" action. Its purpose is to prevent over-control of the airplane by making the controls move slowly into position as the balance pot in the servo unit approaches its balance point. The amount of control surface movement during each "peck" is determined by the relay contact gaps, the relay spring tension, and other factors. The setting of the throttle control determines the amplitude of the smallest signal that will cause continuous operation of the servo unit, while the setting of the sensitivity control determines the signal amplitude below which servo motion stops entirely. The effects of these controls on the speed of flight correction are illustrated in Fig. 4.

Combined Amplifier Circuits

The complete circuit for the three amplifier channels and the power pack of the autopilot (integral in one small chassis) is given in Fig. 5. Parts values for the elevator and aileron channels are essentially as given in Fig. 3 for the rudder channel. Filament power is obtained directly from the 24-volt aircraft storage battery, while 19-volt, 105-cycle power to energize the primary of the power transformer is obtained from a small rotary inverter operating from the storage battery. Connections at the left in Fig. 5 go to the a-c bridge circuits for the respective channels and to the manual adjustments provided for use by the pilot. The relays at the right all control solenoids actuating the clutches and brakes in the servo units.

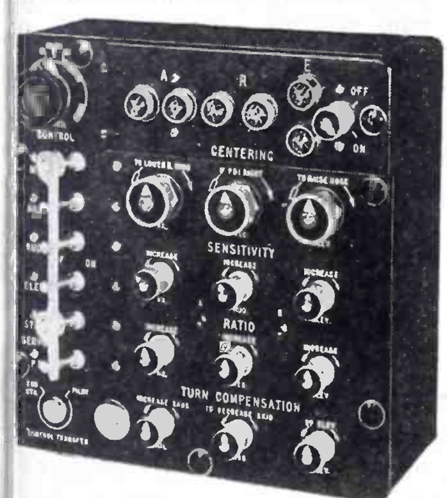
Servo Motor Units

The servo unit used to supply the mechanical force to the control surfaces for each channel consists of an electric motor driving a cable drum through a gear-reduction system and a reversible differential assembly incorporating solenoid-actuated friction clutches and brakes. The cable drum is connected to its control surfaces by ⅛-inch flexible eel cables which attach to the ain control cables of the plane.

The shunt-wound 1/20-hp d-c mo- ›r in each servo unit operates di- ›ctly from the aircraft storage attery, and runs continuously in ıe same direction while the auto- ilot is in operation.

The power transmission system ıat couples a servo motor to its ıble drum is illustrated in Fig. 6. he motor pinion *A* meshes with utch gear *B*, which in turn drives utch gear *C*. Each of these gears as a cork insert on the side away rom the motor. The gears rotate ontinuously in opposite directions vhile the autopilot is in operation.

The clutch gears rotate on ball earings which are fitted to two arallel operating shafts, *D* and *E*, n such a way that the ball bearings nd gears are free to slide a lim- ıed distance along the shaft. The hafts in turn are free to slide end- vise in their bearings in the servo nit frame.



utopilot control panel, mounted within onvenient reach of the pilot. With the utopilot in control at any given altitude, he plane can be maneuvered by finger- p adjustment of the turn-control and ele- ator knobs or by similar remotely located knobs near the bombardier

Firmly attached to each operat- ng shaft is a clutch-and-brake disk *F* and *G*) which has two flat fric- ion surfaces. One surface faces he cork insert in the adjacent lutch gear and the other faces a imilar cork insert (*H* and *I*) in the rake ring fastened to the servo nit frame.

Also firmly attached to the oper- ting shafts are gears *J* and *K* re- pectively, which mesh with differential drive gears *L* and *M*. The gears rotate freely on the differential shaft, one on each side of the differential crosshead which supports the two crosshead bevel pinions. Rotation of the crosshead is transmitted to the cable drum through the cable-drum pinion.

Between the clutch gears and their adjacent clutch-and-brake disks are coil springs *N* and *O*, which press the ball-bearing housings of the clutch gears in one direction against clutch arms *P* and *Q*, and press the operating shafts *D* and *E* in the other direction against brake arms *R* and *S*.

Two brake solenoids, *T* and *U*, one on each side of the motor, operate pullrods which compress brake tension springs *V* and *W*. The tensions of these springs, applied through brake arms *R* and *S* to the ends of the operating shafts, force the brake surfaces of the clutch-and-brake disks against their cork-faced brake rings.

Two operating solenoids *X* and *Y* apply pressure through pushrods against clutch arms *P* and *Q* whenever the operating solenoids are energized. The clutch arms force the rotating cork-lined clutch gears against the clutch-and-brake disks.

Working Sequence of Servo Unit

Operating solenoids are energized individually by the closing of relays in the amplifier. In series with each operating solenoid is a cam-operated limit switch which prevents the servo unit from driving the control surfaces against their mechanical stops. A 0.5-μf capacitor in parallel with each solenoid-switch combination prevents arcing of the relay contacts.

The balance pot, by balancing out the original deviation signal, controls the amount of cable-drum rotation résulting from a given deviation of the airplane. Its wiper is fastened to the cable drum by means of a friction clutch that facilitates centering the wiper at the electrical center of the pot when the control surface is in normal flight position.

As soon as the autopilot master-switch is turned on, the motors in all three servo units begin to run. Each motor drives its two clutch gears in opposite directions. These gears rotate freely on their operating shafts and no motion is transmitted to the clutch-and-brake disks which are in their neutral positions. Therefore, the cable drum can be rotated freely even though the motor is running, and the servo units will not interfere with manual operation of the controls until the pilot engages the servo brakes.

After the servo brakes have been engaged the operation of the servo unit takes place in the following

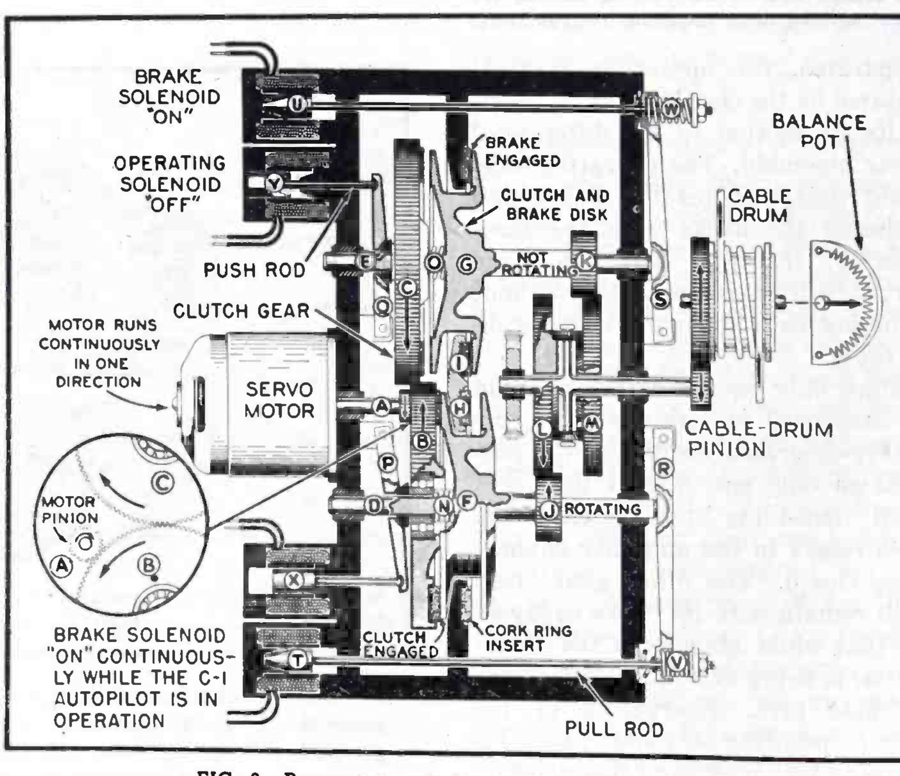
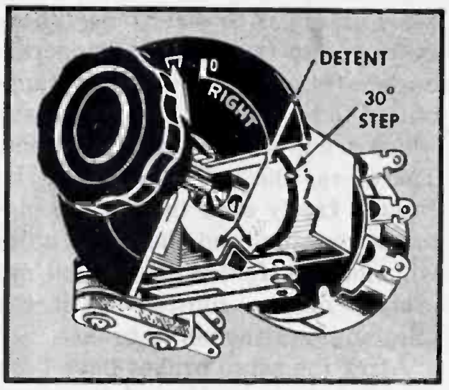


FIG. 6—Power transmission system of a servo unit

manner: When an a-c bridge or pilot-operated control transmits a signal to an amplifier, calling for movement of a particular control surface, the amplifier channel responds by closing one or the other of its two relays. The relay contacts then complete a d-c power circuit that energizes the correct operating solenoid in its servo unit. This causes the solenoid plunger and push-rod to move in against the clutch arm, which in turn forces the constantly rotating cork-faced clutch gear against the clutch surface of the clutch-and-brake disc. Continued inward movement of the clutch arm moves the entire clutch-and-brake disc assembly lengthwise, compressing the brake tension spring and forcing the brake surfaces apart.

As soon as the brake surfaces are



Construction of the turn control, showing the on-course detent in the cam and the 30-degree step in the cam to caution the pilot making turns requiring steeper banks

separated, the operating shaft is rotated by the clutch gear and transmits its motion to the differential gear assembly. The operating solenoid thus engages the clutch and releases the brake with the same motion, insuring that the cable drum will start instantly without slipping back during the engaging process.

Since only one operating solenoid is energized at any one time, the above-described condition will prevail on only one side of the servo unit, depending upon which of the two relays in the amplifier channel was closed. The other gear train will remain with its brake engaged, so that while one side of the differential is being driven, the other side is held firm. Energizing of the other operating solenoid causes reverse rotation of the cable drum.

At any time the human pilot may open the engaging switch on the autopilot control panel, and thereby release both brakes in the servo unit. When both brakes are released, the operating solenoids cannot cause cable drum rotation because the differential is free to idle.

Turn Control

While the airplane is flying under autopilot control, the pilot or bombardier can maneuver the airplane to make a properly coordinated turn. This is done through the turn control incorporated in the control unit. A corresponding but separate control is provided for operation of the airplane from a remote location by the bombardier or flight engineer.

The turn control consists of a knob-operated pot combined with a triple-contact spring-leaf switch, operated by a cam on the same shaft. This pot is connected into the aileron and rudder bridge circuits in such a way that any displacement of the pot wiper produces signals which result in coordinated movement of ailerons and rudder to produce a properly banked turn.

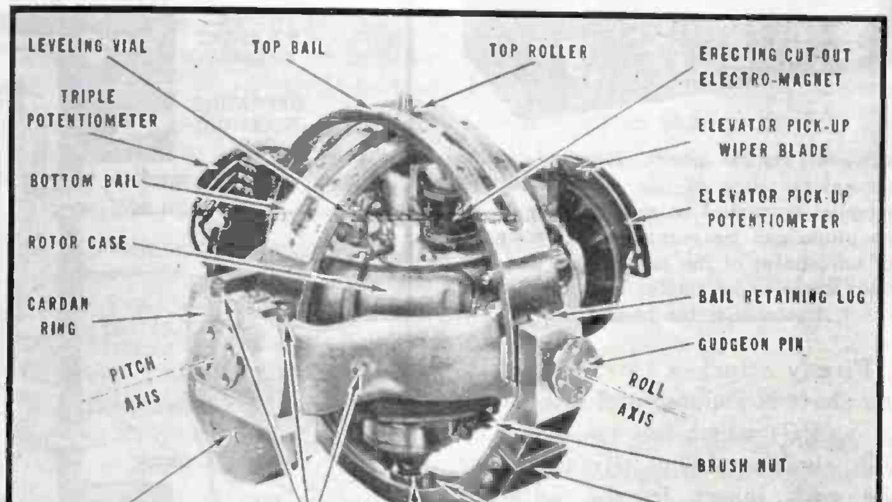
When the turn control knob is at the center position, the cam switch is open, but it closes when the control knob is moved in either direction to make a turn. Closure of the switch locks the directional gyro so that it cannot put in signals to oppose desired turning maneuvers.

Besides a detent which holds the knob at center and simultaneously opens the switch, other steps are provided on the cam to indicate the approach of the airplane to the maximum 40-degree banking limit inherent in the autopilot system. Humps are provided on either side of the detent to stop the free rotation of the knob at the zero point, so the pilot will be reminded to let the aircraft return to straight-and-level flight before he brings the knob back to the center to restore autopilot directional control.

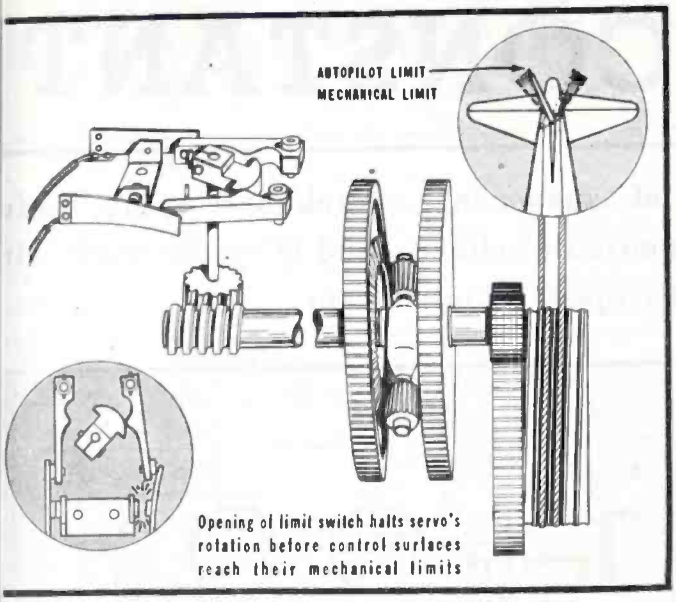
Adjusting the Centering Controls

Before engaging the servo units, the pilot must mechanically trim the airplane for straight-and-level flight. This establishes each servo balance pot wiper at a position corresponding to mechanical trim of its control surface. The pilot then adjusts each centering knob on the autopilot control panel to align the electrical balance point of each bridge circuit with this mechanical trim position of the balance pot wiper. After the engaging switches have been snapped on, the autopilot system, by always returning the balance pot wiper to its trimmed position, will keep the airplane in straight-and-level flight.

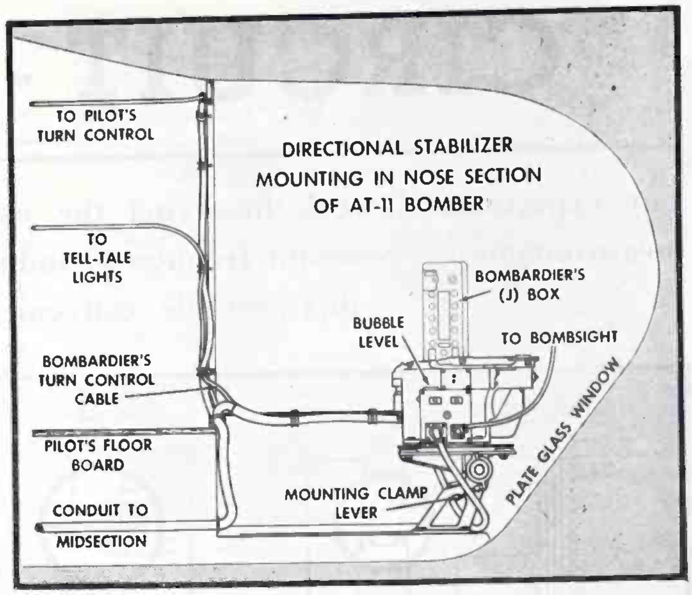
Directly above each centering control knob is a pair of indicating lights which are connected in



Vertical gyro of autopilot, with housing removed to show the erecting mechanism that keeps the gyro lined up with the pull of gravity despite rotation of the earth. The gyro rotor is a cup-shaped mass surrounding and driven by an electric motor in the center of the assembly



Example of limit switch used to prevent a servo unit from jamming the control surfaces of the plane against their stops



This gyro detects off-course deviations and causes potentiometers to produce signals calling for the required maneuver

arallel with the operating soleoids of the corresponding servo nit. One light or the other of each air is illuminated whenever the utopilot amplifier is calling for rvo unit rotation, whether or not ne servo unit is engaged. Thus, hen the pilot is engaging the autolot to the airplane, the illumination of either tell-tale light indiates that the balance point of the ridge circuit is not lined up with he trim position of the balance pot iper, and further adjustment of e corresponding centering control required.

Example of Operation

A step-by-step description of the ction of the autopilot in correcting pitch-axis deviation will give the implest fundamental principles involved in correcting deviations, for o aileron or rudder movements are equired for pitch axis deviations.

When the airplane is in straightnd-level flight, the elevator pickup ot in the gyro is at its normal position and the balance pot of the levator servo is centered, holding ne elevator control surfaces in their ormal, level-flight position. Under his condition the bridge circuit is alanced and no correcting signal s applied to the amplifier.

Assume now that a sudden air urrent raises the nose of the airplane. The gyro case and its atached elevator pickup pot tilt with he plane, causing displacement of he pot wiper and unbalancing of the bridge circuit, with the result that a correcting signal is applied to the elevator channel. This causes the down-elevator relay in the amplifier channel to close, sending a down-elevator impulse to the elevator servo unit. The servo unit responds by driving the elevator control surfaces downward by means of cables, thereby lowering the nose of the plane. The direction of rotation is such that the balance pot wiper on the servo unit approaches a position where the bridge circuit will again be balanced.

As the airplane begins to level off, the pickup pot in the vertical-flight gyro begins to return to its normal position. At some intermediate position the bridge circuit will again become balanced and the down-elevator relay will be released. At this point the servo cable drum will stop, with down-elevator still applied.

It is now necessary to return the control surface to neutral to prevent over-control. This is achieved automatically because as the plane continues leveling off, the gyro unbalances the bridge circuit in the opposite direction. Now the up-elevator relay closes, resulting in opposite rotation of the servo unit and upward movement of the elevator, back toward its normal level-flight position. This principle is basic in aircraft control; after a correction has been applied by moving a control surface away from its normal position, the control surface must be returned to normal again.

As the airplane approaches level flight attitude, the speed of control-surface movement is gradually reduced by the autopilot. By the time the airplane reaches its normal level-flight attitude, the bridge circuit is again balanced, this time with all pots electrically centered, and the autopilot action ceases. The separate steps described above actually take place in a gradual progression, each movement blending into the next to produce smooth correction that may be rapid at first, but which tapers off smoothly as the plane resumes its normal flight attitude.

Commercial Future of Autopilot

In announcing the development of the C-1 autopilot and the electronic turbo regulator system described in May 1944 ELECTRONICS, W. J. McGoldrick, vice-president in charge of aeronautical engineering for Minneapolis-Honeywell Regulator Company, pointed out that these electronic controls take over some of the duties of the flight crew and enable the pilot and flight engineer to perform their work more effectively in the rarefied air of the upper atmosphere. Planes like the B-29 become easy to fly despite their huge size and weight, indicating an important role for these electronic controls in passenger and freight Stratoliners of the future.

CIRCUIT - CONSTANT

For experimental work involving the use of components of unknown value, useful measurements of resonant frequency, inductance, capacitance, and *Q* can be made with this portable, conveniently operated instrument

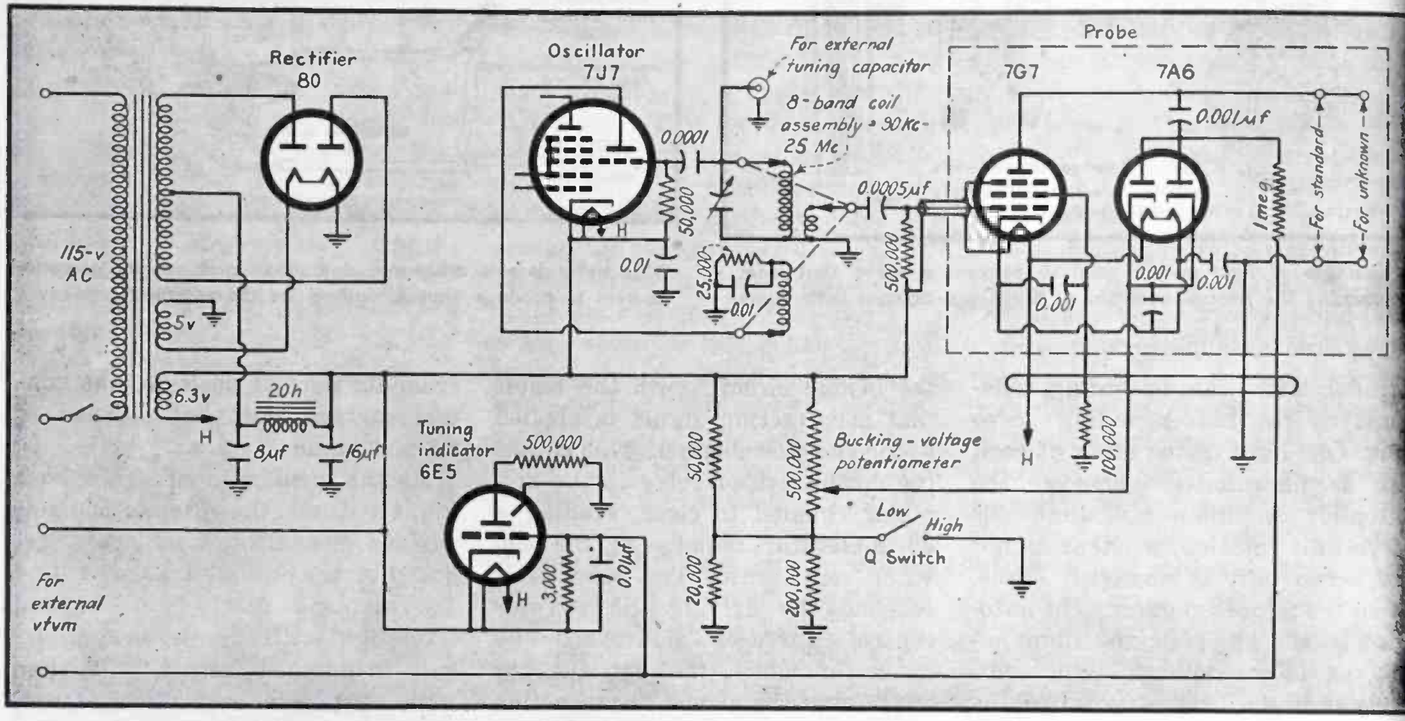


FIG. 1—Wiring diagram of the circuit-constant checker. Resonant tank for capacitance measurements and capacitance standard for inductance measurements are interchangeably connected to probe binding-posts at right

By G. ZAHARIS

Instrument Dept.
Carbide & Carbon Chemical Corp.
South Charleston, W. Va.

IN experimental work where values of existing parts are altered to fit new needs, the writer has found use for a small portable instrument that will rapidly measure quantities such as resonant frequency, inductance, capacitance and *Q*.

Basically, the instrument to be described uses the resonance method of measurement. As diagrammed in Fig. 1, the unit is composed of a calibrated oscillator (90 kc-25 Mc) driving a pentode amplifier. For practical purposes, the amplifier can be considered a constant-current generator in which the developed resonance-voltage is proportional to the *Q* of the load. The amplifier and accompanying diode are mounted inside a probe, illustrated in Fig. 2.

A panel control is provided on the checking unit itself to introduce a bucking potential to the diode in slide-back-voltmeter fashion, although no absolute voltage measurements are made. When the bucking potential is equal to the peak r-f voltage, zero bias appears on the grid of the 6E5 tuning indicator which is thus made to just close at resonance over a wide range of load *Q*. In addition a spst toggle-switch is provided to reduce the bucking voltage to 71 percent of its initial value, which permits determination of the off-resonance points where the developed voltage has dropped to 71 percent of maximum resonance value.

Design Considerations

Selection of tubes for use in the probe amplifier is a compromise between shunt capacitance and g_m. High-frequency tubes materially reduce capacitance, but develop insufficient voltage across low *Q* circuits.

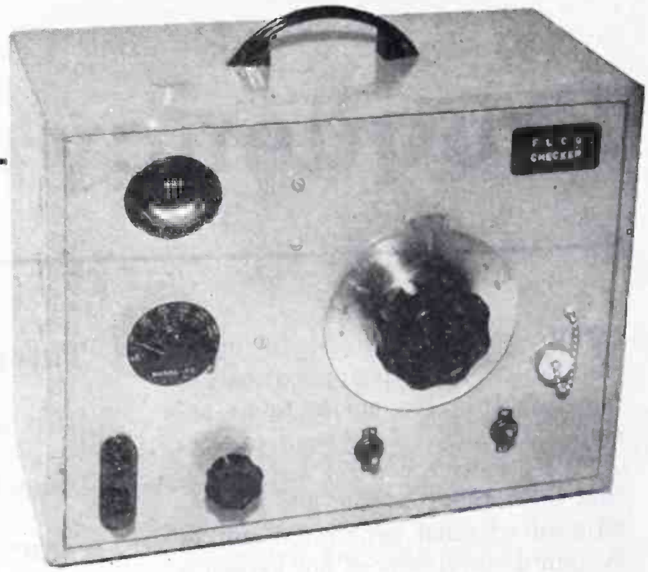
The positive terminal of the instrument power-supply is grounded. This conveniently permits the cold end of the resonant circuit to be at ground d-c potential. An original model used an a-c/d-c type of power supply, but the lack of line isolation was found to be highly undesirable.

Panel binding posts are provided for connecting an external vtvm to the probe diode for more accurate *Q* measurements. Also, there is provision for connecting to the oscillator tank circuit an external variable capacitor for making small incremental changes in frequency. This is useful in testing frequency-discriminator circuits.

Operating Procedure

In determining the resonant frequency of a tank circuit, the tank is

CHECKER



The circuit-constant checker. At the left are the tuning indicator, band selector, connections for external vtvm, and bucking-voltage potentiometer. Below the large oscillator-tuning control are the on-off and the Q switch. External tuning-capacitor receptacle is at the right

ınnected across the measuring ırminals of the probe and the oscil-ltor is adjusted for resonance as ıdicated by the 6E5. Since the ıntode will act as a frequency ıultiplier, resonance will be indi-ıted at sub-harmonics of the tank ındamental, but this is not ob-ıctionable because the developed ınk-voltage is always greater at ıe fundamental frequency. Also ıe fundamental is the highest fre-ıency at which any voltage can be ıveloped.

Capacitance can be measured by ınnecting a standard tank and the ıpacitor to be measured across the ıeasuring terminals. When the os-ıllator is adjusted for resonance $= 1/\omega^2L$ where C is the total tank ıpacitance. The capacitance scales ıould preferably utilize the two ıwest frequency bands. The low ıd of the calibration is sufficiently ıread to allow capacitance meas-ırements to be made on video am-ılifiers, while the upper limit is ıbout 100 $\mu\mu$f. With the particu-ır oscillator ranges used, a 456-kc ıf transformer with an additional ıhunt capacitance serves as a stand-ırd tank.

The i-f transformer padder is ıtilized as a zero positioner for the ıapacitance scales. It is advisable to ıalibrate the capacitance scales against a standard Q meter or some other capacitance standard, rather than by computation based on the inductance and total capacitance of the standard tank.

Inductance measurements are made in a similar manner by using a fixed capacitance standard. With a 387 $\mu\mu$f standard and the 13 $\mu\mu$f residual probe capacity, the formula for L simplifies to $L = 63.2 \times 10^6/f^2$ where f is in kc and L is effective series inductance in μh. The effective series inductance may differ from the true inductance by less than 2 percent for coils having less than 10 $\mu\mu$f of distributed capacitance. The inductance range is 1μh to 9 mh.

Determinations of Q can be roughly made by using the frequency-variation method. If the coil is shunted by an air capacitor

$$\text{Coil}\,Q = \left(\frac{F_r}{F_r - F_0}\right)\left(\frac{F_0}{F_r + F_0}\right)\left(\sqrt{\frac{E_r^2 - E_0^2}{E_0^2}}\right)$$

where F_r and E_r are the resonant frequency and voltage respectively and F_0 and E_0 are the off-resonant frequency and voltage respectively.

When $E_r/E_0 = \sqrt{2}$, as is the case when using the instrument Q-switch —and also assuming that the first two terms of the equation above are equal to $\frac{1}{2}F_r/(F_r - F_o)$—the equation simplifies to $Q = F_r/\Delta f$ where Δf is the frequency difference between the points at which response is down to 71 percent. The above assumption contributes error at low Q values, but it is less than the accuracy of measurement. It is best to find Δf by multiplying dial-division difference by kc per division for the particular portion of the dial used. For very high Q values, this method again becomes approximate because of the inability of determining Δf closely enough and also because of the finite dynamic plate resistance of the pentode amplifier and diode.

These Q measurements are simple but, at best, they are quite rough. When greater accuracy is desirable, the reactance-variation method is recommended. Still other measuring methods will suggest themselves, based on a high-impedance r-f source.

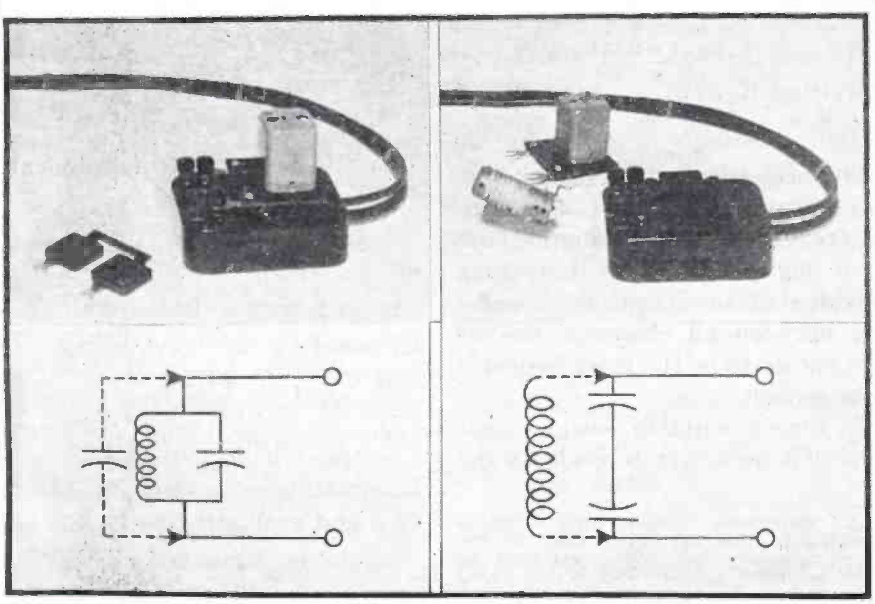


FIG. 2—Probe, which is permanently connected to checker proper, is shown at left equipped with resonant tank for capacitance measurements and at right with capacitance standard replacing tank, and inductance in place for checking

Frequency Allocation for

This method for assigning channel frequencies takes into account the response of the filter circuits, and cross-talk due to channel proximity. It provides the same electrical performance on all channels, and distributes the channels so that harmonic interference is minimized

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THE problem arises, in many radio-electronic applications, of selecting the frequencies to be assigned to each of a group of frequency-selective control circuits so that the total cross-talk due both to adjacent-channel proximity and to system distortion does not exceed a prescribed value.

A usable frequency distribution plan could be obtained by experimentally trying different frequency combinations, or by empirically arranging selectivity response curves for each channel on a frequency scale until a satisfactory compromise arrangement were obtained. The first method has obvious utility only when the number of channels is small, whereas the second provides no information regarding the effect of system distortion.

In the event that all channel filters are of the same type and have similar Q factors, as is commonly the case, a solution can be developed based upon an analytic allocation plan which will provide equal electrical performance on all channels and from which the problems arising from operation of any number of channels can be solved.

Logarithmic Distribution

Just as the frequency response of each of a series of selector filters of equal electrical characteristics but different channel frequencies can be written by identical equations when expressed in percents of their respective channel frequencies, so if the frequency separation between successive channels can be written by identical equations, each channel will be as well situated electrically as any other. If the percent frequency separation between channels is constant, such identical equations can be written. The requirement that no one channel be favored over the others in its separation allotment is fulfilled if separation be based on a constant percent of the mean of the respective channel frequencies. That this is so will become more apparent when the expressions for band allocation are derived.

It will be shown that a logarithmic distribution provides this constant mean-frequency separation.

Let:

n = channel number, where channels are numbered consecutively from 1 to N starting with the lowest-frequency channel

f_n = frequency of any specific channel number n

f_{max} = frequency of highest-frequency channel, numbered N

f_{min} = frequency of lowest-frequency channel, numbered 1

m = slope constant, defined by the following:

$$n = 1 + m \log (f_n/f_{min}) \qquad (1)$$

$$dn = m(df_n/f_n) \log_{10} \epsilon = 0.434m(df_n/f_n) \qquad (2)$$

Rewriting Eq. (2),

$$dn/df_n = 0.434m/f_n \qquad (3)$$

This equation states that channel separation is related to the channel frequency by a constant. That is, a logarithmic allocation plan provides mean frequency separation between all channels, as has been shown to be the most desirable arrangement.

To obtain suitable design equations it is necessary to evaluate the slope constant, m, and obtain general expressions for any channel frequency and for the channel separation.

If dn is made equal to unity, Eq. (2) reduces to

$$df_n/f_n = 2.303/m \qquad (4)$$

Writing the general Eq. (1) for the particular channels $n1$ and $n2$ where the 1 and 2 indicate different channels, $n2$ being higher than $n1$ but in no other way specifying the location of these two channels in the frequency spectrum, the following expressions are obtained:

$$n1 = 1 + m\log(f_{n1}/f_{min}) \qquad (5)$$

$$n2 = 1 + m\log(f_{n2}/f_{min}) \qquad (6)$$

$$n2 - n1 = m\log(f_{n2}/f_{n1}) \qquad (7)$$

$$m = \frac{n2 - n1}{\log (f_{n2}/f_{n1})} \qquad (8)$$

Rewriting Eq. (1) in exponential form

$$f_n/f_{min} = 10^{(n-1)/m}$$

or

$$f_n = f_{min} 10^{(n-1)/m} \qquad (9)$$

Eliminating m between Eq. (8) and (9), and letting $n1 = 1$, and $n2 = N$

$$f_n = f_{min} 10^{[(n-1) \log f_{max}/f_{min}]/N-1} \qquad (10)$$

Eliminating m between Eq. (4) and (8), and evaluating as in Eq. (10)

$$\frac{df}{f} = \frac{2.303}{N-1} \log \frac{f_{max}}{f_{min}} \qquad (11)$$

* All statements, opinions and assertions appearing in this paper are those of the writer and are not to be construed as official or reflecting the views of the Naval Department or the naval service at large.

Multi-Channel Systems

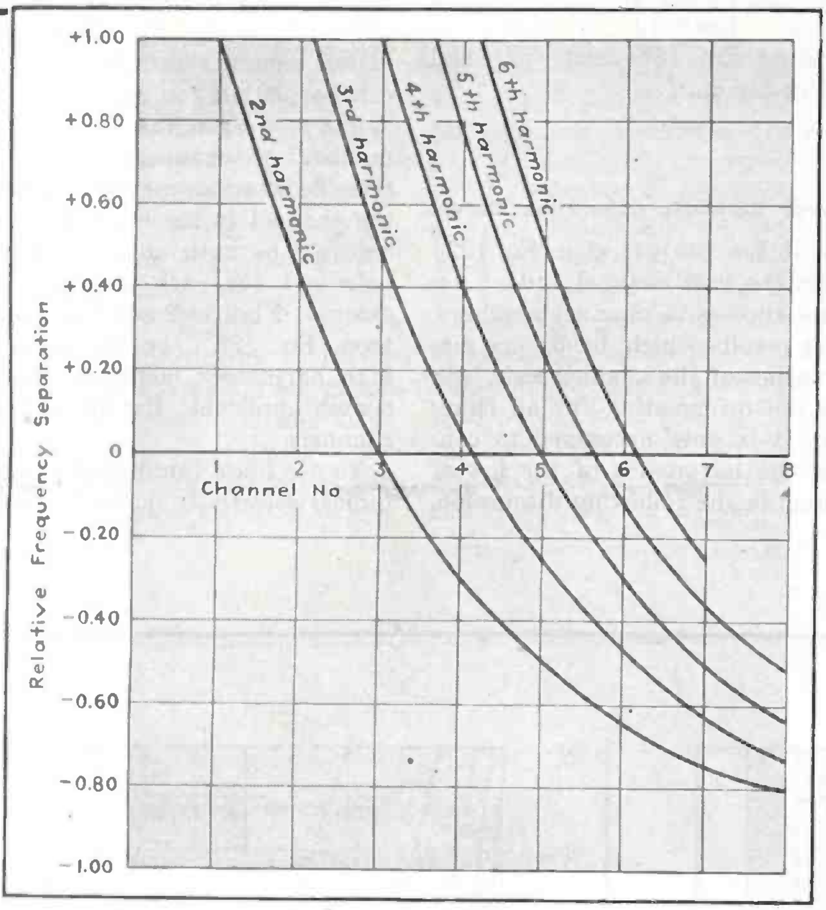


FIG. 1—When the ratio between successive channel frequencies is $\sqrt{2}$, the separation between a given harmonic of the lowest channel and any of the other channels is as shown. The graph can be used for harmonics of other channels by shifting the channel No. scale to the left

Equation (10) gives the fre-uency of any channel n as a func-ion of the maximum and minimum hannel frequencies and the num-er of channels to be contained vithin these limits. Equation (11) ives the mean channel separation n terms of the ratio of the highest o the lowest channel frequencies nd the total number of channels.

Geometric Distribution

Allocation based upon a geomet-ic progression is identical with re-ults obtained by following a log-rithmic distribution of channel requencies. The logarithmic de-ivation has been presented because f the insight which it gives to the asic theory. However, because of he concept of channel multiplier vhich it introduces, the geometric derivation will also be briefly presented.

If the frequencies of the channels are in a geometric series the expression for any channel frequency is

$$f_n = f_{min} r^{n-1} \tag{12}$$

where r, the ratio in the geometric series, will be called the channel multiplier from its physical significance.

If Eq. (12) is written in logarithmic form,

$$\frac{\log (f_n/f_{min})}{\log r} = n - 1 \tag{13}$$

it will be recognized as equivalent to Eq. (1) where

$$m = 1/\log r \tag{14}$$

By following a procedure similar to that used to evaluate m in the logarithmic derivation, r can be evaluated.

$$r = 10^{[\log (f_{max}/f_{min})]/(N-1)} \tag{15}$$

The remainder of the derivation need not be reproduced. That the geometric and logarithmic plans of allotment are identical has been verified, and the concept of a channel multiplier has been introduced to replace the slope constant which arose in the logarithmic derivation.

Frequency Separation Between Harmonics

Having determined the plan by which channel frequencies will be alloted, it is next essential to examine the manner in which the harmonics of the channels will distribute themselves throughout the frequency spectrum. The channels can then be assigned frequencies both in accordance with the previous relations and also in such a sequence that interference in any channel from harmonics of the lower channels will be a minimum. Let:

h = the order of the harmonic
Δf = the separation between a harmonic and a channel
α_f = relative separation between channels
α_h = relative separation between a harmonic and a channel

Mathematically these terms are defined as follows:

$$\Delta f = h f_{n1} - f_{n2} \tag{16}$$

which is the frequency separation between the h order harmonic of the $n1$ channel, and the $n2$ channel itself. Relative channel separations then are

$$\left.\begin{aligned} \alpha_f &= \frac{f_{n-1} - f_n}{f_n} = 1 - \frac{1}{r} \text{ (higher channel)} \\ &\text{or} \\ \alpha_f &= \frac{f_{n-1} - f_n}{f_n} = r - 1 \text{ (lower channel)} \end{aligned}\right\} \tag{17}$$

$$\alpha_h = \frac{\Delta f}{f_{n2}} = \frac{h f_{n1} - f_{n2}}{f_{n2}} = \frac{h}{(f_{n2}/f_{n1})} - 1 \tag{18}$$

but

$$\frac{f_{n2}}{f_{n1}} = \frac{f_{min}\, r^{n2-1}}{f_{min}\, r^{n1-1}} = r^{n2-n1} \tag{19}$$

therefore

$$\alpha_h = \frac{h}{r^{n2-n1}} - 1 \qquad (20)$$

In particular, if $n1$ equals the first channel, $r = \sqrt{2}$, and $n2$ assumes channel numbers from 1 to 8, the plot of Fig. 1 results.

Equation (20) gives the relative separation between the h harmonic of channel $n1$, and channel $n2$. However, it is not necessary to solve the equation for all possible combinations of $n1$ and $n2$. The single solution plotted in Fig. 1 suffices (for cases where $r = \sqrt{2}$). If, for instance, it is required to obtain the same information for the proximity of the harmonics of channel 2 to the other channels, shift the channel numbers one unit to the left. In this manner, the relative locations of the harmonics of all the channels can be studied.

To generalize Eq. (20) further it is necessary to eliminate the channel multiplier, which can be done as follows:

From Eq. (17),

$$r = 1/(1 - \alpha_f) \qquad (21)$$

From Eq. (20),

$$r = \left[\frac{h}{\alpha_h + 1}\right]^{1/(n2-n1)} \qquad (22)$$

Equating Eq. (21) and (22) and solving for α_h,

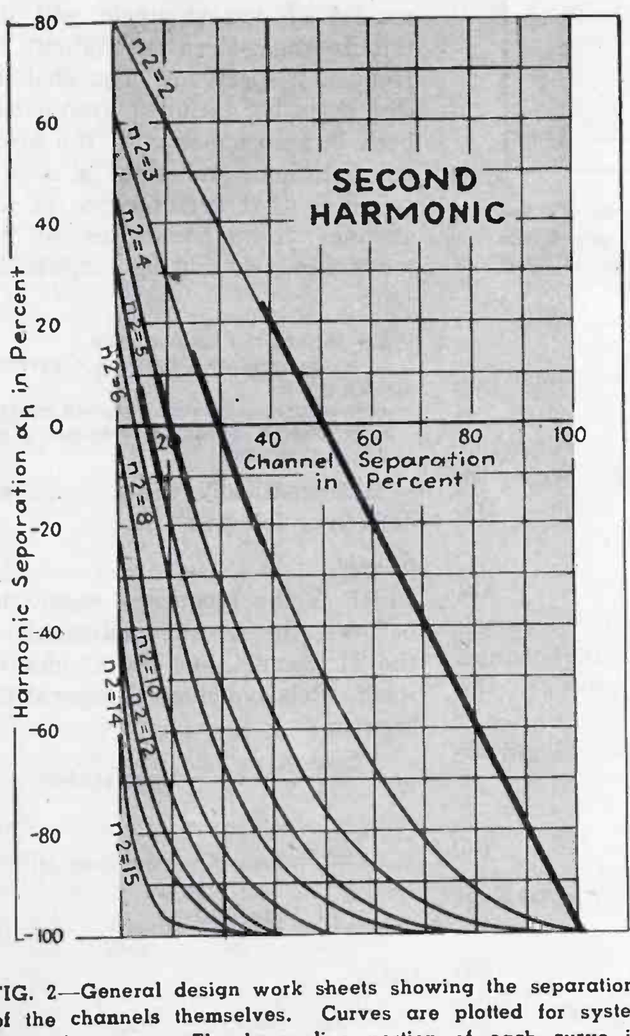
$$\alpha_h = h(1 - \alpha_f)^{n2-n1} - 1 \qquad (23)$$

General Harmonic Separation Curves

As in Eq. (20), if $n1$ in Eq. (23) equals the first channel and $n2$ assumes successive channel numbers, a plot results which, by proper manipulation of the channel axis, will give the information for all channels. It is only necessary to consider the harmonics of the lowest channel in the following discussion, the method of generalization being understood.

Equation (23) relates the frequency separation ratio between channels and harmonics for any order of harmonic and any number of channels. As this equation involves analytic relations, without reference to specific circuit properties, separate families of curves can be plotted for each order harmonic corresponding to a specified number of channels. These will then be general curves associating the channel to harmonic frequency separations with any of the channels and for each harmonic considered. Figures 2 and 3 are plotted from Eq. (23) for the second to fifth harmonics inclusive, showing curves applicable for up to fifteen channels.

To use these families of curves, a typical selectivity curve for one of



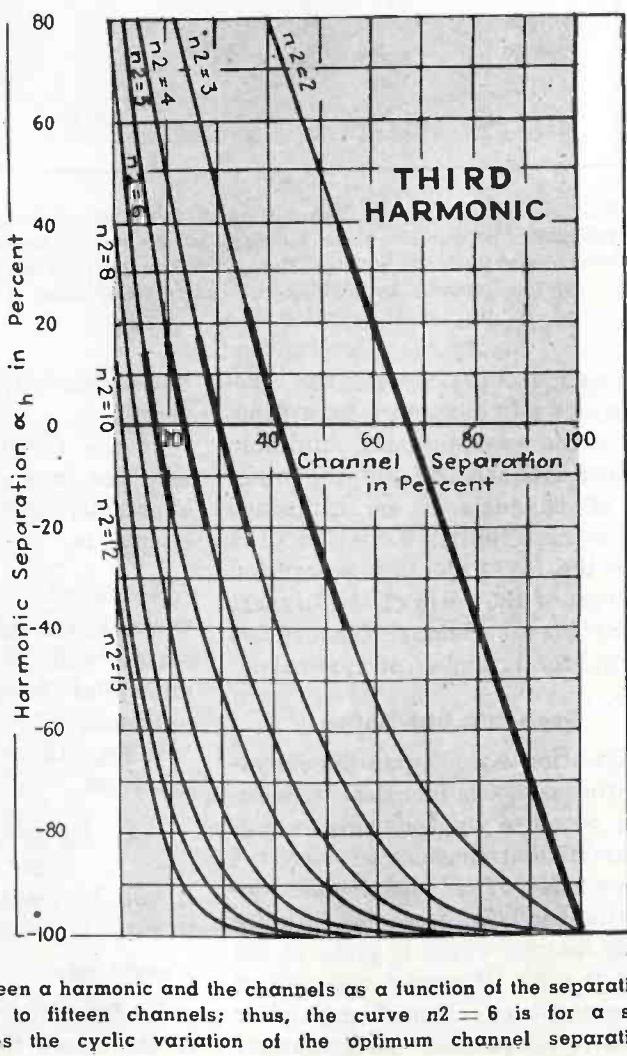


FIG. 2—General design work sheets showing the separation between a harmonic and the channels as a function of the separation of the channels themselves. Curves are plotted for systems up to fifteen channels; thus, the curve $n2 = 6$ is for a six-channel system. The heavy-line portion of each curve indicates the cyclic variation of the optimum channel separation

:he channel filters is required. Figire 4, for example, may be used :o illustrate applications of the nethod. Shown also in this figure ire selectivity curves corresponding :o 10 and 25 percent total distor:ion. The channel information is expressed in percent separation from the channel frequency for convenience in application of Eq. (23) or of the harmonic work sheets.

Example

For a system of ten channel selectors, a channel multiplier of 1.48, and a signal distortion of 25 percent second harmonic and 10 percent third harmonic, it is desired to know the maximum cross-talk on any channel resulting from adjacent-channel proximity and harmonic distortion. Figure 4 will be used as a typical selectivity characteristic for the channel filters.

The channel separation ratio determined from Eq. (17) for r = 1.48 is 32.4 percent and 48.0 percent respectively. Reference to Fig. 4 gives 6.5 percent (point A) and 8.5 percent (point B) cross-talk due to adjacent-channel coupling. These two values are for the two adjacent channels, one above and one below the channel under consideration. Referring to the harmonic families of curves on Fig. 2, corresponding to a 32.4 percent channel separation for a ten channel system the second harmonic will pass as close as 8.7 percent, and the third harmonic as close as 7.4 percent to the nearest channel, and on the low-frequency side. When these quantities are used in Fig. 4, it is found that for the above conditions the maximum cross-talk on the channel which is the most affected by second harmonic from a lower channel will be 32.2 percent (point C), and on the channel similarly affected by third harmonic will be 13.0 percent (point D). The cross-talk on the lowest channel will be 8.5 percent from the second channel proximity. On the second channel, cross-talk will be 6.5 percent from first channel proximity and 8.5 percent from third channel proximity. The third channel will be affected by second and fourth channel proximity, and by 32.2 percent second harmonic from the lowest channel. The fourth channel will have channel proximity cross-talk, and in addition third harmonic from the lowest channel, and second harmonic from the second channel. The maximum cross-talk which can appear on any channel, as obtained by taking the quadrature sum of all cross-talk terms, is $(6.5^2 + 8.5^2 + 32.2^2 + 13.0^2)^{\frac{1}{2}}$ =

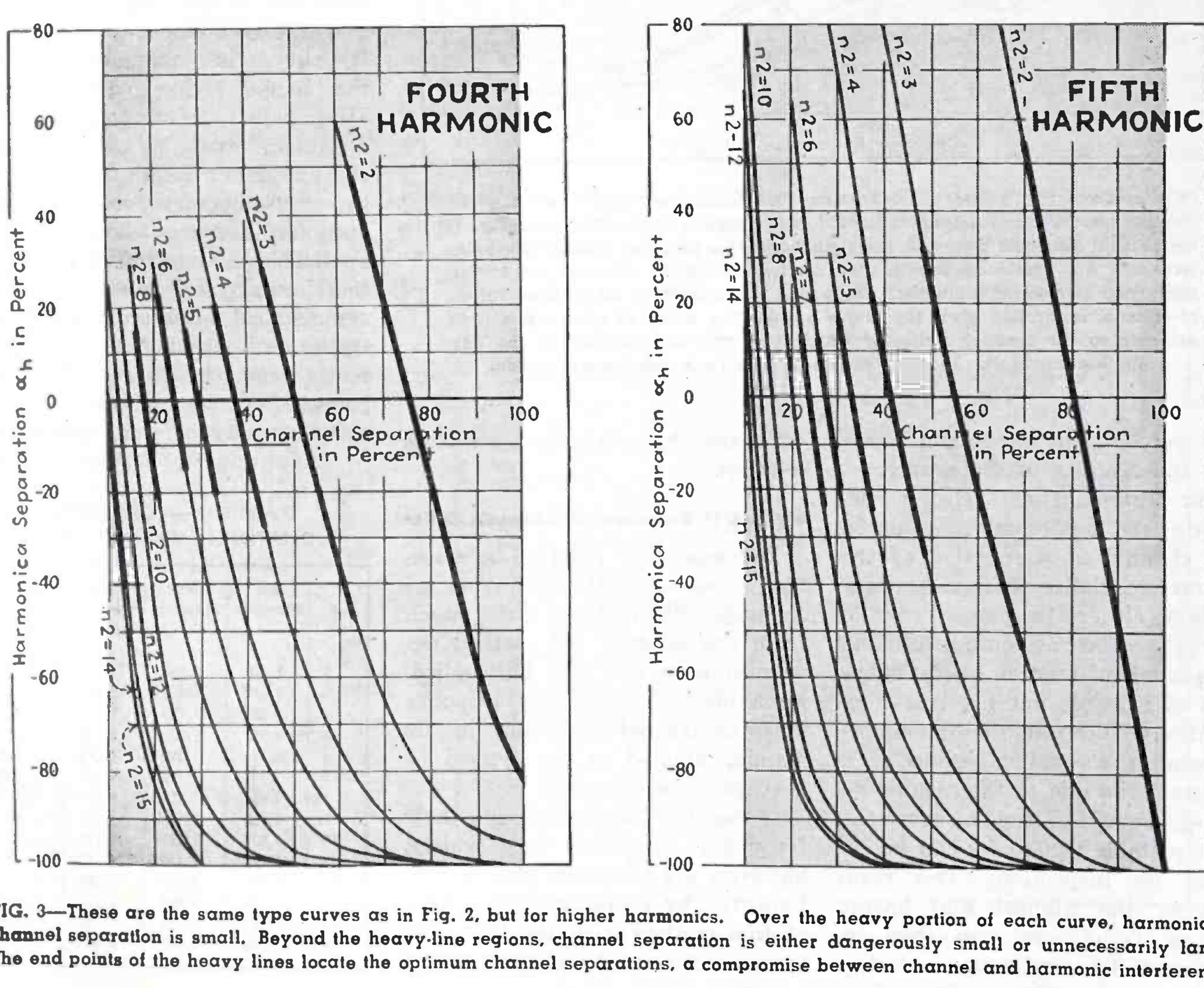


FIG. 3—These are the same type curves as in Fig. 2, but for higher harmonics. Over the heavy portion of each curve, harmonic to channel separation is small. Beyond the heavy-line regions, channel separation is either dangerously small or unnecessarily large. The end points of the heavy lines locate the optimum channel separations, a compromise between channel and harmonic interference

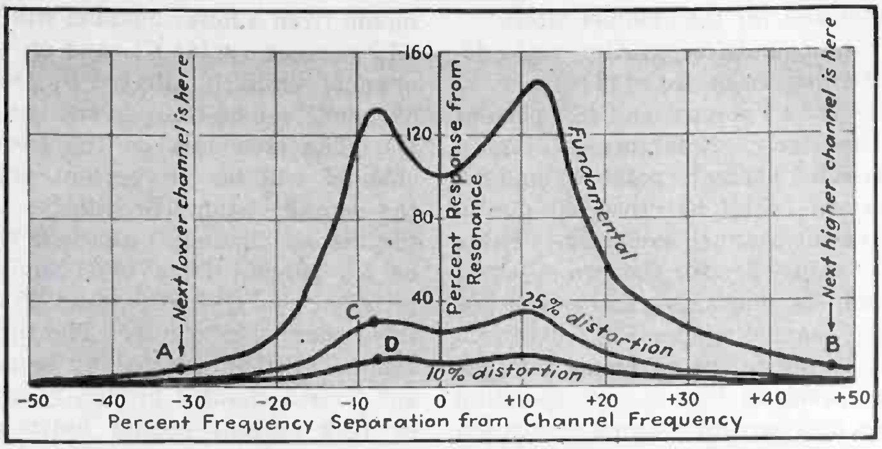


FIG. 4—Frequency response of the channel selector used in the illustrative examples. Instead of considering the distortion component as a percent of the signal, the response of the channel selector to the distortion is considered as a percent of the response to the signal. Response curves corresponding to 25 percent and 10 percent distortion are plotted on the same axis to facilitate cross-talk calculations

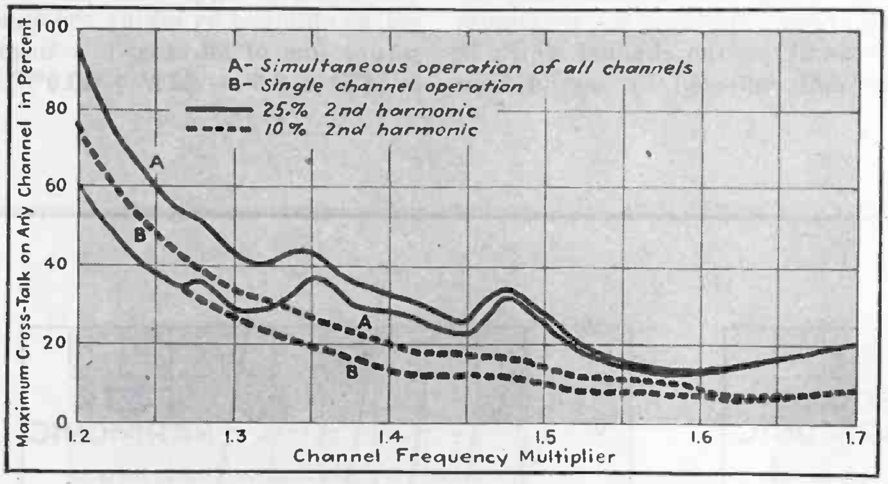


FIG. 5—From Fig. 2 and 3 the harmonic to channel separation for a given channel separation is determined. With this harmonic separation and Fig. 4, the percent harmonic cross-talk is determined. This plus the channel proximity cross-talk are combined and plotted against the given channel separation (converted to channel multiplier). Repeating this procedure for various values of channel separation gives the above graph. The utility of such a plot is in determining the channel multiplier which will give the minimum or the permissible cross-talk. The plot shown here is for a ten-channel system

36.4 percent, the maximum cross-talk the circuits must tolerate.

For a ten-channel selector, determine the maximum cross-talk on any channel as a function of the channel multiplier. The system may contain either 10 percent or 25 percent second harmonic distortion. This is a continuation of the above type of example but involves computation of the total distortion corresponding to various values of r. Figure 5 is a plot of the results obtained. From this type of curve the most suitable value of r can be selected by inspection. The ratio between the highest and lowest channel frequencies can then be computed by application of Eq. (12), thereby providing a complete solution.

Method if Response of Channels Differ

The examples involved a selectivity characteristic typical to all channels. Where these differ much from one another the method developed here can still be applied. Each channel selectivity response must be treated separately in the manner applied to the typical or average response curve.

If the Q of the circuits and their frequency responses vary widely, however, the allocation plan can be improved by compromising results of this method with the best performance reached by experimentally manipulating the channel frequencies. In extreme cases, it is conceivable that the latter procedure will prove most effective.

Optimum Channel Multipliers

In the process of utilizing the harmonic versus channel separation curves, it is evident that the ordinate erected at any channel separation value determines the relative frequency separation from the channel frequency for the particular harmonic involved. From these curves, it is therefore possible with the aid of a pair of dividers to determine the closest harmonic separation from any of the channels. Supplementary curves can thus be derived to designate this condition. The heavy lines of Fig. 2 and 3 show that part of the curves used to give this supplementary type of graph. An examination of such curves discloses the interesting fact that they vary cyclically, and for any harmonic there correspond specific allocation plans for channel frequency separations, which result in the greatest harmonic separation from any of the channels.

In the event the channel selectivity curves are symmetrical about the channel frequency, these operating points denote conditions for minimum cross-talk. Accordingly, the maximum amplitude points of the supplementary curves establish optimum frequency allocation plans, applicable to any filter-channel system employing elements with symmetrical selectivity responses. Optimum locations may be read directly from the curves. For purposes of tabulation, however, the accuracy may be improved by re-

TABLE 1 — OPTIMUM CHANNEL MULTIPLIERS

n	2nd Harmonic	3rd Harmonic	4th Harmonic	5th Harmonic
2	1.620	2.182	2.730	3.260
3	1.322	1.568	1.769	1.948
4	1.232	1.373	1.495	1.595
5	1.167	1.278	1.365	1.435
6	1.135	1.222	1.288	1.343
7	1.117	1.185	1.239	1.283
8	1.097	1.158	1.204	1.241
9	1.085	1.138	1.174	1.209
10	1.076	1.132	1.157	1.185
11	1.068	1.110	1.142	1.166
12	1.062	1.103	1.128	1.151
13	1.057	1.092	1.117	1.137
14	1.053	1.085	1.108	1.127
15	1.049	1.079	1.100	1.117

ırting to computation from a deved formula.

Maximum Harmonic Separation

Let α_{h1} and α_{h2} be the harmonic ıparation for any two successive ıannels. From examination of ig. 2 and 3 it is seen that maxiıum separation of harmonics from ıannels occurs at

$$\alpha_{h1} + \alpha_{h3} = 0 \qquad (24)$$

y applying Eq. (23) and manipuıting, there results

$$r = [(h/2)(1+r)]^{1/N} \qquad (25)$$

his equation can be solved on a g-log slide rule.

In Table 1 are optimum values ır the channel frequency multiıliers which yield minimum crossılk due to any harmonic up to the fth when applied to symmetrical electivity characteristics. The umber of channels being considıred for use determines the number f valid channel multipliers availıble from the table. For example, five channels are contemplated, ll multipliers above row 5 in the ıble may be considered. All other alues have no meaning. The table an be similarly interpreted for ther numbers of channels.

Asymmetrical Channel Selectivity Response

If the frequency response charıcteristic of the channels is asymıetrical, a measurement can be ıade of the degree of dissymmetry. orrection factors can then be apılied to Table 1 for conversion to he required optimum multipliers.

Referring to Fig. 6, the response issymmetry coefficient can be deıned as the ratio of the highest to he lowest frequencies which proıuce equal responses.

$$k = a/b \geqq 1 \qquad (26)$$

'rom Eq. (24) and (26)

$$\alpha_{h2} + k\alpha_{h3} = 0 \qquad (27)$$

ubstituting Eq. (23) into Eq. 27), and evaluating at $n1 = 1$ and $2 = N$,

$$h(1-\alpha_f)^{N-1} - 1 + k[h(1-\alpha_f)^N - 1] = 0 \qquad (28)$$

'rom Eq. (21)

$$(1/r)^{N-1} + k(1/r)^N = (1+k)/h \qquad (29)$$

$$(1/r)^N(k+r) = (1+k)/h \qquad (30)$$

$$r^N = h(k+r)/(1+k) \qquad (31)$$

When $k = 1$ (i.e., the response is ymmetrical about the channel requency),

$$(r_{k=1})^N = h(1+r)/2 \qquad (32)$$

When k is not equal to 1,

$$(r_{a/b})^N = h(k + r_{a/b})/(1+k) \qquad (33)$$

Letting $r_{a,b}/r_{k=1} = \beta$, the ratio of the optimum channel multiplier for asymmetrical channel response to the optimum multiplier for symmetrical response, and writing $r_{a,b} = \beta r_{k=1}$ and dropping the subscript $k = 1$,

$$\beta = \left[\frac{2\,(k+\beta r)}{(1+r)\,(1+k)}\right]^{1/N} \qquad (34)$$

Here β is the correction factor to be applied to the optimum channel multipliers of Table 1. Figure 7 shows correction factors for asymmetry coefficients from 1.0 to 1.5.

From Table 1 and Fig. 7, the channel multipliers giving the least cross-talk from any harmonic up to the fifth can be identified, taking into account the shape of a typical channel response curve and the number of channels.

Conclusions

A desirable choice of frequency assignment to the elements comprising a group of frequency-selective circutis appears to be based upon a constant percent frequency separation plan. This is predicated upon the condition that the circuit Q factors for the various elements are substantially alike. For this condition all channels will have identical electrical performance properties, which is normally desirable in connection with the use of frequency-selective circuits.

Separation on a constant mean percent frequency basis can be realized by utilizing a logarithmic or geometric progression plan of allocation.

A method has been developed with working equations and general curves which provides a means for solving all important problems associated with such an allocation plan, provided, however, that knowledge of the selectivity responses for the selector channels is available.

Optimum allocation plans which minimize cross-talk resulting from any harmonic are related to the degree of response dissymmetry. These can be identified for any particular problem by means of derived general expressions or the plotted work sheets.

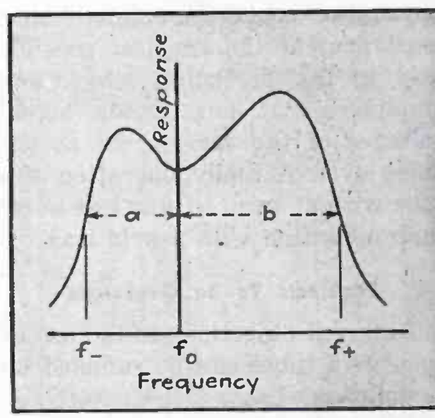


FIG. 6—Where the dissymmetry of the channel-selector filters is great a correction is introduced. The ratio of a to b is the dissymmetry coefficient of the channel-selector response curve

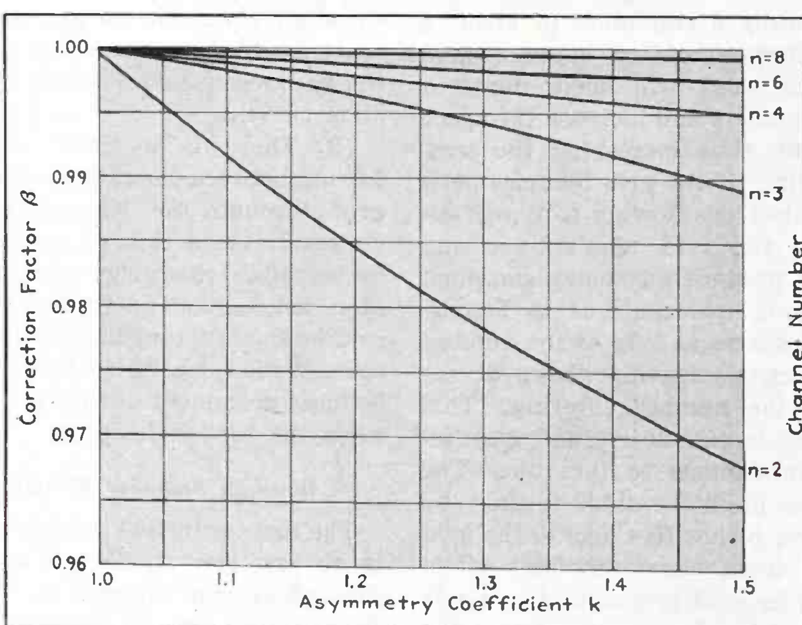


FIG. 7—To correct for selector response dissymmetry the factors given above for asymmetry coefficients through 1.5 and channels up to eight are applied to the optimum channel multipliers given in Table 1

OPEN-GRID TUBES IN LOW-LEVEL AMPLIFIERS

By ROBERT J. MEYER

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FOR CERTAIN APPLICATIONS in amplifiers requiring a high input resistance and low noise level it has been found desirable to eliminate the grid leak, and no undesirable effects resulted from using the tubes in this manner. Examples of such applications are amplifiers operating from a low-level, high-impedance source, amplifiers that must present the smallest possible load to the preceding stage, and amplifiers that must handle signal voltages of the same order as the noise level. Actually, operation of a tube with an open grid is less noisy than operation with a grid leak.

Problems To Be Overcome

Different objections to the use of open grid tubes can be summed up as follows:

(1) It has been suggested[1] that if the operating temperature of the tube is high enough, the grid will emit electrons. When this occurs in a conventional circuit, the resulting current through the grid leak (generally a resistance of about 2 megohms connected between grid and cathode) will make the grid less negative and increase the space current, thus increasing the temperature. If the grid becomes positive, electrons flowing to it will increase the grid temperature and might produce secondary emission. The grid will continue to become less negative as long as the number of electrons leaving the grid exceeds the number entering. This process is cumulative and may result in damage to the tube. The process might be aided initially by the flow of positive ions to the grid when it is negative. This effect would be most pronounced in a soft tube. It has been asserted that the use of extremely high cathode-to-grid resistance (such as an open grid) would tend to aid the process by producing large voltage drops in the grid circuit.

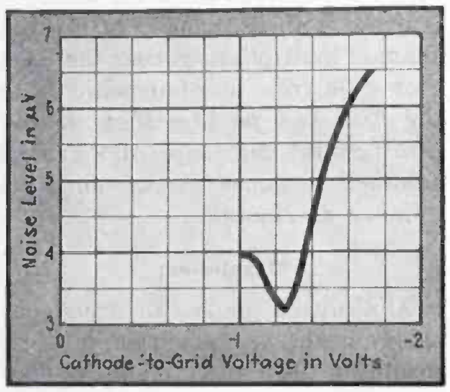


FIG. 1—Noise level vs. cathode-to-grid voltage for a 6SJ7 tube connected as a triode, with 40 μμf in the grid circuit to simulate a high-impedance crystal pickup having no shunt resistance

(2) If the grid leak is omitted, electrons will flow to the grid from the cathode and the grid will accumulate a negative charge.[2] Then any slight change in the grid capacitance would change the grid potential and produce fluctuations in the plate current.

(3) There is a small current flowing between the cathode and the grid through the leakage paths. However, these leakage paths are continually changing and thus there is a random fluctuation in the grid leakage current which produces noise in the tube. This effect should be most prominent during the time when the tube is heating.

Noise in Amplifier Circuits

The three principal types of noise in an amplifier circuit are flicker, shot effect and thermal agitation. These noises can be considered as being developed by equivalent generators in the grid circuit of a noise-free tube.

The flicker voltage, which is produced by irregularities in the temperature of the heating element, is inversely proportional to the square of the frequency.

Shot noise is uniformly distributed throughout the frequency spectrum, independent of the electron velocity and independent of the manner in which the total current divides between the electrodes. The values of the shot voltage E for triodes can be calculated from the formulas[3]

$$|E| = 2 \times 10^{-10} \sqrt{\Delta F / g_m} \qquad (1)$$

For pentodes, the formula is

$$\left|E\right| = \frac{2 \times 10^{-10}}{g_m} \sqrt{\frac{I_b}{I_b + I_{c2}} (g_m + 8 I_{c2}) \Delta F} \qquad (2)$$

The thermal agitation voltage developed by a resistor is

$$E^2 = 4KTR\,\Delta F \qquad (3)$$

where R is the resistance, ΔF is the frequency band passed, T is the temperature in degrees Kelvin and K is Boltzmann's constant (1.39×10^{-23}).

If the impedance in the grid circuit is not a pure resistance, the resistive component is a function of the frequency and the voltage can be obtained from:

$$E^2 = 4KT \int_{F_1}^{F_2} R(f)\, dF \qquad (4)$$

These formulas apply only to wire-wound resistors or to carbon resistors in which no current is flowing.

There is always some capacitance across a resistor and this parallel combination forms a low-pass filter which affects the thermal agitation voltage e as follows:

$$e = 1.28 \times 10^{-10} \sqrt{RF_0\left(\tan^{-1}\frac{F_2}{F_0} - \tan^{-1}\frac{F_1}{F_0}\right)} \qquad (5)$$

where $F_0 = 1/2\pi RC$ and F_2 and F_1 are the upper and the lower frequency limits, respectively, being

)mission of the grid leak in a conventional low-level amplifier, leaving only surface ɛakage paths between the grid and cathode, reduces the noise due to shot effect and hermal agitation. A cathode resistor of proper size gives further lowering of noise level

onsidered. It can be seen from Eq. 5) that the thermal agitation voltge output of an RC combination is ndependent of the value of R, beause $F_1 = 0$ and $F_2 = F_0$, reducing from a function of R and C to a unction of C only.

If the noise voltage from an RC ombination is applied to an ampliier, some of this voltage may be in part of the frequency spectrum which is not passed by the ampliier. In this case the voltage passed y the amplifier would be a function f R as expressed in Eq. (5), where F_1 and F_2 would now be the frequency limits of the amplifier, and and C would be the grid leak and he input capacitance in the ampliier circuit. If F_1 is very much less han the upper frequency limit of he amplifier, Eq. (5) reduces to:

$$e = 1.28 \times 10^{-10} \sqrt{\frac{1}{2\pi C} \cot^{-1} \frac{F_1}{F_2}} \qquad (6)$$

The form of Eq. (5) can be hanged to show more clearly the elation between the thermal noise nd the value of R.

$$e = 1.28 \times 10^{-10} \sqrt{\frac{1}{2\pi C}\left(\tan^{-1} 2\pi F_2 CR - \tan^{-1} 2\pi F_1 CR\right)} \qquad (5a)$$

$$\tan\left[\frac{2\pi Ce^2}{(1.28 \times 10^{-10})^2}\right] = \frac{2\pi C(F_2 - F_1)R}{1 + 4\pi^2 F_1 F_2 C^2 R^2} \qquad (5b)$$

Eq. 5(b) shows that the noise inreases as the value of R increases rom zero, reaches a maximum at ome finite value of R, and decreases s the value of R is increased beyond this value. This equation hows that operation of a tube vith an open grid would be less noisy than operation with a grid eak. In an amplifier circuit, to obain minimum noise, the grid leak s sufficiently high if the thermal noise is less than the shot effect.

Another source of noise is the flow of leakage current between the cathode and the grid. This noise would be at a minimum when the cathode-to-grid voltage is at a minimum. Thus the tube would be quietest with a proper value of bias and it remains to be shown that the open grid tube automatically biases itself to that bias voltage.

To aid in determining the desirability of an open grid, a low noise level, wide-range amplifier was built. The first stage had a 6SJ7, triode-connected, with a gain of 11 db. The next two stages, using 6SJ7 tubes, had a gain of 68 db. The output stage, using a 6J5, was a cathode follower. The frequency response was down 6 db at 200 cy-

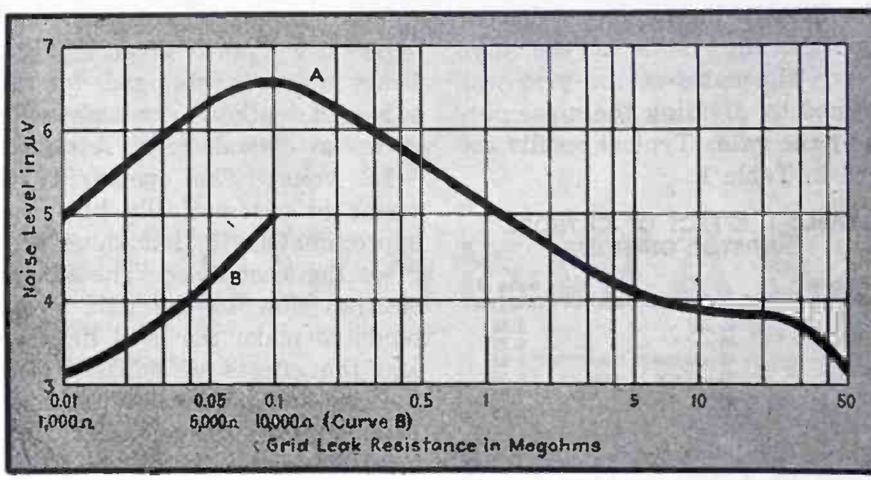


FIG. 2—Noise level vs. grid leak value for a triode-connected 6SJ7 tube. Curve B is for very low values of grid-cathode resistance

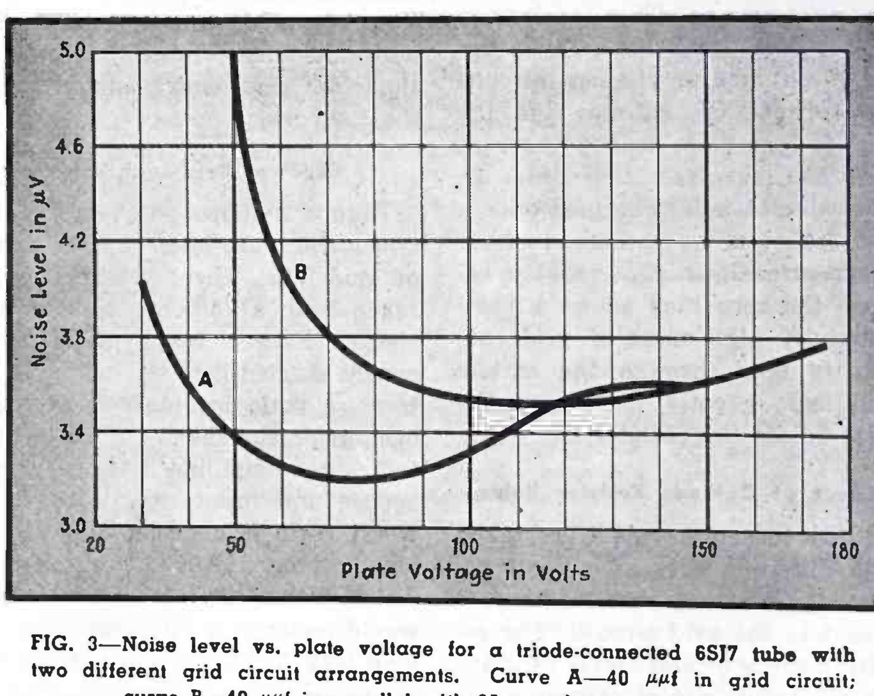


FIG. 3—Noise level vs. plate voltage for a triode-connected 6SJ7 tube with two different grid circuit arrangements. Curve A—40 μμf in grid circuit; curve B—40 μμf in parallel with 35 megohms in grid circuit

cles and at 200 kc. The entire amplifier was built in a copper box which gave excellent shielding. Because flicker noise is a low-frequency effect and not dependent upon the grid leak, a high-pass constant-K filter was placed at the output of the amplifier to suppress frequencies below about 650 cps and thus substantially eliminate the flicker effect.

Experiments With Open-Grid Tubes

The first tests were made with a cathode resistor alternately in and out of the first stage. A 40-$\mu\mu$f capacitor was used in the grid circuit to simulate the condition of an open-grid tube operating from a high-impedance crystal. For the next two measurements a 35-megohm resistor was put in parallel with the capacitor to give the condition of operation with a high-value grid leak. Finally, the grid was shorted to obtain the value of the tube noises. The noise at the grid was obtained by dividing the noise output by the gain. Typical results are given in Table 1.

TABLE 1. EFFECT OF CATHODE RESISTOR ON NOISE

Cathode Resistor	Grid Circuit Impedance	Noise at Grid (μv)
In	40 $\mu\mu f$	3.32
Out	40 $\mu\mu f$	4.26
In	40 $\mu\mu f$ and 35 meg.	3.68
Out	40 $\mu\mu f$ and 35 meg.	8.40
In	Short	3.00
Out	Short	3.69

These results show that the noise is less with an open grid than with a grid leak. In all three cases the noise is less with a cathode resistor than without one. This result is to be expected, for the cathode resistor voltage drop reduces the voltage between the cathode and the grid, reducing the leakage current and the noise resulting from it. The value of noise obtained with a grid leak and no cathode resistor is exceptionally high, probably because the zero bias allows a comparatively high value of grid current to flow through the carbon grid leak, greatly increasing the noise across the resistor.

Effect of Cathode Resistor Value

Noise measurements were taken with different sizes of cathode resistors. The test was made with 40 $\mu\mu$f in the grid circuit. The resulting curve of noise level vs. cathode voltage is not so important as the curve of noise level vs. cathode-grid voltage. Since this voltage cannot be measured directly because any voltmeter would upset the circuit conditions, it was necessary to obtain a calibration curve of plate potential vs. grid voltage without a cathode resistor.

The curve of noise level vs. cathode-grid voltage is given in Fig. 1. Least noise is obtained for that value of cathode resistor which gives a cathode-grid voltage of −1.2 volts. The open-grid tube seems to automatically bias itself approximately to that value which gives the least noise. The effect of electron flow to the grid (which tends to make the grid negative) and the effects of emission from the grid and gas current to the grid (which tend to make the grid positive) balance each other to give the grid a small negative bias.

The foregoing test was repeated with a 35-megohm grid leak in addition to the 40-$\mu\mu$f capacitor. The minimum noise obtained was greater than the minimum noise without the grid leak.

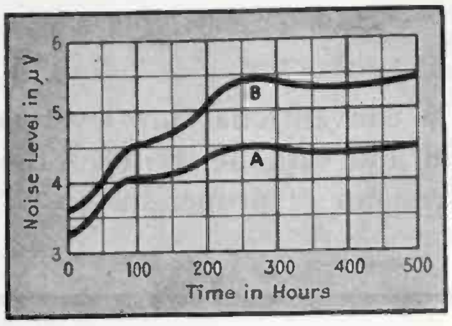


FIG. 4—Noise level vs. number of hours of continuous operation for a triode-connected 6SJ7 tube. Curve A—40 $\mu\mu$f in grid circuit; curve B—40 $\mu\mu$f in parallel with 35 meg in grid circuit

Effect of Grid Leak Value

Figure 2 shows the relation between the noise level and the value of grid leak. These readings were taken with a 750-ohm cathode resistor. Except for a shorted or nearly shorted grid the best signal-to-noise ratio is obtained with an open grid. For the constants in this test, i.e., amplifier frequency response and input capacitance, the worst ratio is obtained for a grid leak around 100,000 ohms. For a different amplifier the worst ratio would occur at a different value of grid leak but the general shape of the curve would be the same. These results are in agreement with Eq. 5(b) and the discussion following it.

Effect of Plate Voltage

The relation between the plate voltage on a tube and the noise level at the grid is given in Fig. 3. Again there is less noise without a grid leak than with a grid leak, but in both cases the best signal-to-noise ratio is obtained for a plate voltage of about 90 volts.

It would be expected from Eq. (1) that the noise would continue to decrease as the plate voltage is increased because the g_m is increasing. However, the larger number of positive ions and secondary electrons present in the tube at higher plate voltages tends to make the tube slightly noisier.

Effect of Temperature and Time

In various measurements it was noticed that the noise changed as the temperature of the tube changed, the noise in a cold tube being greater than the noise in a warm tube. This effect is undoubtedly due to leakage paths, which change as the tube is heated and become saturated when the tube is hot. The change in the noise level is just as great with a grid leak as without one, and thus the addition of a grid leak does not reduce the noise due to the random leakage paths. An attempt was made to reduce this transient effect by boiling the tube and its socket in wax, but this did not help nor did it reduce the noise level.

A long-time test was performed on five 6SJ7 tubes by continuously drawing plate current through the tubes and measuring the noise level at certain time intervals. Typical results are given in Fig. 4. It can be seen that the tubes have a general tendency to become noiser with age, but that in all cases, the noise is greater with a grid leak than without a grid leak. These tests show that tubes operated without a grid leak do not tend to become any more erratic than tubes operated with a grid leak.

Conclusions

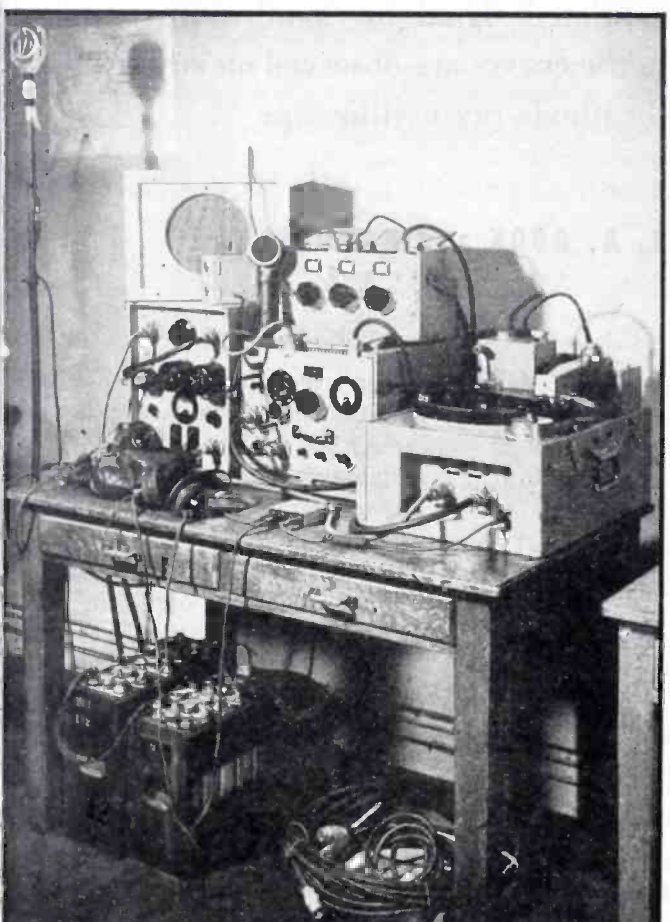
In the experiments performed, the noise level was always less without a grid leak than with one. In

(Continued on page 234)

Recording equipment developed by the British Broadcasting Corp. for use at the front is often housed in trucks of this type, which include living facilities, 200 yards of microphone cable, a shortwave receiver and a three-channel mixer

RECORDERS at WAR

RIGHT—Midget recorder developed by BBC weighs only 37 lb. Driven by a double-spring motor, it contains amplifier and batteries. Single knob turns amplifier on, starts turntable, and lowers piezoelectric cutter. Volume indication is by neon lamp. Disks are double-sided with three-minute playing time and 15 are carried. Fifteen seconds before the end of cut a warning light appears



LEFT—Closeup of 450-lb. recording equipment shows arrangement for use in a motor torpedo boat. Turntable at the right is powered by a 12-v d-c motor with friction drive. Speed-control rheostat works in conjunction with neon stroboscope run by a stable oscillator. High-sensitivity cutter-head has satisfactory response from 60 to 4500 cps. Pentodes are used in the first amplifier stages and in the output stage in push-pull while negative feedback keeps total harmonic content below one percent at normal recording level. Program-level meter operates from a diode rectifier and pentode amplifier. Motor-generator, driven by nickel-iron battery, provides plate voltages

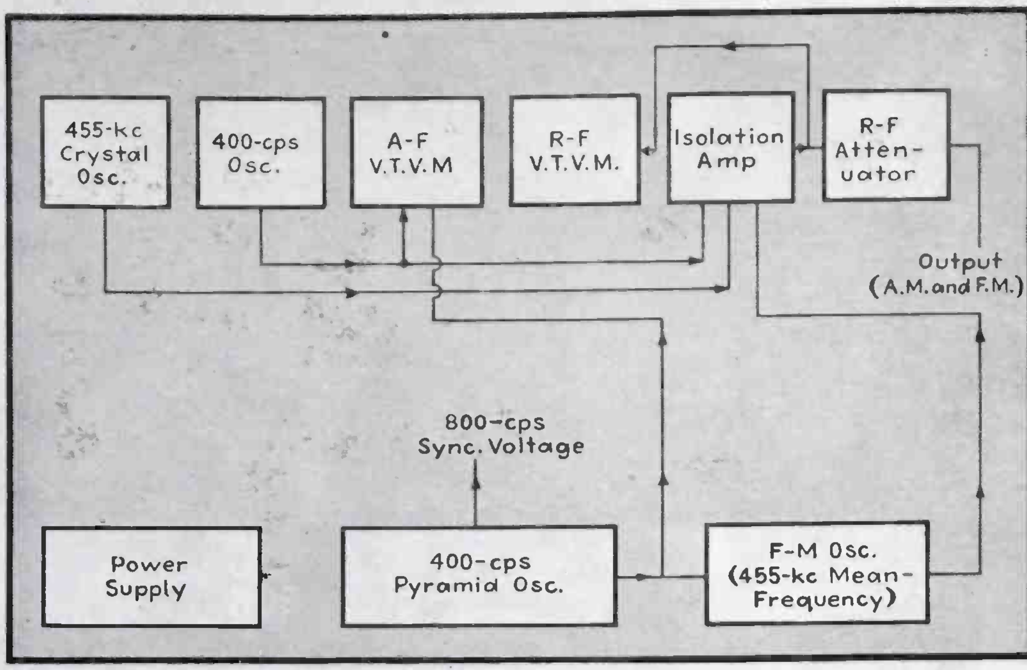


FIG. 1—Block diagram of the test unit, shown without switching. A complete schematic is given in Fig. 5

Visual Alignment of

Production test unit provides an amplitude-modulated signal for sensitivity measurements and a frequency-modulated signal for band-width adjustments. Response curves are observed on an external cathode-ray oscilloscope

By H. A. COOK and HAROLD MOSS

Collins Radio Company
Cedar Rapids, Iowa

ALIGNMENT of the wide-band i-f amplifiers in high-fidelity receivers on a production basis is a difficult operation. One common method involves the use of an amplitude-modulated signal generator and an output meter for sensitivity measurements, and a frequency-modulated signal generator in conjunction with a cathode-ray oscilloscope for band-width adjustments. Obviously, the adjustment and switching of several instruments introduces complications.

This paper describes a production test unit which greatly simplifies the job. It contains an a-m generator, an f-m generator, an isolation amplifier and an output attenuator common to both generators, an a-f vacuum-tube voltmeter and an r-f vacuum-tube voltmeter. It also provides synchronizing voltage for an external oscilloscope. A block diagram of the test unit, with switching omitted, is shown in Fig. 1.

A-M Signal Generator

The a-m signal generator consists of a 455-kc crystal-controlled 6SJ7 in a Colpitts circuit, driving a 6C5 cathode-follower type amplifier which provides low-impedance output. With a reasonably active crystal, about 400 cycles of frequency adjustment may be obtained by varying the tuned-circuit constants. Temperature control of the crystal is unnecessary.

The a-m generator is modulated in the grid circuit of the separator tube. The modulator, which operates at 400 cps, is of the *R-C* type shown in Fig. 2 and its frequency is given by the expression

$$f = 1/(2\pi\sqrt{C_1C_2R_1R_2})$$

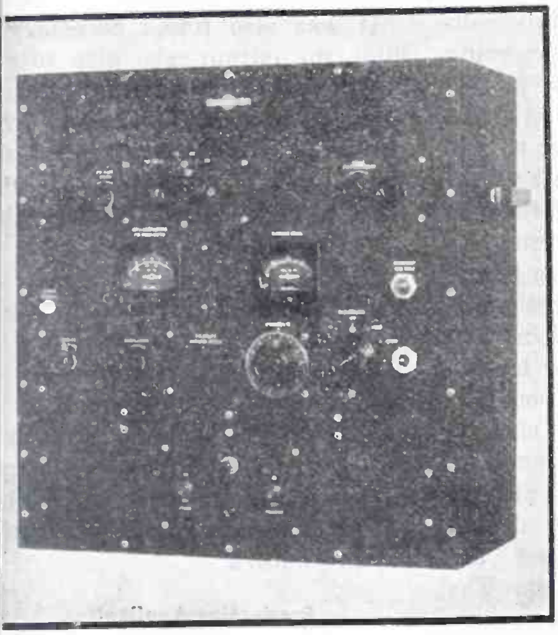
This circuit provides an excellent source of sinusoidal audio frequency.

Improved stability of oscillation results when a ballast resistor of some kind, rather than an ordinary resistor, is placed at R_8. A 3-watt 110-volt lamp seems satisfactory.

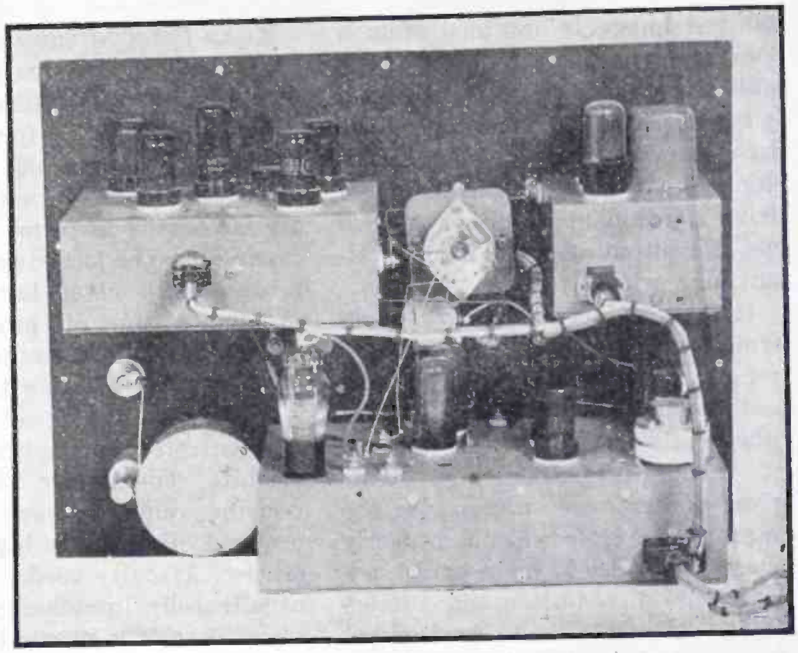
F-M Signal Generator

While the *R-C* oscillator circuit of Fig. 2 is ordinarily used at audio frequencies, it is equally adaptable to radio frequencies.[1]

From the expression for frequency of oscillation given above, it is apparent that a variation of R_1, R_2, C_1 or C_2 will result in a variation in frequency. By substituting the plate resistance of a vacuum tube for either R_1 or R_2 and varying



The production test unit. A cathode-ray oscilloscope is used externally



Back view of the test unit, with the bottom section (containing the power supply) removed

Wide-Band I-F Amplifiers

ne grid voltage at an audio rate, requency modulation will result. logical choice indicated the section of R_2 as the variable element, nce it had one end at ground potential.

In order to obtain practical values or R_1, R_2, C_1 and C_2 at 455 kc, the athode-follower circuit was used or R_2 in the actual circuit. Varying the grid voltage in the cathode-follower stage then varies the frequency of oscillation. Figure 3 indicates the variation in frequency obtained as the grid potential of the variable-resistance tube serving as R_2 is varied. As may be seen, frequency excursions of 80 kc are possible with a four-volt peak audio signal.

An ordinary resistor, rather than a ballast resistor, is used at R_3. A ballast resistor does not operate satisfactorily at R_3 at the higher frequencies, although an improvement in wave form results. At 455 kc, the ballast resistor swings constantly, seeking equilibrium, which shifts the mean-frequency several kilocycles. This objectional effect is not important at audio frequencies.

A 6SN7 connected as a multivibrator operating at 400 cps supplies about 50 volts to a 6SJ7 clipper circuit.[2] The output of the clipper circuit is a pyramid wave, extremely sharp at the corners and nearly straight sided. It proved wise to adjust the constants of the multivibrator until the resultant square-wave pulses were of equal lengths, as this affects the symmetry of the pyramid. A slight curvature still remaining on one pyramid slope is due to loading of the multivibrator on one side only; however, this is minor and of little consequence. About 4.9 volts peak is available at the output, the wave form of which is shown at Fig. 4.

Connection of the pyramid wave to the modulating grid of the resistor tube constituting R_3 causes frequency modulation linear with time; that is, the rate of change is constant across the entire excursion.

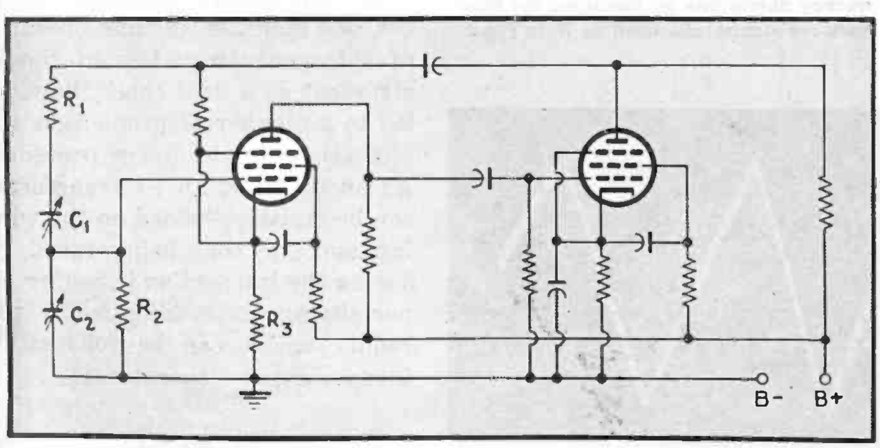


FIG. 2—Simplified schematic showing the type of R-C oscillator circuit used to obtain 400-cps modulation of the 455-kc amplitude-modulated signal generator. A similar R-C circuit is used as the frequency-modulated signal generator

Oscilloscope Synchronization

The necessary double frequency to properly synchronize the doublehumped image is obtained from a point common to both plates of the multivibrator, which supplies a pulse on each half of the square wave, serving as a frequency doubler. About 2 volts is available to drive a resonant amplifier at 800 cps, the output of which is an excellent sine wave.

It proved necessary to supply synchronizing pulses in this manner because of the tendency of the oscilloscope sweep to "pull" on every other cycle if the pulse is supplied at modulating frequency. This gives an erroneous pattern, as the uncontrolled cycle will not properly overlap, and leads to incorrect adjustment. In addition, the oscilloscopes available had interlocking controls. Also, when they were supplied with a square synchronizing pulse the sweep would trigger at times difficult to control, making it very hard to center the image.

The use of a sine wave, making it possible to adjust the triggering time of the sweep circuits along an even slope, plus the incorporation of a phase-shift network ahead of the sync output, makes it possible to obtain smooth adjustment of the position of the image. About 80 degrees phase shift is available at the grid of the sync output section of the 6SN7, using an R-C network with $R = X_c$. This, plus the apparent phase shifts possible by adjustment of the oscilloscope-sweep triggering level, permits positioning of the trace without the usual jockeying of controls. About 6 volts rms at 800 cycles is obtained from the sync output, reducing to about 4 at maximum phase shift.

An 800-cps amplifier incorporated in the test unit utilizes a toroid coil with a good Q (about 45 at 1000 cps), and an inductance of about 169 mh, those being the values available in toroids of small sizes.

The value of double-frequency sine-wave synchronization has been demonstrated in the ease with which oscilloscope positioning is obtained during production tests.

Other Circuit Details

The precision slide-wire attenuator common to both signal generators is directly calibrated in microvolts. Maximum f-m and a-m output values are greater than two volts, developed across 500 ohms.

The a-f and r-f vacuum-tube voltmeters are of the same type, being peak reading and calibrated in rms values. Some wave form error is caused by the pyramid, but this is of no consequence since these values are calibrated in terms of the f-m excursion. The latter was found on a band-width meter, but can be approximated for all practical purposes by the shift attained in variation of the resistance tube bias.

The incorporation of a sensitivity control in both vtvm circuits permits considerable tolerance in resistor values, always a difficult problem. Due to the highly degenerative circuit used, tubes are usually fully interchangeable. The two-volt scale is nearly linear.

The power supply unit is conventional in design. Voltage-regulator tubes were employed to aid in stabilizing the f-m oscillator, which proved somewhat critical of supply voltage.

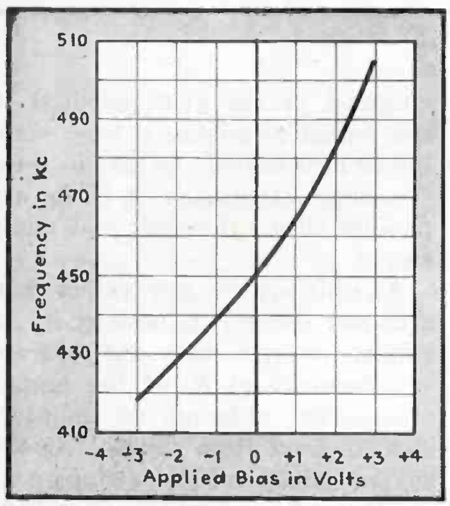


FIG. 3—Variation in f-m oscillator frequency around the 455-kc mean-frequency obtainable by changing the bias on a resistance-tube used as R_2 in Fig. 2

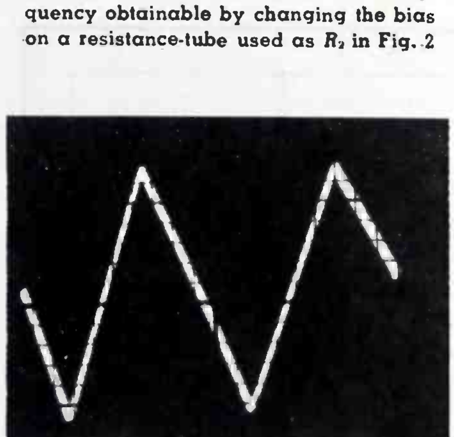


FIG. 4—Output wave form of the 400-cps pyramid oscillator used to modulate the f-m signal generator

It was also found necessary to filter the output-tube bias to prevent 120-cycle modulation. This is accomplished with a simple R-C circuit. The available bias is quite constant, staying within 5 percent in spite of a load variation of better than 2:1.

The complete circuit schematic for this test unit is shown in Fig. 5, with component values suitable for 455-k operation. Care must be taken to prevent interaction between circuits and the leakage of extraneous signals into the output. Adequate shielding and careful layout will tend to minimize all trouble of this nature.

Production Application

When using the equipment for production alignment of receivers a preliminary alignment is usually first made on amplitude modulation, adjusting the i-f amplifier to maximum output and taking a reading of overall sensitivity. At this point, sets showing insufficient gain are diverted to the repair lines.

The generator is then switched to f-m output and adjusted to 455 kc mean frequency. The sweep is adjusted to superimpose the traces. It is now possible to make the corrections in i-f tuning for symmetry and width of the "nose" of the trace. The wide excursion of frequency available permits examination of any stage with a simple adjustment of the band-width control.

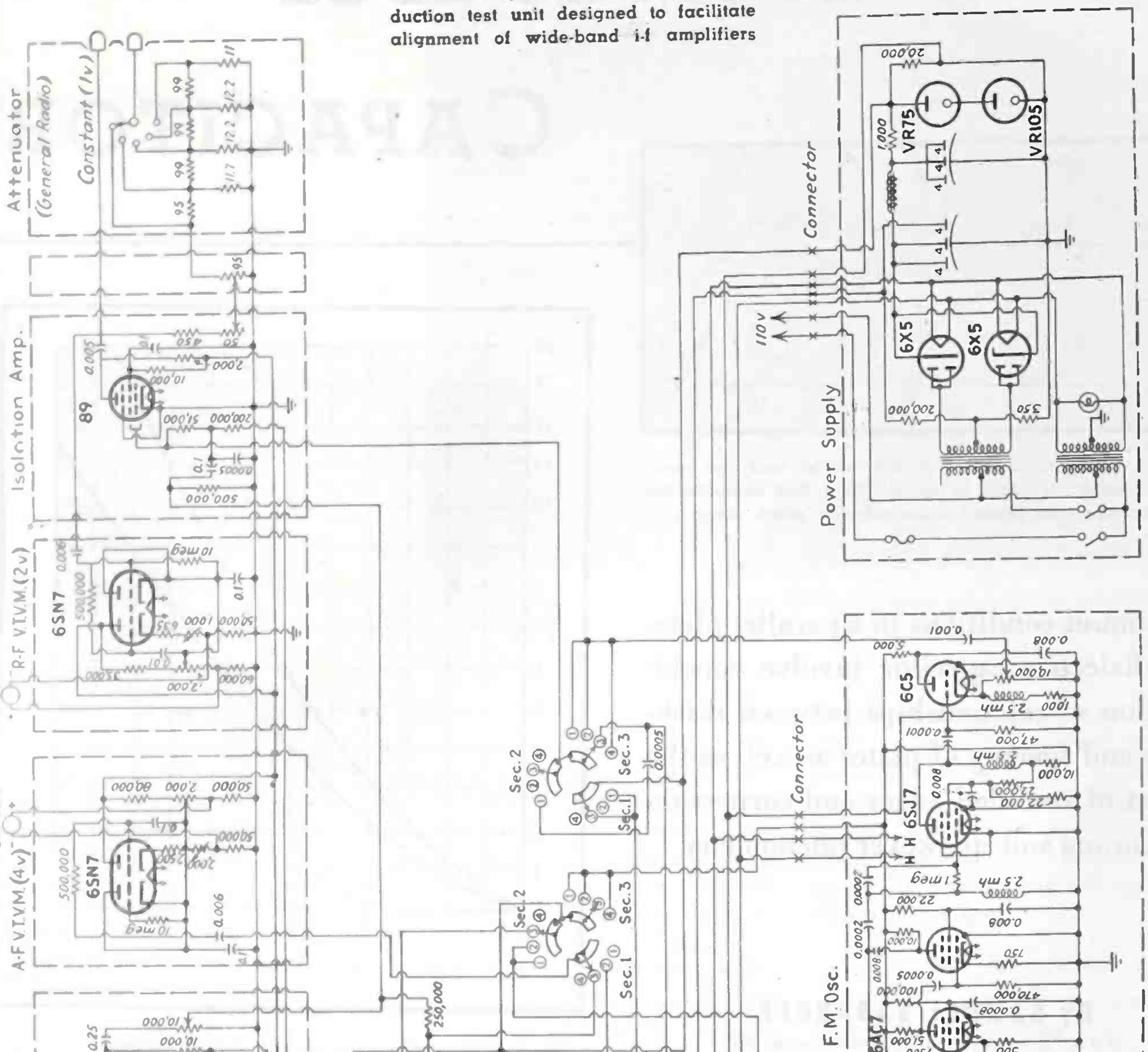
The final check is made with a-m output as the above procedure reduces the overall sensitivity by a small amount. F-M alignment is not an end in itself, due to the many variables encountered.

A well-trained operator is, of course, required in the operation of this generator. Use of the instrument as a final check, however, led to a number of production simplifications in alignment procedure. As an example, an i-f transformer can be resistive-loaded on the winding opposite that being tuned, reducing the interaction in tuning and permitting an adjustment procedure which can be followed by inexperienced operators.

References

(1) Chang, C. K., F-M Resistance-Capacitance Oscillator, *Proc. IRE*, Jan. 1943.
(2) Mayer, H. F., Visual Alignment Generator, ELECTRONICS, April 1940.

FIG. 5—Complete schematic of the production test unit designed to facilitate alignment of wide-band i-f amplifiers



ROUNDED-EDGE CAPACITOR

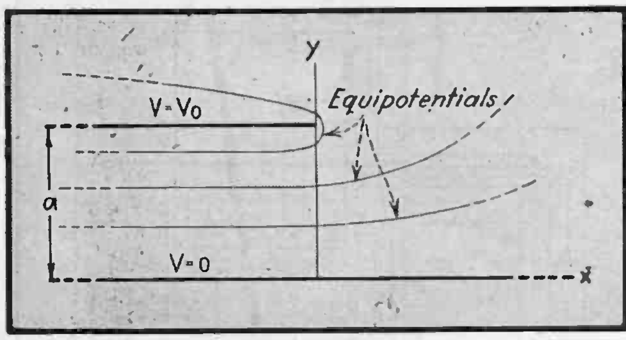


FIG. 1—Situation adjacent to one infinite and one semi-infinite capacitor plate in space. Note that equipotential contours tend toward a curved-edge plate, above

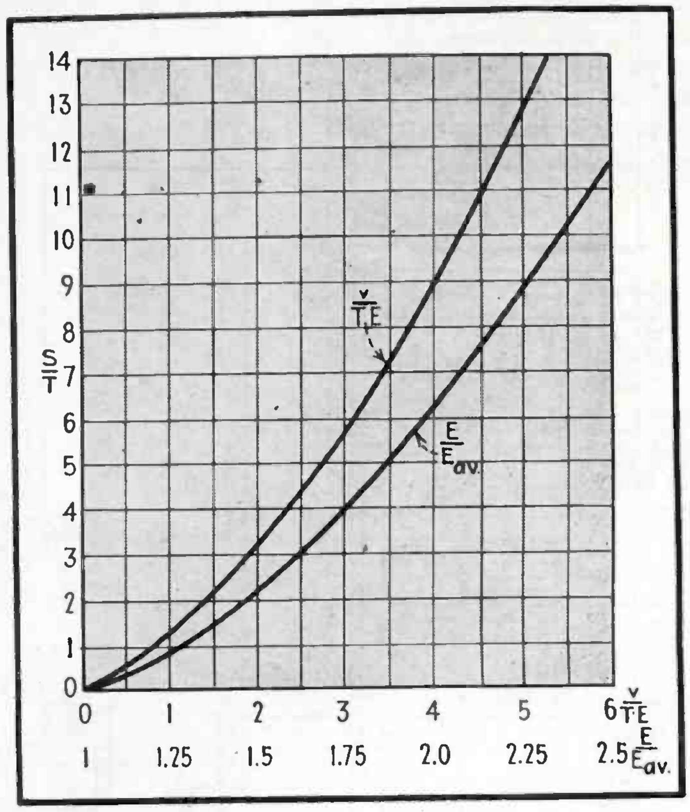


FIG. 2—Values of capacitor-plate spacing-thickness ratio are plotted against potential and gradient relationships

Optimum conditions in a parallel-plate, air-dielectric capacitor involve consideration of relationships between thickness and spacing of plates as well as the effect of rounded edges and corners on corona and sparkover phenomena

By SAMUEL SABAROFF

WCAU Broadcasting Co., Philadelphia, Pa., Consultant to Barker and Williamson, for whom this material was originally prepared.

BETWEEN two oppositely charged parallel plates of infinite extent the field is said to be uniform. It is known, however, that the field between two finite plates is *not* uniform, tending to greater gradients at the edges.

Stress at a point in a dielectric is determined by the gradient at that point and stresses above certain critical values lead to the formation of corona and sparkover. A knowledge of the factors determining maximum gradient assists in proper design of a capacitor.

Approach is Analytical

In this discussion, the dielectric will be taken as air. Plate thickness is assumed to be small, compared to any other linear dimension, except where otherwise noted. Plates with corners are assumed to have them rounded so that their radii of curvature will be large compared with the plate thickness.

It is an easily demonstrable fact that the gradient at a sharp edge is greater than at a rounded surface. Application of a sufficiently high voltage to a conductor will make corona stream from sharp edges while there is very little evidence of it on the flat surfaces. At the outset, then, it would seem advantageous to construct a capacitor with edges having a maximum radius of curvature. Disregarding the possibility of curling the edges over to increase curvature, the plates should be as thick as possible up to a certain point. This lessens the gradient at the edges.

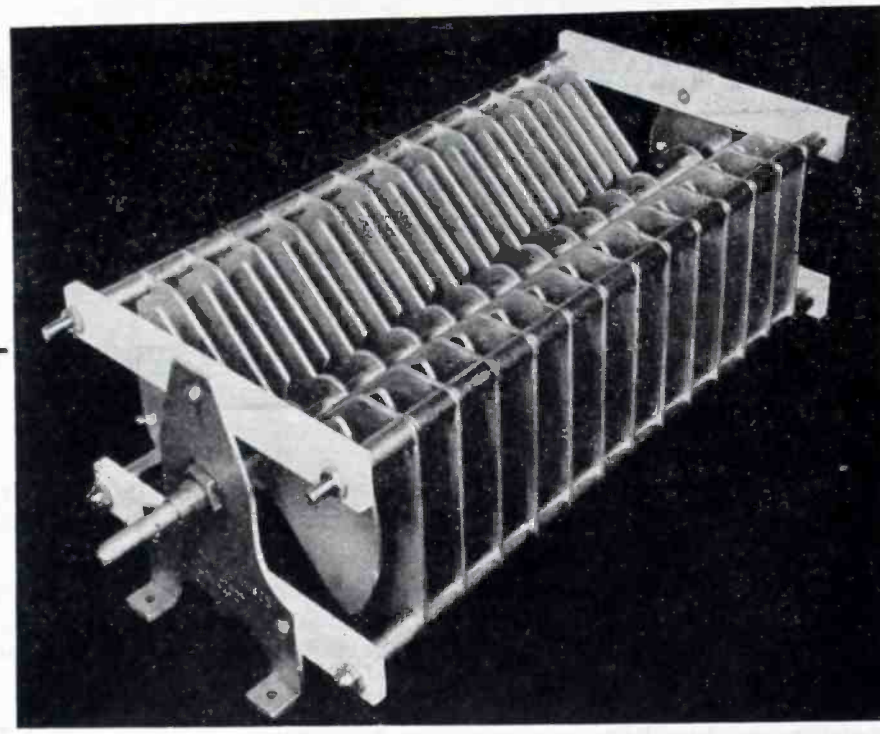
Now suppose the spacing between the two plates is very small compared to plate thickness. For sufficiently small spacing, breakdown will occur between the plates and the edge effect becomes relatively minor.

In view of these considerations it appears that there may be a relation between plate spacing and thickness which will give a minimum gradient for a fixed voltage and a given plate spacing. This is the basic design problem.

Spacing-Thickness Relation

This may be pictured as follows with plate spacing identified as S and thickness as T. For large values of S/T the radius of the plate edge

PLATES



Rounded edges are a corona and sparkover-resistant feature of this Barker and Williamson capacitor. Type is similar to those discussed in the text

small and a high gradient exists iere. As plate thickness is in-eased—keeping plate center-to-nter spacing and applied voltage nstant—the radius of edge curva-ire is increased. This decreases ie edge gradient. Inside the ca-acitor however, the gradient in-eases because of the reduced spac-ig. The best value of S/T can be cated at the crossover point be-ween these two opposing effects. t this point the maximum gradi-at that can occur becomes a min-num. Such critical values have een calculated and observed for her electrode shapes.[1]

It has been suggested by Ek-rand[2] that the best value of S/T iay be between the values of 2 nd 3. This investigation seems to rroborate his figures by fixing ie optimum S/T at 2.77.

What Constitutes Breakdown?

Let us now consider some fac-ors having to do with capacitor reakdown. It has become some-hat of a habit to consider break-own as coincidental with spark-ver. Actually breakdown has oc-urred at the first sign of corona, nd corona may become evident at considerably lower voltage than parkover.

When a conductor is raised be-ond a certain critical potential, the ir adjacent to it becomes ionized, orming corona. The ionized air, eing itself a conductor, can be onsidered to increase the size of he original conductor. If this ef-ect is accompanied by an increase f gradient, the condition becomes nstable and sparkover occurs. If here is a decrease in gradient, the ondition is stable and corona re-nains as such.

Application of this concept to our apacitor is almost obvious. Sup-ose that S/T is greater than the critical value. Now, as we apply a gradually increasing voltage, corona will commence. If we consider the corona as part of the plate, then in effect the plate thickness has been increased, thus reducing the value of S/T. Sparkover should then take place when the value of S/T is less than the optimum.

If we start applying voltage when S/T is less than the best value, then the transition from corona to sparkover is almost instantaneous since an increase in plate thickness will increase the gradient. Of course, there are irregularities in the practical manifestation of this principle. One reason is that corona will not form uniformly on the plates, being most evident where the gradient is maximum.

It has been found that in the case of wires, spheres, and concentric cylinders[3], corona appears for a constant gradient at a distance proportional to $\sqrt{r}$ from the surface, where r is the radius. It may therefore be expected that experiment will show the existence of a similar factor in the formation of corona at the edges of a capacitor.

The microcosmic picture of air breakdown is complex and even of a somewhat metaphysical nature[4] but breakdown characteristics have, in general, been determined by experiment.

This discussion concerns, in the main, a calculation for the best value of S/T. Note that the derivations and approximations are guided by existing physical conditions. Results must inevitably be tested by experiment and qualified where necessary.

Basic Assumptions

Assume that the plates are semi-infinite in extent and that the radius of curvature of an edge is equal to half the plate thickness. Because of symmetry, thus applying the theory of images, it only will be necessary to consider the field between one semi-infinite plate and an infinite plate. This latter is placed midway between the semi-infinite plates and has a potential equal to half their sum.

First, however, consider a pair of plates that are of extreme thinness. The solution for this case is well known.[5] An approximate plot of the equipotentials is shown in Fig. 1, in which it is assumed that the semi-infinite plate has a potential of V_0 volts with respect to the infinite plate and is spaced a inches from it.

Notice particularly the trend in the shape of the equipotentials as they approach the semi-infinite plate. Any equipotential can be replaced by a conductor (of the same

TABLE I. PLATE-DIMENSION RATIOS AND VOLTAGES OF CAPACITORS AT VARIOUS FREQUENCIES

T in.	S in.	S/T	Sparkover kv			Max. gradient (calculated) kv/in.		
			60 cps	700 kc	1500 kc	60 cps	700 kc	1500 kc
0.128	0.218	1.705	14.0	13.5	13.7	89.1	85.8	87.1
0.04	0.192	4.8	8.4	7.59	6.82	80.2	72.5	65.1
0.064	0.719	11.24	24.0	14.28	11.7	82.0	48.8	40.0

shape and charged to the same potential) without disturbing the external field in any way. Thus, if the equipotentials are replaced by equivalent plates, they will tend to an ordinary thin plate with rounded edges as the potential of the semi-infinite plate is approached. The procedure will now be to match, as far as possible, an actual plate to one of these equipotentials and thus obtain an expression for the maximum gradient at its edge. A somewhat arbitrary extension will then be made to indicate the maximum gradient on a plate of any thickness.

Potential around an infinitely thin plate, semi-infinite in extent, can be expressed in the following parametric form

$$\left.\begin{aligned} x &= \frac{a}{\pi}\left[1 + e^{-\pi U/V_0}\cos(\pi V/V_0) - \pi U/V_0\right] \\ y &= \frac{a}{\pi}\left[e^{-\pi U/V_0}\sin(\pi V/V_0) - \pi V/V_0\right] \end{aligned}\right\} \quad (1)$$

where V is potential at any point having the coordinates xy. U is the force or stream function.

In complex form Eq. (1) is

$$Z = \frac{a}{\pi}\left(1 + e^{j\pi W/V_0} + j\pi W/V_0\right) \quad (2)$$

where $Z = x + jy$, $W = V + jU$, and $j = \sqrt{-1}$.

Finding the Gradient

At any point the gradient is found by

$$E = \left|\frac{dw}{dz}\right| = \frac{V_0/a}{\sqrt{1 + e^{-2\pi U/V_0} + 2e^{-\pi U/V_0}\cos(\pi V/V_0)}} \quad (3)$$

where E is gradient in volts per inch.

Along an equipotential, the gradient will depend entirely on concentration of the lines of force. In order to find the point of maximum gradient for any potential, it will be necessary to maximize E partially with respect to force function U. Thus $\delta E/\delta U = 0$ when

$$e^{-\pi U/V_0} = \cos\left[\pi(V_0 - V)/V_0\right] \quad (4)$$

Substituting Eq. (4) in (1) and (3)

$$\left.\begin{aligned} x_m &= \frac{a}{\pi}\left\{\sin^2[\pi(V_0 - V)/V_0] + \log\cos[\pi(V_0 - V)/V_0]\right\} \\ y_m &= \frac{a}{\pi}\left\{\pi V/V_0 + \sin[\pi(V_0 - V)/V_0]\cos[\pi(V_0 - V)/V_0]\right\} \end{aligned}\right\} \quad (5)$$

and

$$E_m = \frac{V_0/a}{\sin[\pi(V_0 - V)/V_0]} \quad (6)$$

As V approaches V_o, Eq. (5) and (6) become

$$\left.\begin{aligned} x_m &= \frac{a\pi(V_0 - V)^2}{2V_0^2} \\ y_m &= a \end{aligned}\right\} \quad (7)$$

and

$$E_m = \frac{V_0^2}{a\pi(V_0 - V)} \quad (8)$$

Selecting the Curvature

At this point it becomes necessary to determine the manner in which an actual plate should be matched to an equipotential. A reasonable condition is that the radius of curvature of the actual plate and the radius of curvature of the equipotential at the point of maximum gradient be made equal.

For the radius of curvature the formula is

$$R = \left[1 + \left(\frac{dy}{dx}\right)^2\right]^{3/2}\left(\frac{d^2y}{dx^2}\right)^{-1} \quad (9)$$

At any point on an equipotential the radius of curvature, as found from Eq. (1) and (9), is

$$R = \frac{a\left[1 + 2e^{-\pi U/V_0}\cos(\pi V/V_0) + e^{-2\pi U/V_0}\right]^{3/2}}{\pi e^{-\pi U/V_0}\sin(\pi V/V_0)} \quad (10)$$

On any equipotential, at the point of maximum gradient, the radius of curvature is found by substituting Eq. (4) in (10), thus

$$R_m = \frac{a\sin^2[\pi(V_0 - V)/V_0]}{\pi\cos[\pi(V_0 - V)/V_0]} \quad (11)$$

As V approaches V_o, the radius of curvature becomes

$$R_m = a\pi(V_0 - V)^2/V_0^2 \quad (12)$$

Let S equal the actual plate spacing and T equal the plate thickness. An approximate match can be assumed when $(y_m - R_m)$ is identified with $S/2$ and R_m is assumed equal to $T/2$. It is not necessary to consider x_m and it is now ignored. V is made equal to $v/2$ where v is the actual potential between the plates. When a and V_o are eliminated from Eq. (7), (8) and (12),

$$S = \frac{v}{E}\left(\frac{v}{\pi ET} + \frac{2}{\pi}\right) - \frac{T(\pi - 1)}{\pi} \quad (13)$$

where the subscript has been omitted from E_m.

Since T is assumed small with respect to S, the right-hand term can be omitted in Eq. (13), resulting finally in

$$S = \frac{v}{E}\left(\frac{v}{\pi ET} + \frac{2}{\pi}\right) \quad (14)$$

Up to this point a small value of T has been assumed with respect to S. Now disregard the derivation and consider Eq. (14) alone. If we allow the plate thickness to approach infinity in Eq. (14), it becomes

$$S = \frac{2}{\pi}\frac{v}{E} \quad (15)$$

Compare this with the relation

$$S = \frac{v}{E} \quad (16)$$

which holds for two plates in which the edge effect is negligible. This is equivalent to the condition when T equals infinity.

Condition Generalized

Similarity between Eq. (15) and (16) suggests the possibility of Eq. (14) being adjusted so that it would hold for T large as well as small. This can be done approximately by replacing the constant $2/\pi$ in Eq. (14) by unity, thus

$$S = \frac{v}{E}\left(\frac{v}{\pi ET} + 1\right) \quad (17)$$

Eq. (17) is admittedly approximate. Assuming for the moment that its accuracy has been established, let us examine it for the presence of a best value for S/T. This best value is, of course, the

(*Continued on page 268*)

CATHODE FOLLOWER Calculations

Equations relating cathode follower output impedance to the value of the cathode resistor, the plate load resistance of the cathode follower tube, and the transconductance of the tube

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In SOLVING for the output impedance of a cathode follower such as the one shown in Fig. 1(a) it is most convenient to set up the required circuit equations by assuming the cathode of the tube driven by a generator of voltage E_1 and internal resistance R_1. Fig. 1(b) shows the addition of this generator and Fig. 1(c) is the resulting equivalent circuit.

The general equations for a two-loop network are*

$$Z_{11}I_1 + Z_{12}I_2 = E_1 \qquad (1)$$

$$Z_{12}I_1 + Z_{22}I_2 = E_2 \qquad (2)$$

where Z_{11} is the total impedance in loop 1, Z_{22} is the total impedance in loop 2, Z_{12} is the mutual impedance between loops 1 and 2, and E_1 and E_2 are the generator voltages in loops 1 and 2 respectively.

According to Fig. 1(c) the equivalent voltage acting in the grid circuit, or the rise in voltage from cathode to grid, is $(I_2 - I_1)\,R_2$, and $-\mu(I_2 - I_1)\,R_2$ is the voltage acting in the plate circuit in the direction shown if it is taken as voltage driving I_2 clockwise. Upon substitution of these values in Eq. (1) and (2) there results

$$(R_1 + R_2)\,I_1 - R_2I_2 = E_1 \qquad (3)$$

$$-R_2I_1 + (R_2 + R_p)\,I_2 = -\mu\,(I_2 - I_1)\,R_2 \qquad (4)$$

Solving these two simultaneous equation yields for the driving point impedance

$$Z_1 = R_1 + R_2 - \frac{R_2^2\,(1+\mu)}{R_p + (1+\mu)\,R_2} \qquad (5)$$

from which it is obvious that the impedance looking into the cathode; that is, the output impedance of the cathode follower, is

$$Z_1 - R_1 = R_2 - \frac{R_2^2\,(1+\mu)}{R_p + (1+\mu)\,R_2} = Z_{out} \qquad (7)$$

Since μ is much larger than 1, especially in high-gain triodes and pentodes, Eq. (7) may be converted to

$$Z_{out} = R_2 - \frac{R_2^2}{(R_p/\mu) + R_2} = R_2 - \frac{R_2^2}{(1/g_m) + R_2} \qquad (8)$$

This impedance is made up of the cathode resistance and the internal impedance of the cathode in parallel; and if Z_c represents the latter, Eq. (8) can be written

$$Z_{out} = \frac{Z_cR_2}{Z_c + R_2} \qquad (9)$$

After transformation and substitution of Eq. (8) for Z_{out}

$$Z_c = [(1 + g_mR_2)/g_m] - R_2 = 1/g_m \qquad (10)$$

If the cathode follower tube had been used with a plate load, either to limit the plate current or to provide a push-pull voltage, the equation for the internal impedance of the cathode follower would be

$$Z_c = (1/g_m) + (Z_L/\mu) \qquad (11)$$

where Z_L is the plate load.

The internal impedance of a cathode follower is given by Eq. (10) for the case of no plate load, or by Eq. (11) if there is plate load. It is seen from Eq. (9) that the effect of the internal impedance of the cathode follower tube is to add an impedance Z_c, in parallel with the cathode load impedance.

* Everitt, W. L., "Communication Engineering", McGraw-Hill Book Co., p. 217-229.

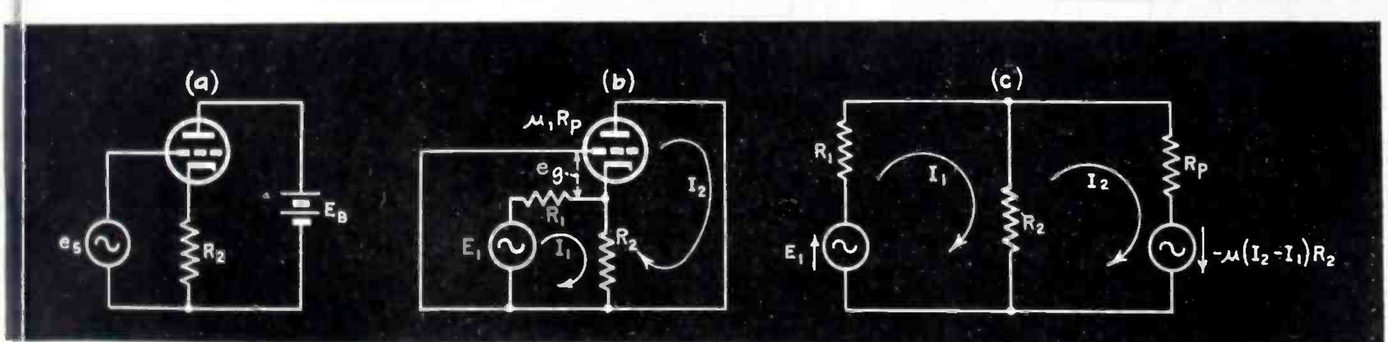

FIG. 1—(a) The actual circuit in which the impedance across R_2 is sought. In (b) a fictitious generator, E_1, of internal impedance R_1, is introduced. The equivalent circuit from which the derivation begins is shown at (c)

Circuit Response to NON-SINUSOIDAL

Short-cut method of determining the current response either graphically or analytically in circuits energized by square, saw-tooth, repeated exponential and similar waves, by decomposing into components starting at different instants, then adding responses

FOURIER'S analysis[1] is a general method for evaluating the circuit response to non-sinusoidal periodic waves. But it is not always the most convenient method for evaluating the transient response, especially to those non-sinusoidal periodic waves which are discontinuous in the wave itself or its derivative with respect to time. The actual solution of a problem by means of this method is sometimes tedious and time-consuming.

Another method, possibly first used by Poisson and later by Duhamel[2] and based on the superposition of step functions, decomposes any kind of waves, periodic or not, into so-called Heaviside unit functions[3] which start at different instants. This method has been used more extensively in treating non-periodic waves. In fact, it is a very powerful tool for evaluating the circuit response to some types of commonly encountered non-sinusoidal waves which are discontinuous in the wave itself or its derivative with respect to time, such as square waves, saw-tooth waves, trapezoidal waves, repeated exponential waves and output voltage waves of controlled rectifiers.

Owing to the geometry of the non-sinusoidal wave, an easier solution can often be obtained; instead of being decomposed into Heaviside unit functions, the wave can be decomposed into waves of other types which have the same wave form but start at different instants. This short-cut method (based on an extension of "superposition of step function," generally known as Duhamel's integral), permits determining the transient response easily by either analytical or graphical methods.

Decomposition of Square Waves

Square waves are used in the communications field for testing the frequency response of electric circuits[4]. A symmetrical square wave having an amplitude A and a period of $2t_1$ can be decomposed into a number of different constant-ampli-

* Based on a paper presented before the Chinese Institute of Engineers, American Section, in New York City July 2, 1944.

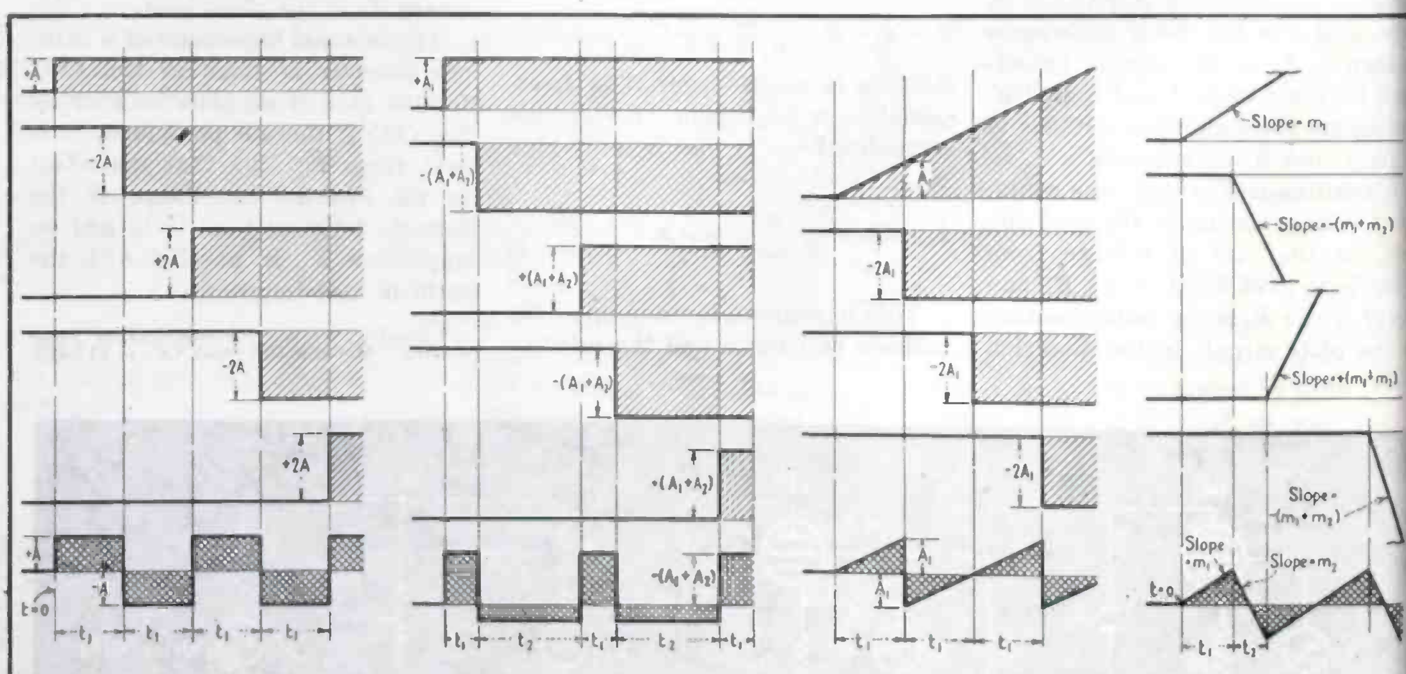

FIG. 1—Decomposition of symmetrical square waves shown at bottom with double shading

FIG. 2—Decomposition of unsymmetrical square wave into components shown above

FIG. 3—Decomposition of ideal saw-tooth wave into two types of components

FIG. 4—Decomposition of saw-tooth wave into rising and falling components

WAVE FORMS

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ble components starting at differ-e time intervals, as shown graph-ically in Fig. 1. The first compo-nent starts at $t = 0$ and has an am-plitude of $+ A$. The second starts later and has an amplitude of $2A$. At interval t_1 after this, the third component starts with an amplitude of $+ 2A$. Thereafter, components of $-2A$ and $+2A$ in amplitude start alternately at suc-cessive intervals of t_1.

The decomposition of an unsym-metrical square wave, having un-equal positive and negative ampli-tudes of A_1 and A_2 respectively, shown in Fig. 2. The duration of is t_1, and that of A_2 is t_2.

Saw-Tooth and Trapezoidal Waves

Saw-tooth waves can also be used test frequency response of elec-trical circuits. In some respects, these waves are superior to square waves, as suggested by Waidelich[5]. An ideal saw-tooth wave, having a slope A_1/t_1 and a period of $2t_1$, can be decomposed into a linearily ris-ing voltage having a slope of A_1/t_1 and starting to occur at $t = 0$, plus constant driving forces of $-2A_1$ starting to occur at succeeding in-tervals of t_1 as shown in Fig. 3.

The saw-tooth waves of Fig. 3 can hardly be produced by practical means, since it takes some time for the saw-tooth wave to fly back to its original position. Figure 4 shows more practical saw-tooth waves which can be produced by some electronic circuits[6]. These waves can be decomposed into: A linearly rising wave of slope m, starting at $t = 0$; a linearly rising wave of slope $-(m_1 + m_2)$ starting t_1 later; a wave of slope $+(m_1 + m_2)$ start-ing at $t_1 + t_2$; a wave of slope $-(m_1 + m_2)$ starting at $2t_1 + t_2$, etc. (The linearly rising waves in Fig. 4 should continue to rise, but in order to save space they are not shown beyond the broken lines.)

Figure 5 shows the decomposition of trapezoidal waves. The procedure is more or less similar to that for saw-tooth waves.

Output Voltage Waves of Gaseous Rectifiers

When gaseous-discharge type rec-tifiers, such as thyratrons and ig-nitrons, supply an inductive load with continuous conduction of cur-rent, the geometry of the output voltage wave depends on the num-ber of phases of the rectifier circuit and the angle of phase retard.[8]

Figure 6 shows the decomposi-tion of the output voltage wave of a bi-phase uncontrolled rectifier cir-cuit having no phase retard. It can be decomposed into a continuous sine wave having a peak value A_1, starting in a positive direction at $t = 0$, followed by a series of sine waves each having a peak value of $2A_1$, and starting in a positive di-rection every half-cycle later.

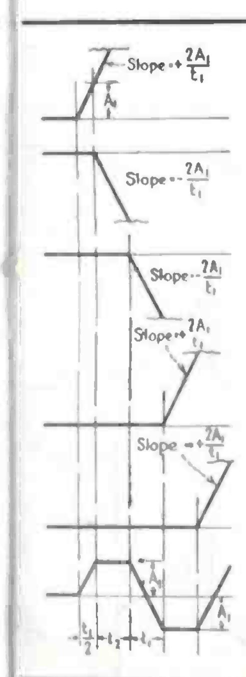


FIG. 5—Decomposition of trapezoidal waves. Components are cut off here to conserve space

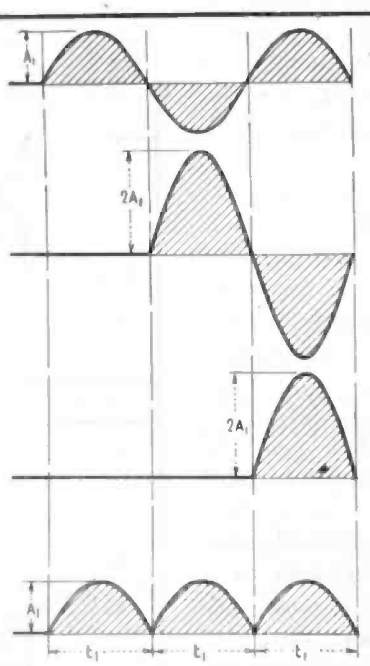


FIG. 6—Decomposition of output voltage of bi-phase uncontrolled rec-tifier; no phase retard

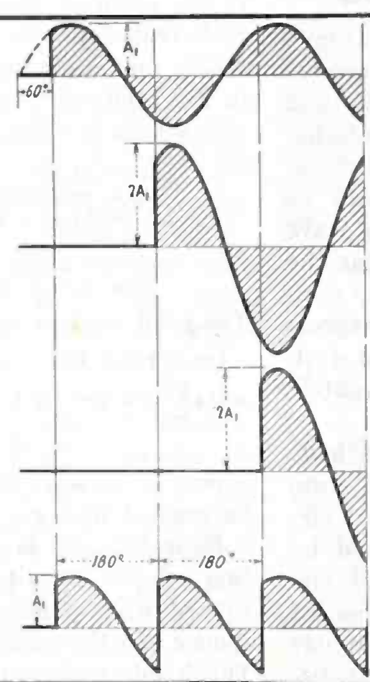


FIG. 7—Decomposition of output voltage of bi-phase rectifier, phase retarded 60 degrees

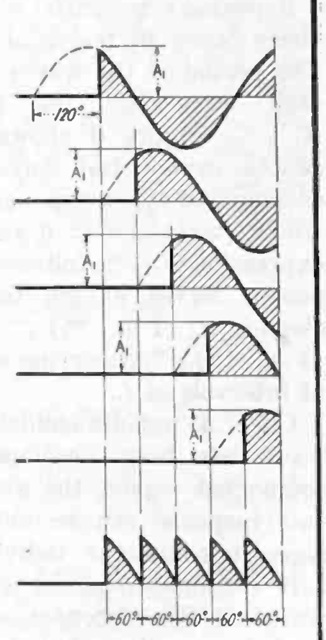


FIG. 8—Decomposition of output voltage of six-phase rectifier, phase retarded 60 degrees

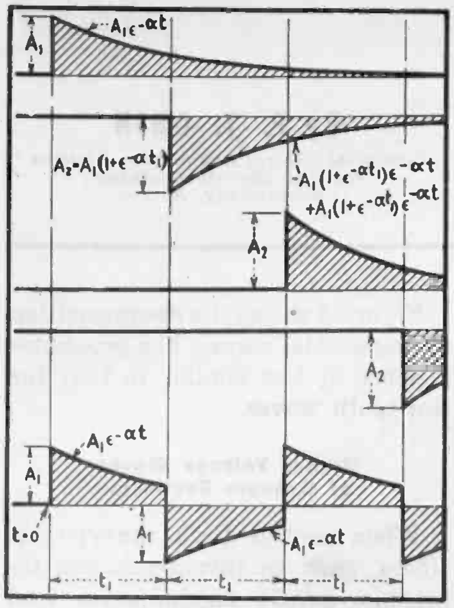


FIG. 9—Decomposition of repeated exponential waves

Figure 7 shows the decomposition of the output voltage wave of a bi-phase rectifier with a phase retard of 60 electrical degrees. It is evident that the decomposition is similar to that shown in Fig. 6 except that each sine wave starts with a magnitude corresponding to the value $A_1 \sin 60°$ instead of zero.

Figure 8 shows the decomposition of the output voltage wave of a 6-phase rectifier. The continuous sine waves are spaced at 60° and all the sine waves have the same peak value A_1.

Repeated Exponential Waves

Repeated exponential waves sometimes occur in television circuits.[3] The period of the waves is $2t_1$ and each wave has the expression $A_1\,\epsilon^{-\alpha t}$. Figure 9 shows that repeated exponential waves can be decomposed into a exponential wave which starts at $t = 0$ and has the expression $A_1\,\epsilon^{-\alpha t}$, followed by component waves having the expressions $-A_1\,(1 + \epsilon^{-\alpha t_1})\,\epsilon^{-\alpha t}$ and $+A_1\,(1 + \epsilon^{-\alpha t_1})\,\epsilon^{-\alpha t}$, occurring alternately at intervals of t_1.

Once a non-sinusoidal periodic wave has been decomposed into component waves, the over-all circuit response can be obtained by superimposing the individual circuit responses on the component waves. These responses are similar in their wave form but start at different instants. Two examples, one for a square-wave voltage applied to R and C in series and the other for the output current of a bi-phase controlled rectifier supplying an inductive load, will be used to show the procedure used in both the analytical and graphical versions of this short-cut method of determining circuit response.

Circuit Response to Square Waves

Suppose it is required to find the transient response of a circuit to a symmetrical square-wave voltage having a magnitude A and a period $2t_1$. This involves finding the response during the existence of the nth square wave after the square-wave voltage is applied.

Analytical Solution

Taking the analytical solution first, assume that time is zero at the beginning of the $(n + 1)$th square wave, n being an even number. The component waves are

Component Wave	Magnitude	Instant at Which Wave Starts
$n+1$	$+2A$	0
n	$-2A$	$-t_1$
$n-1$	$+2A$	$-2t_1$
$n-2$	$-2A$	$-3t_1$
....	....	....
3	$+2A$	$-(n-2)t_1$
2	$-2A$	$-(n-1)t_1$
1	$+A$	$-nt_1$

Let i_{n+1}, i_n, ..., i_2, i_1 be the current responses to the $(n + 1)$th, nth, ..., 2nd and 1st component waves respectively. Now, since the response of the circuit is a function of time [written $f(t)$, with its significance depending on the particular combination of circuit elements in the circuit], the individual circuit responses to the component waves may be specified as follows in the general analytical solution where time is defined as $t_1 \geqq t \geqq 0$:

$$
\begin{aligned}
i_{n+1} &= 2A\, f(t) \qquad (1)\\
i_n &= -2A\, f(t + t_1)\\
i_{n-1} &= 2A\, f(t + 2t_1)\\
&\cdots\cdots\cdots\cdots\\
i_2 &= -2A\, f[t + (n-1)t_1]\\
i_1 &= A\, f(t + nt_1)
\end{aligned}
$$

The total current response is

$$
i = i_1 + i_2 + i_3 + \ldots\ldots + i_n + i_{n+1}
$$

$$
= 2A\sum_1^n (-1)^{s-1} f(t + st_1) - Af(t + nt_1) \qquad t_1 \geqq t \geqq 0 \qquad (2)^*
$$

where s is any integral number between 1 and n.

Equation (2) is a general solution of the circuit response to a square wave from its known response to a Heaviside unit function. The steady-state solution can be obtained by making n approach infinity.

* Equation (2) is also true when n is odd.

As an example of the analytical solution, suppose the circuit is made of a resistance R and a capacitance C in series. The circuit response to a Heaviside unit function $f(t)$ will be $(1/R)\epsilon^{-t/CR}$, and the total current response will be

$$
i = \frac{2A}{R}\epsilon^{-t/CR}\left[\sum_1^n (-1)^{s-1}\epsilon^{-st/CR}\right] - \frac{A}{R}\epsilon^{-(t+nt_1)/CR} \qquad t_1 \geqq t \geqq 0 \qquad (3)
$$

The expression in brackets is a familiar geometric series. When its sum is substituted in Eq. (3), the total current response becomes

$$
i = \frac{2A}{R}\epsilon^{-t/CR}\left[\frac{1 - \epsilon^{-(n+1)t_1/CR}}{1 + \epsilon^{-t_1/CR}}\right] - \frac{A}{R}\epsilon^{-(t+nt_1)/CR} \qquad t_1 \geqq t \leqq 0 \qquad (4)
$$

The steady-state solution can be obtained by letting n approach ∞:

$$
i = \frac{2A}{R}\epsilon^{-t/CR}\left[\frac{1}{1 + \epsilon^{-t_1/CR}}\right] t_1 \geqq t \geqq 0 \qquad (5)
$$

The graphical solution for the current response during the first four square waves is summarized in Fig. 10. It is performed by plotting the circuit responses to component waves which have a magnitude of A for the first component and $-2A$ $+2A$ and alternatively for the successive components, spaced at a time interval of t_1. Superimposing all the responses gives the resultant current response, shown at the bottom in Fig. 10. The graphical method is

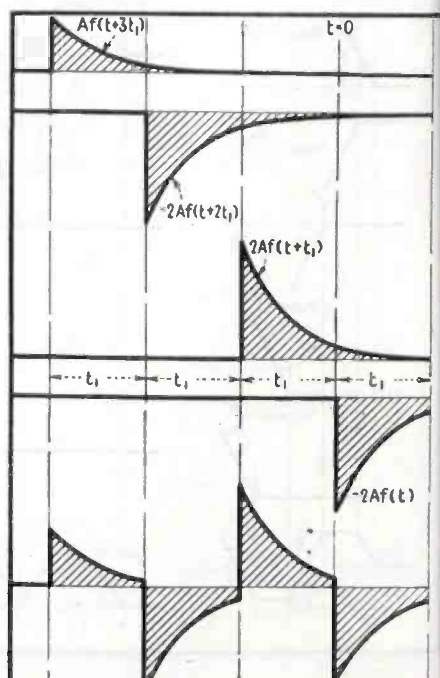


FIG. 10 — Current response where square-wave voltage is applied to R and C in series

ɪvenient in obtaining the tran-
ꞅnt response during the first few
cles, but as time goes on, the
nnipulation becomes more and
ore tedious and the result less
ıd less accurate.

Current Response of Bi-Phase Controlled Rectifier

With an inductive load consisting o a resistance and an inductance i series supplied by a controlled ꞅtifier of the gaseous discharge ɔe, the current during successive ɔnduction periods will be different ɑter the closing of the switch if tɜ conduction is continuous. It is ꞅquired to find the transient curꞅnt response at any instant durꞅ the existence of the nth rectified ltage wave after the closing of te switch

Again starting with the analytical ɜution, the peak value of the anode ltage is A. The phase retard of tɜ controlled rectifier can be exꞅessed as θ_f electrical degrees. The ıne interval equivalent to 180 elec-ical degrees is t_1, and is equal to $\omega = 1/2f$. The beginning of nth ꞅctified wave is taken as the zero ɑis of time.

Component Wave	Magnitude	Time at which Wave Starts	
		In Elec. Deg.	In Sec.
nth	$2A$	0	0
$-1)$th	$2A$	π	$-t_1$
$-2)$th	$2A$	2π	$-2t_1$
....			
2	$2A$	$(n-2)\pi$	$-(n-2)t_1$
1	A	$(n-1)\pi$	$-(n-1)t_1$

The transient current response of ɑ inductive load consisting of R ıd L in series to a unit sinusoidal ve closing at sin $(\omega t + \theta_f)$ is[10]

$$= \frac{1}{Z} \sin(\phi - \theta_f)\,\epsilon^{-\alpha t} + \frac{1}{Z}(\omega t - \phi + \theta_f) \quad (6)$$

which

$$Z = [(\omega L)^2 + R^2]^{0.5}$$
$$\theta = \tan^{-1}(\omega L/R)$$
$$\alpha = R/L$$

ıen the current responses to component waves are

$$= \frac{2A}{Z}\sin(\phi - \theta_f)\,\epsilon^{-\alpha t} + \frac{2A}{Z}\sin[\omega t - \phi + \theta_f]$$

$$_1 = \frac{2A}{Z}\sin(\phi - \theta_f)\,\epsilon^{-\alpha(t + t_1)} + \frac{2A}{Z}\sin[\omega t - \phi + \theta_f + \pi]$$

....

$$= \frac{2A}{Z}\sin(\phi - \theta_f)\,\epsilon^{-\alpha[t + (n-2)t_1]} + \frac{2A}{Z}\sin[\omega t - \phi + \theta_f + (n-2)\pi]$$

$$= \frac{A}{Z}\sin(\phi - \theta_f)\,\epsilon^{-\alpha[t + (n-1)t_1]} +$$

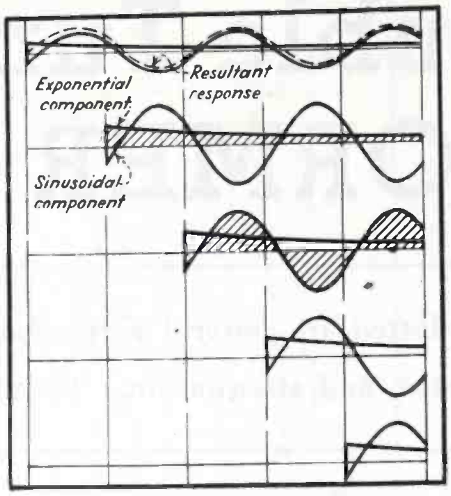


FIG. 11 (above)—Responses to component voltage waves of a controlled gaseous rectifier, for an inductive load

FIG. 12 (right)—Total response for arrangement of Fig. 11 is obtained by combining each type of component voltage separately, then combining the two resultant wave forms

$$\frac{A}{Z}\sin[\omega t - \phi + \theta_f + (n-1)\pi]$$
$$t_1 \geqq t \geqq 0 \quad (7)$$

The total current response is

$$i = i_1 + i_2 + \ldots\ldots\ldots\ldots\ldots i_{n-1} + i_n$$
$$= \frac{2A}{Z}\sin(\phi - \theta_f)\,\epsilon^{-\alpha t}\left[\frac{1 - \epsilon^{-n\alpha t_1}}{1 - \epsilon^{-\alpha t_1}}\right] - \frac{A}{Z}\sin(\phi - \theta_f)\,\epsilon^{-\alpha[t + (n-1)t_1]}$$
$$+ \frac{A}{Z}\sin(\omega t - \phi + \theta_f)$$
$$t_1 \geqq t \geqq 0 \quad (8)$$

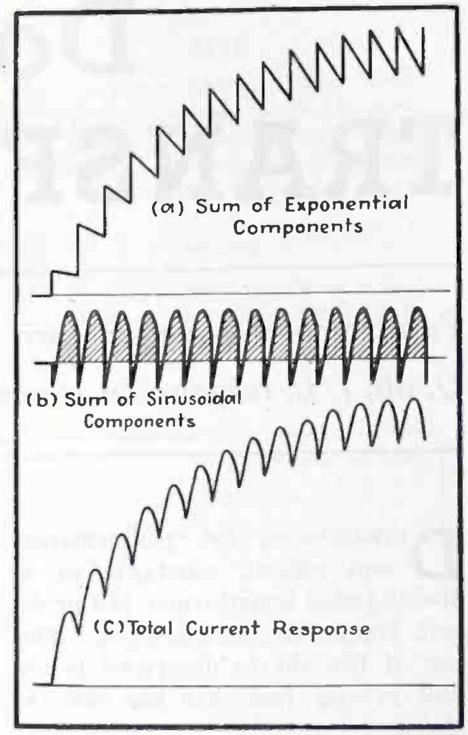
The steady-state solution, with $n \to \infty$, is

$$i = \frac{2A}{Z}\sin(\phi - \theta_f)\,\frac{\epsilon^{-\alpha t}}{1 - \epsilon^{-\alpha t_1}} + \frac{A}{Z}\sin(\omega t - \phi + \theta_f)$$
$$\pi \geqq \omega t \geqq 0 \quad (9)$$

Figure 11 shows the current responses to the component waves graphically. The exponential and sinusoidal components for each component wave are plotted separately. The resultant of exponential components, which is in the form of stepped exponential waves, is shown in Fig. 12(a). The sum of all sinusoidal components, which is a discontinuous periodic wave consisting of 180 electrical degrees of sine wave starting from sin $(\phi - \theta_f)$, is shown in Fig. 12(b). The total response is the sum, shown in Fig. 12(c).

Conclusions

The principle of decomposing some types of non-sinusoidal waves into waves of the same wave form



but starting at different instants can be utilized as a short-cut method to obtain both the transient and the steady-state circuit responses to these waves.

The mathematical analysis involved in this method is comparatively simple and fundamental. It can be performed by those who do not have an adequate training in higher engineering mathematics, such as Laplacian transformation often used as a tool in solving problems of this nature.

The graphical analysis is very convenient for evaluating the transient response during the first few cycles, but may become more tedious and less accurate for evaluating the steady-state response, especially for circuits with large time constants.

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Double-Tuned TRANSFORMER DESIGN

Fundamental equations are plotted in general form showing the relations between k, Q, db, f/f_0, response at resonance, and attenuation. Examples illustrate use of curves

By DAWKINS ESPY

Design Engineer
Collins Radio Company
Cedar Rapids, Iowa

DETERMINING the performance and circuit constants of a double-tuned transformer is a problem frequently encountered. The use of the charts described below will greatly facilitate the calculations.

The general expression for the attenuation of two identical coupled circuits is[1]

$$\text{db} = 20 \log \frac{\sqrt{4\left(Q\dfrac{\Delta f}{f_0}\right)^2 + \left[1 + (Qk)^2 - \left(Q\dfrac{\Delta f}{f_0}\right)^2\right]^2}}{2Qk} \quad (1)$$

This relation is plotted in Fig. 1 so as to give the level variation of a family of Qk curves with respect to $Q(\Delta f/f_0)$.

The coupling between the two coils, k, and the Q of the coils is related to width of the pass-band by[2]

$$\frac{\Delta f}{\sqrt{2} f_0} = \sqrt{k^2 - 1/Q^2} \quad (2)$$

where $\Delta f/f_0$ is the fractional frequency deviation. The $\sqrt{2}$ converts from peak separation to bandwidth[3]. The level change in the pass-band may be obtained by setting $\Delta f/f_0 = 0$ in Eq. (1) and dividing the result by 2 in order to obtain the variation in gain from the average, as a function of coupling. This leads to

$$\Delta\text{db} = 10 \log \frac{(Qk)^2 + 1}{2Qk} \quad (3)$$

Equations (2) and (3) are plotted simultaneously in Fig. 2. This chart gives the solution of the problem involving the four variables k, Q, $\Delta f/f_0$, and Δdb, with any two of them known. Since k is usually an adjustable variable, there are three possible cases

Known	*Unknown*
(1) $\Delta f/f_0$ and Δdb	Q and k
(2) $\Delta f/f$ and Q	Δdb and k
(3) Δdb and Q	$\Delta f/f$ and k

The relative response at resonance, due to variations in Qk, is obtained from the reciprocal of the expression resulting from setting $\Delta f/f_0 = 0$ in Eq. (1). This gives

$$\text{Gain reduction factor} = \frac{2Qk}{(Qk)^2 + 1} \quad (4)$$

The solid curve in Fig. 3 is plotted from Eq. (4). The factor used to determine the average gain in the pass-band, as a function of Qk, is obtained by averaging the gain reduction factors at maximum pass-band gain and at resonance. This yields

$$\text{Gain reduction factor} = \frac{(Qk + 1)^2}{2[(Qk)^2 + 1]} \quad (5)$$

A plot of this expression for values of $Qk \geqq 1$ is shown by the dashed line in Fig. 3.

Design Considerations

Design requirements of double-tuned r-f transformers ordinarily involve some particular attenuation at a given frequency-deviation from resonance. Knowing the required response in db, $\Delta f/f_0$, and the

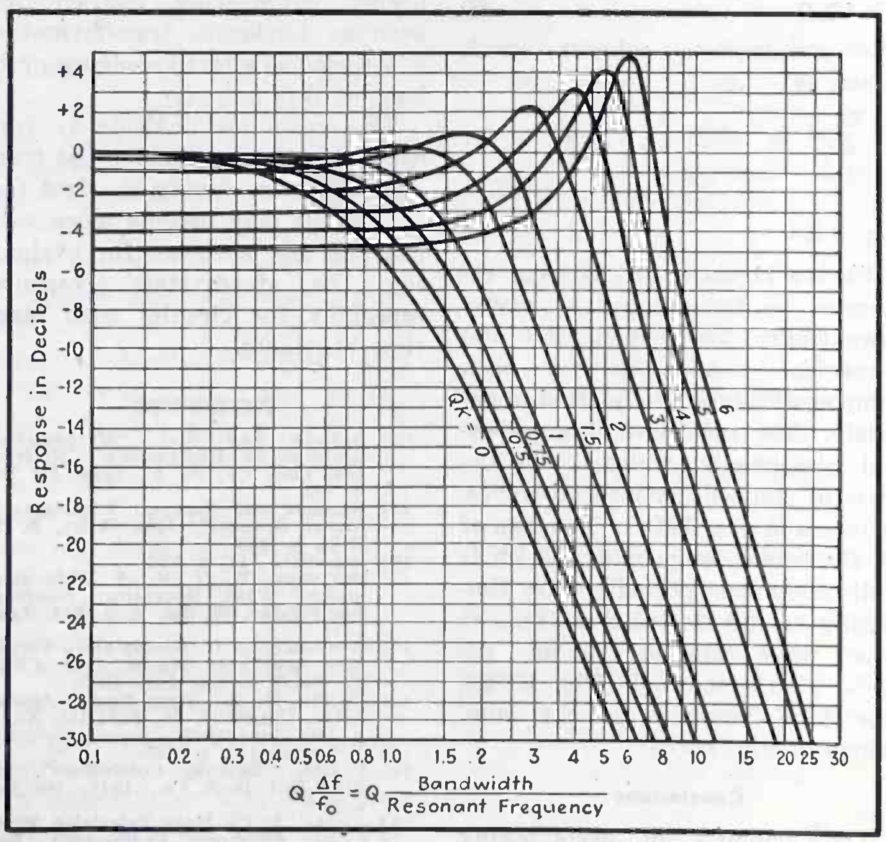
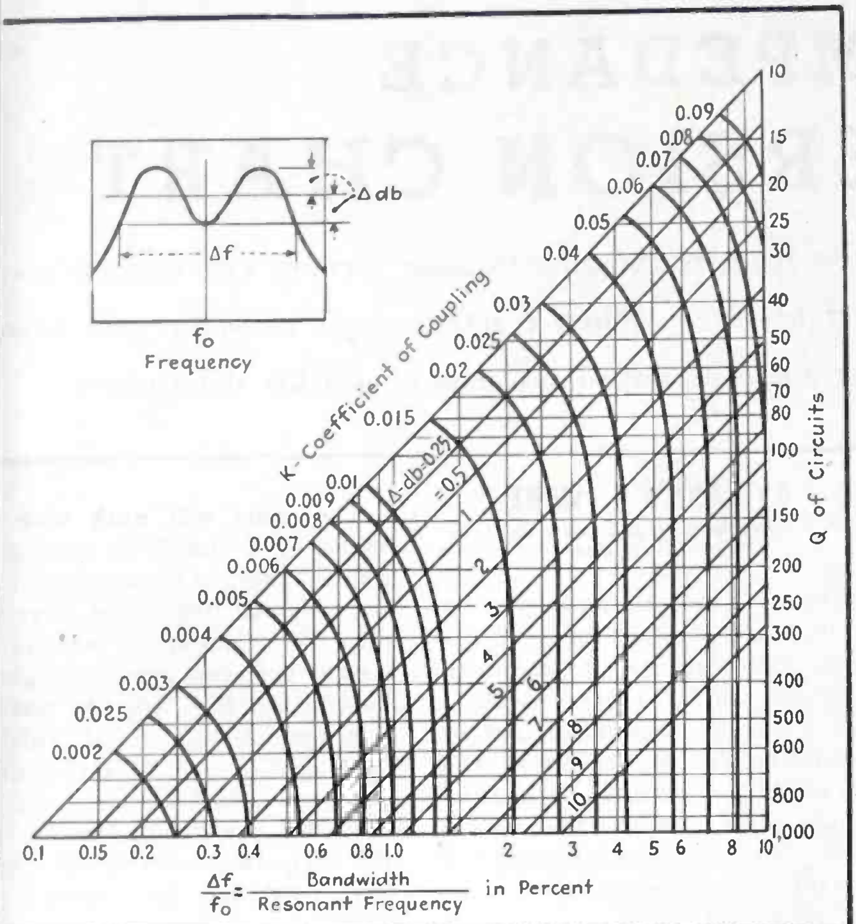


FIG. 1—Universal selectivity curves, showing deviation from average pass-band response vs deviation from resonance

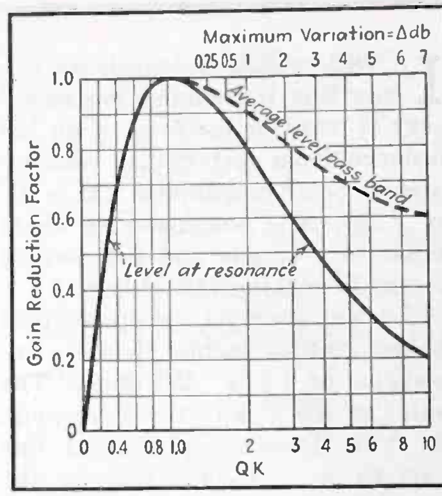


LEFT

FIG. 2—Three-parameter chart giving the relation between frequency deviation, coupling coefficient, and circuit Q for values of maximum response variation within the band

BELOW

FIG. 3—Output level plotted as a function of the product of coupling coefficient and circuit Q



ailable Q, the required Qk is determined from Fig. 1, and thus the value of k is found. If attenuation at a specific point has been the design criterion, the resulting Δdb can be determined from Fig. 2.

Frequently a transformer must be designed with a certain allowable response deviation from the average pass-band response. Usually the deviation, given in the charts as Δdb, the width of the band, given as Δf, and the resonant frequency, f_o, are known. By using Fig. 2, it is possible to calculate the corresponding Q and k. The resulting attenuation at various frequencies can be determined by the use of Fig. 1.

Design Procedure

1. Determine Q, k, $\Delta f/f_o$ and Δdb from Fig. 2.
2. Calculate maximum gain from ($g_m X_L Q/2$) where g_m is the transconductance of the tube driving the transformer, and X_L is the reactance of either coil at f_o.
3. From Qk or Δdb, find the gain-reduction factor from Fig. 3 and multiply it by the gain obtained in step 2 to obtain actual gain.
4. Determine the gain at any portion of the response curve from Fig. 1.

Examples

1. An i-f transformer operating at 456 kc with a tube having a g_m of 3000 μmhos is required to have a pass-band of 16 kc. The response must not vary more than one db from the average. The inductance of each transformer winding is 250μh. Find Q, k, the average gain, and the attenuation at 20 kc from resonance.

Calculating $\Delta f/f_o = 16/456 =$ 3.51 percent
From Fig. 2: $Q = 70$; $k = 0.028$
Max. gain $= g_m X_L Q/2 =$ $3000 \times 10^{-6}\, 2\pi 456 \times 10^3 \times 250 \times 10^{-6} \times 70/2 = 75.2$
Average gain in pass-band $75.2 \times 0.9 = 67.7$, where the 0.9 is read from Fig. 3.
For 20 kc deviation, $\Delta f = 40$ kc and
$(Q\Delta f/f_o) = (70 \times 40/456) = 6.14$
$Qk = 70 \times 0.028 = 1.96$
From Fig. 1 the attenuation = 18 db.

2. An i-f transformer is required to work at 3 Mc with a tube which has a g_m equal to 5000 μmhos, and using a 30-μh coil with a Q of 200. Find k and gain at resonance to give a compromise between gain and selectivity. Determine the gain at bandwidths of 10, 25, 50 and 75 kc.

A value of $Qk = 0.5$ is a good compromise between gain and selectivity, reducing the gain to 0.8 of the value obtained at critical coupling (Fig. 3), while improving the selectivity (Fig. 1).

For $Qk = 0.5$, $k = 0.5/200 =$ 0.0025
Max. gain $= g_m X_L Q/2 = 283$
Gain at resonance $= 283 \times 0.8 =$ $226 \equiv 47.1$ db
$Q/f = 200/3000 = 0.0667$
From Fig. 1

Δf in kc	10	25	50	75
$Q(\Delta f/f_o)$	0.667	1.667	3.333	5.000
Attenuation in db from Fig. 1	2.2	9.3	19.5	26.0
Gain in db: 47.1 minus Attenuation	44.9	37.8	27.6	21.1

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IMPEDANCE CONVERSION CHART

Conversion of complex quantities from rectangular to polar form or vice versa is readil accomplished, using only a straight-edge. When reactance and resistance are know the magnitude and phase angle of impedance may be quickly determined

By PERRY H. WARE
Simplex Wire and Cable Co
Cambridge, Mass.

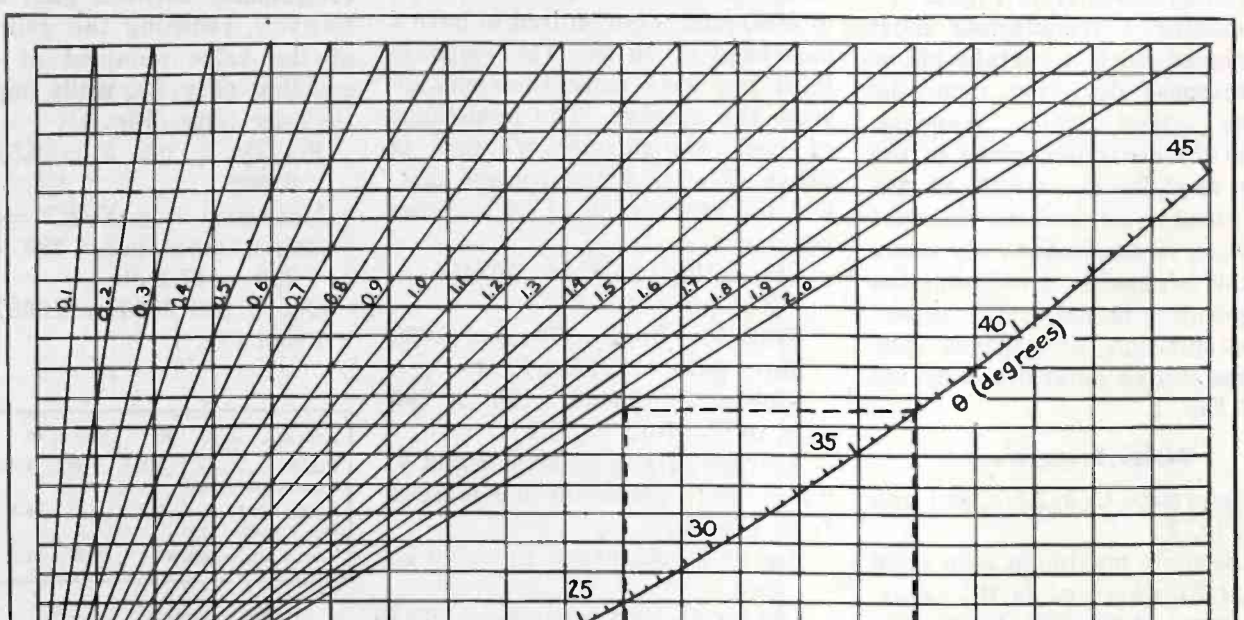
IN THE COURSE of impedance calculations, it often becomes necessary to transfer the form of an impedance from rectangular coordinates to polar coordinates ($R + jX = Z\angle\phi$). The accompanying chart provides a simple and time-saving means of making this change.

As an example, suppose that bridge measurements yield an impedance of $1.5 + j2.0$ ohms. The value of R/X is in this case equal to 0.75. Drawing a vertical line (shown as a dashed line on the chart) through 0.75 on the horizontal scale, it will be seen that this line intersects the phase-angle curve on the chart at a value of 36.9 degrees. This angle, θ, is the complement of the true phase angle, 53.1 degrees. Drawing a horizontal line to the left from 36.9 on the phase-angle curve until it intersects the diagonal line 2.0 corresponding to the value of X, then dropping a perpendicular to the horizontal scale, we obtain a correction $Z-X$ of 0.5, which when added to the value of $X = 2.0$, yields the impedance, Z, equal to 2.5; therefore $1.5 + j2.0 = 2.5\angle 53.1°$.

If R is larger than X, the ratio X/R is used as the original argument, and θ is the phase angle directly as read. The diagonal line corresponding to R rather than X is used, and correction is added to R.

The chart will work with an values of X and R, by moving th decimal point in the scales of X (o the diagonal lines) and correctio term $Z - X$ (on the scale of ab cissas) the same number of place leaving the R/X scale as marke For example, $20 + j15$ yields value of $X/R = 0.75$, giving pha angle equal to 36.9 degrees. Consi ering the line $R = 2.0$ as $R = 2$ the correction term is 5.0, rathe than 0.50, and the impedance $25\angle 36.9°$.

The inverse operation ($Z\angle\phi =$ $+ jX$) may also be carried out b means of estimated values, an practice will enable the user of th chart to carry out the computation quite rapidly.




ore often than not,
if it's a metal-plastic
assembly it's a CINCH
it's "Know How"

INDUSTRIAL CONTROL

Machining Control Cuts Finishing Time

A REDUCTION in finishing time from 13½ hours to 5 minutes in the machining of aluminum spar beams for plane wings has been accomplished at one Cleveland aircraft plant, with the help of General Electric Thy-mo-trol installed on a large automatic contour milling machine designed and built by the Onsrud Machine Works, Inc. of Chicago.

The spar beams are long, one-piece structural channels which run lengthwise through the wing, from fuselage to wing tip. Wing ribs and cap strips are fastened on the beams to make up the rigid framework of the wing. The spar must be machined accurately to permit perfect joining of ribs and cap strips, and it must also be contoured exactly to conform with the irregular shape of the wing itself.

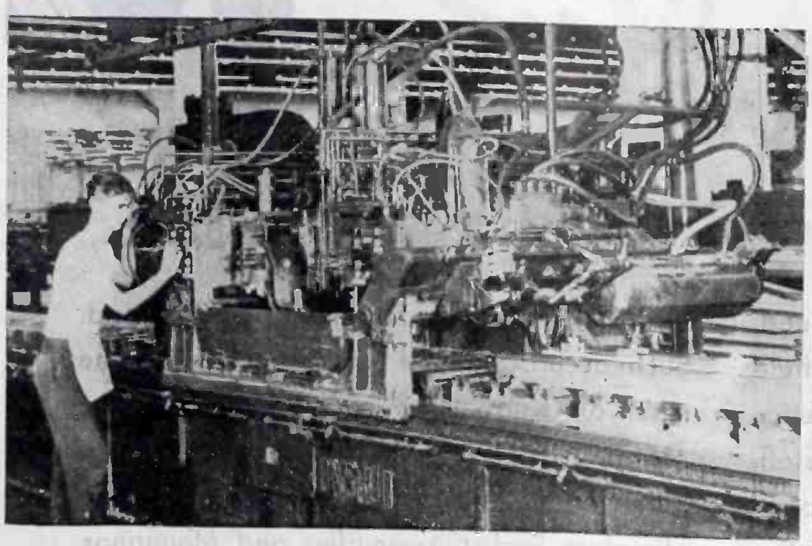
The carriage of the milling machine houses four cutter motor assemblies, providing two horizontal and two vertical cutters which turn at 3,600 and 10,800 rpm, ideal speeds for the aluminum alloys involved. Each cutter is controlled by a follower which travels over a template or former bar as the carriage moves from one end of the table to the other. The bed and table are long enough to permit machining the long spar in a single setup. With the four cutters, every type cut required by spar beam design may be made, such as face, slot, and side milling, twist cutting, beveling, and making cutouts for weight reduction.

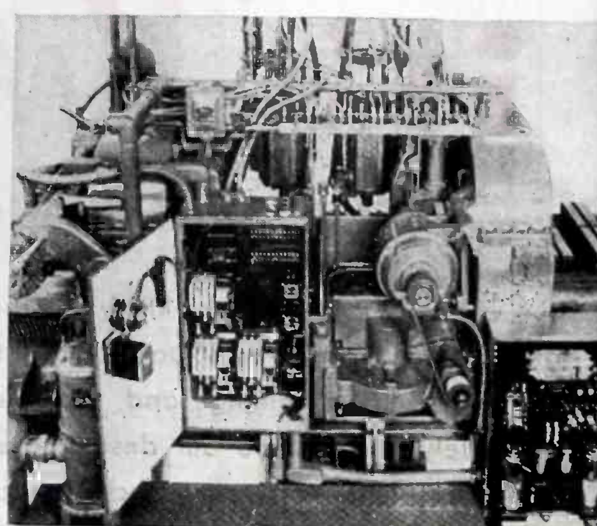
Carriage Control

Need for a flexible carriage speed control was met by the Thy-mo-trol drive, which assures that the cutters are fed to the work at all times in proper relation to the changing contours of a spar beam. For example, in one pass over the table the depth of cut may increase and decrease several times while the number of cutters entering the work may change from one to four. Such varying conditions required a change of feed to avoid overloading of the cutter motors. Moreover a fast "skip" speed was essential to save time when no cutting at all is necessary.

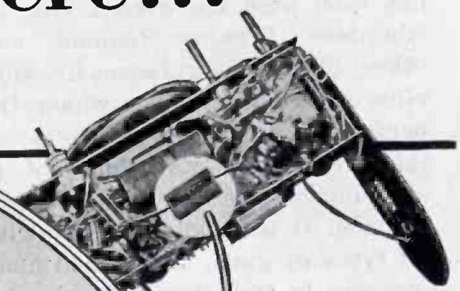
With the electronic system, a-c power is converted to d-c to obtain a stepless speed range with a rheostat-controlled d-c carriage-drive motor. The control unit makes possible a carriage feed at any speed from 4 in. to 18 ft 6 in. per minute. This infinitely variable speed within the established limits has resulted in the topspeed machining of the complex spar beam at all times.

An automatic cam bar feed designed by Onsrud engineers makes it unnecessary for the operator to judge the maximum speeds at which the carriage can be fed during the many different conditions encountered in a pass. During carriage feed, a rheostat-connected follower travels over the cam bar, which is contoured accurately in proper relation to the work. Up-and-down travel of the follower as governed by the cam varies the control of the rheostat, and at every point of the pass the mechanically pre-determined carriage speed is at the exact maximum that work will permit.


Automatic contour milling machine in operation. Equipped with G-E Thy-mo-trol, it does in 5 minutes a finishing operation in the machining of aluminum spar beams that formerly took 13½ hours


Close-up of G-E Thy-mo-trol panel and a-c magnetic controller (at left, door open) on the milling machine. The control panel at right without cover is for the 2-hp motor (center) which drives the carriage feed

Not Much Space Here...



But The P. R. MALLORY & CO. Inc. MALLORY Type WB Capacitor

Doesn't Need Much Space!

Keep Backing the Attack with War Bonds

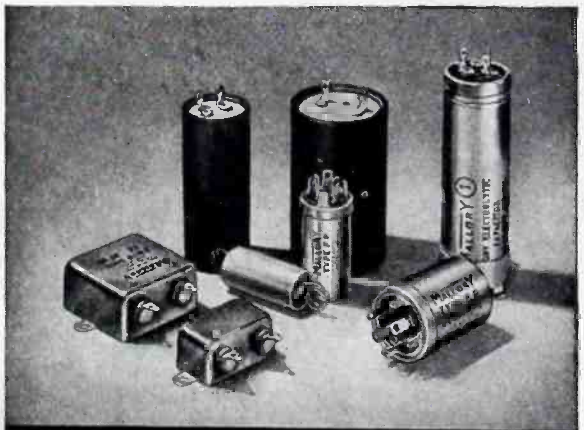
MALLORY has pioneered the manufacture of dry electrolytics through the age of "specials" and individual specifications . . . can still supply them upon demand. But developments have proved that industry can best be served by standardized types of capacitors. The Mallory WB type capacitor is such a unit: an example, too, of careful design and production offering maximum capacity in a minimum amount of space.

Mallory type WB capacitors are housed in aluminum tubes that provide an effective seal against moisture absorption and loss of electrolyte, A cardboard cover provides excellent insulation against shorts when the aluminum tube is assembled in close quarters.

These electrolytic capacitors are ideal for applications in AC/DC sets and wherever space is at a premium. They are shorter than most cardboard tubulars that require extra length for sealing wax at either end.

These advantages—plus the hermetic seal of WB's—makes possible a tubular capacitor that withstands humidity and temperature changes harmful to most cardboard types. See your Mallory distributor or write direct for further information.

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



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

Test Muzzle Velocity with Time-Interval Counter

AN ELECTRONIC INSTRUMENT that has been used for over a year at Aberdeen Proving Ground and other places instantaneously supplies information upon which the performance of a given gun is established and the uniformity of its ammunition checked within a few seconds. It is equally effective with all types of guns, from small hand weapons to 16-inch rifles.

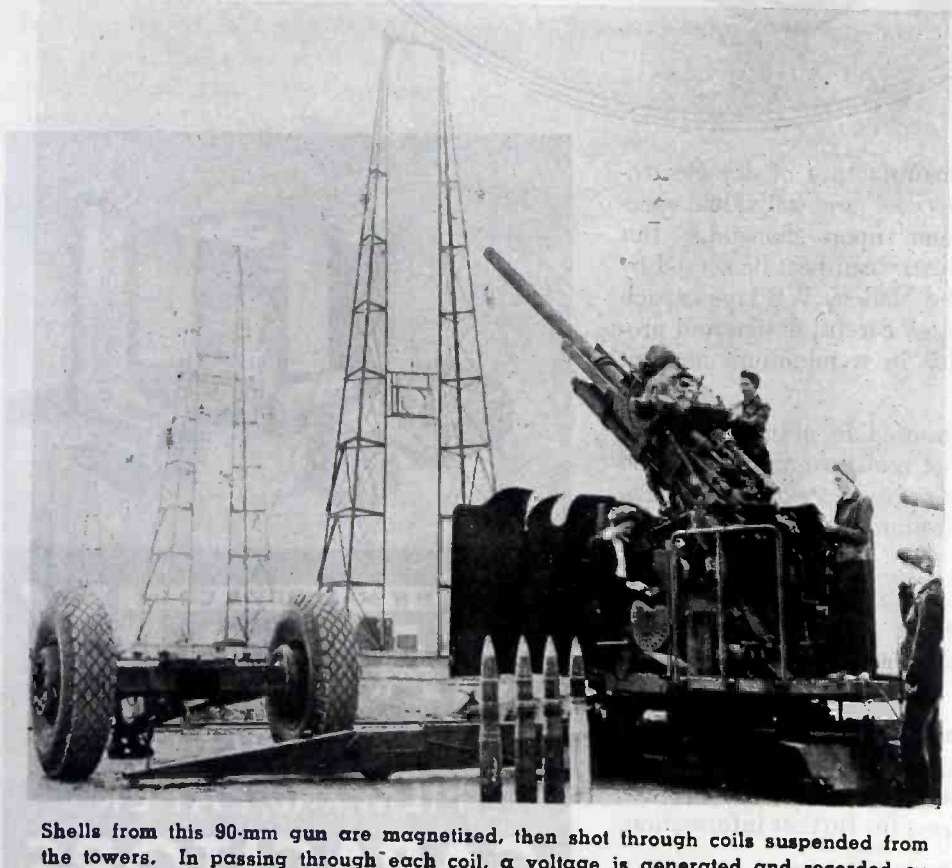
Developed especially for the Aberdeen Grounds by RCA Laboratories at Princeton, N. J., the electronic time-interval counter is designed to measure, with great accuracy, a time interval in the order of 0.01. Extreme accuracy is obtained through the ability of the device to give this measurement to within 0.00001 second. The research on this device was brought to fruition, and a very practical device made available to the military services through the work of Igor E. Grosdoff, RCA research engineer.

Principle of Operation

Each range is equipped with two electrical coils, arranged so that a projectile will pass through them in succession. By magnetizing the projectile, a small electrical signal is generated by each coil as the bullet passes through. If the coils are 30 feet apart, and the time between the two signals is 0.01 second, the bullet is traveling 3,000 feet a second. The measurements can be made at the rate of hundreds of observations a day.

The counter consists of three essential parts: an oscillator, a gate, and the counter proper. The frequency of the oscillator is controlled, as in a radio transmitter, by a quartz crystal ground to operate at precisely 100 kc. The gate is a vacuum-tube circuit which passes the pulses into the counter, which counts them and finally, when the gate is closed, shows by indicator lamps the number of pulses that have passed through. Thus, it shows the number of hundred-thousandths of a second from the time the gate opened until it closed.

In operation on the firing ranges, the counter's gate is opened by the electrical signal from the first coil as the bullet passes through it, and is closed again by the impulse from the second coil. The operator records the time of flight between coils and computes the velocity. It is noted down along with the record of the particular gun and projectile being tested for subsequent analysis by ballistic experts. The operator then touches the reset button and is ready to repeat.



Shells from this 90-mm gun are magnetized, then shot through coils suspended from the towers. In passing through each coil, a voltage is generated and recorded on a chronograph. Electronic equipment permits determining the time interval to within a hundred-thousandth of a second

Electronic Sorting Table for Small Parts

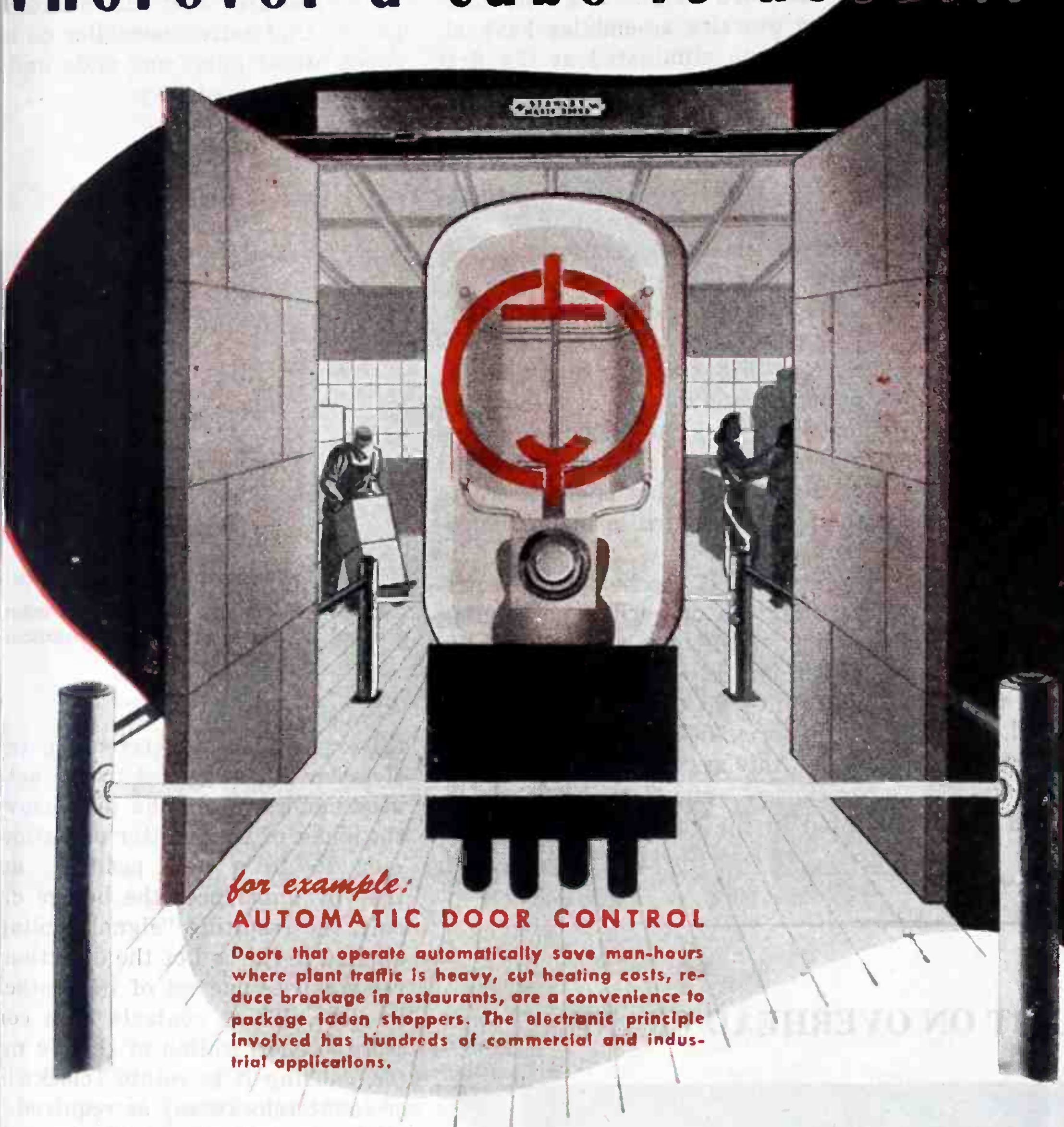
MUCH GREATER SPEED in the sorting and inspection of tiny contact assemblies produced at General Electric's Schenectady Works has been made possible through the development of an electronic sorting table which routes the assemblies into three different channels depending on whether they are too high, too low, or within the tolerances.

Previously, the contact assemblies, each almost small enough to require handling with tweezers, were sorted and inspected by hand. Each assembly was checked with a needle micrometer to determine whether it was oversize, undersize, or within the tolerances, and then sorted accordingly.

Small assemblies being fed onto a slide for electronic sorting. The chutes for oversize and correct-size assemblies are located at lower left. Units that are too small travel the full length of the slide

The specially designed sorting table incorporates an electronic relay and a factory-constructed "contact head." Each assembly is fed

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.

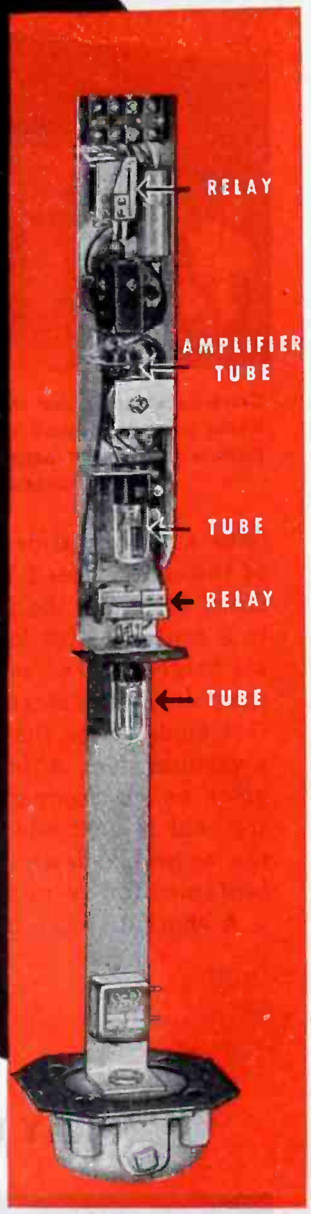


PHOTO-ELECTRIC DOOR CONTROL

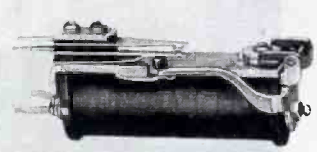
Above unit manufactured by General Electric Co., is a part of STANLEY "MAGIC DOOR" CONTROLS.

THERE'S A JOB FOR *Relays* BY GUARDIAN

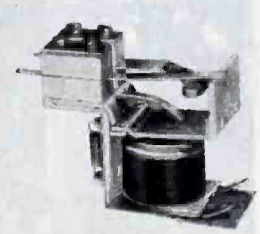
★ The "Magic Door" made by The Stanley Works of New Britain, Conn., uses a General Electric control unit which operates automatically at the approach of a pedestrian or vehicle. In this unit a beam of light focused on the cathode of a phototube causes a tiny current to flow. Enlarged through an amplifier 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

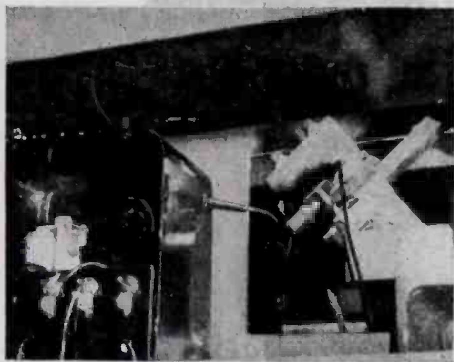


Series R-100 H. F. Relay

GUARDIAN ELECTRIC

1625-L W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY



Close-up view of the work table for electronic sorting of small assemblies. At the right is the contact head and at the left is the electronic relay

onto a 45-deg slide which is part of the contact head. About halfway down the slide, the assembly comes to a contact point located at a preset height. If the assembly touches the point, it is oversize, and the contact made closes the grid circuit of a vacuum tube, which in turn energizes an electromagnetic relay. A solenoid is next energized, sending the assembly down a chute into a container for oversize parts.

A short distance beyond the first point, a second contact point is set at standard height less tolerance. Since oversize assemblies have already been eliminated at the first contact point, parts touching the second point are within acceptable limits and are "shot" down another chute. Undersize assemblies do not touch either point and slide undisturbed to a third tray.

Positioning Controls for Planes and Ships

FOR COMPLETELY ELECTRICAL remote positioning of rudders or other controls on airplanes or ships, it is possible to use a simple direct-current bridge circuit in which two potentiometers are connected in parallel across the d-c power source and the coil of a sensitive polarized or directional relay is connected to the movable contact arms of the potentiometers.

Figure 1 is a schematice electrical diagram of such a positioning control circuit. As shown here, the directional relay controls a reversible split-field direct-current motor with series-field windings F_1 and F_2. In this system, the transmitter, or control potentiometer P_T, is located in the cockpit, while the receiver, or position reference potentiometer P_R, is geared to the actuator motor. When the pilot moves the slider of transmitter potentiometer P_T to a new position, and thereby unbalances the bridge circuit, the resulting "signal" voltage applied to the coil of the directional relay causes one set of its contacts to close. These contacts then control the energization of the d-c motor, causing it to rotate (clockwise or counterclockwise) as required to move the actuator and the controlled aircraft members to the desired new position, corresponding to the pilot's setting of the transmitter control P_T.

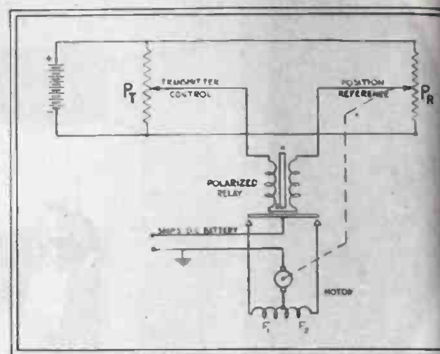


Fig. 1—Positioning control circuit using a balanced d-c bridge and polarized relay

The broken line connecting the motor and position reference potentiometer P_R represents the gearing which causes the motion of the slider of this potentiometer to be proportional to that of the controlled aircraft member and, therefore, when the latter reaches the desired position, the slider of potentiometer P_R matches the pilot's of P_T. The bridge is again balanced so that no further control signal voltage is applied to the coil of the directional relay, thus allowing its contacts to reopen. The motor is thereupon deenergized and the actuator remains in its new position.

Unless the relay is made exceptionally sensitive, the system shown is subject to positioning errors of

X-RAY UNIT ON OVERHEAD CRANE

Crankcases and other component parts for Navy ships are x-rayed for possible faults at Warren City Mfg. Co., Warren, Ohio. One of four of its kind in the country, the overhead x-ray equipment in the background can photograph steel plate up to 4 inches thick. Other portable industrial x-ray units appear in the foreground and extreme background

In anticipation of "the day," alert manufacturers recognize the importance of lining up sound sources for the component parts they will require.

Right now, as for many months past, IRC research engineers are busily engaged in war development work on many new types of resistances which will fit the pattern of post-war applications. In addition, special design problems have been undertaken in instances where the prospective volume warranted such course.

That IRC will have in its expanded line most of the resistance devices industry will need, is assured as a result of careful market surveys. These quality units will be offered at prices consistent with mass production methods made possible through operation of the world's largest resistor plants.

If resistances will play a part in your post-war products, why not get in touch with IRC now? No obligation is entailed.

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

the order of ± 2 percent to ± percent of the total travel the driven device. It is difficult such a system to provide for ant hunt or stabilizing means in th electric motor control. Thus, due t the inertia of the motor, the spee of operation of the controlled mem ber has to be limited and the widt of the null, or backlash, zone mu be considerably wider than is nece sary in a system that may incorpo ate a proper degree of "anticip tion."

Electronic Positioning Control

To avoid using an extremel sensitive and delicate relay on aircraft to obtain higher positio ing accuracy and also to provid absolute stability and antihunt fe tures, an electronic control circu has been developed in which th sensitive relay is replaced by a vac uum-tube and differential-rela combination. Such a system was de scribed by William P. Lear of Lea Avia, Inc., in a paper delivered at joint meeting of the Franklin In stitute and the Philadelphia sectio of AIEE.

Figure 2 shows a schematic dia gram of a positioning control ci cuit using the electronic tube—re lay system with a balanced alter nating-current bridge connected t the secondary S_1 of power trans former T_1. In this circuit, the slid

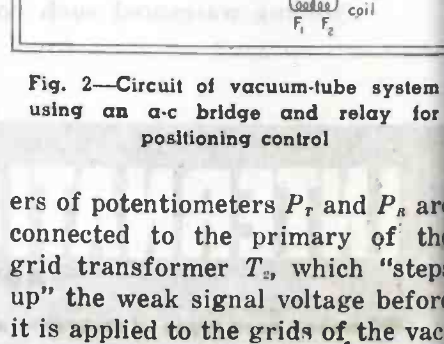

Fig. 2—Circuit of vacuum-tube system using an a-c bridge and relay for positioning control

ers of potentiometers P_T and P_R are connected to the primary of the grid transformer T_2, which "steps up" the weak signal voltage before it is applied to the grids of the vacuum tube VT. The differential relay coils, which are connected respectively in series with the plates of the tube, receive their power from the secondary S_2 of the power

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There is a range of 210 degrees between the prevailing temperatures at the Equator and the Arctic Circle. Yet microphones must operate unfailingly, whether used at New Guinea or Murmansk. Shure Research, in heated chambers and dry ice temperatures, assures our armed forces Microphones that will bring the message through under any temperature condition. It's the same Shure Research that assures you a better postwar product.

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transformer. When the bridge cir cuit is balanced there is no a-c sig nal to the grids of the tube, and th relay coil currents are balanced The relay contacts are open and th motor is de-energized.

When the pilot moves the slide of transmitter potentiometer P_T t a new position, the tube amplifie and rectifies the resulting unbal anced signal voltage, causing on relay coil current to increase an the other to decrease. The rela operates to energize the actuato motor, which then moves the drive aircraft component, and with it th slider of position reference poten tiometer P_R to the position corres ponding to that of the transmitte potentiometer P_T. The bridge cir cuit is again balanced so that n further control signal voltage is ap plied to the grids of the vacuum tube VT and the relay coil current return to their balanced values, a lowing the relay to open and sto the actuator in its new position.

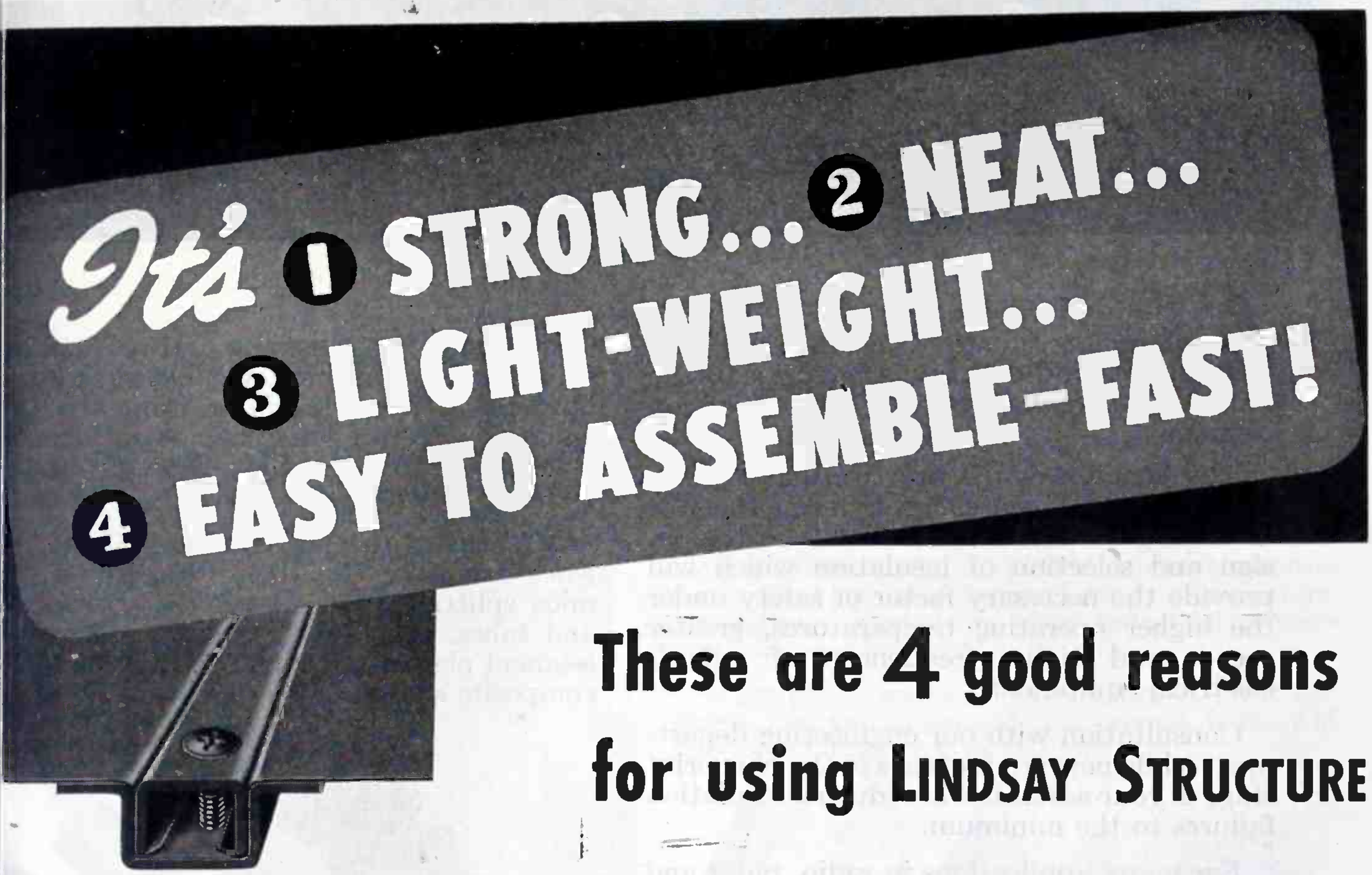
Magnetic Clutch

An important feature in stabiliz ing the operation of this contro system is the use of a fast-acting low-inertia clutch. One such clutc that has proven satisfactory i actual service is the Lear "Fastop magnetic clutch which is electr cally connected with the motor a shown in Fig. 2. As previously ex

• • •

TWIST-TEST FOR C-R TUBES

After soaking in warm water for 18 hours, cathode-ray tube bases are inserted in the holder shown above and the tube twisted against the torque of the weight on the arm. Virginia Connick tests the cement on the tube base in this manner at the Dobbs Ferry plant of North American Philips



Lindsay Structure utilizes all the strength in light steel sheets through uniform tensioning.

These are 4 good reasons for using LINDSAY STRUCTURE

No tooling, no trimming, no welding, no riveting. Parts for Lindsay Structure, die-cut and die-formed to exact specifications, are ready for quick assembly with simple tools. Finished units are attractive, modern, all-steel structures of great strength. Amazingly light in weight, they protect even the most delicate equipment.

Lindsay Structure, economical for use on one or a thousand models, is practical for:

HOUSINGS FOR	CABINETS FOR	BUILDINGS
Geophysical apparatus	Amplifiers	Repeater stations
Transmitting equipment	Intercommunicators	Humidity test chambers
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Sound systems	Oscillographs	Refrigerator buildings
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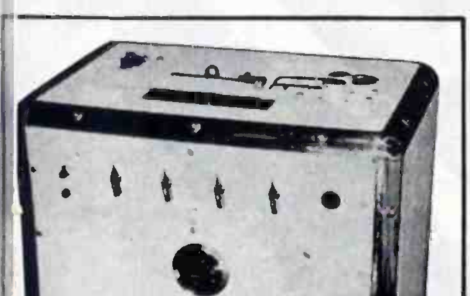
	Special receiving equipment	

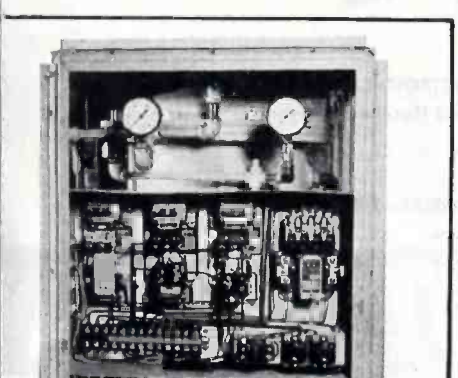
Panels

Immediate service on your pilot jobs—write for complete information. Lindsay and Lindsay, 222-D W. Adams St., Chicago 6, Ill.; or 60 E. 42nd St., New York 17, N. Y. Lindsay Structure (Canada) Ltd., Dominion Square Bldg., Montreal.

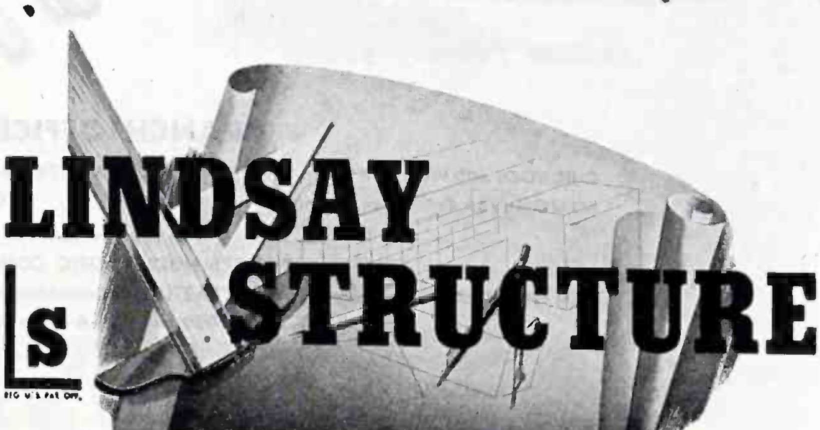
Ls CORNER DETAILS



EASY TO MOUNT EQUIPMENT



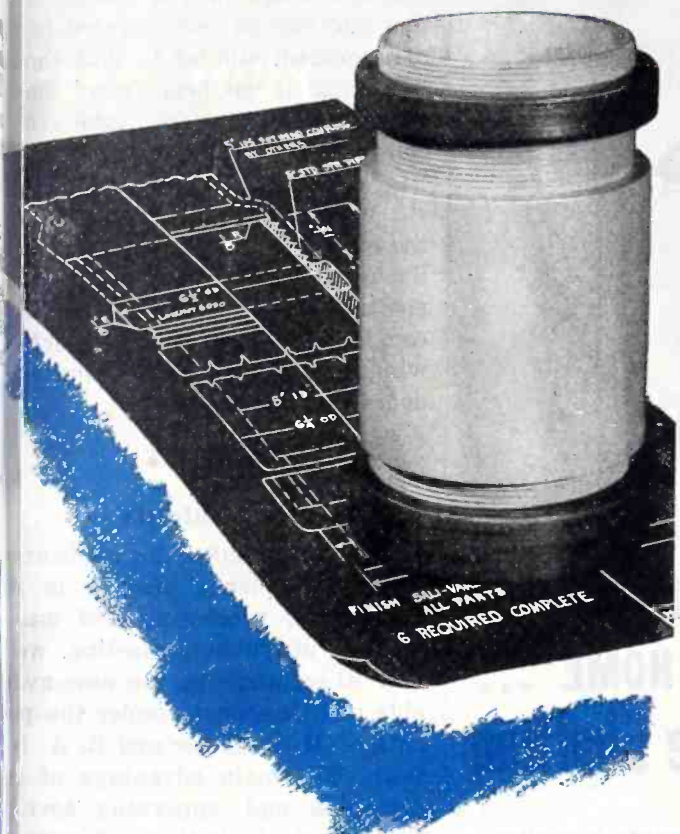
Ls SUPPORTS ALL EQUIPMENT



U. S. Patents 2017629, 2263510, 2263511 — U. S. and Foreign Patents and Patents Pending

THE MODERN METHOD OF LIGHT METAL CONSTRUCTION

Electrical Equipment



Specially designed insulating parts machined from LAMICOID plastic laminates meet mechanical and electrical specifications not possible to obtain with a less versatile material. Lightness, structural and dielectric strength—machinability that permits fabrication into simple or intricate shapes, and dimensional stability—all make it ideal for fabrications of parts like that illustrated at left.

In addition to Mica Insulator Company's own plant in Schenectady, New York, expert fabrication facilities are available through LAMICOID fabricators, strategically located in large industrial centers (see addresses below).

These plants maintain large stocks of LAMICOID sheets, rods and tubes, and offer prompt delivery of LAMICOID fabrications of all kinds.

O particular interest is this new EMPIRE "3 mil bias ta e" which combines extreme thinness with excellet dielectric strength and elongation properties. I s especially adapted for use on irregularly shaped c ductors; or for solenoid and instrument coils.

'he EMPIRE line also includes a complete line of v nished cloths and tapes and Varnished Fiberglas (: Class B insulation).

FABRICATORS

Mica Insulator Company, 200 Varick Street, New York 14, N. Y. • Insulating Fabricators Inc., 12 East 12th Street, New York 3, N. Y. • Insulating Fabricators of New England, Inc., 22 Elkins St., S. Boston 27, Mass. • Lamicoid Fabricators, Inc., 3600 Potomac Avenue, Chicago 51, Illinois • The Kirby Company, 13000 Athens Avenue, Cleveland 7, Ohio • Bakoring, Inc., 1020 Houston Avenue, Houston 10, Texas

INSULATOR COMPANY

200 VARICK STREET, NEW YORK 14, N. Y.

plained, this clutch disconnects t motor from the gearing actuat immediately upon de-energizati of the motor and also permits t clutch member to brake the gea ing, whereby the actuator and ai plane member are almost instant stopped. Other features will i crease the stability or anti-hu characteristics of the control sy tem and can be incorporated in a arrangement similar to that show in Fig. 2. It has been found that potentiometer-vacuum - tube - rel control system, as exemplified l Fig. 2, can position remotely to a curacies well within one percent the total travel of the driven devic Such accuracies are ample for tl positioning of most accessories an components on an aircraft, such a wing flaps, landing gear, shutter doors, cowl flaps, etc.

• • •

H-F Heating Patents

LICENSES COVERING the applicatio of high-frequency heating in th production, processing and manu facture of rubber, plastics, woo and other products, are now avai able in this country under the pat ents of H. A. Leduc and R. A. Du four. The main advantage of th processes and apparatus covere by the patents is that non-metalli dielectric materials can be rapidl and uniformly heated throughou their mass, and that temperatur and temperature rise can be ac curately controlled.

Originally developed by the in ventors with a view to overcomin the difficulties inherent in the vul canizing of massive rubber objects the high-frequency heating proces has become the means for makin possible heat transfer in man poorly conducting or non-conduct ing materials.

According to the claims, th practical applications of the proc ess in the rubber field include thermal plasticizing of bales of raw rubber; reclaiming by heat; vulcan izing of sponge, thick masses, rol coverings, rubber-coated metals rubberized or plasticized parts proofed goods and molded articles concentration, sterilization and vul canizing of stabilized latex; coagu lation of heat-sensitized or elec trically unstable latex; manufac ture of insulated cables and wires

and production of latex sponge. One of the patents is claimed to be a basic patent for coagulating any "coagulatable fluid material", from spaghetti to wallboard.

Leduc's invention was demonstrated at the Exposition of Paris in 1935 and the French Rubber Association honored him with its medal. In a report to the French Senate, it was stated that the Dufour-Leduc inventions alone justified the more than 20 years of operation of the immense Government Research Center. In this country the B. F. Goodrich Co., Akron, Ohio will issue licenses covering rubber applications. W. H. Giodvad Grell, 33 University Place, New York 3, N. Y. will issue licenses in all other fields.

Advantage

Since the discovery of vulcanization in 1839, rubber has been vulcanized by applying steam heat to the outside surface of a rubber article and depending upon conduction to carry the heat into the rubber. Owing to its poor heat-conducting characteristics, the rubber was not heated uniformly and, in many cases, inferior articles were produced. In the electronic vulcanizing method, heat is generated inside the body of rubber so that large masses of rubber may be vulcanized quickly and uniformly.

Already finding extensive commercial application in the rubber and other industries, the electronic process promises to be used not only for vulcanizing rubber articles but also for the vulcanization of thermosetting materials. In many cases, the duration of the "cure" may be shortened enough to permit continuous conveyor vulcanization where such practice would not be feasible otherwise.

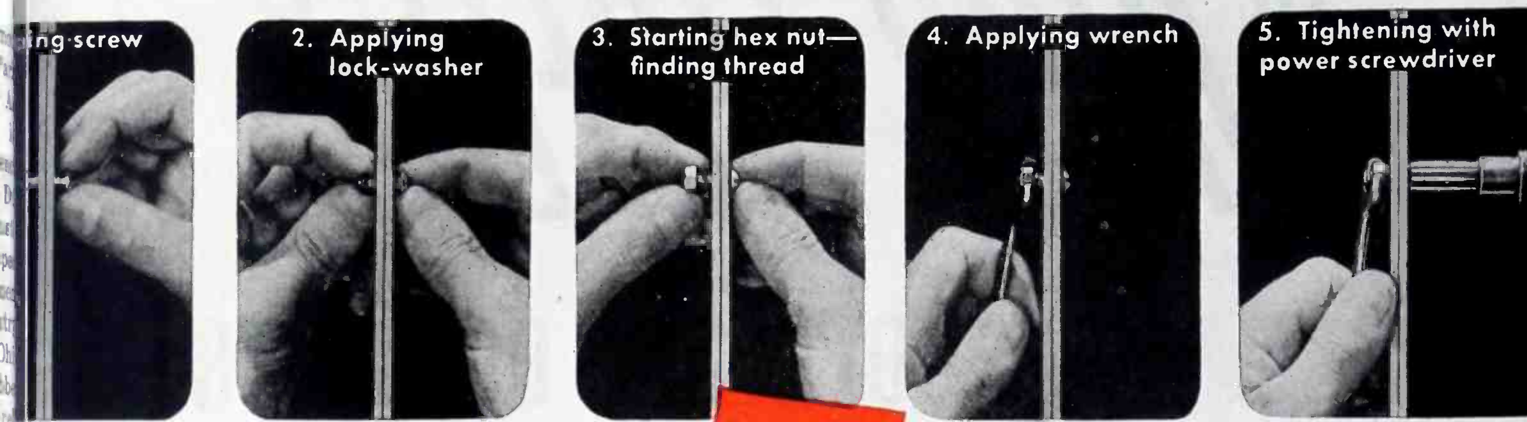
• • •

Electronic Induction Heating on Production Line

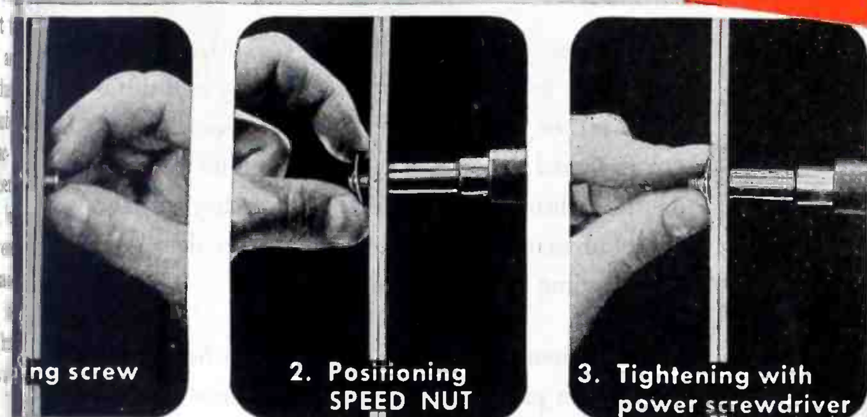
HIGH SPEED ELECTRONIC heating on a production line has been established for case-hardening finished bearing pins to a depth of 0.025 in. The pins were fed automatically through a glass tube and quenched with water as they left the heating coil at a rate of 75 pins per minute.

The r-f generator operated at a frequency of 5 megacycles and

Which is Better?



THE OLD WAY WITH 5 HAND OPERATIONS



OR THE SPEED NUT WAY WITH ONLY 3 OPERATIONS

d a SPEED NUT is a self-locking nut, too, that weighs less,
s vibration loosening and cuts assembly costs 40-50% . . .

The SPEED NUT method requires only 3 hand operations as shown in photos above. And only 2 parts are needed instead of 3. Why go through 5 hand operations when only 3 are necessary? Why handle 3 parts when only 2 are required? For an eye opener on the economies of the SPEED NUT system just multiply this 40% motion-saving by the millions of fasteners you use per month. Then add to that the saving by eliminating 1/3 of the parts. Your figures will amaze you. The winning products in postwar competition will be those that are assembled faster and protected against loosening from vibration. Billions of SPEED NUTS were used before the war and on war products, too. More billions will be used on postwar products. Over 2,000 shapes and sizes. Engineers who move up faster are those who know how to make assembly lines move faster. Write for literature.

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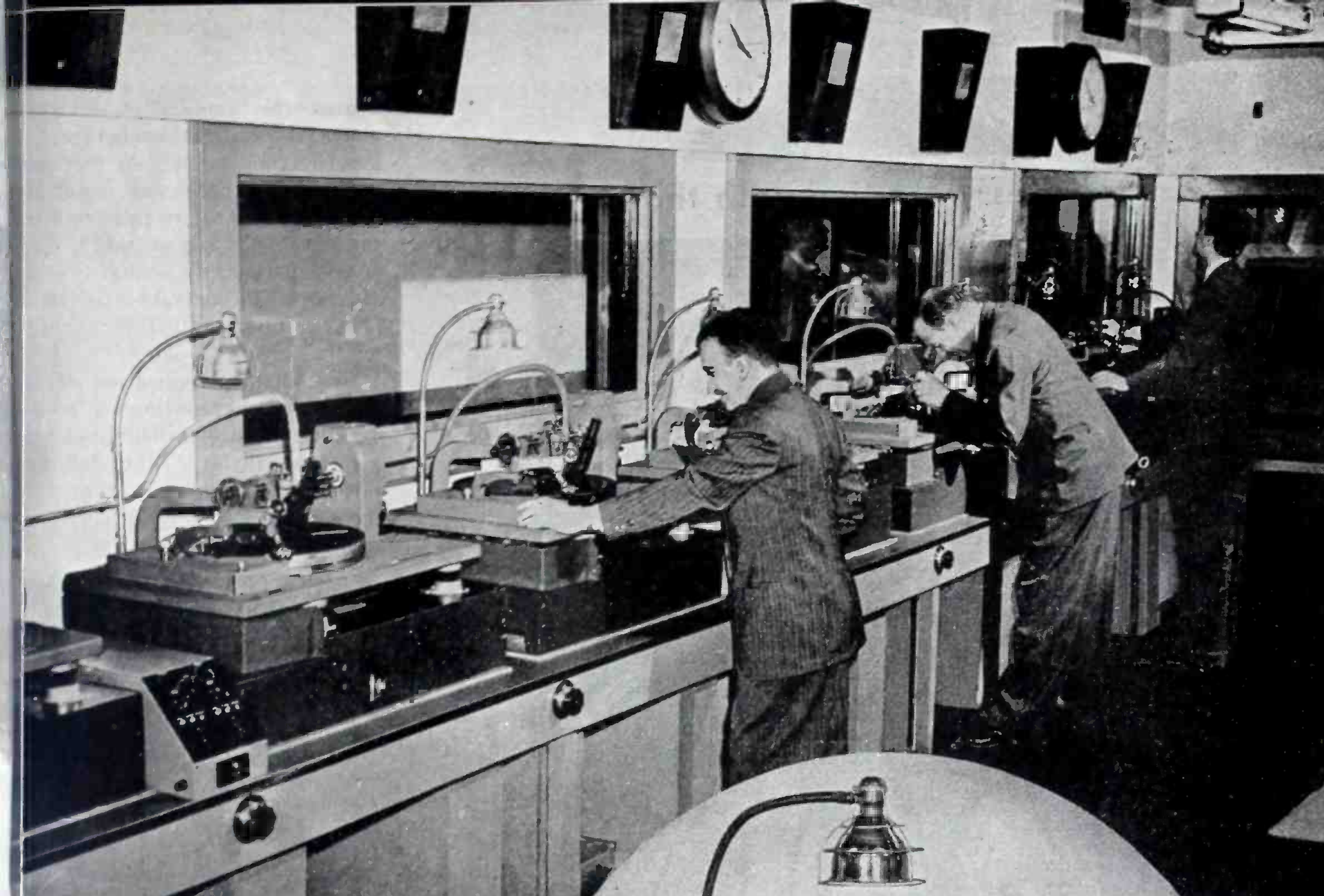
In Canada: Wallace Barnes Co., Ltd., Hamilton, Ontario
In England: Simmonds Aerocessories, Ltd., London

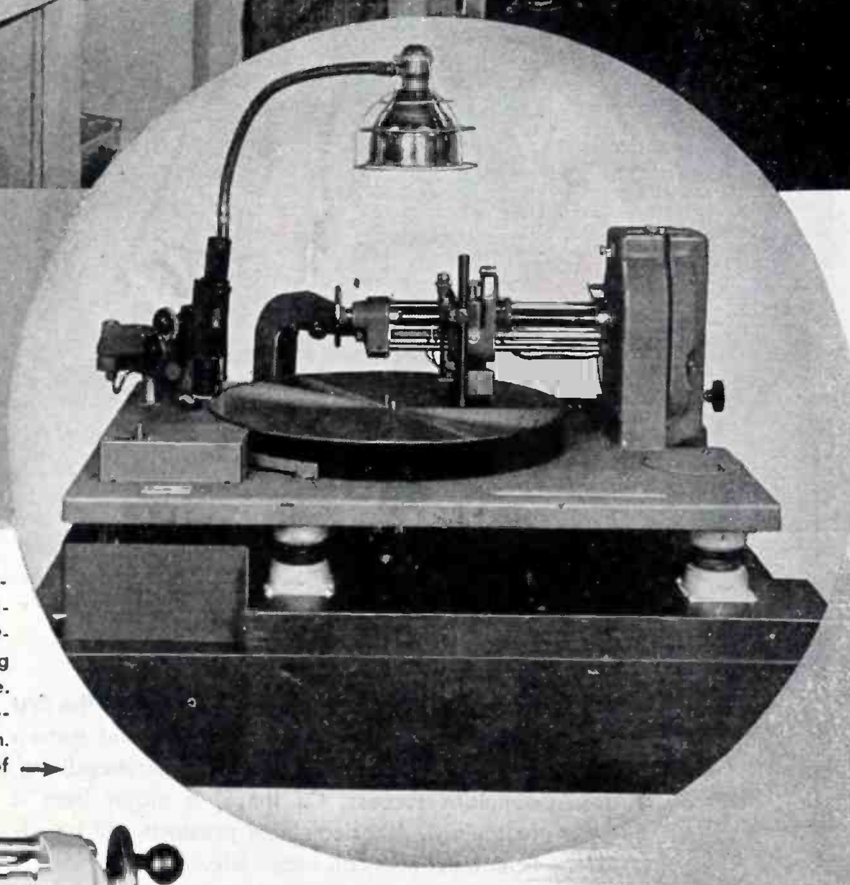
FASTEST THINGS IN FASTENINGS

Speed Nuts *
[PATENTED]

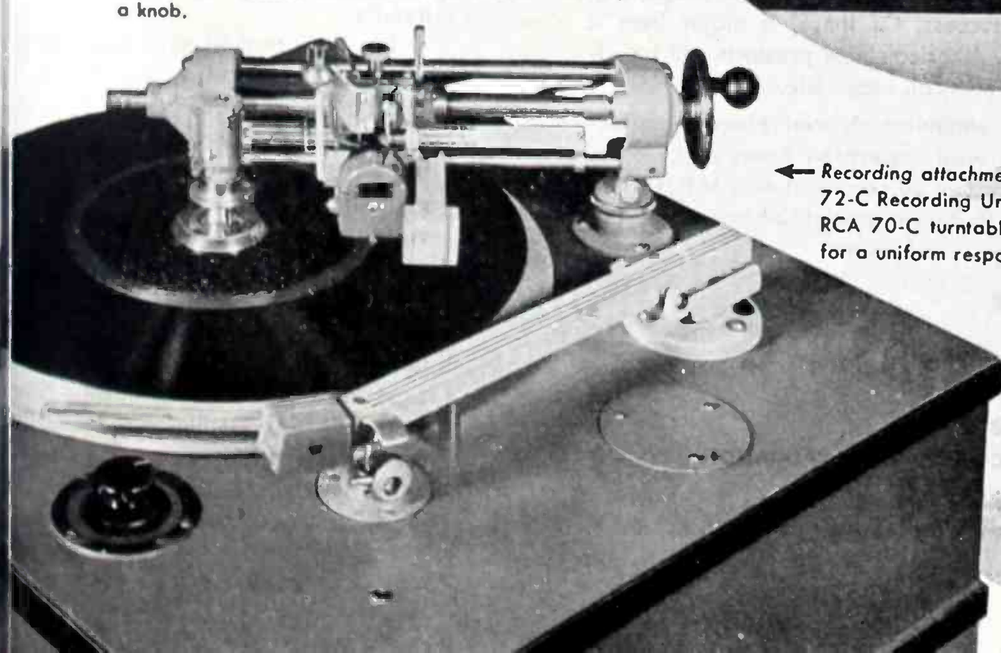
*Trademark Reg. U. S. Patent Office



tured here is the recording lathe bank at (WI Headquarters, New York City. These RCA orders are used in making transcriptions of WI news and entertainment programs for over-s broadcasting.



Close-up view of the RCA recording model employed at OWI Headquarters. A professional-type unit, the 73-AX Recorder provides highest-quality, instantaneous recordings for broadcasting purposes. 30 to 10,000 cycle frequency response. Records at 33⅓ or 78 r.p.m., outside-in or inside-out at 96, 112, 120, 136 or 154 lines per inch. Speed and groove adjustments at the turn of a knob. →



← *Recording attachment for turntable mounting.* The Model 72-C Recording Unit for control room use with standard RCA 70-C turntable equipment. Cutting head provides for a uniform response from 60 to 6000 cycles.

heated the surface of each pi above its critical temperature i less than one second. At this spee of heating, there was insufficien time for the heat to penetrate int the core and only a thin surfac layer experienced a change in physi cal state. The central portion of th parts retained all their origin toughness and strength.

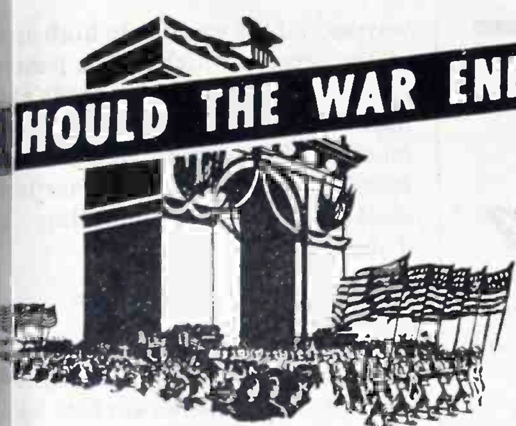
The factory application of thi process to the continuous produc tion line surface hardening of bear ing pins involved the followin equipment: the hopper from whic the unhardened parts are fed int

Case-hardening of chromium-molybdenum steel bearing pins with a 5-Mc r-f generator. Inset at right is a microphoto of the hardened surface. The white portion is the outside case which has a thickness of 0.025 in.

the glass tube; the heating coil; a Megatherm induction unit manufactured by the Federal Tel. and Radio Corp.; a connection provid ing a continuous flow of water for quenching, and a work table with suitable containers for hardened pins as ejected from the heating fixture.

The coil used in this bearing pin application contains five turns of small copper tubing wound in a single layer approximately 1-in. long by $\frac{3}{4}$-in. in diameter. The coil is grounded and does not carry high voltage. It is exposed to continuous wetting by the water used for quenching.

The metal was chromium molybdenum steel NE-9442 and the surface hardness developed was Rockwell C 60—about file-hardness. The pins were finish ground prior to heat treating, and, after the hardening process, there was no scale or



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FOR TODAY'S WAR REQUIREMENTS–
FOR TOMORROW'S PEACE NEEDS–
specify **ELCO!**

SPECIFICATIONS:

"A-1"—15/32 long x ½" dia.—Mountable with 6-32 flat or filester screw. No. 21 tinned copper wire leads. 1 to 300,000 ohm value—½% standard accuracy—non inductive pie wound—½ watt, 30° C. temperature rise in free air—100° C. maximum operating temperature—200 D. C. maximum operating voltage. Baked varnish finish.

"A-R"—Same as A-1, with leads reversed.

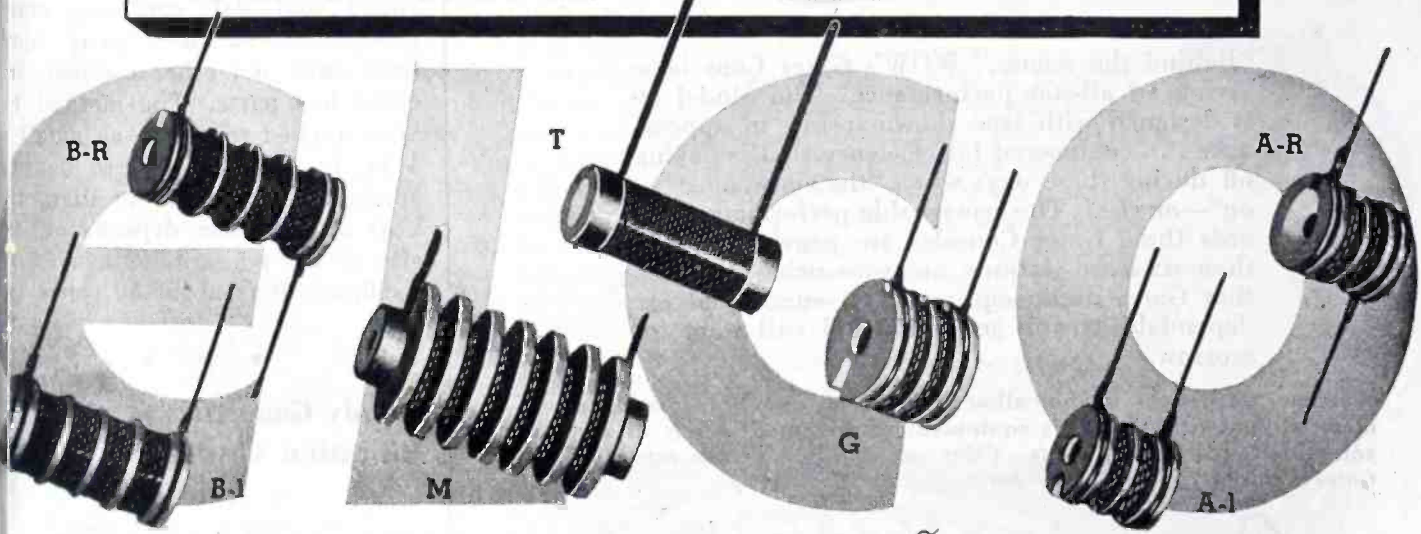
"B-1"—15/16 long x ½" dia.—Mountable with 6-32 flat or filester screw. No. 21 tinned copper wire leads. 1 to 500,000 ohm value—½% standard accuracy—non inductive pie wound—1 watt, 30° C. temperature rise in free air—100° C. maximum operating temperature—300 D. C maximum operating voltage. Baked varnish finish.

"B-R"—Same as B-1, with leads reversed.

"T"—1-1/32 long x 7/16" dia.—Inductively wound—⅛ x .015 strap terminals—35 to 35,000 ohms—2 watts, 100° C. maximum operating temperature—normal accuracy 1%. Baked varnish finish.

"M"—1-13/32 long x ¼" dia.—Mountable with 6-32 screw—⅛ x .015 thick strap terminals—non inductive wound—1 meg ohm maximum resistance—600 volts maximum operating voltage—100° C. maximum operating temperature—1.5 watts—1% normal accuracy Baked varnish finish.

"G"—15/32 long x ½" dia.—Mountable with 6-32 flat or filester head screw. No. 21 tinned copper wire leads. 1 to 500,000 ohm value. ½% standard accuracy—non inductive pie wound .8 watts, 30° temperature rise in free air. 100° C. maximum operating temperature. 200 D. C. maximum operating voltage. Baked varnish finish.



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warpage. This was due to high spee of the process which makes possibl the surface hardening of parts afte finish grinding. This eliminate much costly finishing which hereto fore has been required on hardene steel parts because of sealing an distortion.

Depth of Treatment

The microphoto insert in the il lustration shows a highly magnifie view of the hardened surface as de veloped on the bearing pin. Th white portion is that of the hard ened outside case, and it will be ob served that it extends a distance o 25 thousandths of an inch beneath the surface. Of this 25 thousandths, there is no visible change in the structure or depth of approximately 15 thousandths of an inch. From this depth in, there is a sligh change in the apparent structur in the material, but there was n measureable loss of hardness insofar as was determined with a carefully conducted superficial Rockwell test. The dark portion is that of the unaffected core material. At n point in the transition zone from fully hardened case to the dark unaffected core material was there any evidence of softening or tempering of this adjacent internal layer.

The bearing pin application is only one of a family which includes a wide range of shafts, bearings, round and flat surfaces, zones, spots, cam surfaces, gear teeth, lever ends and other common machine tool parts. The method has been applied to pieces as small as ⅛ in. in diameter and to bearing surfaces up to 6 in. in diameter. Cost of operation depends on the size of the r-f unit, with a 25-kw oscillator, it is about 50 cents per hour.

• • •

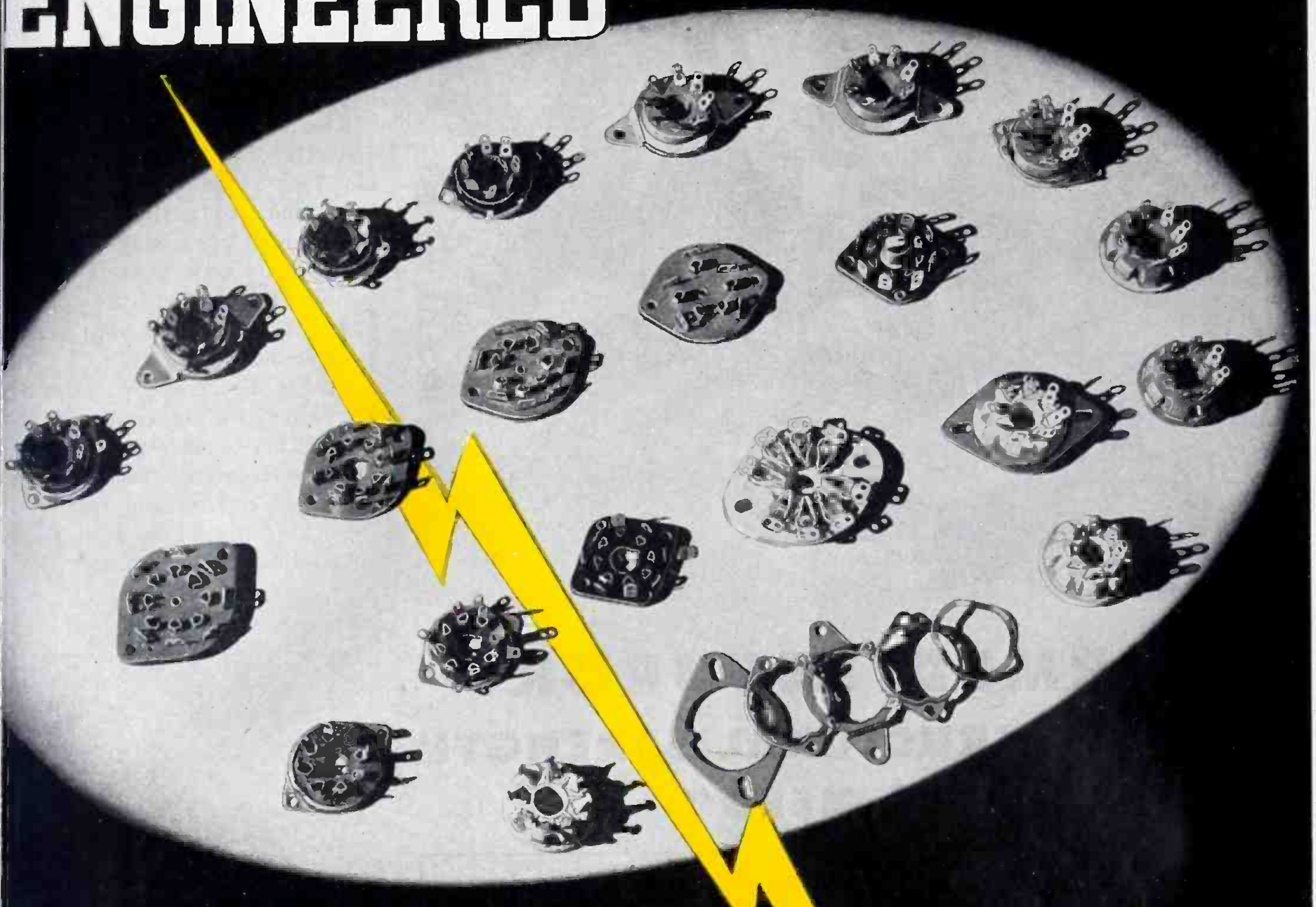
Handy Gage for Vibration Testing

By F. R. Jessop

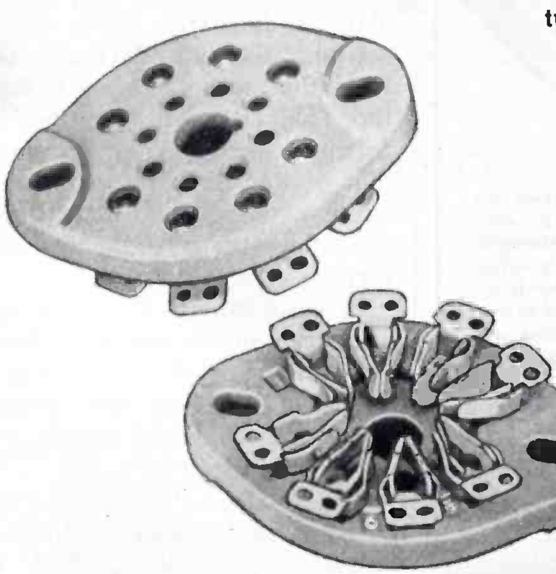
Examiner 1/C Type Tests Inspection Board of United Kingdom and Canada Northern Electric Co., Ltd. Montreal, Que.

BECAUSE ELECTRONIC EQUIPMENT for the armed forces must perform under the severest operating conditions, all production is subjected to vibration testing. The device to be described has proven very useful

ENGINEERED



For a wide variety of applications



Each field of electronic design can fill its needs for correct vacuum tube receptacles with National Fabricated Sockets . . . To meet the demand for the ever-increasing variety of sockets covering all frequency applications, insulations are available ranging from paper base laminated phenolic sheet to mica-filled molded plastics and low-loss ceramics . . . Contact alloys of special steels, brasses, phosphor bronze, silica bronze and beryllium copper are employed — utilizing an assortment of mechanical contact designs to fill all wiring requirements and provide dependable long-life electrical performance.

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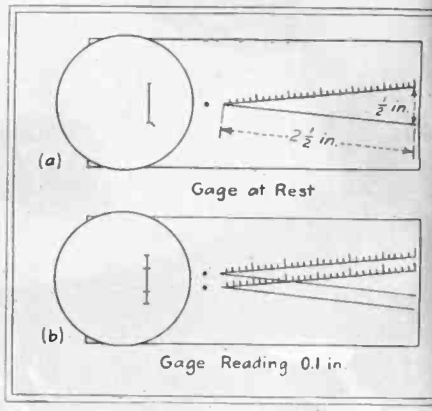
Manufacturers of SOCKETS, TERMINAL ASSEMBLIES, JACKS and CONNECTORS for use in every field of electronics.

for determining the direction of maximum displacement and to accurately measure that displacement to 0.005 in. It is especially useful when it is necessary to take measurements at various points of equipment when studying the effect of shock mounts.

The device consists of a small disc riveted at one end of a rectangular card as shown at (a) in the illustration. Both the disc and the rectangular piece may be made of stiff fiber, plastic or metal. The assembly is secured to the apparatus under test by means of scotch tape or other adhesive.

On the disc is drawn, slightly to one side of the center, a capital letter *I*. This is made equal in height to the extreme displacement to be measured during the test. When used in conjunction with a Strobotac, this letter indicates the di-



Gage for reading displacement of vibrating equipment and components. Made of fiber or plastic, it measures displacements from 0.005 to 0.3 in.

rection of maximum displacement. This is indicated when the two serifs of the letter *I* (made visible when the Strobotac is set at double the frequency of vibration) are farthest apart. The direction is that of the upright portion of the letter, as shown at (b) of the figure where the vibration is purely vertical.

In cases where the vibration is not purely in one direction, the upright will be double lines, but in the direction of maximum displacement, these lines will be closest together.

The small dot on the device is used to determine the frequency of vibration. This is obtained from the dial of the Strobotac when it is adjusted so that the dot is stationary. It is also useful to study the

HIS PROBLEM IS ALSO YOURS...

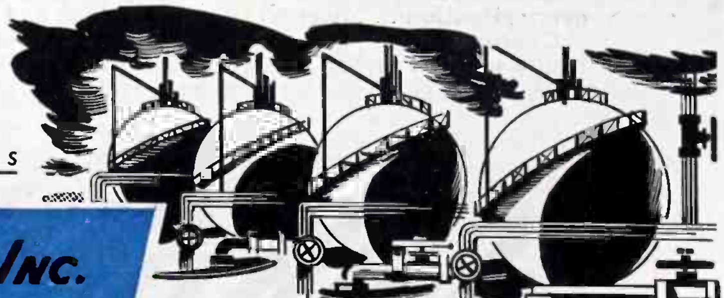
ight now he is looking for a target for one of his eadly "tin fish." But on his watch below he probably vonders what the postwar world back home will be ike . . . and what kind of place it will have for him.

That's his problem . . . and ours, too. For Industry nust be ready to absorb the boys as they are mustered out of the Service.

This means planning for conversion to peacetime production . . . designing new products . . . developing better methods and processes. The WPB has encouraged such thinking . . . has even released material for experimental and development work.

TODAY is not a day too soon to start!

★ BUY MORE THAN BEFORE . . . BONDS



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The modern miracles of Electronics, feverishly developed for the machines of war in the past few years, may readily prove applicable to your plans for the future. Look ahead, and go ahead with Electronics at the controls!

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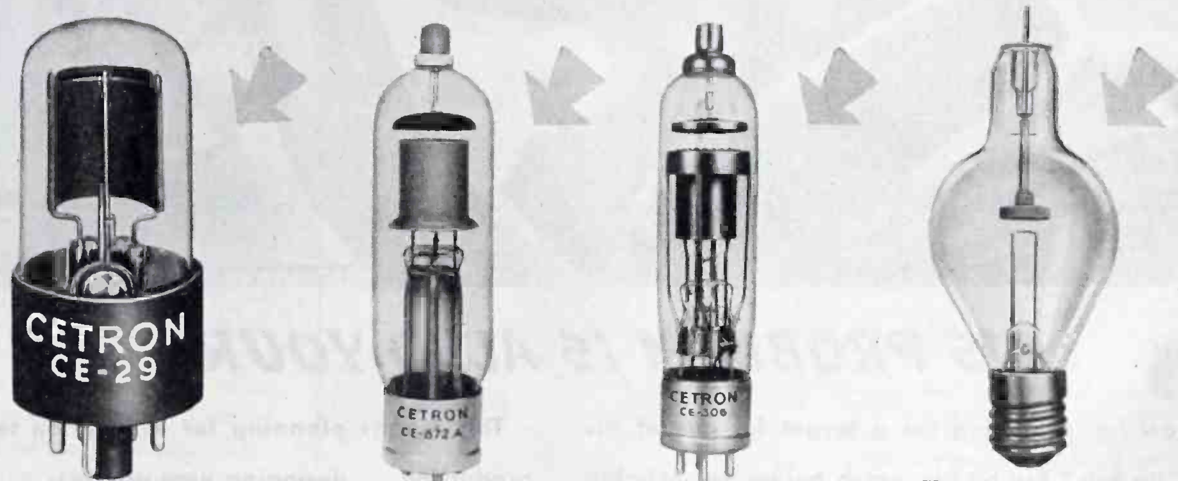
CETRON



Particularly sensitive to blue and violet light. RMA spectral sensitivity designation S-4. 5-Pin base interchangeable with other similar tubes.

Rectifier designed to meet rigid Army and Navy specifications. Incorporates numerous improvements insuring efficiency, ruggedness and long-life.

Grid control Rectifier (Thyratron) especially suited for industrial use, such as handling primary currents of small resistance welders—motor control, etc.

CE-235 is a half wave Argon-filled Rectifier with screw base, sturdily constructed for long, dependable service.

Cetron Rectifiers are available in gas and mercury filled, both full and half wave types in a wide range of ratings.

Cetron Phototubes are produced by us to take care of almost every situation . . . over 50 types, both blue and red sensitivity.

Continental's long experience and careful production methods insure you the utmost in satisfaction from all the many types of tubes we make. Write for complete catalog.

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movement of the equipment whi being vibrated when the Strobot is adjusted so that the dot trac the exact path of a vibration cycl

Displacement Scale

The device also contains a draw ing of an isosceles triangle wit sides $2\frac{1}{2}$ in. long on a $\frac{1}{2}$-in. bas This contains graduations 1/20 i apart on one side to provide di placement readings in which eac small division is 0.01 in.

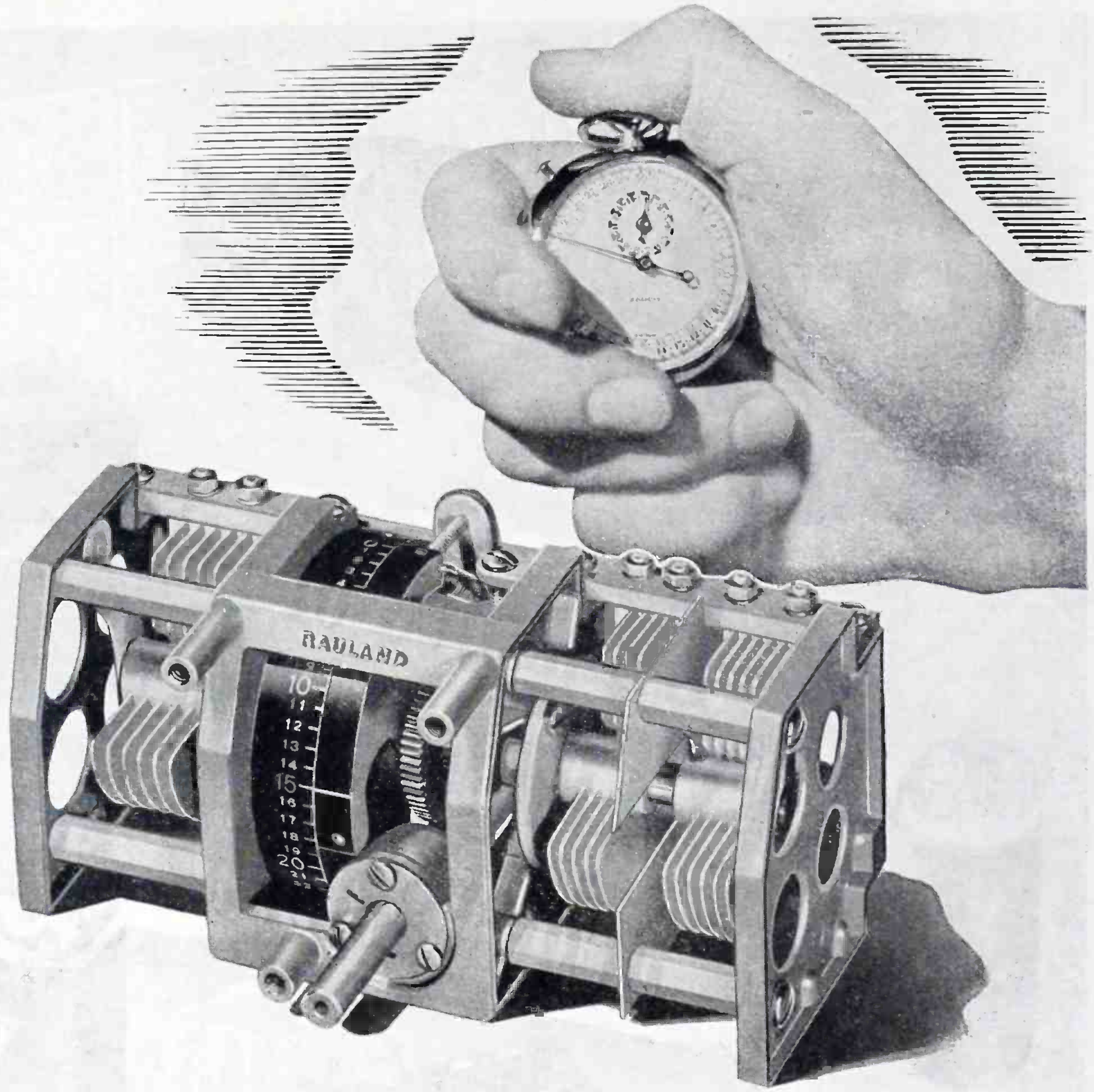
When this printed angle is o served with the Strobotac set twice the frequency of vibratio two complete angles will be seen shown at (*b*) of the drawing. Th reading is made at the point of i tersection of one graduated li with one plain line. To read max mum displacement, it is necessar to mount the gage at right angl to the direction of this displac ment as obtained by the rotatin disc.

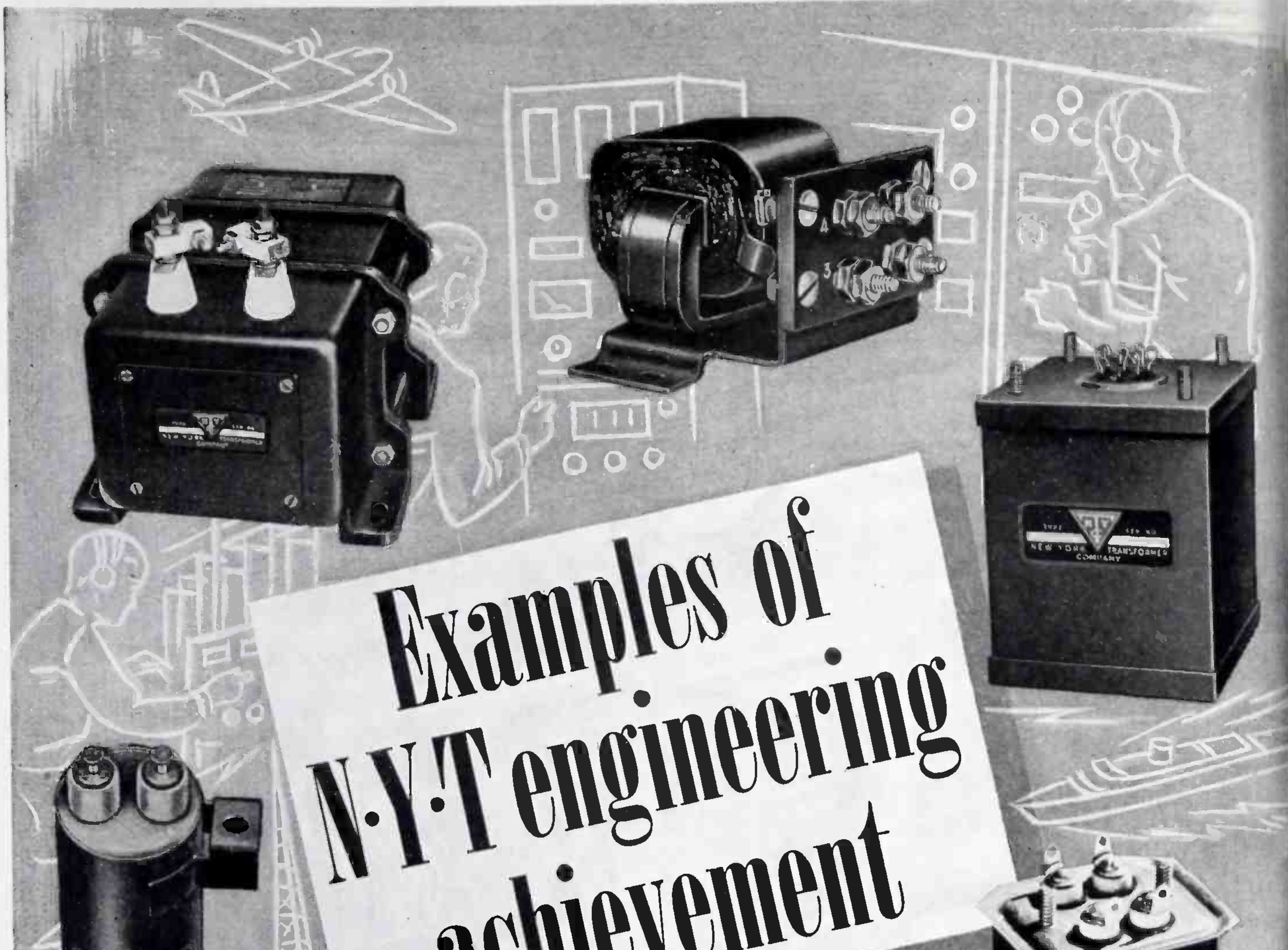
From the frequency reading o tained with the dot and the di placement reading provided by th angle, it is possible to calculate th acceleration G from the formula ($= 0.0511\ df^2$, where d is the tot displacement in inches and f th frequency of vibration in cycles p second.

If the frequency of vibration known, satisfactory readings ca be made with the unaided eye, a the *I* on the disc gives a blurred ef fect which is readily observed an read in the same manner as wit the Strobotac. The angle is als blurred and the reading is take where the two blurred lines meet When this method is used, observa tions of the exact displacement ca be obtained even where it is impo sible for the observer or instru ments to be in a steady state, as al readings depend only on the spee of light for their accuracy.

While no attempt has been mad to do so, it is believed that read ings of much smaller displacements could be made by reducing the di mensions of the angle by photo graphic means and observing the readings by optical methods.

ALMOST 200,000 persons have been trained in radio occupations since July, 1940 under the vocational training for war production program.


RAULAND



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

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E ANOTHER DAY

The lush days of "Cost Plus" that have placed so little emphasis on production economy will disappear when "C-Day" arrives. Conversion to civilian goods will again place a premium on efficiency that springs from a cost "know-how." But cost-sensitive production comes only of long experience. It is not born of wartime . . . it is a stranger to war production.

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Lewyt

LET LEWYT DO IT

BUY MORE WAR BONDS

Vibration Analyzer

(*Continued from page 99*)

the operation of the analyzer study should be made of the b diagram shown in Fig. 2. The trical output of a pickup attac at some point on the engine or plane is a function of the vibra at that point. When a signal f the pickup passes through the lyzer circuit, one frequency c ponent out of the complex wav rectified and moves the pen of recording instrument in a vert direction by an amount proporti to the amplitude of the frequ component.

The output of an electrical t ometer, which is coupled to the gine, is proportional in freque and voltage amplitude to the en speed. After the output of the t ometer is amplified and rectifie is caused to control the motion the recorder pen so that it tak specific position in the horizo direction related to engine sp Therefore, each curve drawn on chart denotes the amplitude of bration for one particular order frequency as the engine speed ies over the entire range.

In view of the fact that the put of the pickup includes com nents at a number of different quencies, it is necessary to prov a method of selecting some part lar component and allowing this one to control the action of recorder pen. To accomplish selection the output of the pic is modulated by the output of oscillator. The frequency of oscillator is made to differ fr that of the narrow-band filter by amount equal to the compon which it is desired to measure. oscillator frequency is controlled engine speed as indicated in Fig

To control the frequency of modulating oscillator, a tuning pacitor is used which is opera by an electric motor. Simu neously, this motor drives a pote ometer in a bridge circuit and each setting of the capacitor th is a corresponding setting the potentiometer. When bridge circuit is in balance, driving voltage is applied to motor. However, when the pot tiometer setting is one that d

Why Plastic Plans Start with Polystyrene

Its outstanding properties . . . its huge production and consequent availability in the future . . . its low price . . . all these factors point to Styron (Dow Polystyrene).

To say that plastic plans start with Styron (Dow Polystyrene) is to make a big statement. But analysis of the plastics field shows it to be backed up by many factors—factors of far-reaching significance.

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You will want to know more about Styron—it is the plastic to keep your eye on. We'll be glad to send further details.

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3¾″
Model 2
Weight (less motor): 4½ oz.
Output: 25 C.F.M. at 8000 R.P.M.
Model 3
Weight (less motor): 12 oz.
Output: 260 C.F.M. at 8000 R.P.M.
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Today, our plant facilities are being utilized for manufacturing special fractional H.P. motors for war products, but our motor development engineers will gladly discuss your post-war fractional H.P. motor problems and requirements with you.

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not balance the bridge, then th motor will be driven in such a direction as to bring about a balance

The potentiometer setting a which the bridge is balanced i different for each applied voltag and, as a result of the action o the motor when the bridge is unbalanced, both the potentiomete and tuning capacitor tend to b held at a position that correspond to the voltage applied to the bridg circuit. The voltage applied to th circuit is the rectified tachomete voltage attenuated by a divide with 28 fixed positions. At each position the divider applies to th bridge circuit a voltage proportiona to the engine speed multiplied b the selected order, and thus the K th armonic of the motor speed.

The design of the circuit is suc that the oscillator has a frequenc of $(92,000 + f)$, where f is equal t the particular frequency componen to be measured. This convenient relation is attained by designing th circuit and tuning capacitor so tha the capacitor setting is made proportional to the voltage applied t the bridge circuit; as pointed out i the preceding paragraph, this voltage is proportional to motor spee multiplied by the pre-selected order which in turn is proportional to th frequency to be checked.

The frequency f from the amplified output of the pickup modulate the frequency $(92,000 + f)$ fron the oscillator in the modulator circuit arranged to balance out the oscillator frequency. Thus, the tw chief components in the modulato output are the sum and differenc frequencies.

The output of the modulator i connected to a crystal-type filte which has a pass band at 92,000 cp that is only 4 cycles wide. By mean of this filter the 92,000-cps sideband is readily passed while th other side band is rejected. Thi signal is then mixed in the demodulator circuit with the outpu of the same oscillator, with th chief components of this secon modulation being the carrier frequency and the upper and lowe side bands. The high frequencie are easily rejected and after th frequency f is rectified it is passe to the recorder to control the position of the pen.

The main elements comprisin the automatic frequency analyze are a tachometer, small control box

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...IN TODAY'S WAR EQUIPMENT

In the U.S. Army crash boats (shown above) and landing barges built by the Owens Yacht Company of Baltimore, American Phillips Screws are used to make *speedier, stronger fastenings* . . . to get these vitally needed craft into service quicker, and to make sure they will stand up to the strenuous service required. Owens workers, using power drivers, make clean and flush fastenings right down the line, with American Phillips Screws. No fumbling starts, no crooked driving, no gouged work-surfaces, no split screw-heads. This is typical American Phillips Screw performance.

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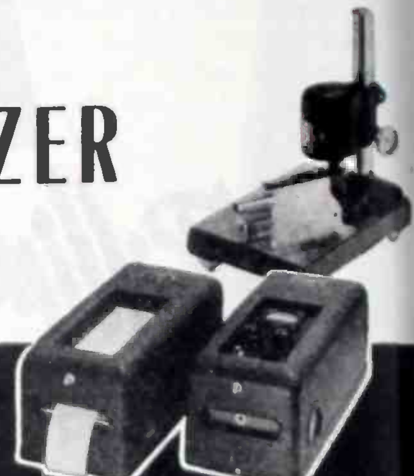

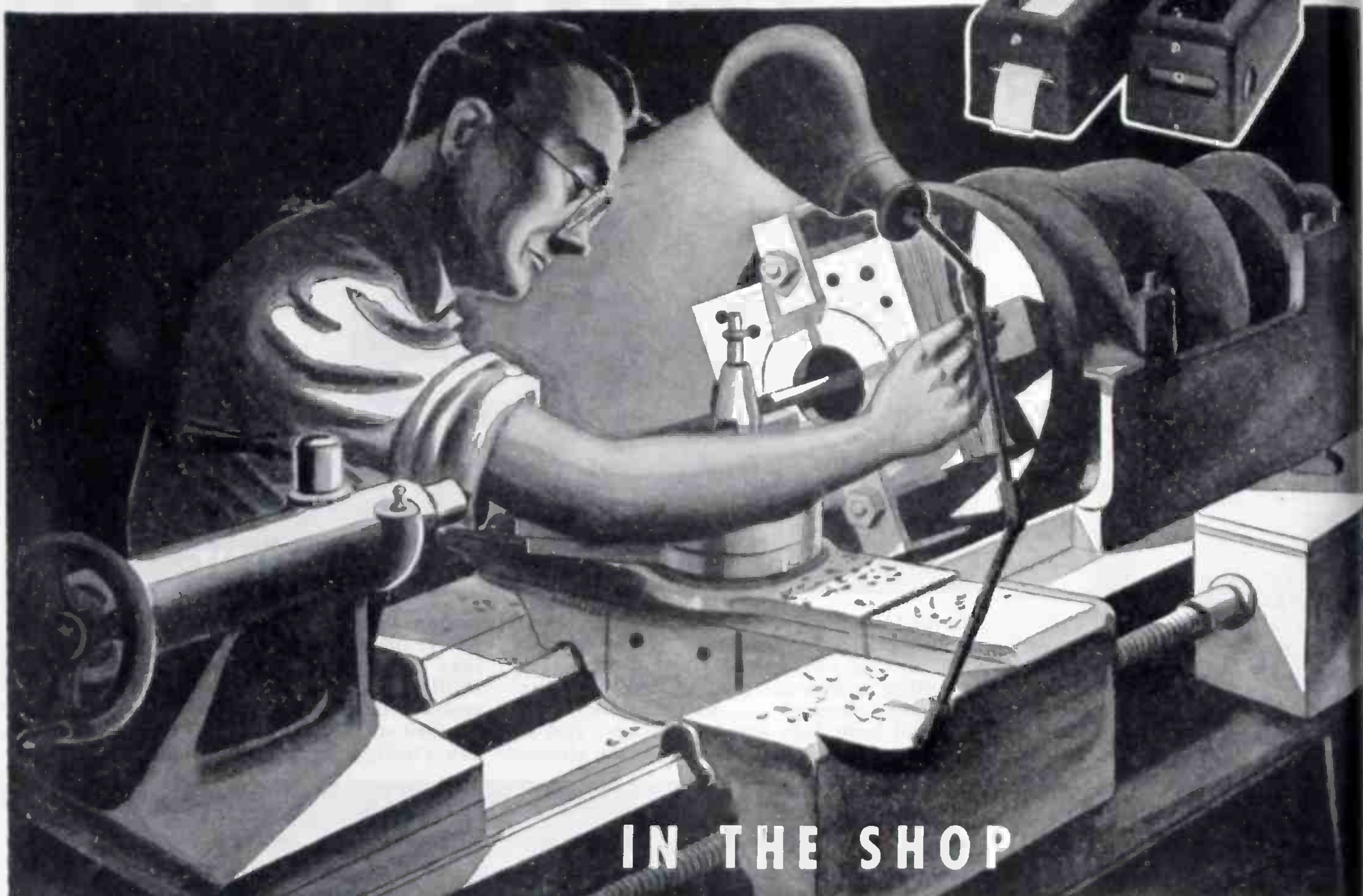

Yes, war has its good points too. War stimulates progress. Industry is called upon to deliver as never before — to produce greater quantities of finer equipment. Higher standards of quality insure our equipment of longer life, dependability and ease of operation. Surface finish is vital to fine quality. The mated surfaces of precision-built parts designed to move at high speeds are but one example of the need for microinch (.000001") smoothness. Such finishes are accurately measured and recorded for laboratory study or production-line inspection by the Brush Surface Analyzer.

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analyzer unit with the tuning capacitor drive attached to it and the recorder. Additional equipment required includes the necessary power-supply units and amplifiers for the capacitor drive unit and recorder.

Method of Use

During a test flight, the control unit and recorder are the only parts of the equipment that require attention. On the panel of the control unit are two meters, one of which registers the amplitude of the measured signal while the other indicates the engine speed. Thus an operator may immediately observe any abnormally large vibration and the speed at which it occurs without reading the recorder. The panel is also provided with a frequency selector with which the order to be measured is selected. Also, to permit vibrations of very large amplitude to be kept within the range of the recorder and indicating meter, an attenuator is provided in the signal input circuit of the analyzer. A potentiometer which determines the voltage applied to the control device of the tuning capacitor during calibration, and four controls for calibrating the set, are also provided on the panel.

Results obtained by the use of the analyzer are being utilized by designers of aircraft engines in the gradual elimination of parts failures caused by excessive vibration.

• • •

PERSONAL TRANSMITTER

A portable transmitter like those used by unlicensed operators and saboteurs was demonstrated by Charles Wilson, FCC equipment engineer, before the Lea committee investigating the FCC

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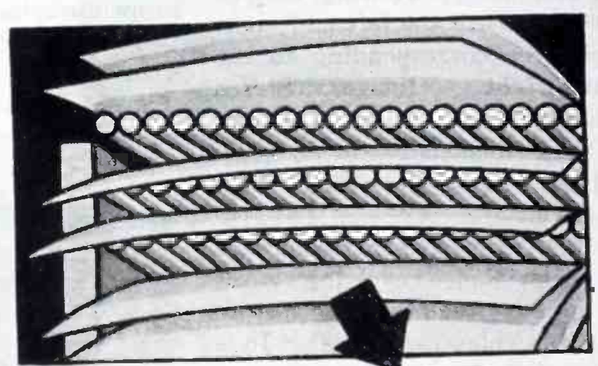
● Anaconda Plastiseal Coils have a 12-year record of outstanding performance, which has now been highlighted by the toughest sort of war applications.

These coils are built up of sealed layers of Lumarith* (cellulose acetate) which is chemically inert under the conditions met within the coil. No paper, wax, varnish or glue is present—nor any other material which might permit electrolysis to occur and corrode the winding. The edges of the cellulose acetate are coalesced by a special process with the end washers, resulting in a complete seal. No impregnation whatever is needed.

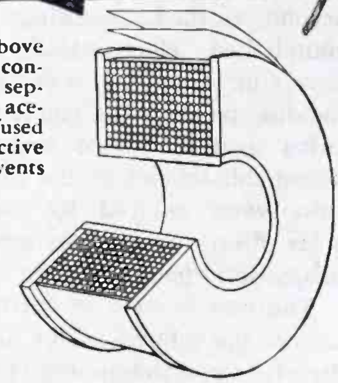
Even in the presence of moisture and direct current, Plastiseal Coils have exceptional resistance to corrosion. Appearance, mechanical strength and insulating qualities are outstanding.

Plastiseal 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. 44236

*Reg. U. S. Pat. Off.



The enlarged cross-section above is distorted to show Plastiseal construction. Each layer of wire is separated by a sheet of cellulose acetate, the edges of which are fused to the end washers. This protective construction effectively prevents corrosion.



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TUBES AT WORK

New Baird Tube Gives Television in Color

COLOR AND STEREOSCOPIC pictures that appear directly upon the screen of a cathode ray tube have been announced by the English inventor, John L. Baird. The system employes a new tube called the Telechrome which differs from the conventional black and white cathode-ray tube in that it has two electron beams and a transparent double-sided screen. One cathode-ray beam produces a blue-green picture on the front surface of the screen, the other a red picture on the back surface. To the viewer, the two blend to form the color picture.

For stereoscopic viewing, colored glasses are used, the left and right eye pictures corresponding to the left and right eye images. Stereo television without the use of glasses has been demonstrated by Mr. Baird but has not been made practical as yet.

In his first demonstration of color television, revolving discs were used for scanning and also to supply the color component. In a second method, scanning was accomplished electronically and a revolving color disc was used. No moving parts were employed in a third system where images produced side by side on the face of the tube were colored by stationary color filters and superimposed by projection upon a viewing screen.

The new 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. The 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. For example, in a two-color system, the two 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. The construction of this type of tube is shown at (a) in Fig. 1. 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 are superimposed to give a color picture.

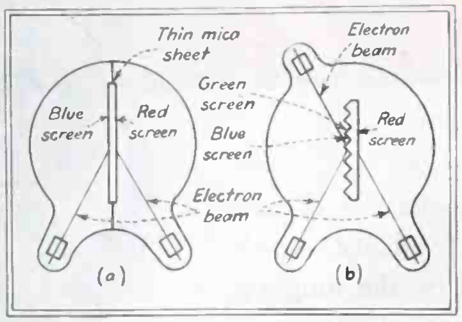


FIG. 1 (a)—Arrangement of phosphor coatings in the new television tube for a two-color system. (b) A ridged back on the screen provides two surfaces on one side of the screen for a three-color system

Three Colors

Where three colors are to be used, the back screen is ridged as shown at (b) in Fig. 1, and a third cathode-ray beam added; the front face of the screen giving the red component, one set of sides of the back ridges giving the green components, and the other sides of the ridges the blue component.

A two-sided tube has been developed that produces a picture from a 600-line, triple-interlaced moving-spot transmitter using a cathode-ray tube in combination with a revolving disc with orange-red and blue-green filters. The receiving cathode-ray tube is shown in the diagram of Fig. 1 and in the photograph of Fig. 2. The screen is a 10-in. diameter disc 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 pro-

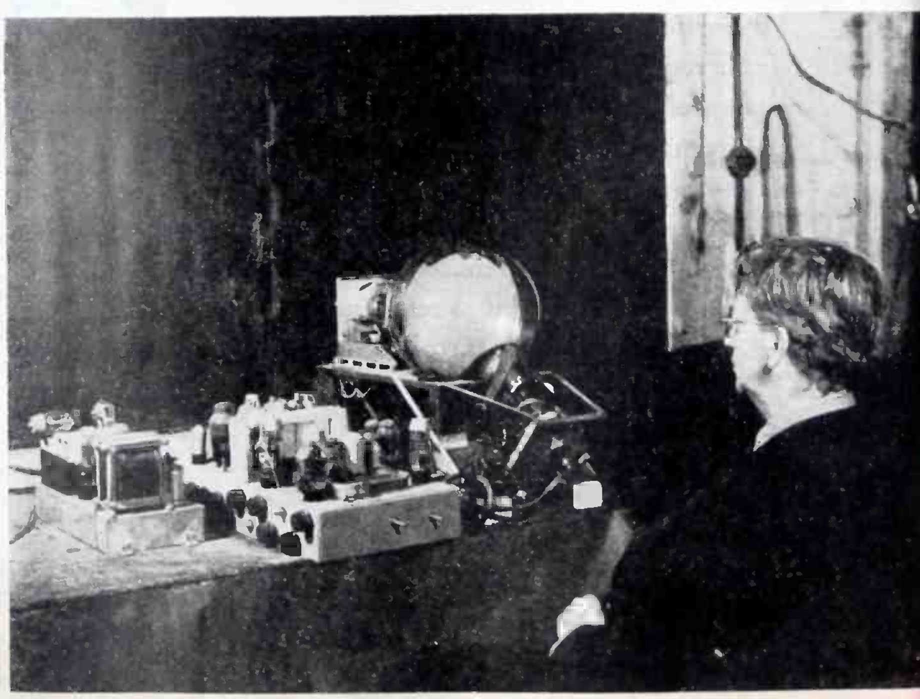
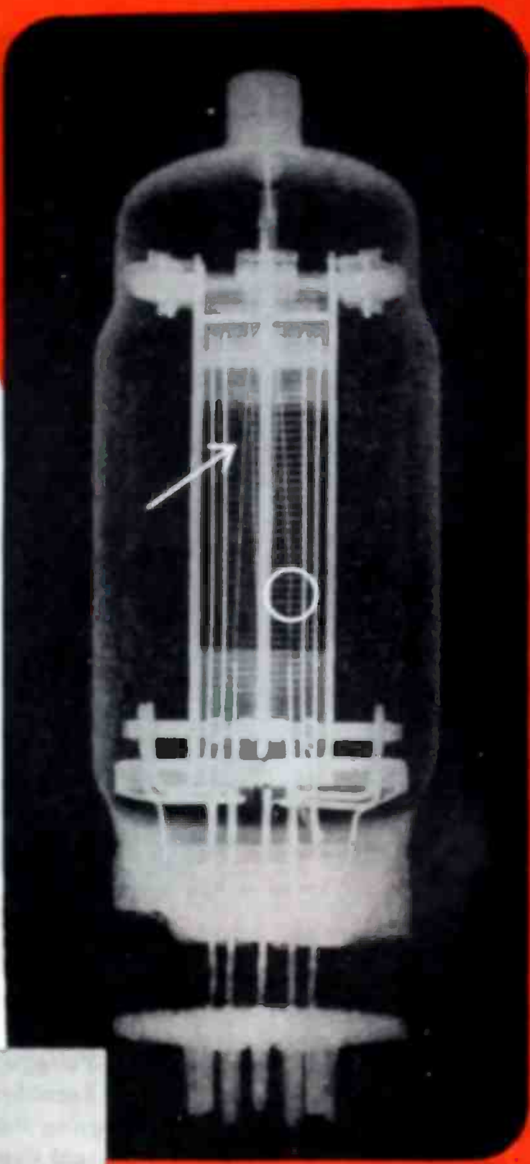


FIG. 2—Complete receiver for color and stereoscopic television with the Telechrome, a new cathode-ray tube invented by John L. Baird, noted English television engineer

Why Norelco Tubes give uniformly high performance



Unretouched radiograph of a defective NORELCO Type 813 tube taken by a NORELCO Model 150 Searchray, showing fractured filament and, on the left side, a misalignment of control and screen grids, as revealed through the surrounding graphite plate.

INSPECTION by X-ray is only one of the many rigid tests applied to NORELCO electronic tubes. Misalignment of elements and similar internal faults, which cannot be seen by close visual inspection, may still permit a tube to function. Spot radiographic inspection by Searchray guards against such "invisible" defects creeping into production runs, thus assuring tubes of high performance and long life.

Typical of the thoroughness of our inspection methods on certain tests is the use of Searchray, the self-contained, rayproof, shockproof, easily operated industrial X-ray apparatus designed and developed by North American Philips. In keeping with this organization's traditional watchfulness over the quality of its products, we make our own X-ray tubes, as well as fine wire for tube manufacture and diamond dies for our own fine wire drawing. These many tests and exacting quality control are reasons why NORELCO electronic tubes, with their consistently uniform characteristics, high performance and long life, should be your choice for postwar industrial use.

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.

...us send you our booklet telling the story of ...th American Philips. Behind this company is ...m of outstanding electronic engineers, headed ...e of America's leading physicists, and coached ... group with worldwide experience resulting ...a fifty years of research and development. ...ay we work for Victory; tomorrow, our aim ... be to serve industry.

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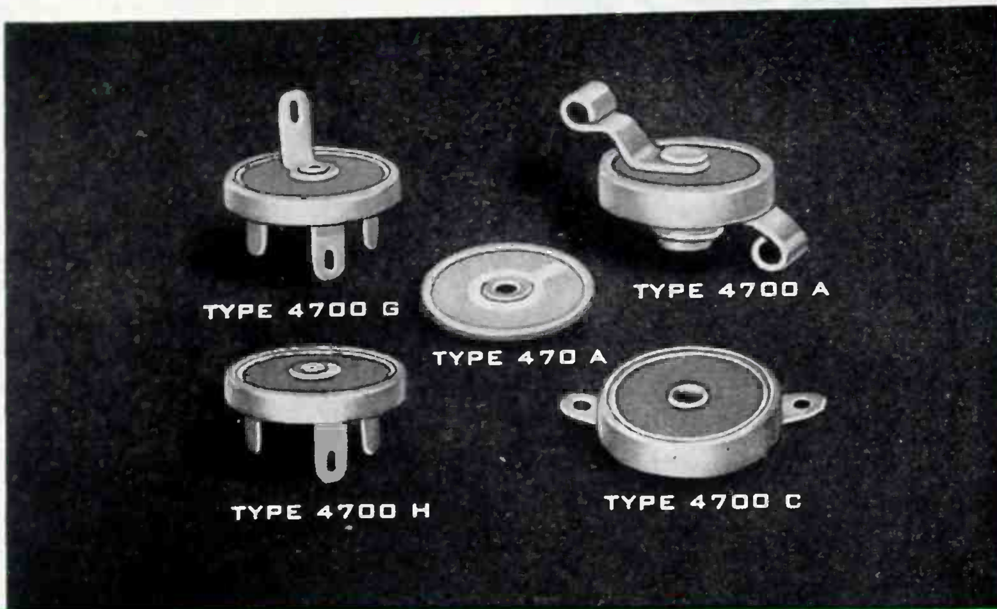

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These small condensers consist essentially of a tack of silvered mica sheets encased in a silver lated housing. The housing forms one terminal, the ther terminal being connected to the center of the tack, thus providing the shortest possible electrical ath through the capacitor.

Types 470 and 4700 have comparatively high apacity ranges and their compactness, together with he wide selection of terminal mounting designs, for y-pass applications, makes them ideal components or V.H.F. and U.H.F. applications, where short ibbon-type leads and low series inductance are rime requisites.

Capacity ranges and electrical characteristics re shown at right.

Samples will be sent to interested engineers n request.

CHARACTERISTICS

CAPACITY RANGE:
Type 470 A —100 MMF to 1000 MMF
Type 4700 A—500 MMF to 3000 MMF
Type 4700 C—500 MMF to 3000 MMF
Type 4700 G—500 MMF to 2000 MMF
Type 4700 H—500 MMF to 2000 MMF

INITIAL POWER FACTOR:
.12% Maximum @ 1 Mc. and @ 25° C.

WORKING VOLTAGE:
500 Volts DC
350 Volts AC

TEST VOLTAGE:
1000 Volts DC

INITIAL LEAKAGE RESISTANCE:
Greater than 10,000 Megohms @ 25° C.

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vided for the back screen by using a white powder and coloring the mica itself.

The tube shown in Fig. 1 (a) may be viewed from both back and front, but if used in this way one group of viewers sees a mirror image. Colored mica must not be used, and a filter is 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.

The tube shown in Fig. 2 can only be viewed from the front, but having one cathode-ray beam perpendicular to the screen simplifies the setup 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.

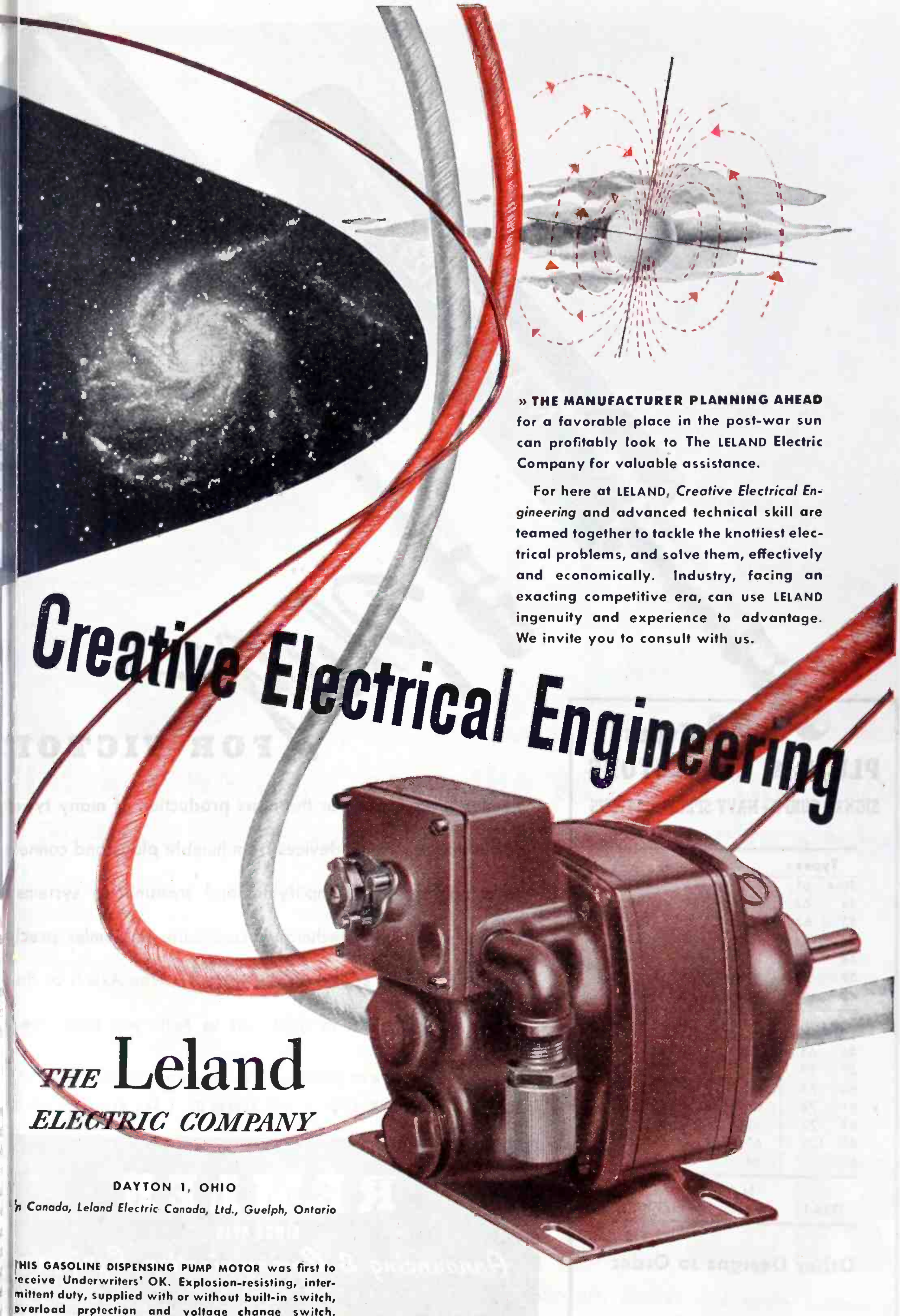
The tubes give excellent stereoscopic television images when used

John L. Baird holds his new double-beam double-phosphor coating cathode-ray tube

with a stereoscopic transmitter. The blue-green and orange-red images form a stereoscopic pair when viewed through colored glasses.

New Form of Scanning

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 the 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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60	68	112	149	

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59	67	59	67	59	65
60	74	60	74	60	74
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Whitaker workers have the will and the skill to produce wiring assemblies to your specifications

The girls who work in our plants are skilled technicians—and we can prove it. For example, the picture shown above illustrates one of the many complicated assemblies being turned out for war needs by our St. Joseph plants. The job looks difficult, and it would be except for the fact that we have a quarter of a century of experience.

Investigate and you will find that Whitaker has the "know how" and ample plant facilities to turn out cable assemblies, wiring harnesses, and flexible leads for power and lighting . . . Your inquiries are solicited. Whitaker Cable Corporation, 1307 Burlington Ave., Kansas City 16, Mo. . . . St. Joseph, Mo. . . . Philadelphia . . . Oakland.

WHITAKER

Cables, Wiring Harnesses and Assemblies for Automotive, Aircraft, Marine and Radio Equipment

shown each of the primary colors.

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 disc system.

• • •

Routing Cabs by Radio

A PLAN PROPOSED by Cab Resear[ch] Bureau, Inc., representing the ta[xi] industry, and the Electronic D[e]partment of General Electric C[o.] would make it possible to establi[sh] contact by radio with any cab [at] any place in Cleveland, redu[ce] cruising mileage and eliminate u[n]attended call boxes connected [to] telephone lines. If approval can b[e] obtained from the FCC, this wou[ld] be the first two-way taxicab radi[o] system in the country.

The plan calls for one mai[n] transmitter for the downtown are[a] and two others to cover the rest o[f] the city. Each transmitter woul[d] have four channels, with 100 cab[s] assigned to each channel.

That radio-equipped cabs mig[ht] be very useful in emergencies gro[w]ing out of fire, crime, and acciden[ts] was pointed out by D. L. Chesnu[t] G-E commercial engineer. H[e] pointed out that, "the taxicab i[n]dustry in each major city mig[ht] draw up an agreement with th[e] city permitting the police depar[t]ment to commandeer its radio ca[bs] and its headquarters station at a[ny] time that a major public distur[b]ance should warrant."

• • •

Robot Radio Stations Fore-cast Weather

AUTOMATIC WEATHER stations i[n] secret locations from the arctic t[o] the tropics are playing a major ro[le] in coordinating allied land, sea an[d] air attacks with favorable weathe[r]. The robot weather bureaus were de

Sgt. Spring, M.E., E.E., MET.E., CH.E., etc.

E'VE GOT HIM COVERED

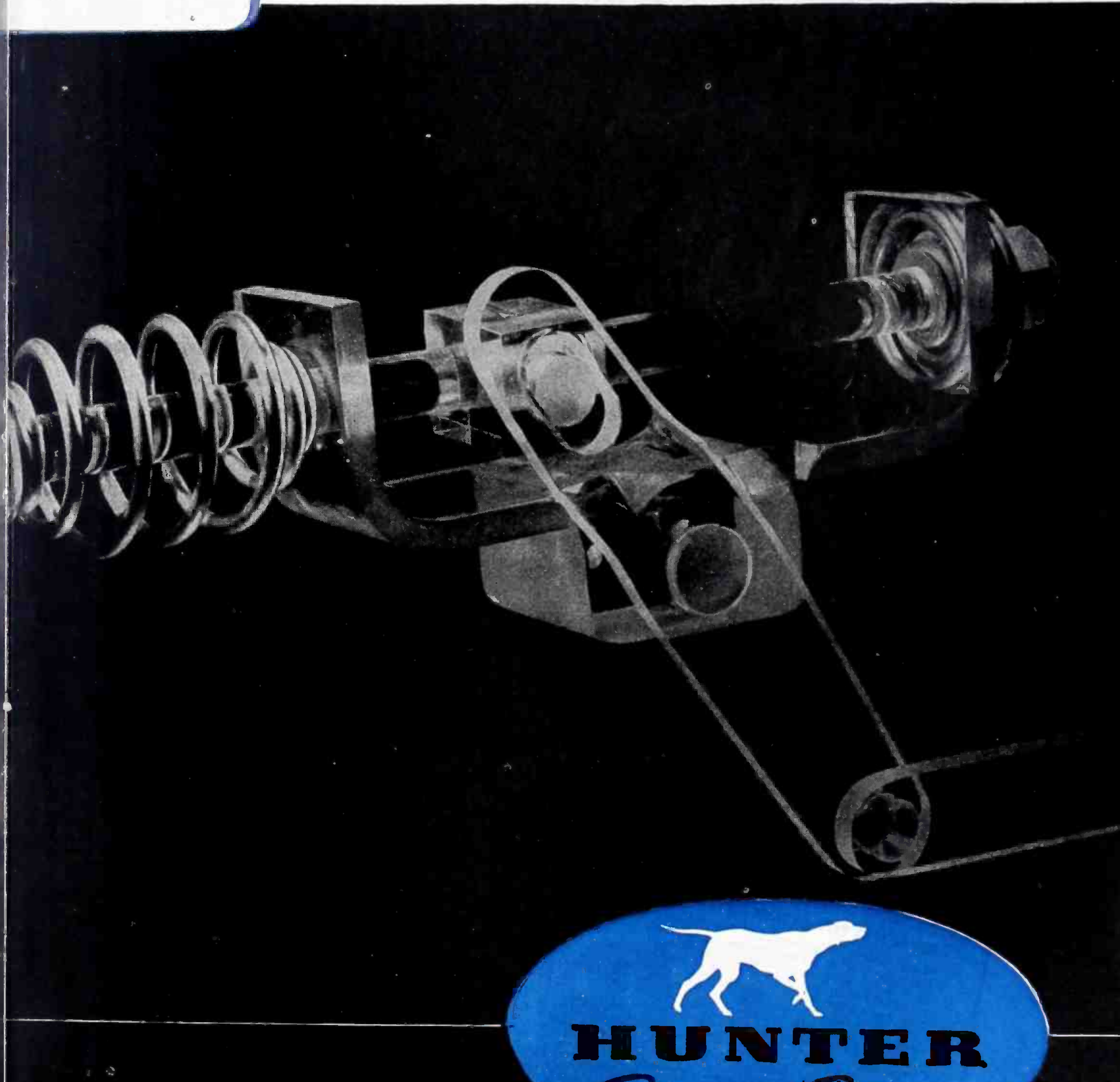
ro the Hunter Data Book have
prited many ideas for spring-
ted devices that are doing their
finish off the Axis. This handy
acked book is full of informa-
ou need at your desk or draw-
ard. For a free copy, send your
ture on your business letter-
It will be mailed promptly.

THERE was a time, very likely within your memory—when a spring was simply a curlicue of wire. You made it. If it didn't work, you gave it another twist and tried again. This cut-and-try approach was certainly not design—and hardly economical manufacture. But it had its day . . . and that day is over.

Now, to fit a spring precisely for the job it must do in your product . . . to make it an ambassador of the quality and performance your customers expect from you, requires all the scientific knowledge a spring manufacturer can bring to bear.

The most naive-looking spring will often surrender only to the combined efforts of calculus, metallurgy and statistical control of quality. But in 99-44/100 percent of the problems, science wins out where rule-of-thumb would flop. The war has proved the case for scientific spring making. Future applications will rest on that proof.

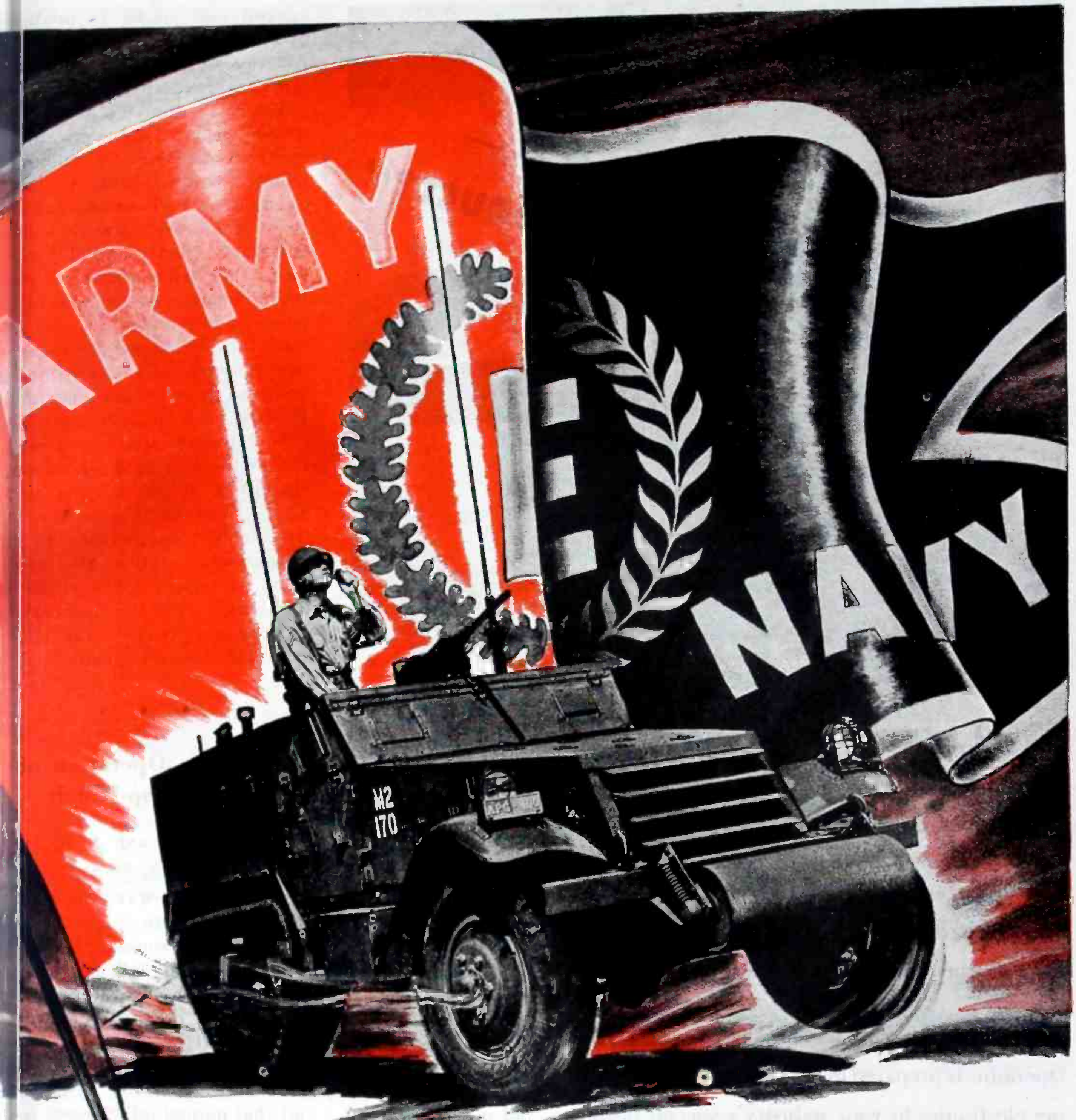
THE BARREL SPRING—*The barrel spring is a fundamental spring form, designed to resist, or store up until wanted, a compressive force, and to compact into the minimum solid height. One of many for-instance applications for barrel springs is shown in the Plexiglas model below.*



HUNTER

Science in Springs

R PRESSED STEEL COMPANY, LANSDALE, PENNA.



Yesterday and TODAY

The Army-Navy Production Award for outstanding achievement in producing vitally important materials essential to the war effort will be an added incentive to the management and employees of WARD PRODUCTS CORPORATION to keep producing more and better equipment for the men who are doing the fighting. While yesterday WARD Antennas were accessories for pleasure, today they are implements of War.

WARD *Antennas*

veloped and placed in production by Friez Instrument Div. of Bendix Aviation Corp. within a year after the Navy requested the devices.

The Navy wanted a device which would report automatically on weather conditions by radio from remote points back to official weather control locations, and while Friez engineers already had the necessary meterological instruments they had to start more or less from scratch on equipment for power and timing of automatic radio devices necessary to broadcast reports and data continuously gathered by recording instruments. Weather and termite-proof insulated houses were developed to shelter the recording and radio instruments. Since weather in the English Channel originates around Greenland, it was necessary to build the automatic stations able to withstand the severe arctic climate of that region. For the most part, the stations require servicing only at intervals of several months.

• • •

Electronic Operation of a Standard Stop-Watch

By R. J. Wey and J. H. Jupe
Middlesex, England

In using a stop-watch over intervals of one minute or less the error, due to human causes, may be appreciable and the following description deals with apparatus designed to overcome this. A phototube is used so that the mechanism being timed is physically separate from the timing apparatus, with the result that mutual interference is nil.

The light beam can be interrupted or modulated in various ways but to reduce circuit errors to a minimum the best method is to operate the relay in the same direction at both ends of the cycle. The inherent time delays will then cancel out. This device has been in use for a long time and has been found to be extremely reliable and convenient for laboratory work.

Four basic modes of operation are possible, as follows:

1. Double occultation;
2. Double illumination;
3. Single occultation;
4. Single illumination.

A schematic of the circuit for the

No wonder American industrialists are dizzy! — Columnists, commentators, conferences and a host of critics on the sidelines advising business to "Go ahead" — to "Hold back" — to "Stand still."

Red lights today, green lights tomorrow.

Through the maze of conflicting regulations, press releases, industry bulletins, it is safe to predict, however, that civilian production will resume shortly. But we must win the war first.

We at G. I., realizing that wars always end more suddenly than they begin, decided long ago on a post war planning schedule. It may help to clarify your problem to know that we will be under way immediately when Uncle Sam issues the go-ahead signal.

The first in our industry to be so honored
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Our products comprise new and improved components in the electronic and radio fields — variable condensers, automatic tuning mechanisms, record changers and new items developed and perfected from the research of our wartime experience.

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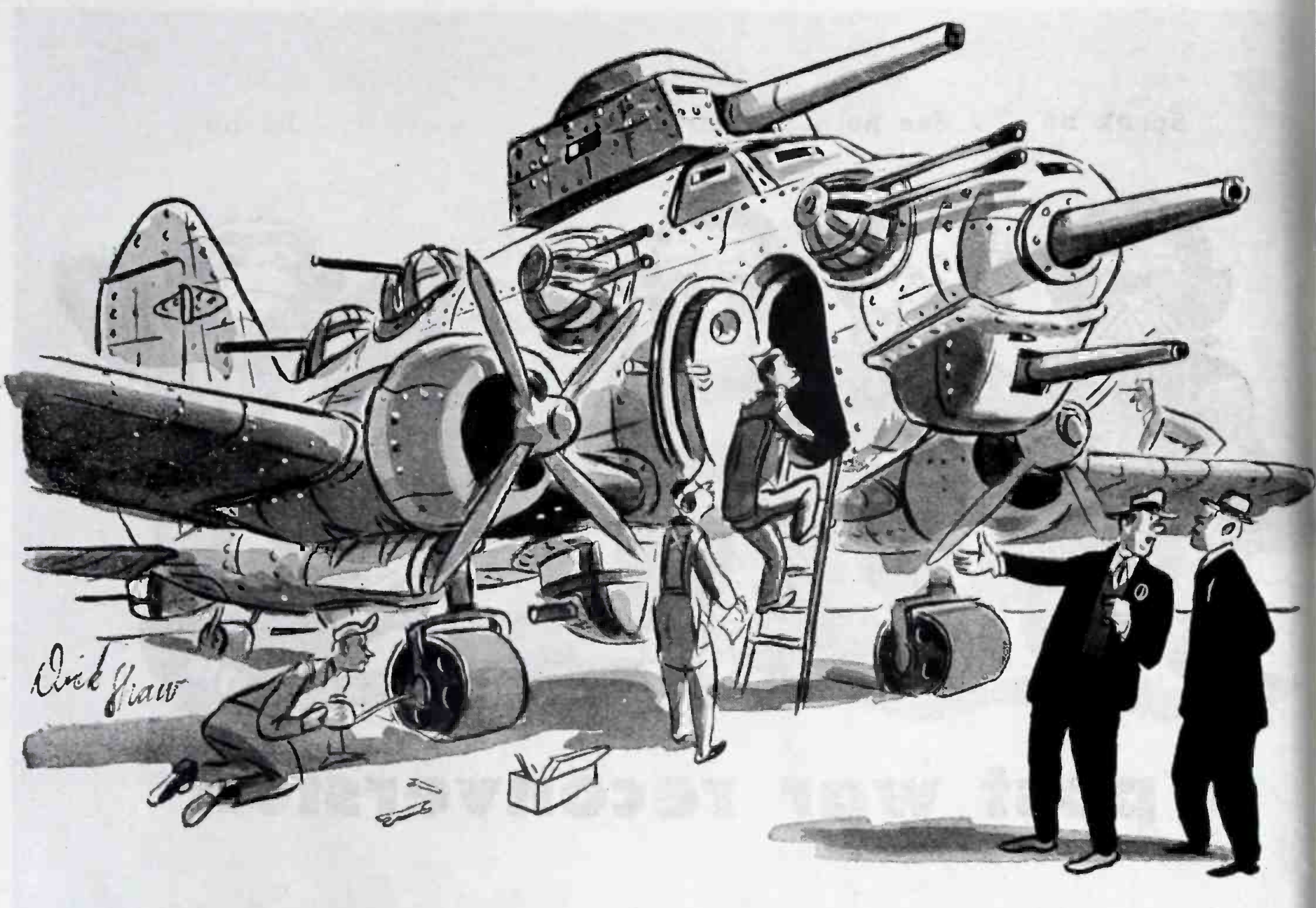

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CANNON PLUGS ARE DEFINITELY ON THE LIGHT SIDE . . .

Sure Cannon Plugs do weigh a little something—but the least possible. They're engineered that way.

First off they're *designed* for aircraft use—not just adapted to it. They're strong where strength is needed. Excess weight is saved by cutting out factors that don't contribute to structural soundness.

Then, too, Cannon Plugs are precision built which means more than just the close fit of all parts. With Cannon, precision also means burring and cleaning, trimming down and finishing off all excess material.

Shells are die-cast of alloys that are tough but light. Pins and sockets machined to closest tolerances to save weight. Inserts, rings, springs, clips and clamps—each part designed to do its job exactly without waste.

The weight saved with one Cannon Plug makes little difference. But with Cannon Plugs on all the circuits a great deal is saved—actually several pounds per plane.

Speaking of weight saving, just look over the lightweight connectors in the Cannon Type AN series, built strictly to Army-Navy Specifications. A new 4th Edition Type AN Bulletin is ready for distribution. It's free for the asking. Write Dept. A-120, Cannon Electric Development Co., Los Angeles 31, Calif.

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most useful (double occultation) is given in Fig. 1.

The phototube is coupled to the grid of the amplifier tube by resistor R_1 and capacitor C_1, while in the anode circuit is an ordinary telephone-type relay. Double-pole double-throw contacts are provided on this and its operation is indicated by the signal lamp L_1 being supplied via contacts 5 and 6. Grid bias of the tube is adjusted by potentiometer R_3 until sufficient anode current flows to give positive operation

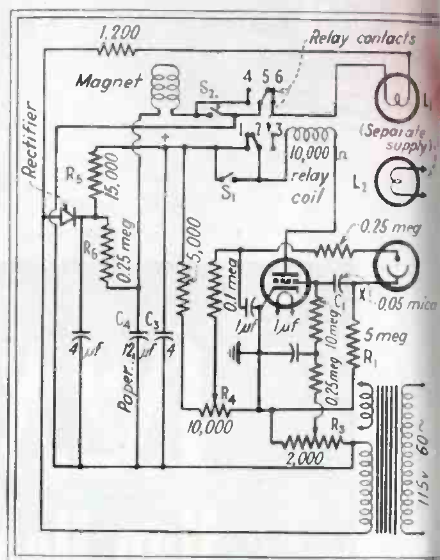

Fig. 1—Circuit for starting and stopping a stop-watch by two interruptions of a lightbeam. Lamp L_1 is a 230-volt, 15-watt bulb

of the relay (approximately 3.5 to 4 ma.). The phototube anode potential is adjusted by means of resistance R_4, both anode supplies being obtained from the metal rectifier and smoothed by capacitor C_4 in conjunction with resistor R_6.

Operation

Normally, the phototube is illuminated, so that point X is positive with respect to the cathode of the amplifier tube. Interruption of the beam causes the grid potential to fall to a low value and the relay releases when the anode current changes. Three things then happen:

The watch is started by the electromagnet being energized; the signal lamp is no longer illuminated; the anode circuit of the amplifier tube is opened.

This last is useful as the amplifier is rendered proof against control by the phototube while timing is in progress. Near the end of the timed

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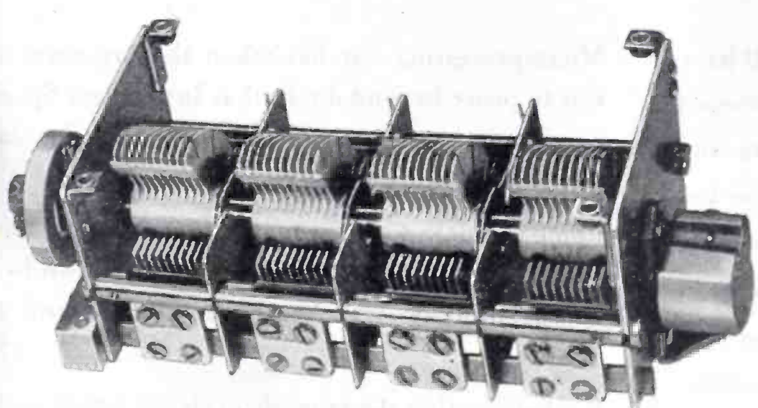

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...signers and Builders of High Frequency Converters Since 1921 cycle, pushbutton S_1 must be operated to reconnect the amplifier by allowing anode current to pass and pull in the relay armature. After this, the first occultation will energize the magnet and stop the watch. Switch S_2 resets the watch to zero.

Referring to the schematic, it will be seen that the current for operating the magnet is obtained from capacitor C_4, which is charged to some 300 volts through resistor R_6 and discharged through the magnet coils when contact 5 closes onto 4. Although the magnet requires some 50 ma. for its operation, the rectifier load is only increased by about 1.5 ma., and as the discharge is comparatively heavy and of short duration, the operation of the device is quick and positive.

Sometimes it is neither desirable nor possible to achieve double occultation of the phototube, in which case a flash of light from a moving mirror may be used to start and stop the watch. The circuit must then be revised as follows: 1. Interchange the positions of the phototube and the resistance R_1; 2. Vary the amplifier tube bias so that the anode current is normally zero and change over the connections to 4 and 6 of the relay. Contacts 1, 2 and 3, also reset button S_1, will be cut out of the circuit.

Single Illumination or Occultation

When operation by single illumination or occultation is required

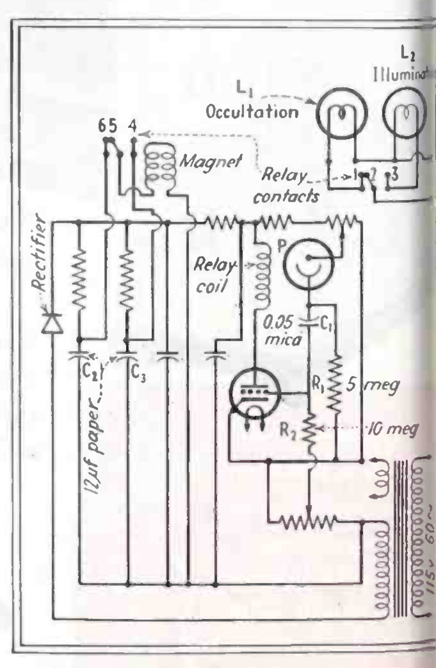

Fig. 2—Single illumination or occultation will operate the circuit above. Except as shown, constants of components are the same as Fig. 1

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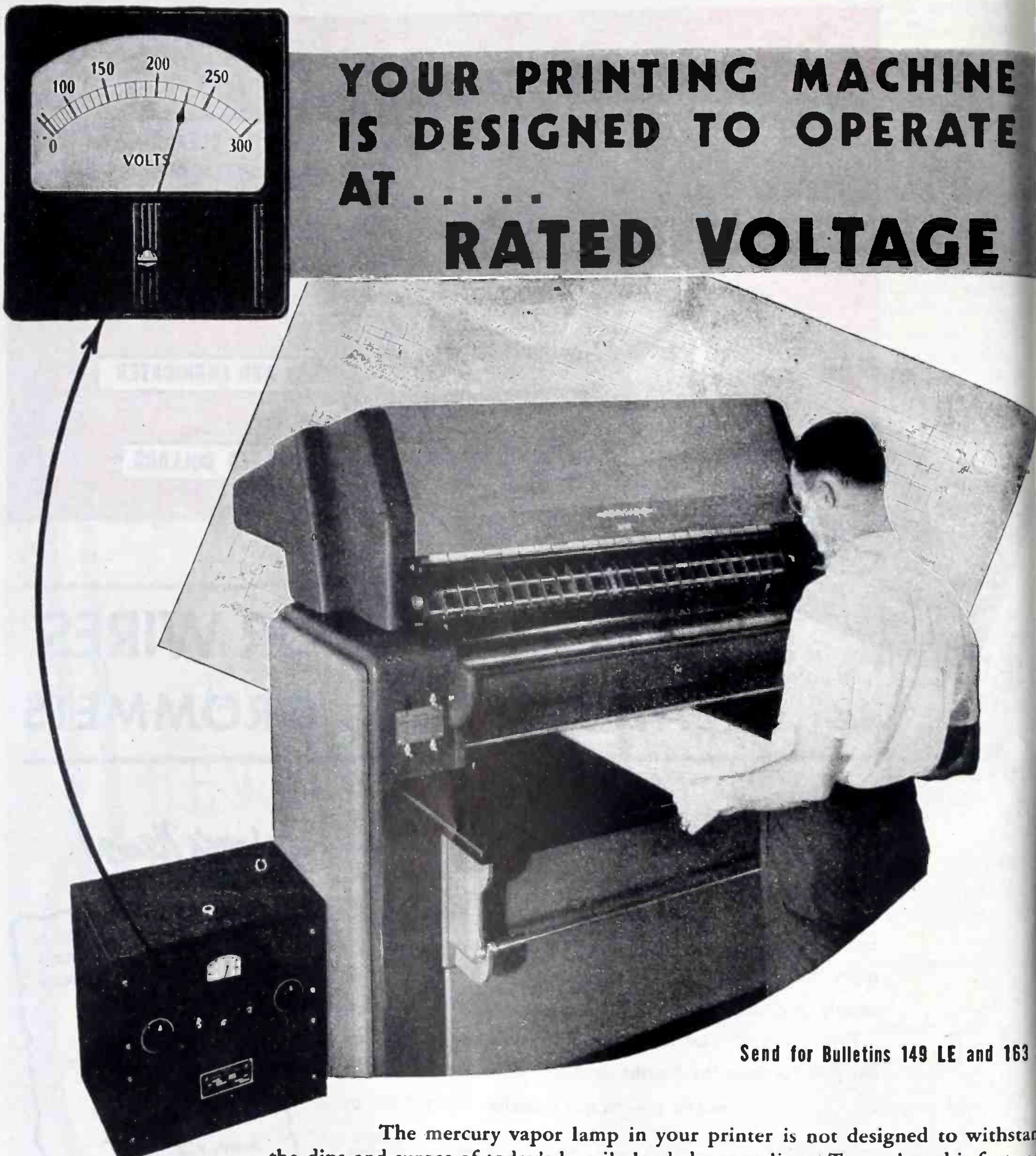

Send for Bulletins 149 LE and 163 LE

The mercury vapor lamp in your printer is not designed to withstand the dips and surges of today's heavily loaded power lines. To neglect this fact may mean a burned-out tube. Subsequent replacement entails costly delays in production and a large expenditure for each new lamp. This can be prevented by employing a SECO automatic voltage regulator to regulate the voltage applied to these lamps.

In the illustration, long lamp life is assured by SECO regulator type 4209. A constant input voltage of 230 volts to the printing machine is maintained irrespective of line variations up to plus or minus 17.5%. Other features of this 9 KVA model are — no internal mechanical adjustments — quick response — high efficiency.

For low cost insurance against tube failure in your machine, install a SECO regulator.

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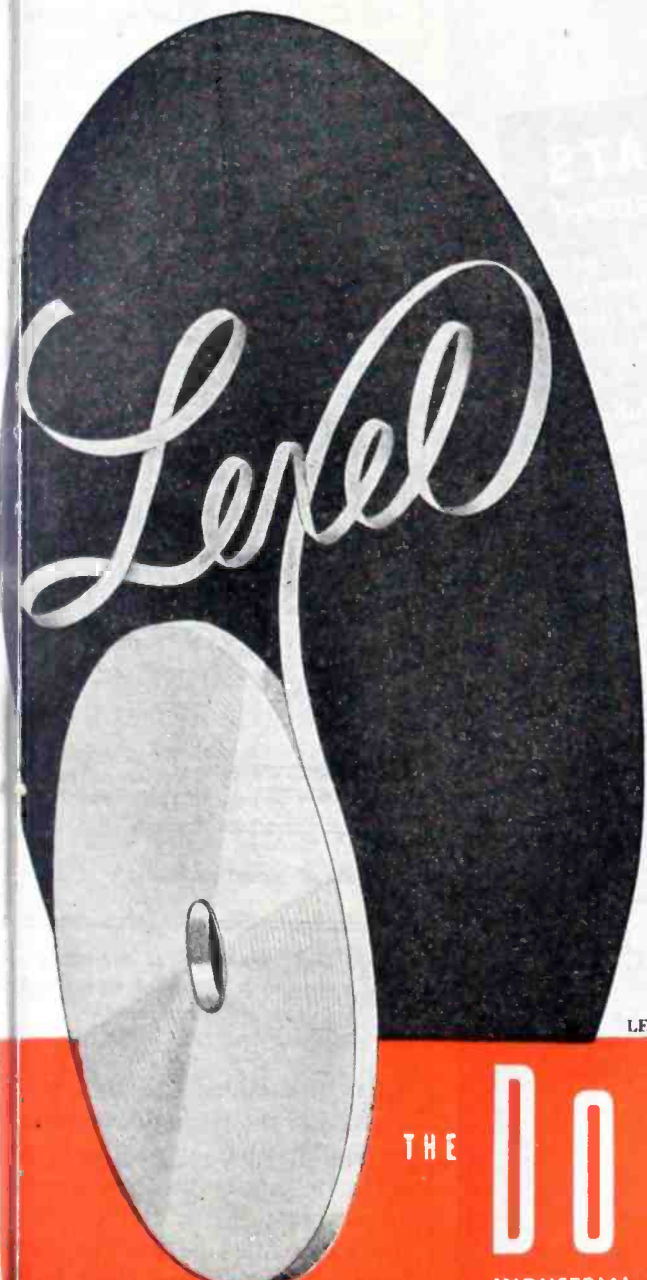

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the simplified circuit shown in Fi
2 may be used, in which case t
bias of the tube is adjusted so th
its normal anode current corr
sponds to the mean operating cu
rent of the relay.

Upon occultation, the relay w
drop out, causing C_3 in Fig. 2
discharge through the magn
winding and so start the wat
While the phototube is in darkne
the anode current will slowly ri
(the time being determined by t
time constant of R_1, R_2, C_3) but w
not operate the relay owing to i
pull-up current being different fro
the drop-out value.

When the phototube is illum
nated at the end of the cycle, t
anode current will rise still furth
and the relay will operate and ene
gize the electromagnet from capa
itor C_2. A little later the anode cu
rent will return to its original val
but the relay will still hold in. T
circuit is then ready to respond to
further occultation of the beam.

Modes of operation 3 or 4 a
made possible by checking that t
relay is in the correct condition b
fore the timing cycle commenc

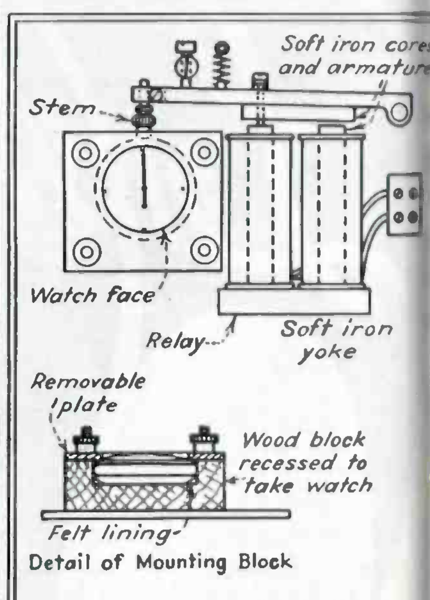

Fig. 3—Construction of mounting unit for adapting a standard stop-watch to an electronic starter

The signal lamps L_1 and L_2 may be marked to show whether occultation or illumination is required to operate the apparatus. As there are two capacitors, C_2 and C_3, in use, the watch must be reset to zero by hand, otherwise two reset buttons are necessary.

The general arrangement of the

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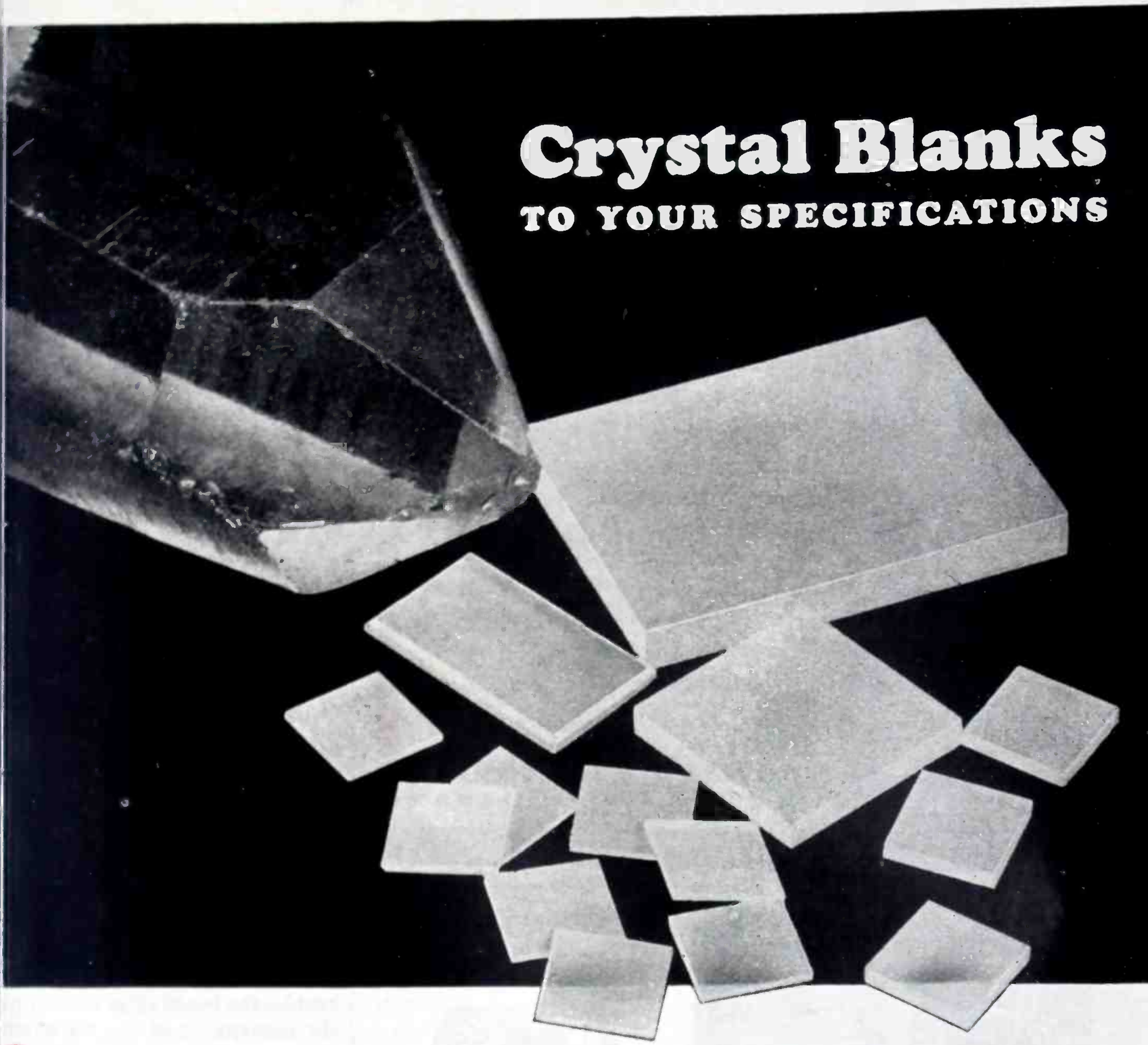

rystal Products Company can supply Quartz Crystal inks in any of the three stages of manufacture: (1) "rough-wed" blanks, (2) "semi-finished" blanks, and (3) "electri-ly finished" blanks.

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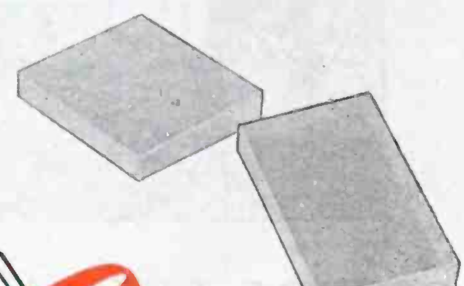
All crystal blanks are cut to specifications from selected azilian quartz and guaranteed free from all impurities such optical twinning, electrical twinning, bubbles, fractures, atches, mineral inclusions, and other mechanical and ctrical imperfections. Dimensions, temperature coeffi-nts, and frequencies are guaranteed within specifications ted. **Send us your holders for replacement of crystal anks to exact specifications.**



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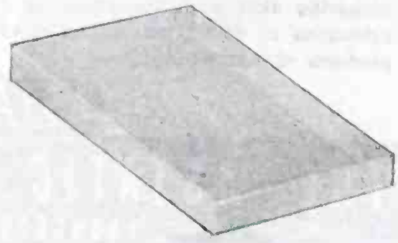

watch unit is given in Fig. 3. Clamping nuts hold the watch in position and a felt pad prevents damage.

The electro-magnet coils are 3¼ in. long by 1½ in. in diameter and are wound with No. 36 B and S enamelled copper wire, about 12,000 turns being necessary. A diameter of ⅝ in. is adequate for the cores while a minimum air gap of 0.02 in. is satisfactory between armature and pole face.

It should be noted that the screw which projects through the armature to the pole face must touch the latter before the knob of the watch is fully depressed, otherwise considerable force may be exerted on the watch mechanism. Thanks are due the Editor of *Electronic Engineering* for permission to reproduce certain copyright material.

• • •

Substitute for Car Antenna Checks Capacitance

By Paul F. Magee

Cross Roads Auto Service, Berlin, Md.

DUE TO THE SHORTAGE of manpower, we have not been able to actually remove or reinstall any car radios, nor make any adjustments on the set in the car. However, we have been repairing them to a great extent on the bench after determining the capacitance of the car antenna with a simply-made capacitance bridge. This instrument enables the serviceman to line up the radio at the test bench under the same conditions as the set encounters when installed in the car.

A reading is obtained by connecting the bridge unit to the car antenna with the antenna lead disconnected from the car radio set. The unit is then carried in to the service bench and plugged into the auto radio for the alignment procedure and a switch is set to connect the proper capacitance into the receiver input circuit. The time required to take the bridge reading is practically nil and by recording this reading the set can be aligned properly without the car antenna at some later date.

As illustrated in the diagram, the device is a bridge circuit using two resistors on one side of the bridge and two capacitors on the other side. One of these is a known

In the photographs shown here, only the square patch of filter paper in the center has been treated with Tropicalized Q-Max Lacquer. The area free from fungus immediately surrounding the patch shows how effectively Tropicalized Q-Max controls fungus growth even on untreated surfaces adjacent to the treated part.

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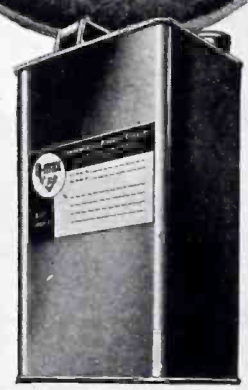

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744 BROAD ST. NEWARK, N. J.
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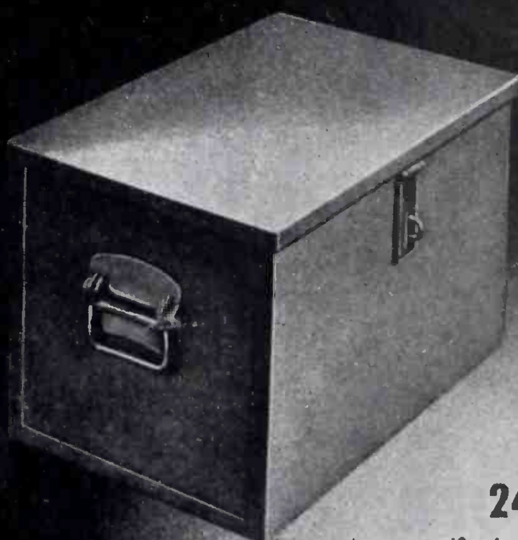

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1025- 4	12	9	9	1025-17	24	18	12
1025- 5	18	9	6	1025-18	24	18	15
1025- 6	18	9	9	1025-19	24	18	18
1025- 7	18	12	9	1025-20	24	12	9
1025- 8	18	6	6	1025-23	30	15	9
1025- 9	18	15	9	1025-14	30	15	12
1025-10	18	12	6	1025-22	36	12	9
1025-11	18	15	12	1025-21	42	9	9
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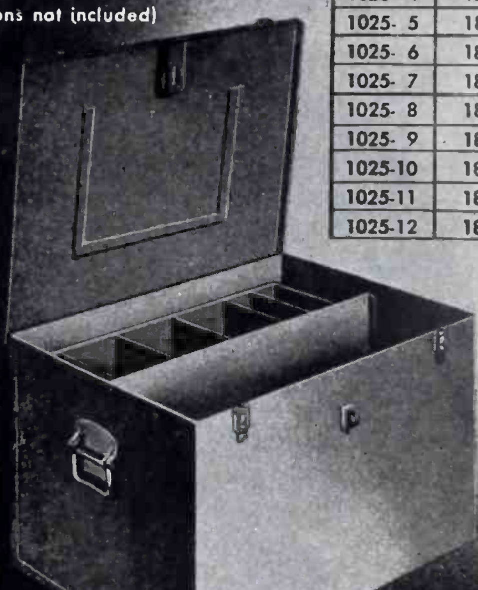

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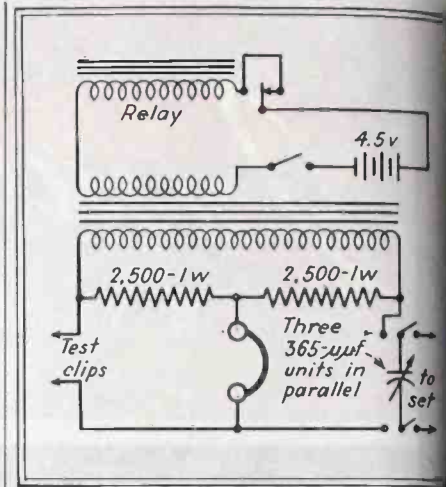


Bridge circuit for measuring the capacitance of a car antenna. The unit acts as electrical substitute for the antenna when it is necessary to align the receiver on the bench. Plug-in antenna adapters permit quick checks

capacitance and the other unknown. When connected as shown, the relay furnishes the buzzing sound to provide an audible sound for balancing the known capacitance to the unknown capacitance of the antenna circuit in the car.

The transformer is a line-to voice-coil type. The voice-coil winding is connected in series with the relay, battery and switch.

Three flashlight batteries have lasted for a long time. The layout of the components is not critical and all of the parts were installed in a box 6 x 9 x 4 in. The dial is mounted on one end and was calibrated with the aid of a capacitance meter used in normal service work.

The device has sufficient antenna effect to permit operation of the set

Dial Reading	Cap. in μμf
0	100
20	160
40	300
60	550
80	900
100	1250

without an additional antenna connected if the set is operating properly. By using the unit on every set, a sense of judgment can be obtained as to whether the repaired set is satisfactory. The set is aligned for greatest sensitivity from one end of the band to the other, even if the oscillator trimmer capacitor has to be varied slightly to obtain satisfactory results.

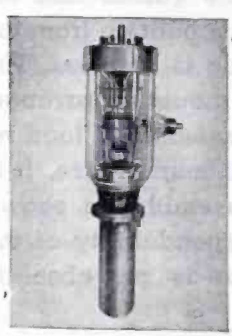
A tuning gang having three 365-μμf sections connected in parallel has sufficient capacitance to cover

R e metals are of increasing importc ce in radio transmitting tubes, and th simple operation above is proof of chlett's ability to handle them. Here b yllium is being rolled into sheets f m 0.004 to 0.020 inch thick, sheets t t are vacuum-tight, and have adeq ate ductility at high temperatures.

ormerly it was believed to be imp sible to make beryllium malleable, b Machlett decided to produce it in th form, because it then could be used a part of the envelope in an X-ray t e. This would result in new tubes of s erior utility in certain important ap p ations, particularly X-ray diffract n, one vital use of which is in determ ing the axes of quartz crystals for r io 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.

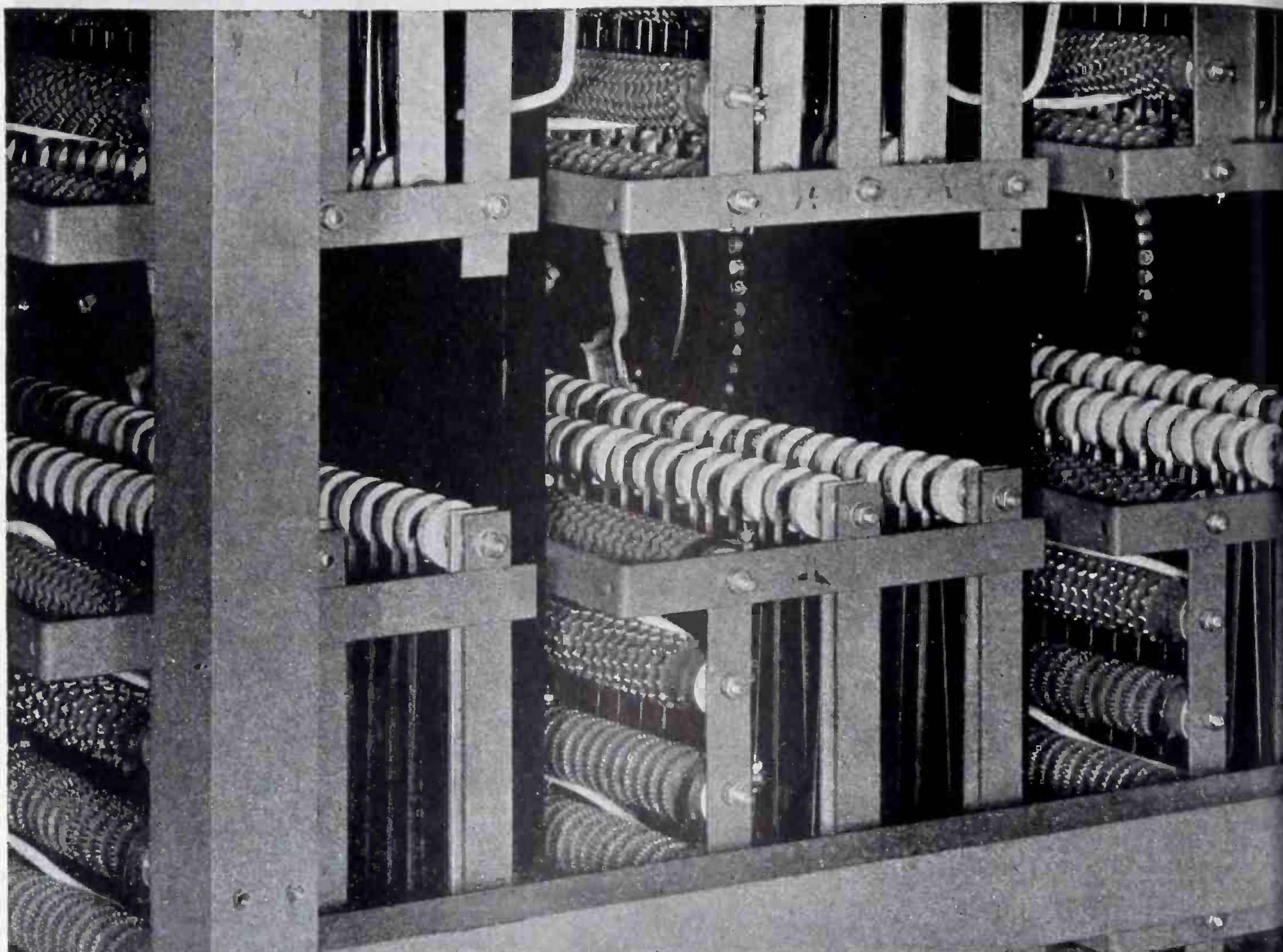


ML-893—high power oscillator and amplifier tube for radio and industrial purposes.

MACHLETT

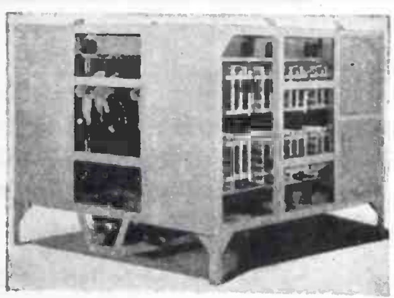
X RAY TUBES SINCE 1898

TODAY THEIR LARGEST MAKER



ADAPTABLE *and* DEPENDABLE RESISTORS

ADAPTABILITY and dependability of resistors assume primary importance in the assembly of large rheostat control units. The wide range of resistance values and capacities that can be built up from the Ward Leonard line is limitless. The many types and mounting arrangements permit the meeting of load requirements in minimum space. It is obvious in an assembly as shown above that the dependability of the individual resistor is an absolute essential.



This motor operated Ward Leonard assembled rheostat is built up from several types of Ward Leonard Resistors.

For over fifty years industry has looked to Ward Leonard for both resistors and resistor assemblies. This experience has given Ward Leonard Engineers the viewpoint of user and designer. It is reflected in the completeness of the Ward Leonard line of Resistors.

Whatever your requirements you will find a Ward Leonard Resistor that exactly meets your conditions. Send for Bulletins.

ARMY E NAVY

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RELAYS • RESISTORS • RHEOSTATS

Electric control WL *devices since 1892.*

BUY MORE WAR BONDS

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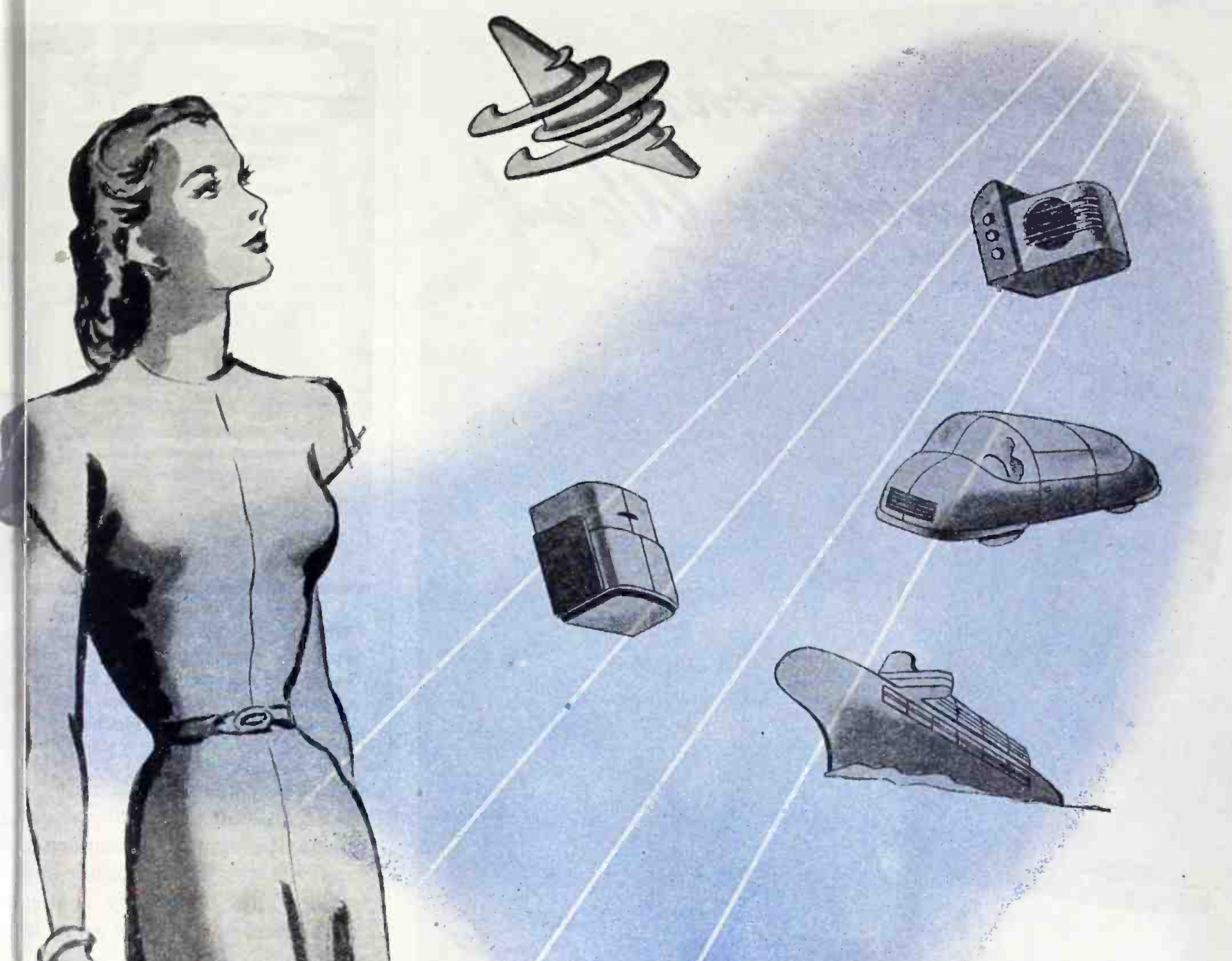
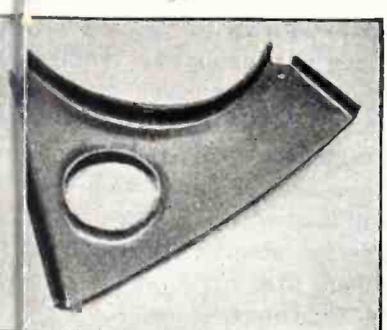


POST FORMED PHENOLITE*

Opens wide avenues for your successful Post-War Products

*A formable thermosetting sheet material—makes parts more resistant to shock



This is a typical Post Formed Phenolite baffle used in aircraft construction.

Post Formed Phenolite parts are playing an important role in today's airplane construction because of their ability to withstand tremendous impact without fracture. This impact strength is approximately ten times that of usual molded parts.

This remarkable property, combined with Phenolite's other exceptional characteristics—resistance to wear and moisture, light weight (about one-half the weight of aluminum), excellent electrical insulator—recommends the broad advantageous use of Post Formed parts in countless peacetime products.

Post Formed Phenolite Parts are economical to produce. The sheet is heated to forming temperature (a matter of seconds). After heating, it is formed in an inexpensive wooden mold with standard press equipment. Practically any desired form or shape may be achieved. Forming takes place in a few minutes. There are no rough edges to be sanded—no flash to be removed. Fabrication may be done before or after forming.

Just now we can supply material for war applications only, but our technical men will be glad to work with your engineers on your peacetime projects. Write us now on Post Formed Phenolite.

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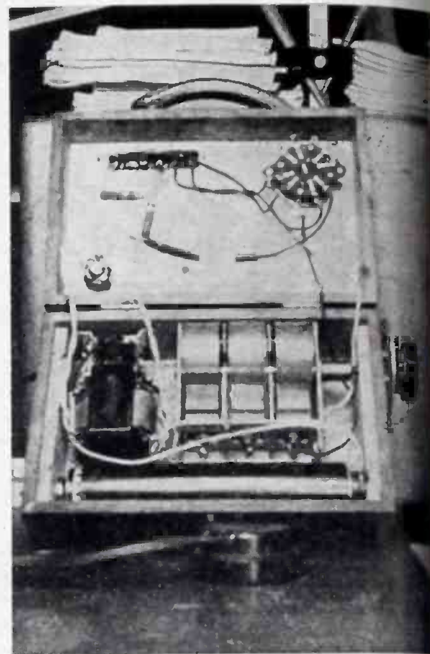


With components mounted in a wooden box, the capacitance bridge can be carried to the car to check the antenna and back to the bench for substitution of the correct capacitance

almost any installation using side-of-car antennas. A 500-$\mu\mu$f capacitor may be connected temporarily to facilitate testing an under-car antenna. This temporary connection can be made across the gang inside the box.

The unit can also be used for regular checking of capacitance, but is of little value where voltage must be applied in the checking process. The dial scale can be elaborated to any extent, but the values given below were sufficient for our purpose.

• • •

Skyhook for Gibson Girl

THE 300-FT ANTENNA used with the Gibson Girl emergency transmitter (shown on the cover of the September, 1943 issue of ELECTRONICS) is supported by a yellow kite made of steel and cambric. Combined with the transmitter, the kite is standard equipment in rubber life rafts on all bombers and transport planes.

The framework of the kite is formed of stainless steel tubing that is first passivated to remove all foreign matter from the metal and is then put through a 200-hour salt-spray test to provide a standard of resistance to the climatic conditions which may later be en

When it's REFRIGERATORS *instead of range finders*

Manufacturers with an eye on post-war markets are "getting the range" through their wartime experience with Western non-ferrous metals . . . "tailored" for specialized requirements.

We are thoroughly experienced in meeting requirements that call for close tolerances, exacting tempers and finishes, and in producing highest quality metals that are easy to stamp, form, draw, buff and plate.

The greatly increased capacity of our mills at East Alton, Ill., and New Haven, Conn., will enable us to supply additional customers with high-grade Western metals—in sheet or strip, cut lengths or long coils, drawn or stamped parts. An invitation to discuss your copper and copper base alloy requirements will be appreciated.

Western BRASS PRODUCTS

Western BRASS MILLS

Division of WESTERN CARTRIDGE COMPANY, *East Alton, Ill.*

BRASS • BRONZE • PHOSPHOR BRONZE • NICKEL SILVER • COPPER

countered in the various war zones. Small corks are inserted in the open ends of the tubing to render them watertight.

The skirts of the kite are made of a water-repellent cambric that has a tensile strength of 39.4 on the warp and are given buoyancy by corner paddings of kapok. Cold-rolled steel clamps which have also been given the corrosion tests hold the skirts to the frame.

A product of Hoffman Radio Corp. of Los Angeles, Calif., the kite can ride out a wind of 50 miles per hour and permits the transmitter to cover a range of 300 square miles in average weather. The kite stands 36 in. high when open and weighs but 12½ oz.

• • •

Light and Sound Control for Television Displays

ELECTRONICALLY CONTROLLED store windows that allow full daytime television, without regard to the amount of daylight and noises from the street, have been designed by the Television Workshop of New York. Constructed in arcade fashion, and recessed from the building line, the postwar video windows would be built at an angle of 60 deg, thus permitting passers-by to come in off the sidewalk to view a store's window video screening, eliminating sidewalk congestion—the chief objection heretofore to store-window television.

A photoelectric device automatically adjusts itself to the amount of light coming from the outside and shades the video screens to allow full daytime viewing.

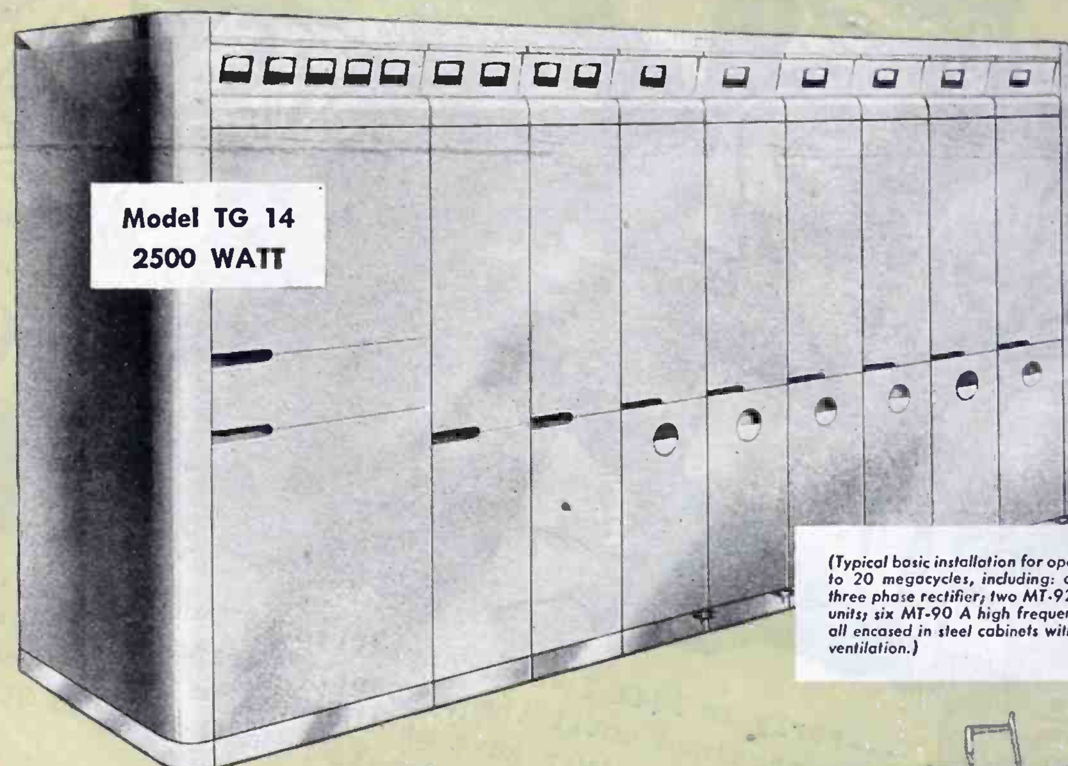
An acoustical device adjusts the audio portion of the program to a level several decibels above street noises, projecting the sound only within the arcade area, thus overcoming the objection of the city fathers to sound amplification from store windows.

The postwar display windows are designed to utilize screens which are 18 x 24 in., with merchandise to be displayed around the screens. When larger screens become available, the windows could be adjusted to accommodate screens up to three-by-four feet and more.

Bendix Radio Presents

A NOTABLE IMPROVEMENT

IN AIRLINE GROUND STATION EQUIPMENT



(Typical basic installation for operation on 2.5 to 20 megacycles, including: one MP-36 A three phase rectifier; two MT-92 A modulator units; six MT-90 A high frequency RF units—all encased in steel cabinets with forced draft ventilation.)

Great Flexibility . . . Exceptional Sturdiness . . . Complete Tropicalization

Bendix Radio*—center of radio research and production for the aviation industry—has now turned its broad experience and extensive facilities to the production of the finest of ground station equipment—and here is one result: a new, unit-type installation providing an unlimited number of operating channels in the frequency range of 200-425 kc. and 2.5 to 20 mc. . . . with sufficient power supply capacity to permit simultaneous operation of 2 radio telephone, 1 radio telephone and 2 telegraph, or 3 telegraph channels . . . and designed to allow quick installation of additional RF channels as traffic loads increase.

Constructed to the quality requirements which have made the products of Bendix Radio the Standard of the Aviation Industry, this equipment has hermetically sealed transformers for tropical use, and is studded throughout with other features to assure peak performance under all conditions. As a further guarantee of reliability *special attention has been given to adequate overload protection,* and *improved electrical design assures the effective reduction of Harmonic Radiation to a minimum.*

Information as to dimensions, weight, construction, electrical characteristics and easy-service features will be sent promptly on request.

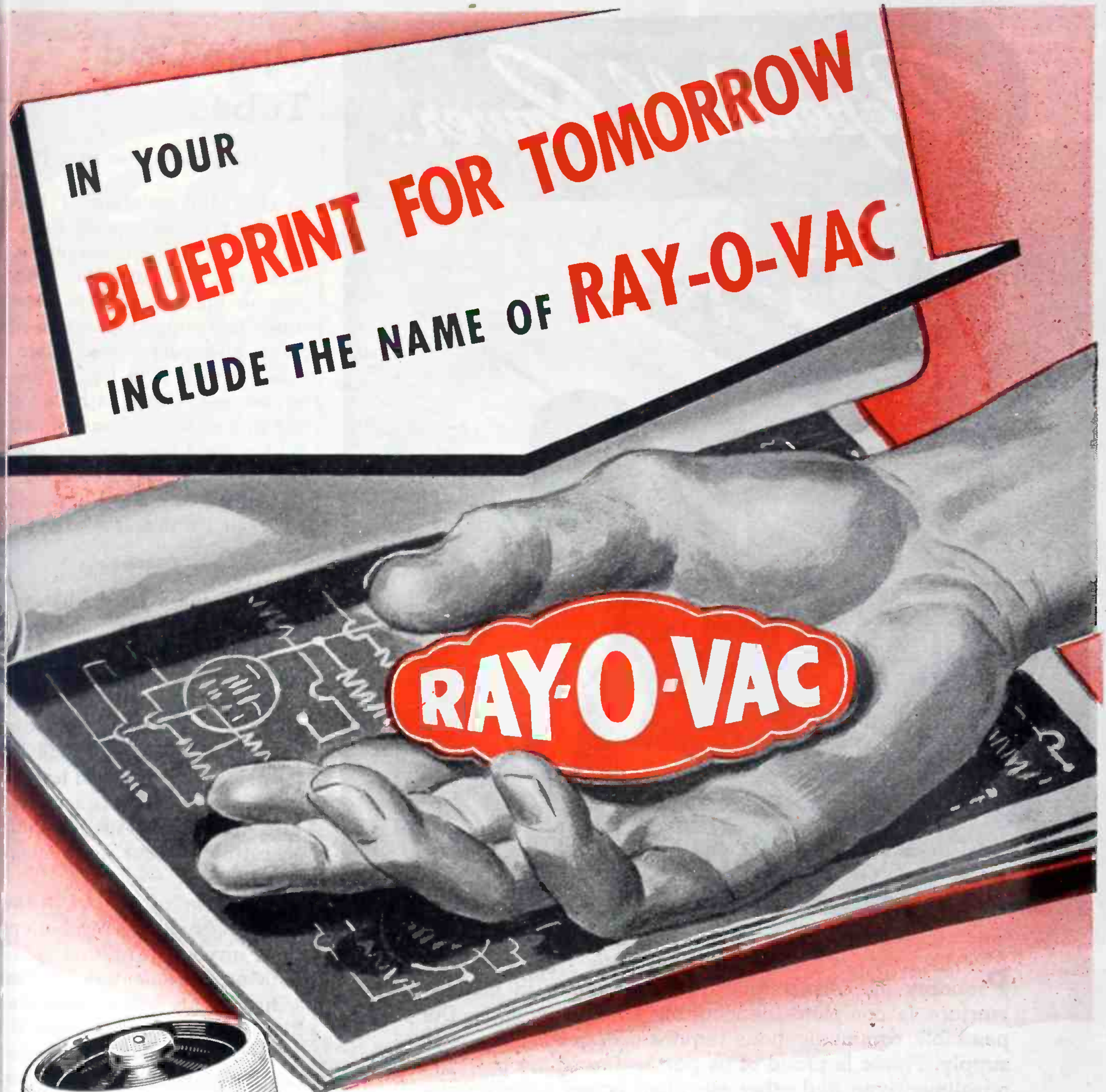
The MS-97 Remote Control Unit, built to individual requirements, provides a method of installing control equipment in a manner which will place all the equipment in locations readily accessible to the operator. The compact low structure of this unit permits it to be installed in such a way that the operator may have a full unobstructed view in all directions.

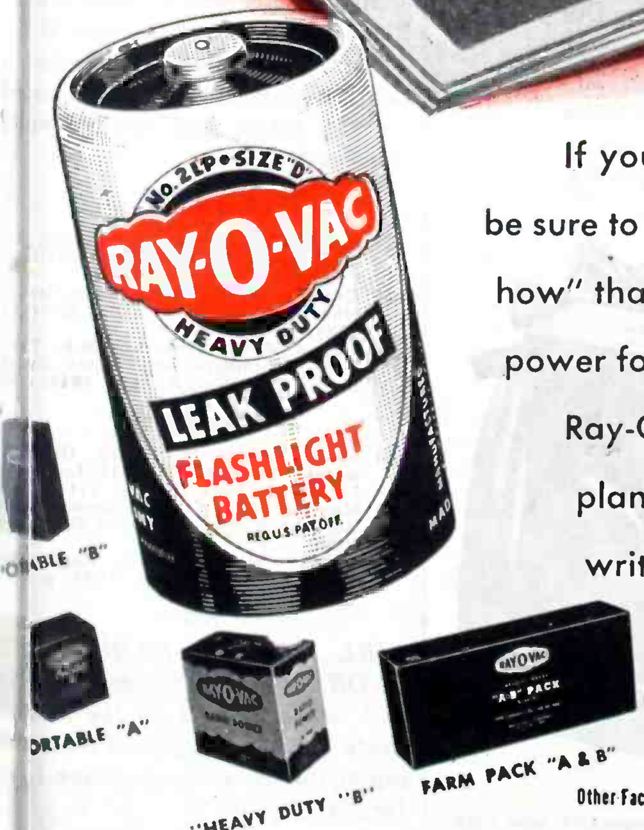
*TRADE-MARK OF BENDIX AVIATION CORPORATION

Bendix RADIO DIVISION

BENDIX AVIATION CORPORATION BALTIMORE 4, MARYLAND

STANDARD FOR THE AVIATION INDUSTRY





If your post-war products will require dry batteries, be sure to include RAY-O-VAC in your plans. The "know-how" that has solved innumerable problems of portable power for our armed forces can be of great value to you. Ray-O-Vac engineers are at your service to aid in planning products powered by dry cells. For details, write Dept. 1-A Ray-O-Vac Company, Madison, Wis.

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Madison 4, Wisconsin

Other Factories at CLINTON, MASS., LANCASTER, OHIO, SIOUX CITY, IA., FOND DU LAC, WIS., MILWAUKEE, WIS.

Open-Grid Tubes

(Continued from page 128)

no case did omission of the gri leak lead to excessively high plat current or to high operating tem peratures, nor did the grid bia become high enough to block th tube. In the ageing test, open-gri tubes also performed better tha tubes with a grid leak. The nois is also less with a cathode resisto (of proper size) than without on With a fixed bias resistor and vari able plate voltage the least nois was obtained with a plate voltag of about 90 volts for a 6SJ7 tub

Conclusions

If the tubes are to be operate with nearly zero grid bias the lowe noise level obtained by the omi sion of the grid leak is especial noticeable. From Table 1 it can b seen that for optimum grid bias th ratio of noise with a grid leak t the noise without a grid leak is 1.1 and for zero bias this same ratio 1.97. This shows the advantage o operating without a grid leak fo zero bias.

Operation of a tube without grid leak seems practical in applica tions involving low-level operatio with no d-c potentials in the pre ceding stage, and a negative gri bias of not more than about 2 vol

Tests were also performed o pentode-connected 6SJ7 tubes an on 6J5 tubes, and similar result were obtained.

References

(1) Reich, H. J., "Theory and Applicatio of Electron Tubes," McGraw-Hill Bo Company, 1939, p. 184.
(2) Everitt, W. L., "Communications E gineering," McGraw-Hill Book C 1937, p. 241.
(3) Harris, W. A., Fluctuations in Vacu Tube Amplifiers and Input Systen *R. C. A. Review*, 5, April 1941, p. 5

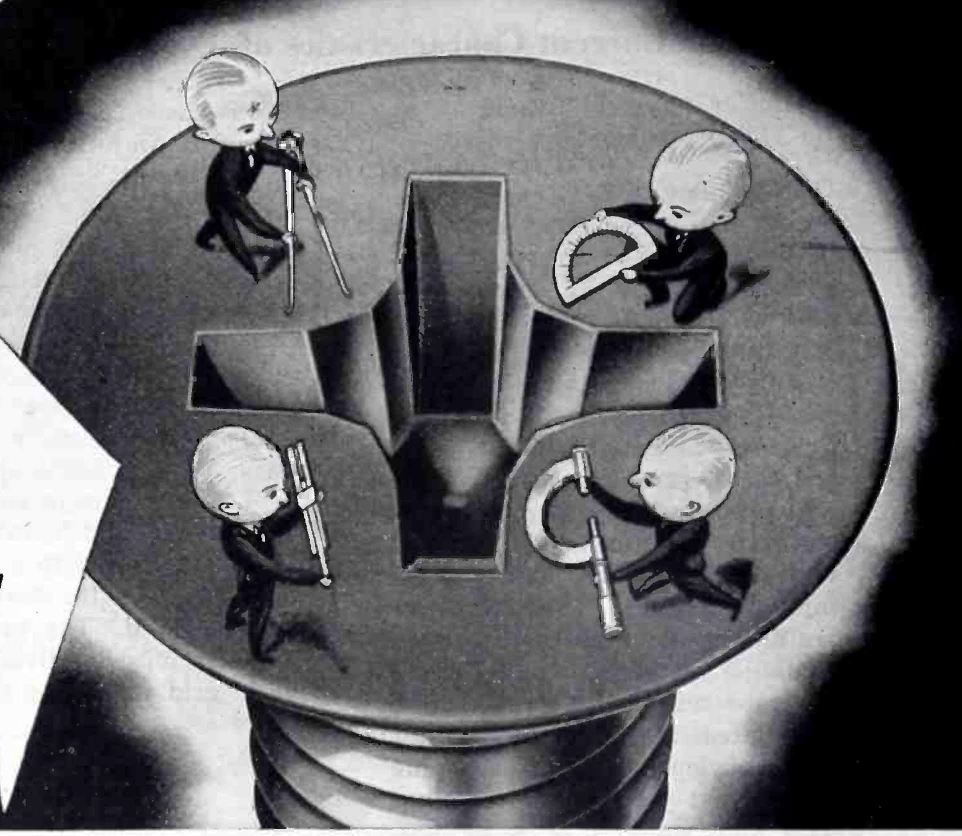
Bibliography

(1) King, Ronald, A Screen Grid Vo meter Without External Leak, *Pro I.R.E.*, 22, June 1934, p. 771.
(2) Moullin, E. B., "Spontaneous Fluctu tions of Voltage," Oxford Univ. Pre 1938.
(3) Terman, F. E., "Radio Engineerin McGraw-Hill Book Co., 1937, p. 22

GIRL POLICE RADIO OPER ATORS, Ruth Boddy and Jean Pi nell, are employed by the Missou State Patrol. They have been work ing at the net control station in Je ferson City.

TAKES A LOT OF *know-how* TO DESIGN

Engineered SCREW RECESS



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S WHAT IT TAKES!

KE A LOOK at the center corners the Phillips Recess above – and t a picture of some real screw gineering!

ESE CORNERS *aren't square!* hey're rounded into a series of 5 flat planes. It's these flat planes at *hold* drivers in the Phillips ecess so well.

EN NOTICE how the 4 wings and e 16 flat planes are angled. It's e scientifically determined de-ree of these angles that elimi-ates fumbling starts . . . makes it ossible to use full turning power . makes it hard to burr Phillips ead Screws, and reduces wear Phillips Bits and Drivers.

FOR ANOTHER INSTANCE of Phillips engineering ingenuity, note the depth of the Phillips Recess. It's not too deep . . . not too shallow. It's just the right depth to give Phillips Recessed Head Screws the strength to stand up under the heaviest driving pressures. Just the right depth to give maximum turning power with a minimum of effort . . . to keep drivers in proper alignment with screws!

COST LESS! Switch to screws with the scientifically engineered Phillips Recess — they cost less because they help you produce more! Available in any head style, type, or size.

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Faster Starting: Driver point automatically centers in the Phillips Recess . . . fits snugly. Fumbling, wobbly starts, slant driving are eliminated. Work is made trouble-proof for green hands.

Faster Driving: Spiral and power driving are made practical. Driver won't slip from recess to spoil material or injure worker. (Average time saving is 50%.)

Easier Driving: Turning power is fully utilized. Workers maintain speed without tiring.

Better Fastening: Screws are set-up uniformly tight, without burring or breaking of screw heads. The job is stronger, and the ornamental recess adds to appearance.

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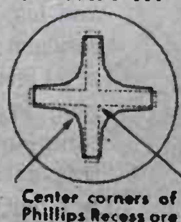
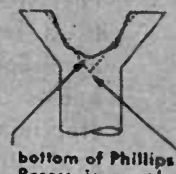


Center corners of Phillips Recess are rounded . . . NOT square.



bottom of Phillips Recess is nearly flat . . . NOT tapered to a sharp point.

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The Southington Hardware Mfg. Co., Southington, Conn.
Wolverine Bolt Co., Detroit, Mich.

THE ELECTRON ART

Grid-Current Characteristics of Typical Tubes

By LOWELL W. ZABEL
Radio Engineer
Wilcox Electric Co.

DURING THE PAST few years, considerable interest has been shown in the applications of vacuum tubes to such problems as the measurement of direct voltage and current. In particular, tubes have been used in stabilized vacuum-tube voltmeter circuits which have sufficiently high input resistances that little effect is had on the measured circuit. Likewise, vacuum-tube microammeters and micro- microammeters such as that of A. W. Vance* require high input resistances. These problems are the same as those met when designing a phototube amplifier where the tube must react to very low light intensities.

The obvious method of obtaining high input resistance combined with high stability is to use specially designed low grid-current tubes in a balanced degenerative circuit. However, in many instances the relatively high cost of such tubes and the lack of necessity of the use of extremely high values of input resistance make it desirable to seek some more readily available and less expensive tube. Since data concerning the grid current characteristics in the negative grid region is not available for the more common tubes, it is the purpose of this article to give some data on a few receiving type vacuum tubes.

The measurement of the minute currents that flow in the grid circuit of a negative-grid, direct-current amplifier must be done indirectly unless a very sensitive galvanometer is available, and even then the grid current of the best of the receiving-type tubes can not be measured. The indirect method which was used to obtain the data given here can be made fully as accurate. The circuit shown in Fig. 1 is used.

Method

The procedure is first to run the grid-voltage vs plate-current curve for the tube in question, using the same values of plate, screen (if a pentode) and heater voltage under which it is desired to operate. At a given value of E_c, the plate current is read on M_s with S both open and closed. The difference in plate current with and without R_g in the circuit can be converted to a change in grid voltage from the static curve previously plotted. The grid current is determined by dividing the change in grid voltage by the grid resistance R_g.

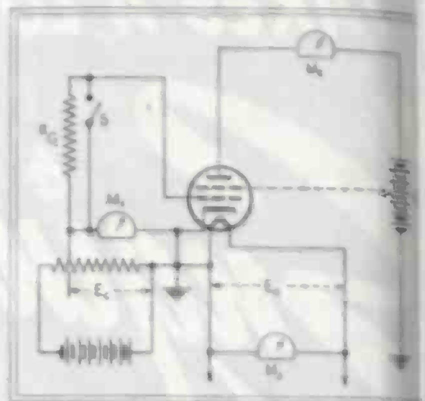

Fig. 1—Circuit used in obtaining data for curves of grid-current characteristics by the indirect method

The accuracy of the method depends on the accuracy of the plate current and grid bias meters and the accuracy to which the grid resistance is known. The overall accuracy can quite readily be kept within ±15 percent.

The tube types selected for measurement are all readily available and are considered representative types. The curves of Fig. 2 show the grid current I_g that may be expected from an average 6J5 triode. These curves show that some improvement can be obtained by lowering the heater voltage below the

TESTING FOUR-IN-ONE DYNAMOTOR

Test panel for Westinghouse dynamotors having four separate output voltages from 14 to 300 volts. Output voltages are held constant for normal input-voltage variations by a regulator field which weakens when the input voltage rises and strengthens when the voltage drops

* Vance, A. W., *Rev. Sci. Inst.*, 7, 489, 1936.

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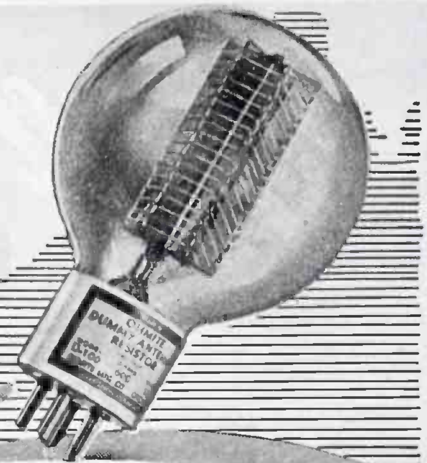
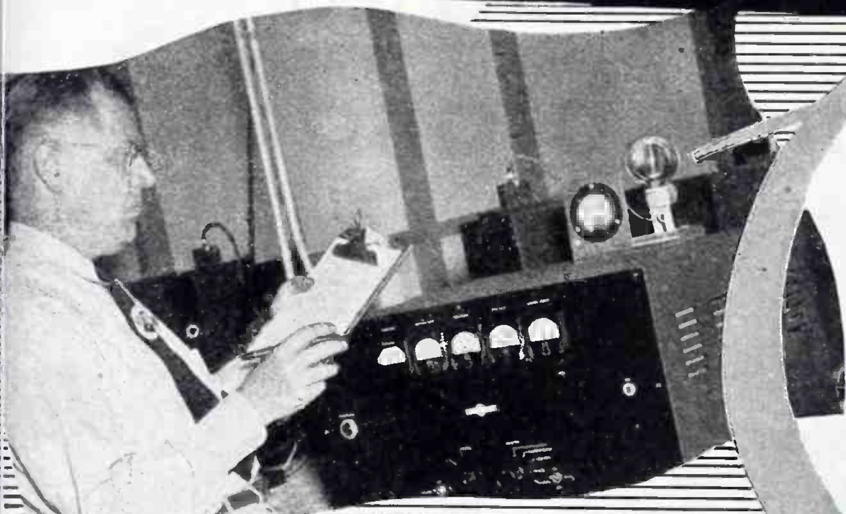
for Radio Frequency Applications





Ohmite Dummy Antenna Used in Testing Critical Transmitting Equipment

Here's what *COLLINS RADIO CO.*, well-known transmitter manufacturer, says: *"Within its power range . . . the most convenient to use, the most stable and the most accurate Dummy Antenna we have encountered . . . Used successfully for testing and measuring power output . . . Gives long life without detectable deterioration."*

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.

Other Ohmite Units doing specialized jobs in radio frequency applications are Vitreous Enameled Non-Inductive Power-Size Resistors, Parasitic Suppressor and R.F. Plate Chokes.

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You'll Want this New

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"Crystal Controlled"
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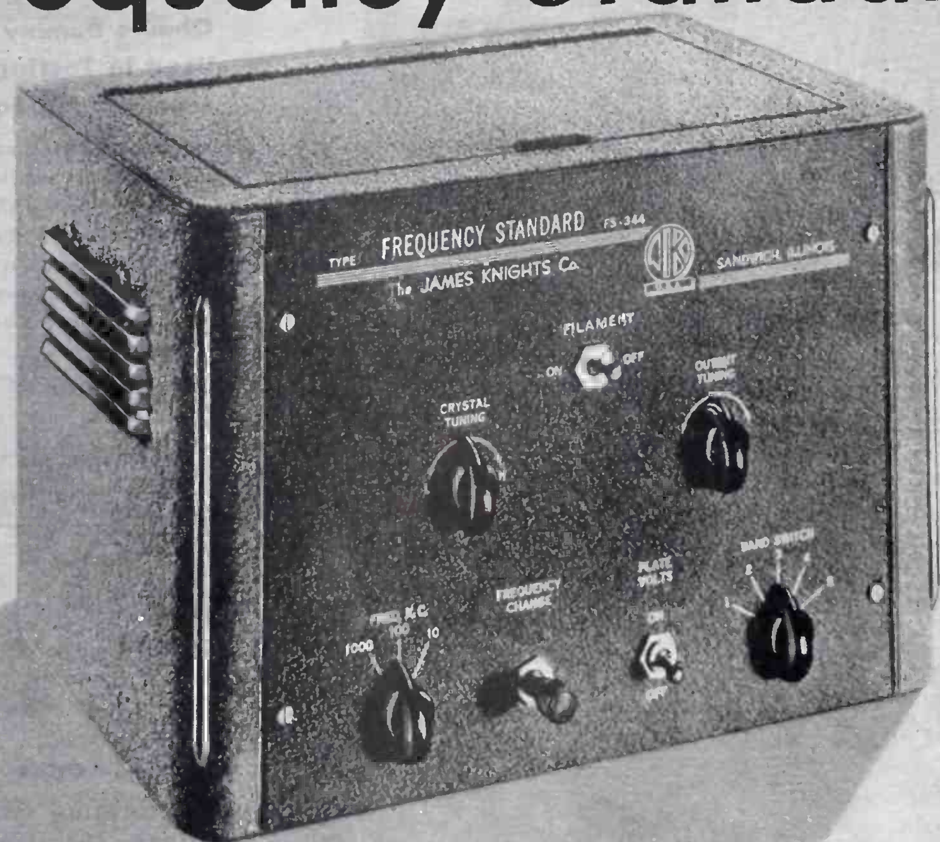

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2 WAYS BETTER

THIS　　NOT THIS

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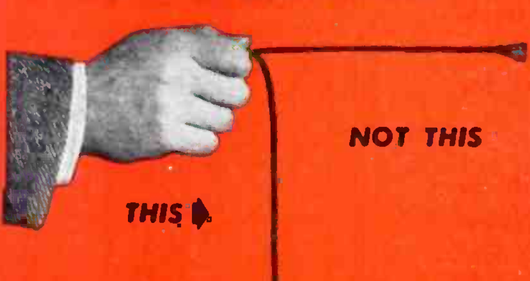

NOT THIS

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Here's an Insulation that Handles Easier, Cuts Cleaner and Saves Time

IF you're exasperated by ordinary sleeving that frays on the ends, works stiffly and doesn't hold up in use . . . then you'll certainly want the low-down on BH *Extra Flexible* Fiberglas Sleeving! For this is a really *flexible* and definitely *non-fraying* sleeving—built around the excellent insulating qualities of Fiberglas by an *exclusive* BH process.

Fiberglas, you know, is moisture-resistant, high in dielectric and tensile strength and is shunned by fungus growths and unharmed by most chemicals. "Punishment" tests prove that BH *Extra Flexible* Fiberglas Sleeving has even more advantages. It is *permanently* non-fraying and non-stiffening. It won't burn because both yarns *and* impregnation are non-inflammable. And it lasts indefinitely without cracking or rotting.

Assembly and repair men say BH *Extra Flexible* Fiberglas Sleeving is a pleasure to handle and a sure bet for long life in the most severe service. So why tolerate a less efficient sleeving any longer? BH is available in all standard colors and all sizes from No. 20 to ⅝", inclusive. Write for samples today and make your own comparison!

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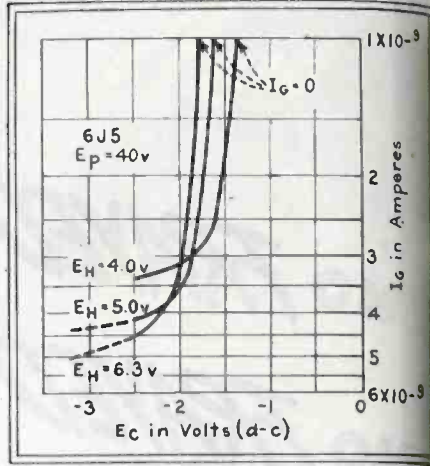


Fig. 2—Grid-current curves of a 6J5 tube with 40 volts applied to the plate

rated 6.3 volts. It is probable that decreasing the voltage below 4.0 volts would result in still more reduction of grid current, but at such a low heater temperature that plate-current saturation is easily reached. Operation of a tube near the maximum emission results in instability, therefore it is advisable not to reduce the heater temperature too far.

Need for Low Voltage

Figure 3 is a similar set of curves for a 6SJ7GT connected as a pentode. Here the variable parameter is plate and screen grid voltage. The curves make it quite obvious that for low grid current it is to a decided advantage that the highest voltage present within the tube envelope be not much greater than 40 volts. Higher voltages than this cause slight ionization of the minute amounts of gas remaining

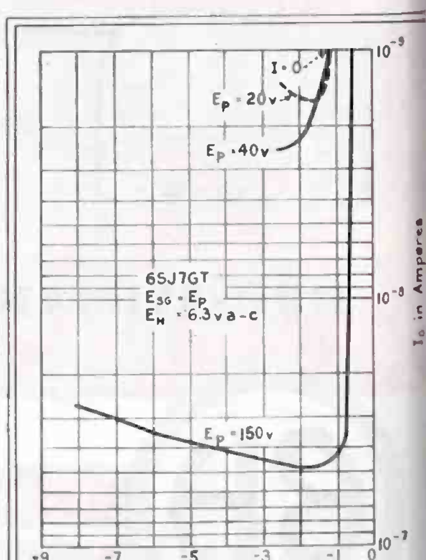
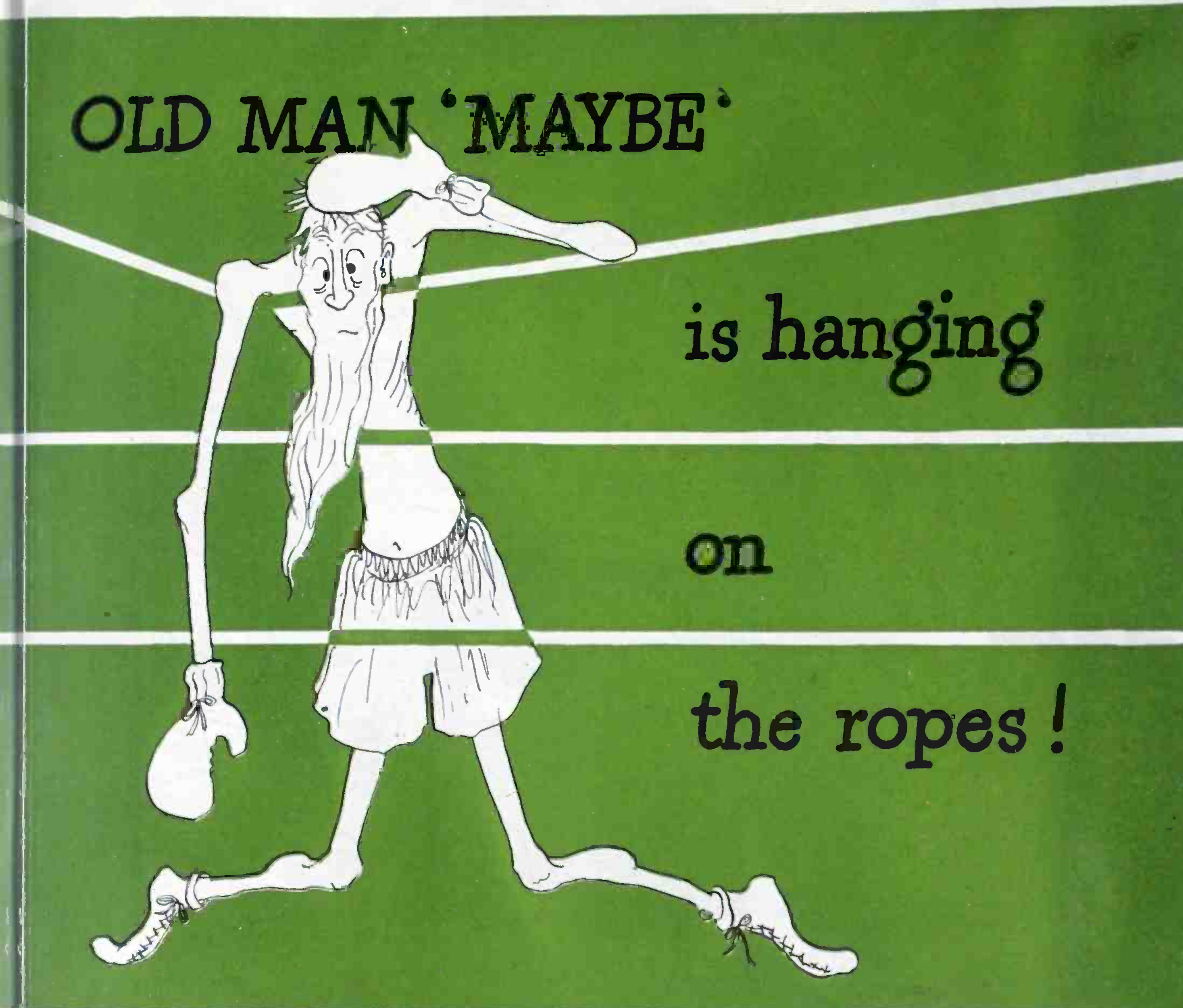


Fig. 3—Grid-current curves for a 6SJ7GT connected as a pentode



THERE'S no place in postwar radio merchandising for guesswork and "maybe." And the exhaustive customer survey we've ju had made—it covers 5,000 radio-homes, scie tifically apportioned to every stage of the marke from top to bottom—should put Old Man "Maybe" out of the picture for keeps!

his 5,000 radio-home survey brings home clear as bell the buyers' tremendous insistence on top quality in radio equipment. They expect and will seek out the very best . . . and back up their insistence with plenty of cold cash.

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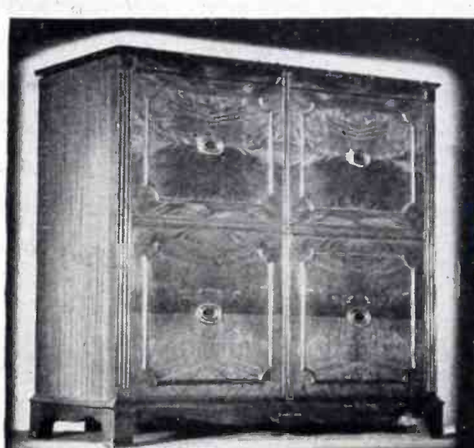

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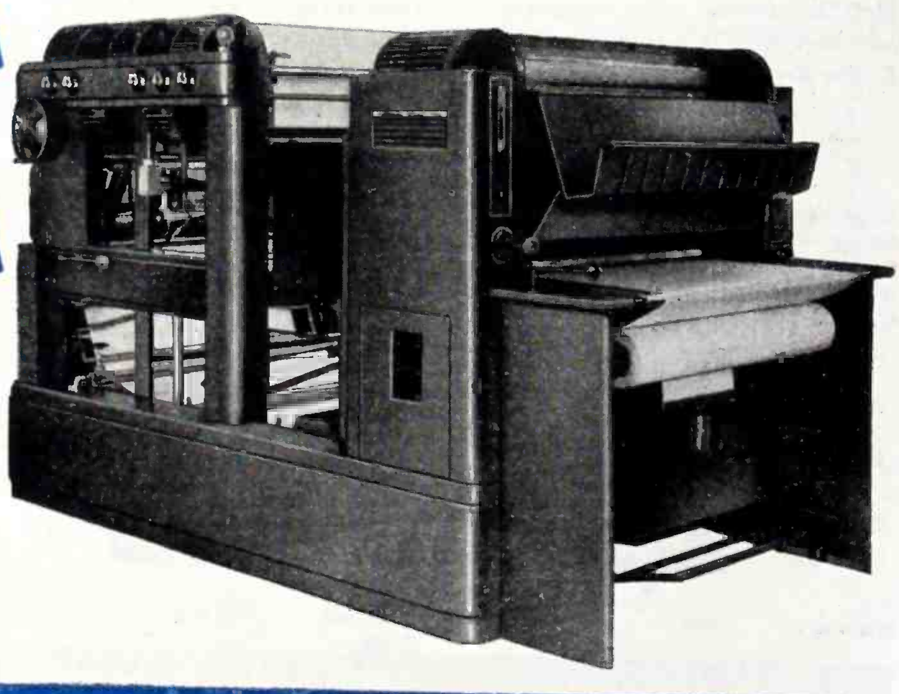

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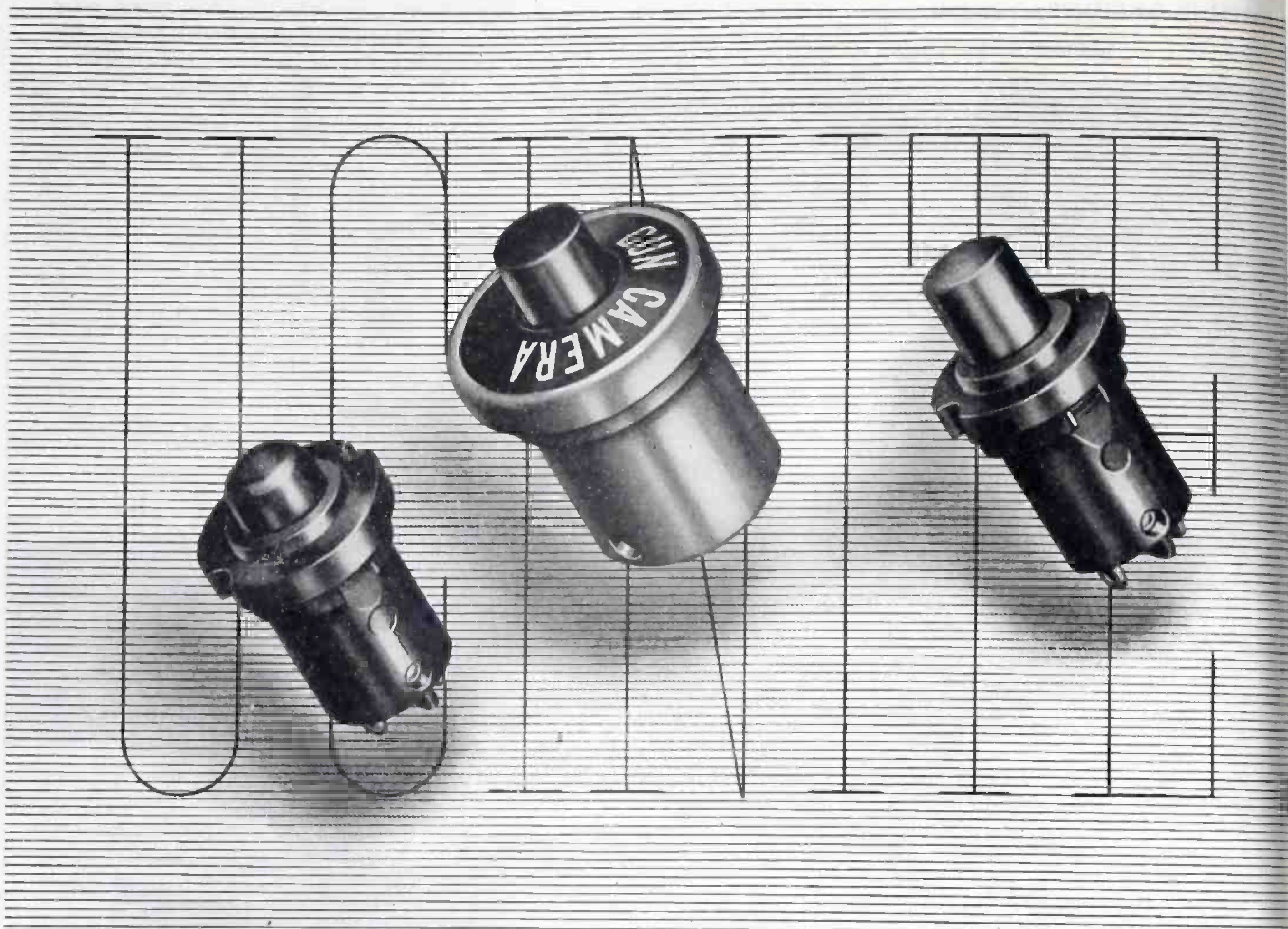

Push-Button De Luxe

This Ucinite push-button switch is used in planes for turret control. It fires machine guns, and operates gun cameras and intercommunication microphones. On the Republic "Thunderbolt" it is used to squirt water into the carburetor for emergency spurts of speed. (See the Ucinite ad in the September 23rd Saturday Evening Post.)

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to the point $I_G = 0$, and the other is zero plate current.

In order to have stable operation, it is necessary to use a grid circuit resistance sufficiently small that the *IR* drop across the grid resistance is small compared to the available grid swing. As an example, if the 6J5 of Fig. 2 were to be used it would not be advisable to attempt to use a grid circuit resistance greater than 25 megohms. With this grid resistor, the loss of bias due to grid current is a maximum of 0.1 volt. In many cases, this loss can not be tolerated and even less grid resistance can be used.

Comparison

Figure 6 is probably the most significant set of curves presented. This shows the magnitude of variations in grid current that may be expected from tube to tube. Tube No. 1 is the best of a group of 12

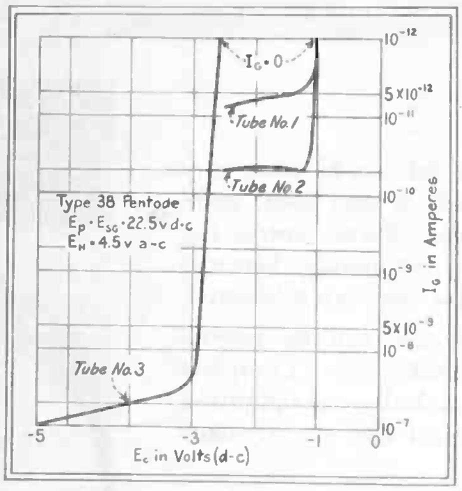

Fig. 6—Curves of grid current obtained from three tubes of the same type

type 38 tubes purchased about three years ago. Tube No. 2 is an average tube and tube No. 3 is a very poor tube which was purchased recently. This is not meant to infer that tubes of recent manufacture are poorer with respect to grid current than older tubes since only two recent tubes were available for test. It is quite obvious from this data that the type 38, on the average, shows superior grid-current characteristics.

Two tubes, whose grid current approximated that of tube No. 1, were used in a balanced bridge circuit for measuring small light intensities falling on a pair of type-929 phototubes. The amplifier was stable, and reliable data was ob-

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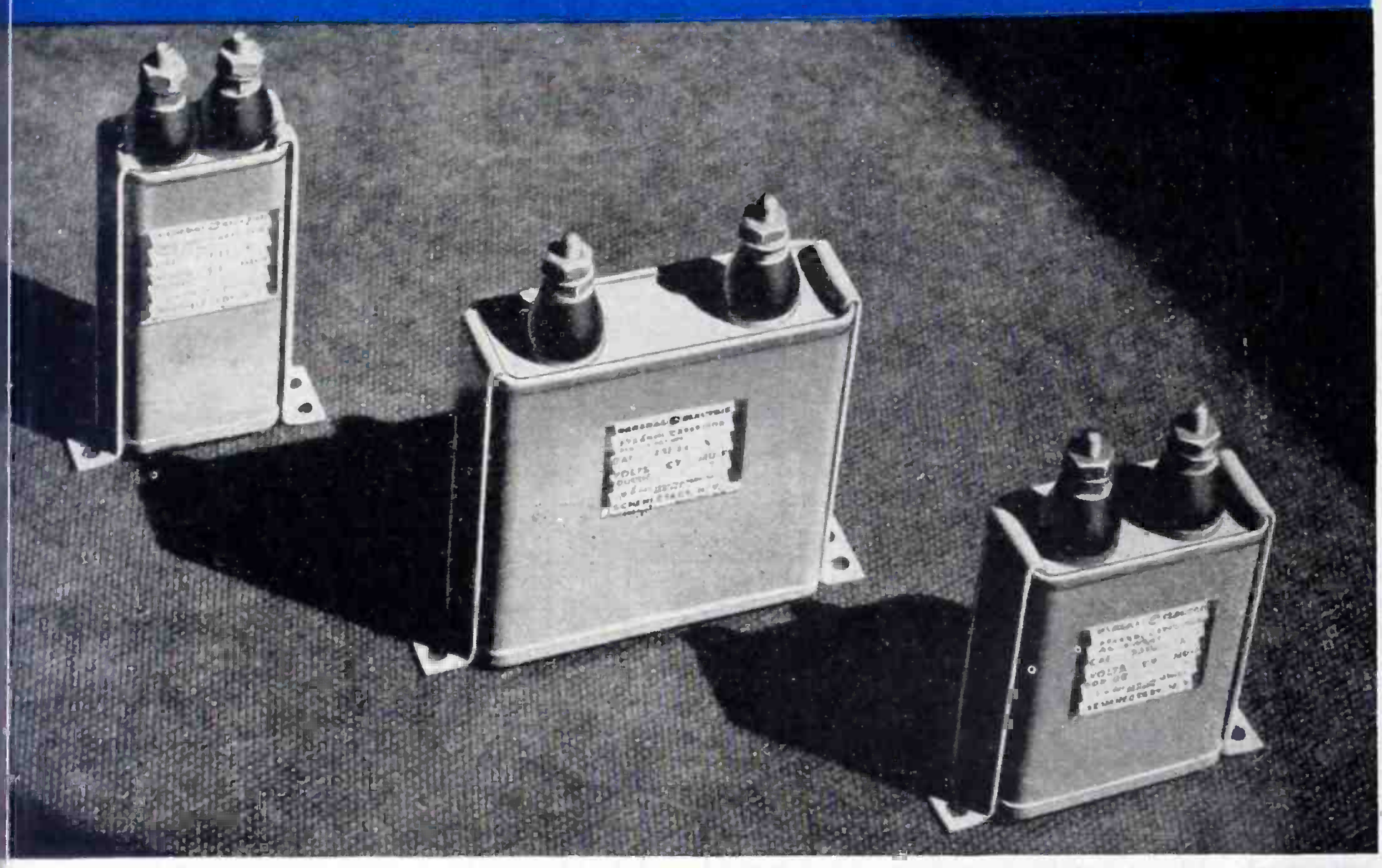

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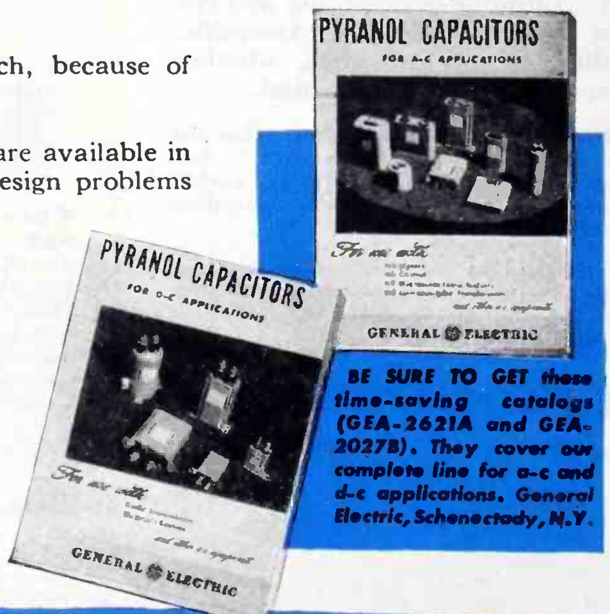

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GENERAL ELECTRIC

tained at light levels which gave a photo current of approximately 10⁻[illegible] amperes. A grid circuit resistance of 5 x 10⁹ ohms was used.

It may be concluded from this data that grid circuit resistance up to a possible maximum of 5 x 10[illegible] ohms can be used with a number of the common receiving type vacuum tubes. If it is necessary to go higher than this, it will be necessary to pick the tubes to be used by actual measurement of grid current and to operate the tubes at a plate voltage not exceeding about 40 volts and a heater or filament voltage 20 percent below normal.

• • •

Electronarcosis Therapy

THE USE OF AN ELECTRIC current for inducing convulsions was reported by Cerletti and Bini in 1938, and since then this method has gradually replaced both insulin and convulsant drug therapy.

Insulin has been used in the treatment of insanity for several years. A coma is produced by the injection of sufficient insulin to reduce the blood sugar to a point where the patient is unconscious. This condition is maintained for some time and is often accompanied by convulsions.

It was noted by many psychiatrists that these convulsions seemed to produce an especially marked improvement in the patient's mental condition, so various more directly convulsant drugs were used. About the same effect was produced with a considerably simpler technique.

In the electroshock treatment, an electric current is passed through the brain by the application of conducting electrodes to the intact scalp on the sides of the head. From 70 to 150 volts at a frequency of 60 cycles is usually applied for a period of 0.1 to 0.5 seconds. (An electronic timer for this purpose is described by Paul Traugott in the November, 1943 issue of ELECTRONICS and its circuit is shown in the illustration.)

Brain Current

The total current flow between the electrodes is ordinarily between 300 and 1000 ma. A very small percentage of this current actually passes through the brain, most of it

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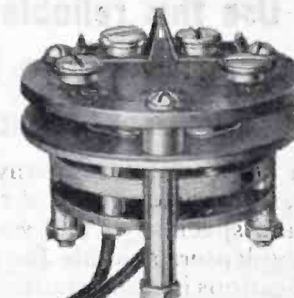

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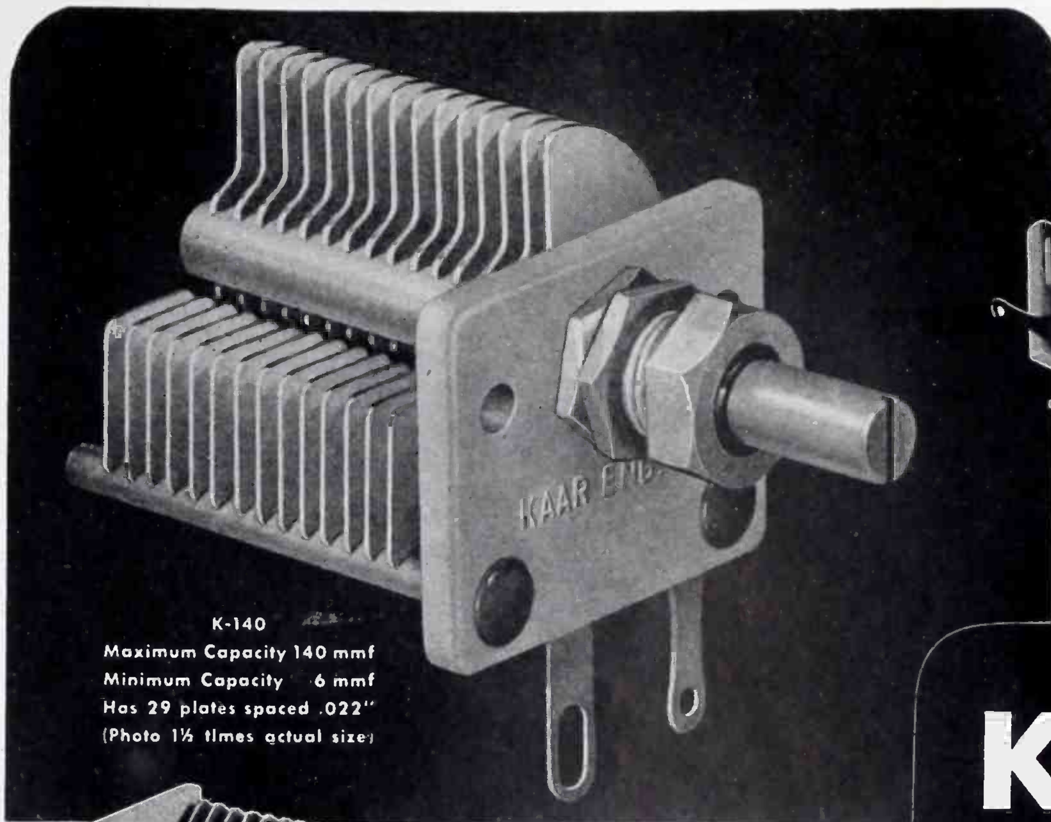

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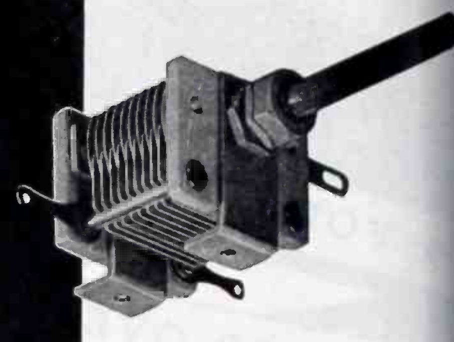

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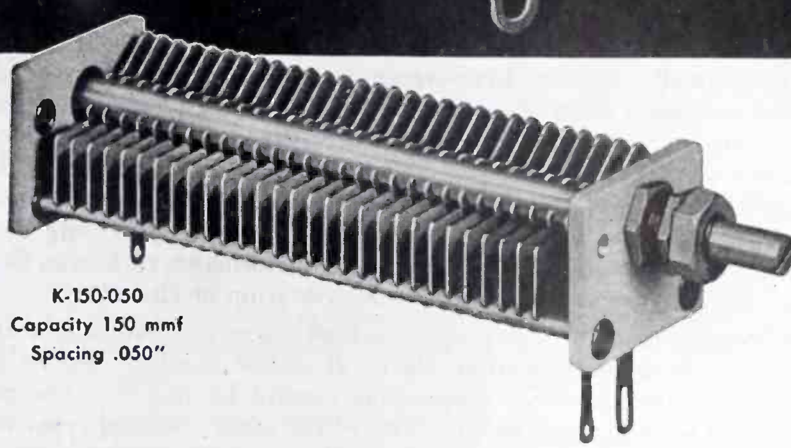

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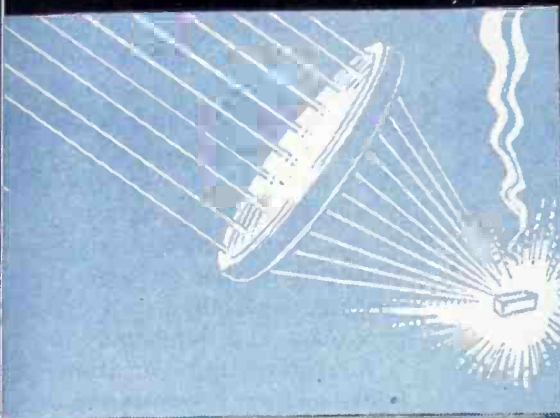

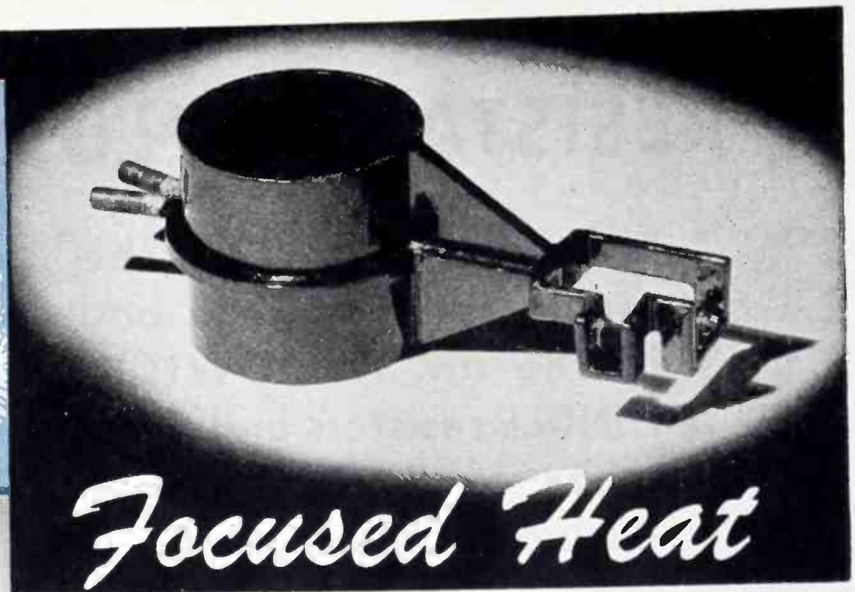

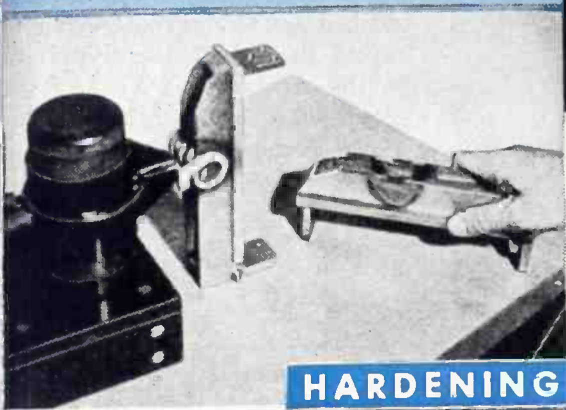

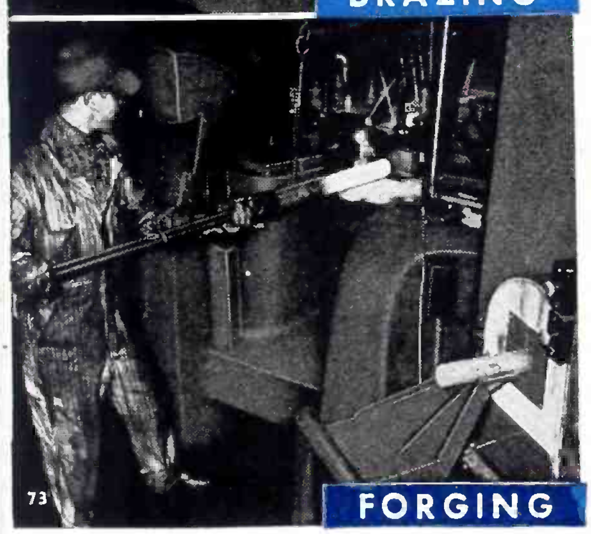

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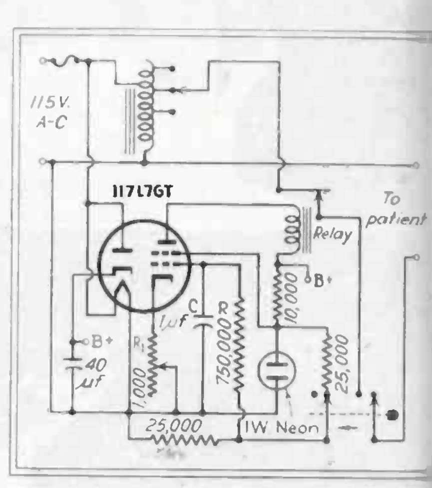
flowing through the scalp. Whe the current is applied, the patie goes into a convulsion closely r sembling an epileptic seizure, whic ceases in a few seconds. He usuall becomes conscious in 9 or 10 mi utes, but remains somewhat co fused for about a half hour. E cellent results have been reporte with this method in some types insanity especially manic depressiv psychosis and schizophrenia.

An interesting variation of th above method is electronarcosis, d scribed by Drs. Frostig, van Ha reveld, Reznick, Tyler, and Wiersm in the *Archives of Neurology an Psychiatry*, **51**: 232–242, 1944. I 1902, Leduc produced electrona



Circuit of electronic timer for control of therapeutic electric shocks. The neon bulb is used as a voltage stabilizer in the screen-grid circuit

cosis in dogs by passing a unidirectional pulse current from the head to the sacrum, and later tried it on himself, with the assistance of Malherbe and Rouxeau. After the application of the electrodes, the current was slowly increased. At a low level there was considerable discomfort at the site of the electrodes, which ceased on further increase of the current. He soon lost his ability to speak, and at a slightly higher level was unable to move. He heard what was said to him, but understanding was dreamlike and painful stimuli felt dull and far away.

About 1910, electronarcosis was used as a method of anesthesia in a few clinical surgical operations with some success. The present study was apparently not made with electrical anesthesia especially in view, but to elucidate further the physiology involved. The first experiments were performed on dogs,

ELECTRONIC HEAT SPEEDS CURVED SECTION GLUING

lass-production Method Promises Savings i Cabinet, Furniture, and Piano Assembly

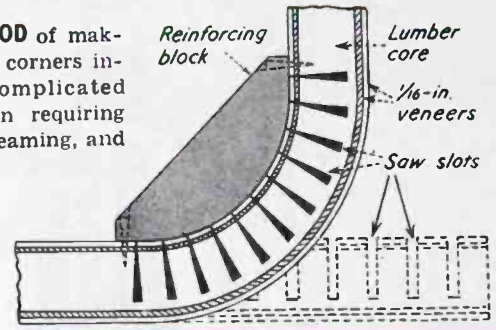
ligh-speed quantity production of both flat and curved lami-ted sections is now practical with the aid of electronic heat to s ed gluing. This conclusion is based on extensive war-time plication experience which shows that on large-production ns, electronic heating offers definite economies.

ctronic heat is produced by passing high-frequency electric rent (produced by electron tubes) through the piece or the e line where heat is needed. The electric power is converted heat in the glue lines instantly, and glue temperature can be sed to the hardening point in a matter of seconds or minutes. example, the use of electronic heat to set scarf, edge, and ninated joints by the Tolerton Lumber Company, Alliance, io, speeded up production of aircraft spars by 700%! The pon below will bring you detailed information.

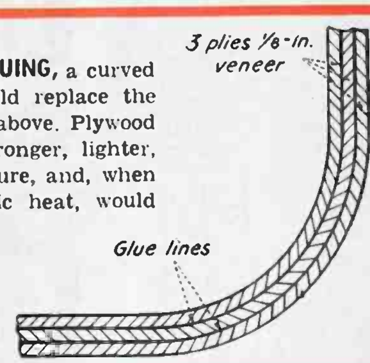
rved-section gluing is illustrated at the right; how electronic t makes possible a simpler, stronger construction is clearly wn. The gluing time on such an operation need not be more n a few minutes, thus large drying areas and quantities of mps, etc., are eliminated.

w about your problem? If you are—or plan to be—engaged the manufacture of glued wood structures where high-speed ing would save you time, money, plant investment, or where u suspect other benefits might be obtained, write to us, outlining r problem. RCA electronic engineers will be glad to consider r application in the light of their wide experience, and recom-nd the proper use of RCA electronic heating equipment. RCA ctronic generators are available now on priority. Address: dio Corporation of America, Electronic Apparatus Section, x 70-41H, Camden, N. J.

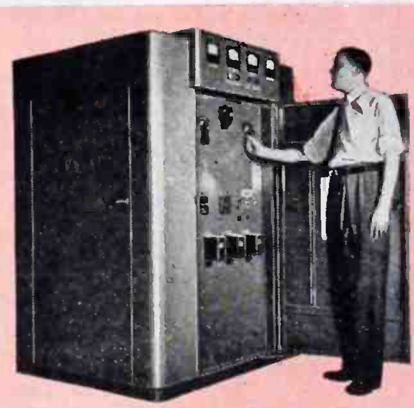
THIS METHOD of making curved corners involves complicated construction requiring slotting, steaming, and bending.



WITH ELECTRONIC GLUING, a curved plywood section could replace the corner piece shown above. Plywood section would be stronger, lighter, quicker to manufacture, and, when glued with electronic heat, would be cheaper.



RCA engineers have had wide experience in building and applying electronic generators such as this RCA 15-kw unit which delivers up to about 50,000 BTU per hour.



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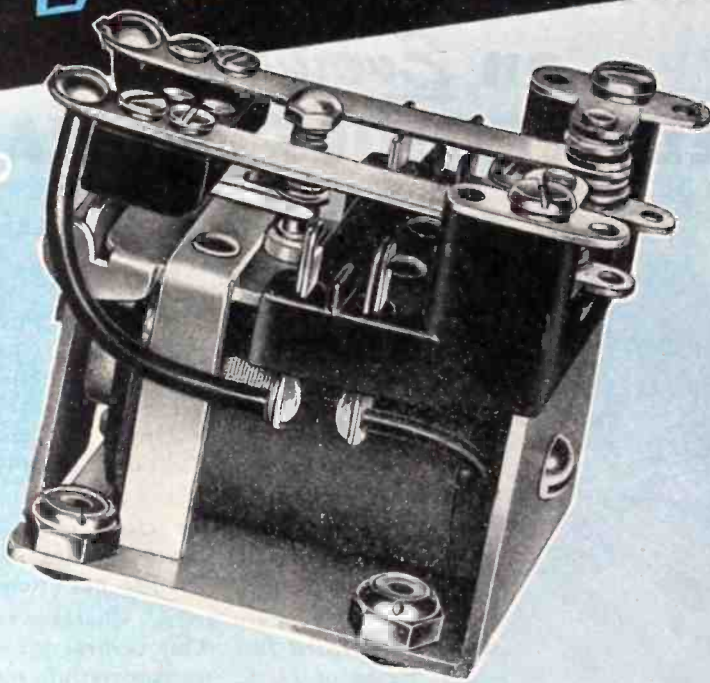
POWER RELAYS



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Overall size 2¼" x 1⅝" x 1⅞"
Weight 8 ozs.

Write for the latest Allied catalog describing type BOL and other precision-built relays.

ALLIED CONTROL COMPANY, INC.

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FACTORIES: NEW YORK · PLANTSVILLE · CHICAGO · LOS ANGELES the later experiments on schi phrenic patients as a variant of t standard electroshock therapy.

Apparently any current capal of stimulating the central nervo system can be used to produce el tronarcosis. This requires a mod ately rapid variation of current duration and slope, repeated at suitable frequency. Sixty or fift cycle alternating current is m generally available, so all of the e periments were done with t power source.

Effect on Humans

In the dog, it was found that t symptoms shown on application the current were quite variab ranging from a quiet narcosis to olent convulsions. In man, the are always some convulsive sym toms present but they never rea the intensity shown in the dog. T initial current used was 150 to 2 ma for thirty seconds, after whi it was decreased to a point whe respiration returned, between and 90 ma. Nine schizophrenic p tients were used as the subjects the human experiments and a tot of over 100 electronarcoses were i duced. All had shown signs of d mentia praecox for over four yea and were physically healthy.

Application of the current w immediately followed by a ligh ning-like movement of the arms a legs, followed by a phase of rigi ity. The chest was fixed in a pos tion of maximal inspiration a there was complete arrest of respi ation during the high initial cu rent flow. It usually resumed aft reduction of the current to t lower prolonged level, but was som times delayed for a total of 50 70 seconds. The heart stopp beating for a few seconds after cu rent flow started and then start again at a low rate, about 20 p minute. The eyes were closed a the pupils were constricted and di not react to light. In women, a erection of the nipple occurred.

When the current was decrease the rigidity ceased and there we usually a few seconds of coar shaking and clonic twitches. Th patient was then in a relaxed stag for three to five minutes. Spontar eous movements, primitive in cha acter, appeared thereafter. The su pine patient tried to roll over or s up. Reflexes, which had been ab

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Manufacturers and designers are invited to avail themselves of Meyercord's free designing and technical consultation service on postwar identification.

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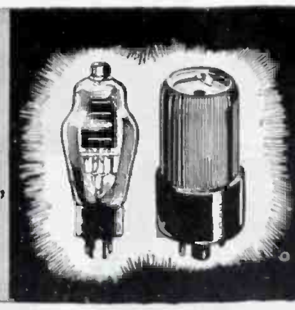
STANDARD TYPE RECEIVING TUBES

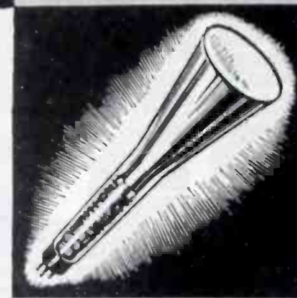
SYLVANIA "LOCK-IN" RECEIVING TUBES



TRANSMITTING TUBES

FACSIMILE RECORDING TUBES

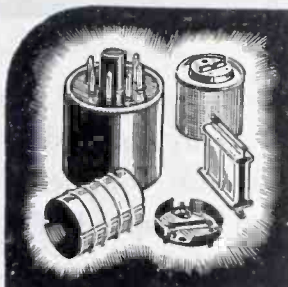
MINIATURE RADIO RECEIVING TUBES



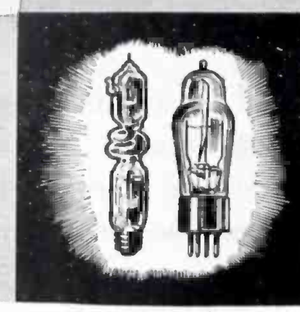
CATHODE RAY TUBES

NEED ELECTRON TUBES?

GAS VOLTAGE REGULATOR TUBES MINIATURE AND STANDARD SIZE



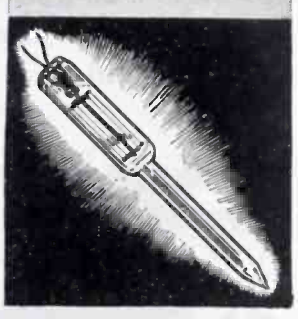
STROBOTRONS



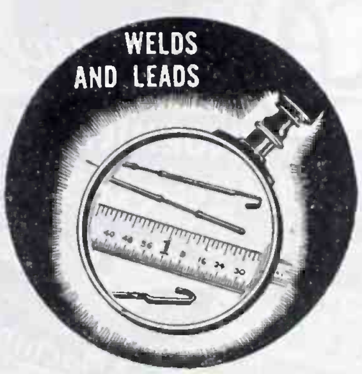
THERMOCOUPLE TUBES

RADIO TUBE PARTS

PIRANI TUBES



WELDS AND LEADS



DID you know that Sylvania is now making an ever-increa ing variety of electron tubes for war uses? What is mor Sylvania now has the experience and facilities to produce eve more of these vital components to your specifications after th war. If you have an electron tube problem, bring it to Sylvan Our engineers will assist you in finding a practical solution. F information, write to Sylvania Electric Products Inc., 500 Fif Avenue, New York 18, N. Y.

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1/50 H.P. CAPACITOR MOTOR

TYPE J-70

SEVEN weeks from inquiry to delivery . . . 3 weeks to engineer final sample . . . 4 weeks to production.

60 Cycles, 115 Volts • Single Phase-3400 R.P.M. • Low temperature rise • High efficiency: Diameter 3 5/16", Overall length 3 1/8", Shaft diameter 5/16", Weight 3 lbs. Applications are for driving blowers in high ambient temperatures and for powering small control devices of all types.

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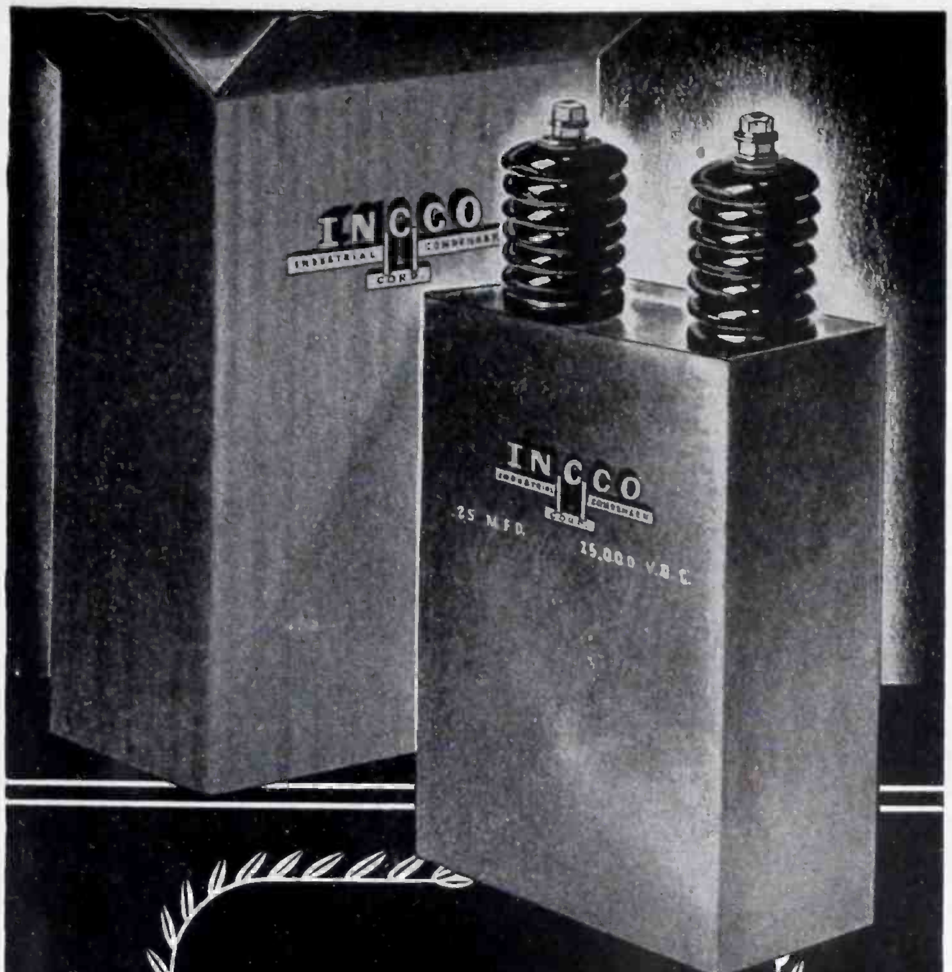
This motor can be supplied to deliver 1/25 H.P., can be wound for 2 or 3 phase and also furnished for 400 cycle applications at higher speeds and H.P.



sent during the earlier period, b gan to reappear. The pupils beg to react to light. After the initi symptoms had passed, the respi atory and heart rates were consi erably higher than normal.

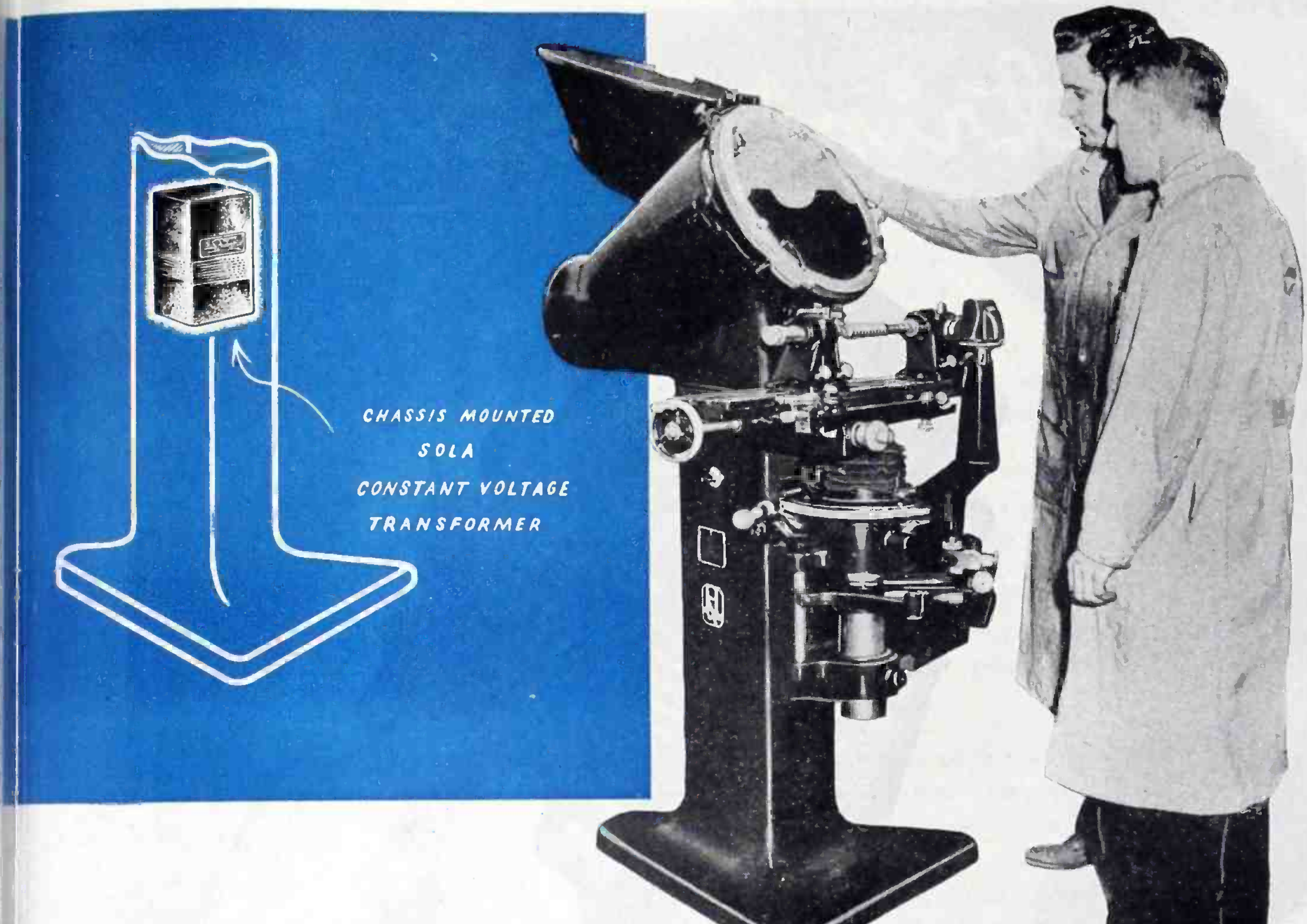
Subject's Sensations

The patients were unconscio during the entire applications the current, but some patien stated that they remembered flash of light at the beginning the treatment, which may ha been due to the stimulation of th optic system by the high initi current. It is interesting to no that according to the results ol tained in electroshock therapy an electronarcosis, electrocution is a parently completely painless. N patient reported any unpleasar sensations during electronarcosi A few minutes after termination o the treatment the patient usuall reacted to his name and a few mi utes later tried to answer question

In the dog, the placement of th electrodes had little effect on th results, which would be expecte because the brain of the dog is quit small in comparison to the muscu lar and bony covering. These fac tors tend to equalize the curren flow in various parts of the brain

In man, the main symptoms o electronarcosis were unchanged b the placement of the electrodes, bu there were minor differences. Lo placement of the electrodes cause a profuse secretion of saliva an tears, which was not present wit the electrodes higher on the head With the electrodes over the fron part of the skull, the pupils wer constricted and did not react t light in the first period of the elec tronarcosis. With the electrode farther to the back, the pupils were less constricted and reacted to ligh earlier. With the occipital location, there was greater respiratory de- pression than with the frontal lo cation.—W.E.G.

WHEN GENERAL INGLES was in the South Pacific, he visited one headquarters in New Guinea which consisted of a one-story shack made of salvaged lumber and grass. He said he began to feel at home when he saw a sign as tall as the shack, on which was painted "The Pentagon."



ONSTANT LIGHT INTENSITY
in the JONES & LAMSON comparator
is maintained with built-in CONSTANT VOLTAGE

ie Jones & Lamson Machine Com- ny uses SOLA Constant Voltage ansformers as a "built-in" compo- nt of their Optical Comparators obtain desired illumination with ximum lamp life. They have found at these transformers give consist- tly satisfactory results.

Because of the extreme brilliance quired of these lamps, the fila- ents run very hot. By incorporat- g a SOLA Constant Voltage Transformer as a component part of the Comparator, illumination may be held at maximum values without danger of lamp disruption from line voltage fluctuations.

Hundreds of similar case histories emphasize the advantages of providing dependable, automatic voltage regulation *within* the equipment, rather than risk dissatisfaction and constant servicing by passing this responsibility on to the user.

Automatic, self-protecting SOLA Constant Voltage Transformers instantly correct line voltage fluctuations as great as 30% to within ±1% of rated requirements. They have no moving parts, require no manual supervision. They are available in standard units from 10VA to 15KVA, or special units can be built to exact design specifications.

To Manufacturers:
Built-in voltage control guarantees the voltage called for on your label. Consult our engineers on details of design specifications.
Ask for Bulletin DCV-74

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

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Foote, Pierson puts at your disposal a modern machine shop well equipped and laid out to accommodate quick change-overs.

At its machines – its drills, lathes, millers, presses—are loyal groups of workers with a surprisingly high proportion of skilled men and women.

In charge of this personnel is a group of trained technicians. Their varied work at Foote, Pierson insures resourcefulness and ingenuity . . . applied specialized knowledge to the fresh challenges of new problems . . . starts with planning . . . supervises the manufacture of product or component, whichever you need . . . controls operations in plating and finishing, assembly, inspection and checking, packing, warehousing and storage. The company's Newark plant is favorably located for rail, water and air freight.

Talk over your product ideas now with Foote, Pierson. Learn how this specialized manufacturing organization is qualified to make parts or articles for you and to deliver them to you or to your markets.

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Foote, Pierson helped pioneer instruments used in municipal fire and police alarm systems, stock tickers, X-ray apparatus, many components of telegraph equipment, instruments and aircraft radio communication apparatus.

Capacitor Plates

(Continued from page 136)

one that makes E a minimum.

Adding T to both sides of Eq. (17) gives

$$S + T = \frac{v}{E} + \frac{v^2}{\pi E^2 T} + T \quad (18)$$

Differentiating Eq. (18) with respect to T, remembering that $(S + T)$ is constant, and then equating dE/dT to zero results in the condition

$$\frac{v}{E\,T} = \sqrt{\pi} \quad (19)$$

Substituting Eq. (19) in (17) results in

$$S/T = 1 + \sqrt{\pi} = 2.77 \quad (20)$$

as the best ratio of plate spacing to plate thickness. Note that the best value of S/T as found above falls within the limits suggested by Ekstrand.

Alternate Forms

Equation (17) may be made more symmetrical by dividing through by T.

$$\frac{S}{T} = \frac{v}{E\,T}\left(\frac{v}{\pi E T} + 1\right) \quad (21)$$

Another useful form is

$$\frac{E}{E_{av.}} = \frac{1}{2}\left(1 + \sqrt{1 + \frac{4S}{\pi T}}\right) \quad (22)$$

where $E_{av} = v/S$.

The form of Eq. (21) suggests that it may be generalized into

$$\frac{S}{T} = \frac{v}{ET} + \sum_{n=0}^{n=\infty} K_n \left(\frac{v}{ET}\right)^n \quad (23)$$

where K_n is to be determined by experiment.

Ekstrand[2] published some measurements on the sparkover voltages of three capacitors with rounded edges at frequencies of 60 cycles, 700 kc and 1500 kc. Table (1) lists calculated values of maximum gradients on these capacitors as determined by means of Eq. (22). Any modification by corona of effective plate thickness has been neglected.

Frequency-Independent Sparkover

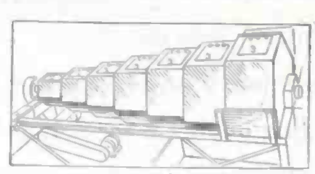
At 60 cycles, the calculated maximum gradients at sparkover do not vary more than about ten percent, with a mean value of 83.8 kv per inch. This value for the sparkover gradient is of the expected order for low frequencies. Only one ca-

A hard landing or even the opening jerk of the chute can prove disastrous to electronic tubes unless they are designed and built to take it. Tubes have no knees to bend or body sway to relieve the shock . . . their ability to withstand shock and still maintain design characteristics has to be built into them at the factory.

To be sure that the TUNG-SOL Electronic Tubes used for this and other severe services are able to withstand rough usage, they are given the "Tumble Test". The admirable way they stand up under it is a tribute to TUNG-SOL engineering and careful production.

Many of the ruggedness features demanded by the Army and Navy were characteristic of TUNG-SOL Electronic Tubes before the war. Manufacturers and users of electronic equipment and controls will find at TUNG-SOL a complete line of war-proven tubes that will meet every peace-time requirement. Let our engineers think with you when you are planning your post-war products.

TUNG-SOL
vibration-tested
ELECTRONIC TUBES



The "Tumble Test" at TUNG-SOL is regularly made on all tubes of new design and tubes picked out at regular intervals from production. Tubes are put into the various sized angular chambers and tumbled. The larger the chamber the greater the shock. Thus the amount of abuse each tube will withstand is determined, giving our engineers accurate data for design and construction improvements.

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

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Santay Corporation introduces its new trademark –

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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.

pacitor, with a ratio of S/T eq to 1.705, approximates this va for 700 and 1500 kc. The other t give breakdown gradients p gressively lower for increasing f quencies. These facts seem to in cate that a critical value may ex for S/T, below which sparkover l comes relatively independent of f quency.

Note that the sparkover p formance of these three capacit at 60 cycles can be predicted fr Eq. (22), at least to common en neering accuracy. For use in te ing this relationship further, E (21) and (22) are plotted in Fig.

Implications of the forego analysis suggest several leads f experimental verification or qua fication, as follows:

(a) Verification of the best val for S/T.

(b) Evaluation of K_n in E (23).

(c) Determination of the rel tion between corona onset a the radius of curvature of the pla edge.

(d) Effect of increasing fr quency.

REFERENCES

(1) Peek, F. W., "Dielectric Phenomena High Voltage Engineering," third e tion, McGraw-Hill Book Co., 1929, 30-31.

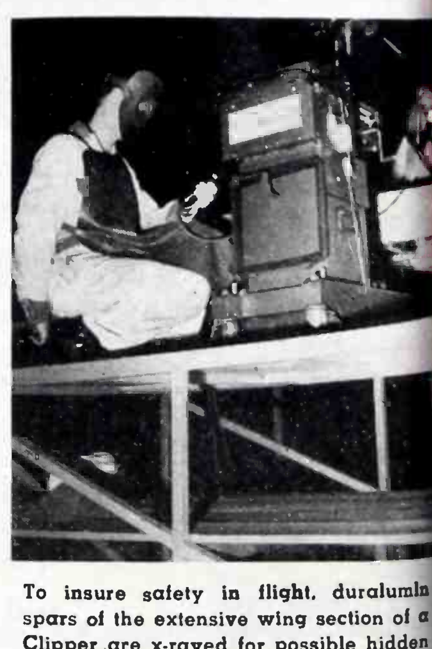
(2) Ekstrand, P. A., Radio-Frequency Spar Over In Air, *Proc. I. R. E.*, 28, No. June, 1940, p. 262-266.

(3) Same as (1), chapters 4 and 5.

(4) Darrow, K. K., "Electrical Phenome in Gases," Williams and Wilkins C 1932, chapter 9.

(5) Ollendorf, R. R., and Pohlhausen, E "Theory of Functions," Technolo Press, 1942, p. 138-140.

X-RAY CLIPPER SPARS



To insure safety in flight, duralumin spars of the extensive wing section of a Clipper are x-rayed for possible hidden flaws that escape visual inspection

NEWS OF THE INDUSTRY

Television possibilities; postwar technical education; Coast-Guard radio; plant broadcasting; relay experiments; conventions; notes from Washington on production, station sales, and communications fellowships

Toward a Standard Television Picture Tube

ONE STANDARD flat-faced 10-in television picture tube may result from activities of Corning Glass Co., makers of the envelopes for practically all cathode-ray tubes. Heretofore it has been impossible to use automatic equipment on production of envelopes because of the wide range of sizes, shapes, and compositions. Hand-made techniques have been responsible for high prices.

A special new department at Corning will combine the development of envelopes with development of machinery for large-quantity production. Having surveyed the field, the company feels that standardization is quite feasible, with particular interest having been shown in the 10-in. size. Resulting picture will be six by eight, a new size for American receivers, though used in British sets. Demand is estimated at one million tubes a year.

Costs for Television Broadcasting Equipment

CONSIDERING THAT 480 of the 917 broadcasting stations in the U. S. have invested less than $30,000 in equipment, Leonard F. Cramer, executive vice president of Allen B. DuMont Laboratories believes the average prospective television broadcaster of the future will be thinking in terms of station costs near $250,000. Speaking recently to the television seminar of the Radio Executives Club of New York he presented the following figures based on pre-war costs:

Studio Equipment and Transmitter	
2 Iconoscope cameras mounted on push dollies; Studio Control Desk	$23,000
Electrically controlled camera dolly	2,500
2 Special film projectors	12,000
2 Iconoscope film pickup cameras	6,000
Master control board	35,000
Transmitter, 25 kw video—12.5 kw audio, with control console	65,000
Antenna	10,000
	$153,500
Field Pickup Equipment	
2 Field pickup cameras with controls	$24,000
Relay transmitter	8,000
Relay receiver	2,000
Field audio equipment	1,500
Truck with generator and antenna	5,000
	$40,500
Installation, Sound, Lighting	
Studio installation	$15,000
Soundproofing, elec. wiring, etc.	25,000
Studio lighting, sound equipment, etc.	10,000
Fireproofing film studio	1,500
Equipment spares and test instruments	13,000
	$64,500
TOTAL	$258,500

Middle East

MARVIN CAMRAS, right, inventor of the magnetic wire recorder developed at Armour Research Foundation, demonstrates its features for Louis P. Birk, director of public information for the United Nations

Relief and Rehabilitation Administration. The unit is to be taken to the Middle East for use in refugee camps. Health and hygiene, friendly relations, and public information and instruction will be featured.

Rochester Meeting Program

TECHNICAL PAPERS scheduled to presented at the Rochester F War Conference on Nov. 13 and include the following subjects:

The Reactance Theorem for a Resona by W. R. MacLean, Polytechnic Inst. Brooklyn.

A Resonant Cavity Method for Measur Dielectric Properties at U-H-F, by C. Works, T. W. Dakin, F. G. Boggs, West house Elec. & Mfg. Co.

The RCA Laboratories at Princeton, E. W. Engstrom, Radio Corp. of Ameri

Low Frequency Compensation of Mu stage Video Amplifiers, by M. J. Larson A. E. Newlon, Stromberg-Carlson Co.

Trends in Receiving Tube Design Application, by L. R. Martin, Radio C of America.

Standardization of Capacitors for Civil Equipment, by J. I. Cornell, Solar Corp.

Report of RMA Director of Engineer W. R. G. Baker.

The Organization of Research in Radio Industry after the War, by Ru Maclaurin, Massachusetts Inst. of Te nology.

Electronic Tube Trends, by R. M. W Sylvania Electric Products Inc.

Silicone Products of Interest to Radio Industry, by Shailer L. Bass T. A. Kauppi, Dow Corning Corp.

Designing Thoriated Tungsten Cathod by H. J. Dailey, Westinghouse Elec. & M Co.

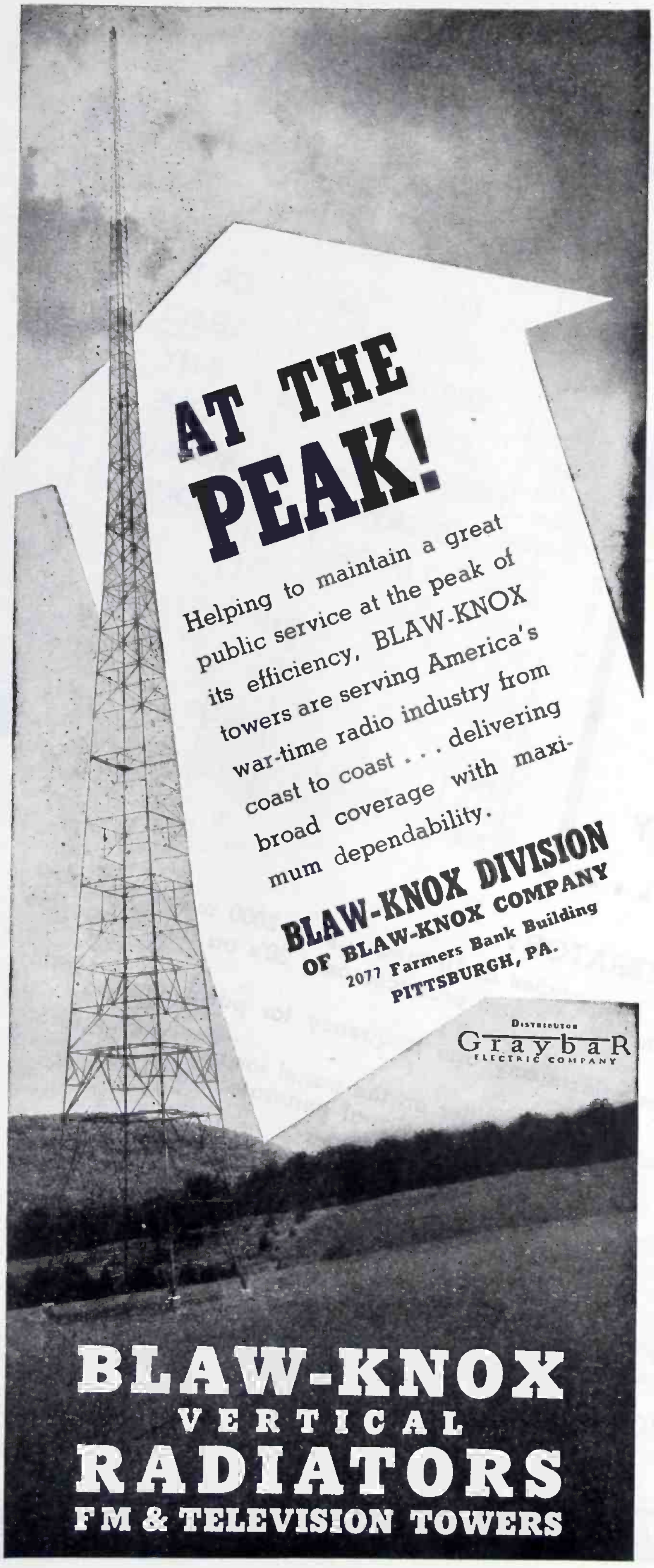
Salvage of Electronic Products

TO SALVAGE AND RECLAIM eve type of electronic product used the Navy, six material and red tribution centers are being esta lished on the Pacific Coast. Obs lete, battle-worn, and surplus equi ment is to be reclaimed, and red tributed as replacements, spa parts or scrap. Centers will be Irvington, Stockton, Torrance, a San Francisco, Calif., and Sale Ore.

Walkie-talkies are the particul consideration of recent instructio sent by the Signal Corps of t Army to signal depots in the U. and abroad. Older reradiati models are dismantled and stripp of 85 parts, 27 of which can be used in or with other Signal Cor equipment. Even the quartz cry tals are turned over to a field grinding unit for further use. R sistors and capacitors with pigtai less than an inch are reluctant scrapped.

Elections in RMA

RECENTLY ANNOUNCED departme directors of RMA include: by-law and organization, Leslie F. Muter engineering, W. R. G. Baker; in dustry reconversion, A. W. Wells NEMA tube classification, W. R. G Baker; RTPB television reportin



Ray H. Manson. In the transmitt division, the following sectic chairmen have been listed: rad transmitter tubes, H. C. Vanc broadcast transmitters, C. W. Mi ler; emergency service communic tion, F. A. Gunther; aviation equi ment, J. W. Hammond; marin equipment, F. R. McMullen; a piezoelectric quartz crystals, G. I Wright.

Other section chairmen are school sound systems, amplifier an sound equipment division, Laur ence A. King; crystals, parts divi sion, F. D. Bliley; insulations (tub ing, tape, sleeving, varnishes, an sealings), parts division, John W Apgar; metal stampings and meta specialties, parts division, W. W Barry; plastics and molded parts parts division, R. R. Titus; speak ers and parts (including headset and magnets), parts division Henry C. Forster.

Police Lineup by Television

A NEW WEAPON for the apprehen sion of criminals after the war may well be the telecast police lineup by which a central station might famil iarize police over a large area with the lawbreakers under current cus tody. Speaking before a meeting of the New York State Association of Chiefs of Police, Commissioner Ed ward J. Hickey of the Connecticut State Police hoped such facilities might be available to combat a pos sible post-war crime wave.

In another talk at the same con ference, Frank J. Wilson, chief of the U. S. Secret Service suggested that similar facilities could be used to make the public familiar with the particular tricks of confidence men thought to be operating in a certain area, to dramatize the conditions leading to juvenile delinquency, and to generally aid in law enforcement.

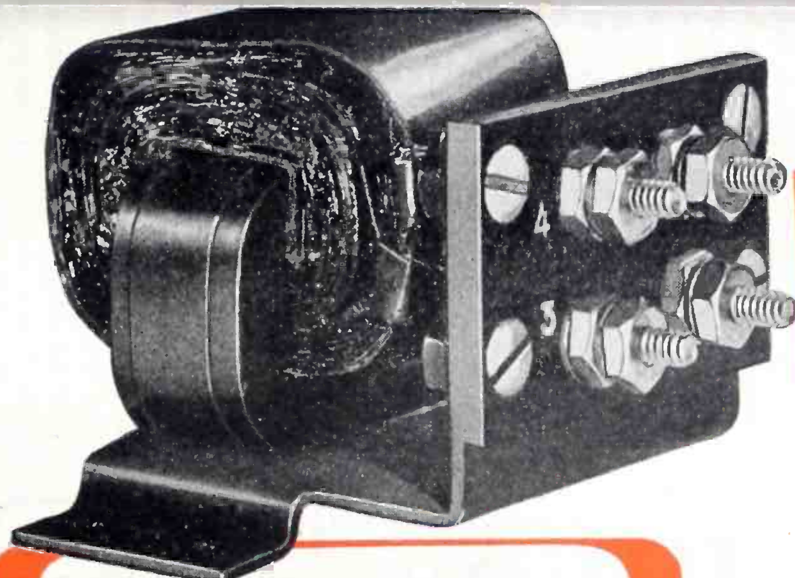
Large-Screen Television Prospects

BASED ON USE of the Skiatron and supersonic light relays which make it possible to project a great num ber of picture elements simultan eously, Scophony Corp. of America expects to merchandise a postwar home television receiver with a flat, projected picture 18 x 14½ in. for a price somewhere in the vicinity of $200.

A similar model was introduced

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 in England just before the wa[r] priced at £70 or approximately $3[..] at prewar sterling rates. The low[er] price will depend upon large-sca[le] production, according to Arth[ur] Levey, president of the compan[y] who addressed a recent session o[f] the television seminar of Radio E[x]ecutives Club in New York recentl[y]. A larger model which included th[e] same electronic gear, but a modi[fi]cation of the optical system, pr[o]duced a picture 24 x 20 in.

Among company development[s], some of which are currently co[n]nected with secret projects, is [a] scrambling device which makes i[t] possible for television programs t[o] be directed to special, authorize[d] subscribers, while television pro[jection] for theaters is anticipate[d] through the company's connectio[n] with Paramount Pictures. Pro[jected] pictures 18 ft wide were use[d] successfully in two London theater[s] before the war.

Postwar Educational Trend

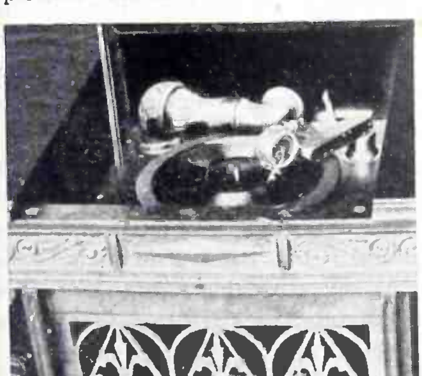
ACCORDING to the G.I. Bill of Rights every eligible veteran will have about $1,000, exclusive of his bonus to spend studying for a better peacetime job. In 1939 there were 125 students in technical and trade schools to each 100 in regular college. Feeling that many of the veterans will prefer trade school preparation to courses in history, literature, or foreign languages, a group of technical schools is forming a trade association, headed by Dr. J. S. Noffsinger, Washington, D. C., to raise standards of ethics, improve courses, and bring technical schools in closer touch with industry. Individual schools will be inspected, revised, and placed on an approved list which will give their graduates greater prestige among employers.

Coast-Guard Radio

CELEBRATING ITS 154th anniversary, the U. S. Coast Guard points out that its history includes pioneer work on ship and aeronautical radio. The Revenue Cutter Service, as the Coast Guard was called then, first used wireless telegraphy in 1903 for ship-to-shore communication. Credit for establishment of the standard 500-kc distress fre-

THERE IS NO SUBSTITUTE FOR EXPERIENCE

In 1915 Magnavox engineers produced this "daddy" of all loud speakers—the horn-type electro-dynamic speaker. Today the electro-dynamic loud speaker is the "voice" of modern sound reproduction in radio, sound motion pictures and all other kindred fields.



In 1922 Magnavox engineers developed this historic instrument—the first amplified radio-phonograph. As the forerunner of all present day radio-phonograph combinations, it marked an important advance in the development of sound reproduction.

THESE EXAMPLES serve to remind us how closely the history of radio is interwoven with that of the Magnavox Company.

In 1911 the electro-dynamic reproducer, developed by this company's engineers, completely revolutionized the art of sound reproduction. The same principle is used in all radios today.

Magnavox for years has been not only the world's largest supplier of loud speakers, but also one of the largest producers of electrolytic condensers. This experience dates from the original "Mershon" to the current Magnavox type.

The experimental work that built the Magnavox reputation is constantly perpetuated—now intensified and broadened by highly diversified war work. Magnavox is your logical source for components and for cooperation in your future projects. The Magnavox Company, Fort Wayne 4, Indiana.

Magnavox

Loud Speakers • Capacitors • Solenoids
Communication and Electronic Equipment

Another important step forward was achieved with this first single-dial radio produced by Magnavox in 1923. Its importance at the time is appreciated when we remember that all previous radio sets required the use of three dials for tuning in a station.

The cone type of electro-dynamic speaker was introduced by Magnavox engineers in 1927. It was the prototype of all electro-dynamic speakers in use today, recognized throughout the world as the most efficient means for the electrical reproduction of sound.

quency and for the use of the te "sparks" in connection with op ators belongs to this service. Lat when the Revenue Cutter Serv and the Life Saving Service h been merged to form the Co Guard, radio was first used for a craft communication and flig guidance. Detailed pioneering i volved the rotatable electrosta cally-shielded d-f antenna a cathode-ray direction indicating i struments.

Radio Relay Allocation

HITHERTO COMMERCIALLY unus frequencies have been allocated American Tel. & Tel. Co. for e perimentation on a radio relay sy tem between New York and Bosto Facilities will be suitable for fr facsimile, and television broadca relay as well as telegraph and tel phone communication.

Two Class 2, 10-watt stations a provided for in the present autho ization, while seven fully automat relay stations are planned for th intervening space. Cost is est mated at $1,000,000.

News by Plant Broadcast

MORE THAN 5,000,000 America workers have been kept up to dat on recent military development through sound systems installed i war plants from coast to coast Stromberg-Carlson Company ha conducted a survey among users o such apparatus.

Keeping the workers continuall apprised as to the true situation has made it possible, at the same time, to utilize the driving power of the worker's reaction and to circumvent gossip.

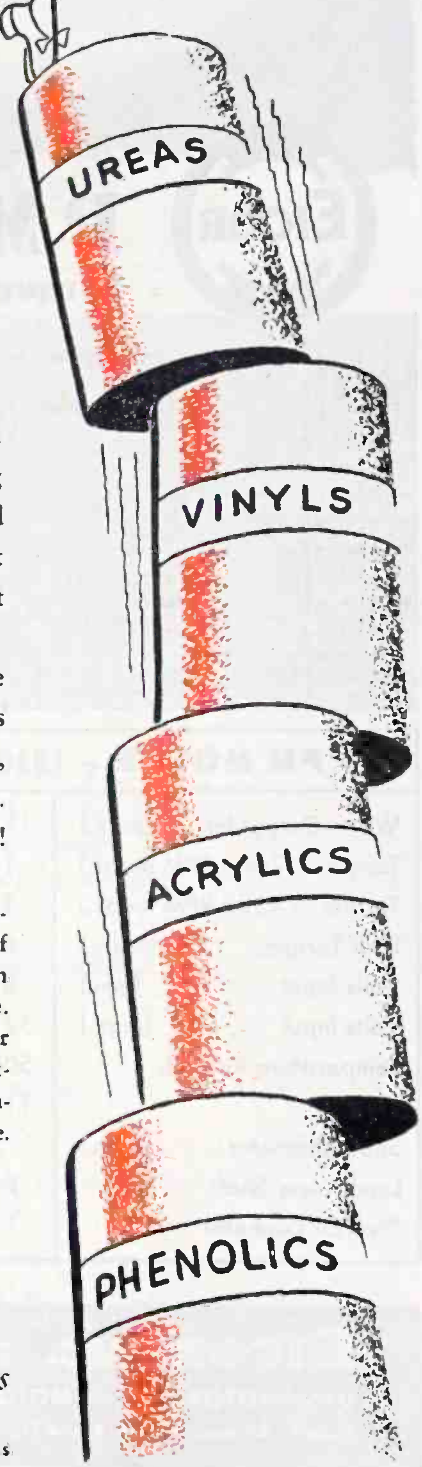
Most of the plants reported casting their communication systems in this role had previously used them mainly for paging officials, broadcasting speeches, and in general utilizing the facilities in the manner of talking bulletin boards.

CONVENTIONS TO COME

Oct. 2–5. Forty-Ninth Annual meeting, Boston, Mass. INTERNATIONAL MUNICIPAL SIGNAL ASSOCIATION, Irwin Shulsinger, secretary, 8 East 41 St., New York, N. Y.

Oct. 5–7. NATIONAL ELECTRONICS CONFERENCE, Chicago, Ill., B. Dud-

That's a TRICK, Mr. Jones ...and we know it!

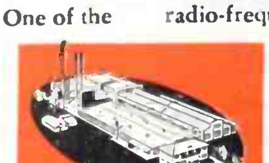


PLASTIC MATERIALS, you know, vary considerably. Not only in regard to physical properties *after* molding, but in regard to molding behavior as well. In other words, your plastic part has to be designed in full recognition of your material. That's why we say that the selection of material is another job for your custom molder!

But Kurz-Kasch does more than team up these two functions. In growing up with the plastics industry, we've found it wise to insist that experts on mold-making, molding and finishing add their opinions during the planning stage. This way, you can rest assured that your job will be estimated right—produced right—and delivered right on schedule.

This service is available from the moment you first wonder if plastics will fit into your program. In fact, that's the time to get the most out of it. We urge you to feel free to use it—now!

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! <u>ALL</u> YOU CAN — <u>WHENEVER</u> YOU CAN

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For over 25 years Planners and Molders in Plastics

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Branch Sales Offices: New York • Chicago • Detroit • Indianapolis • Los Angeles • Dallas
St. Louis • Toronto, Canada. *Export Offices:* 89 Broad Street, New York City

ley, secretary, 520 N. Michigan Ave., Chicago, Ill.

Oct. 12–14. Fall Meeting, Buffalo N. Y. ELECTROCHEMICAL SOCIETY Colin G. Fink, secretary, Columbia University, New York 27, N. Y.

Oct. 16–18. Fifty-Sixth Semi-Annual Fall Conference, New York N. Y. SOCIETY OF MOTION PICTURE ENGINEERS. W. C. Kunzmann, vice president, Hotel Pennsylvania, New York, N. Y.

Oct. 16–19. Twenty-Fifth Annual Meeting, Cleveland, Ohio. AMERICAN WELDING SOCIETY, M. M. Kelly, secretary, 33 West 39 St., New York 18, N. Y.

Oct. 19–21. Electronic Parts and Equipment Industry Conference, Chicago, Ill. PARTS DIV., RMA; ASSOCIATION OF ELECTRONIC PARTS AND EQUIPMENT MANUFACTURERS; EASTERN DIV., SALES MANAGERS CLUB; and NATIONAL ELECTRONICS DISTRIBUTORS ASSOCIATION; H. W. Clough, chairman, PO Box 5070-A, Chicago 80, Ill.

Oct. 20. Annual Meeting, New York, N. Y. ENGINEERS COUNCIL FOR PROFESSIONAL DEVELOPMENT, S. L. Tyler, secretary, 29 West 39 St., New York 18, N. Y.

Oct. 20–21. Twenty-Ninth Annual Meeting, New York, N. Y. OPTICAL SOCIETY OF AMERICA, Arthur C. Hardy, secretary, Massachusetts Institute of Technology, Cambridge 39, Mass.

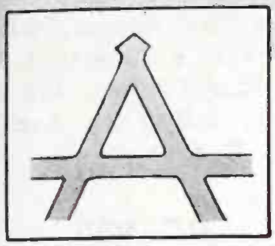
Nov. 2–3. National Time and Motion Study Clinic, Chicago, Ill. INDUSTRIAL MANAGEMENT SOCIETY, C. S. Becker, vice president, 205 West Wacker Drive, Chicago 6, Ill.

Nov. 9–10. Fall Meeting, Dayton, Ohio. INSTITUTE OF THE AERONAUTICAL SCIENCES, Robert R. Dexter, secretary, 1505 RCA Bldg. West, Rockefeller Center, New York 20, N. Y.

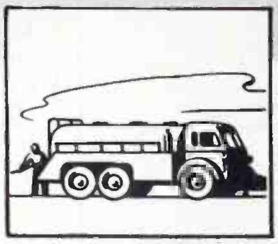
Nov. 13–14. Rochester Fall Meeting & War Radio Conference, Rochester, N. Y. ROCHESTER FALL MEETING COMMITTEE, Virgil M. Graham, chairman, PO Box 750, Williamsport, Pa.

Nov. 13–14. Annual Fall Convention, New York, N. Y. SOCIETY OF THE

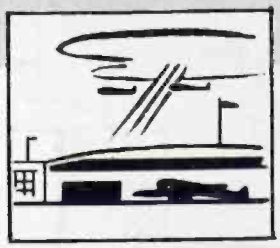
Your Airport may have all of these



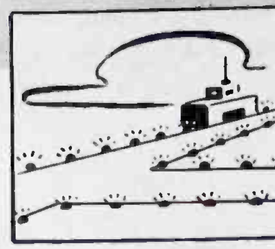
RUNWAYS



SERVICE



HANGARS



LIGHTS

But it still is not a modern airport serving your community to best advantage, if it does not have radio facilities

Essentials of a modern airport, in the order of their importance, might be listed this way:

1. Adequate all-weather runways.
2. Sufficient service for normal requirements.
3. Hangar space.
4. Lights.
5. Control tower.
6. Radio navigational facilities.
7. Weather information.
8. Terminal facilities including restaurants, taxi service, etc.
9. Accessible location.
10. Safe approaches from all directions.

and — an able, adequately paid airport manager who can make the fullest use of his facilities in the interests of the public, flyers and the airlines.

Our job—that of RADIO RECEPTOR—is the provision of radio facilities for navigation—for traffic control—for communication. Chances are RADIO RECEPTOR ranges — supplied to the CAA — may guide the planes to your airport. Let RADIO RECEPTOR traffic control equipment continue the job and bring them down to the runways and up to the gates.

Competent counsel on airport traffic control radio now available—equipment supplied when conditions permit. *Plan* now—*purchase* later.

Send for our informative 16-page, 8x11 publication

"HIGHWAYS OF THE AIR"

which discusses radio navigation and traffic control in all its phases, military and civilian—past, present and future. Free to those writing on their letterhead.

RADIO RECEPTOR COMPANY, INC.

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

Airway and Airport Radio Equipment • Communications Equipment • Industrial Electronics • Electronic Power Generators

SINCE 1922 IN RADIO AND ELECTRONICS

PLASTICS INDUSTRY, C. S. Sho maker, meeting chairman, D Chemical Co., 30 Rockefeller Pla New York 20, N. Y.

Dec. 7–8, First Annual Conferen New York, N. Y. TELEVISION BRO CASTERS ASSOCIATION, Will Balt secretary, 500 Fifth Ave., N York 18, N. Y.

D.C. BIAS

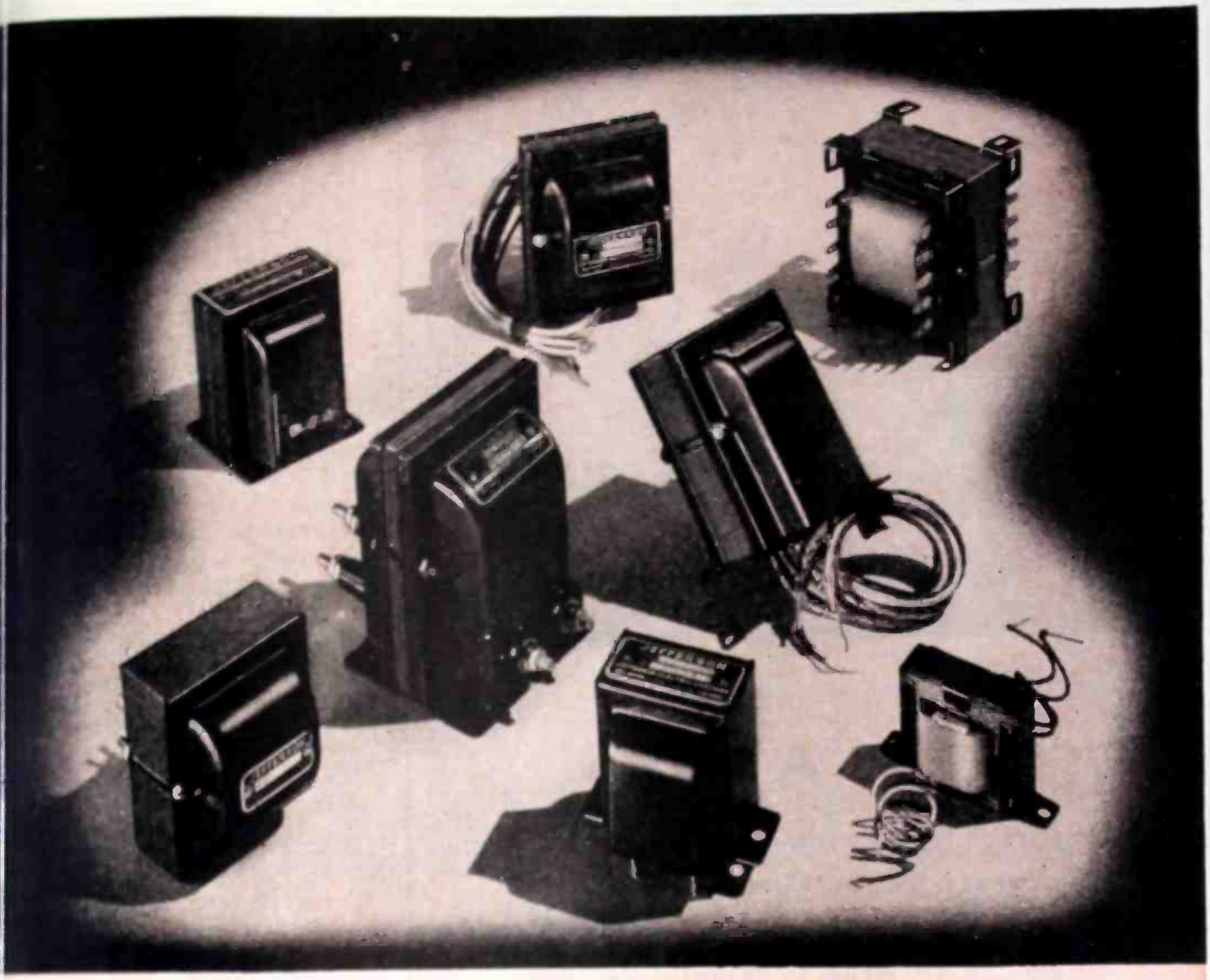
CIVILIAN RADIO. Production of vilian radios will be resumed aft Germany surrenders, and not befo such time, the Radio Industry A visory Committee was told by lea ing WPB officials at a recent mee ing in Washington.

These officials told the committ that the radio-radar production pr gram for 1944 must continue u ward through December and abo 16.4 percent above the July outp rate. Army and Navy officials co curred in this estimate of over-a increase during the remainder the year.

FORESTRY OPERATION. With sever provisos, FCC has amended its rule so a licensed operator who is th holder of a radiotelephone or ra dio-telegraph first or second clas license may be on duty as the oper ator of one or more forestry sta tions licensed in the name of th same person, municipality, or state at any location within the reliabl daytime communication range o each such station in lieu of th transmitter locations or contro point(s) during actual operation o the transmitting apparatus employ ing telephony.

UPHILL PRODUCTION. The forthcoming months will be more critica than any period previously faced by the electronic industry, and as a consequence the industry and WPB must effect the maximum cooperation on all problems, Ray C. Ellis, director of WPB's radio and radar division, recently advised the Industrial Instrument Industry Advisory Committee.

Reasons for the need of closer cooperation include problems of cancellation of contracts, reconversion, and labor which must be anticipated, he said. Commenting on the overall electronic industry production rate, Mr. Ellis pointed out that July, 1944, showed an increase of



Quality in Quantity

WITH COMPLETE control of the design, selection of all materials, and methods of manufacture of all parts to the final assembly, inspection and delivery,—Jefferson Electric Transformers are laboratory correct whether required in small lots or hundreds of thousands.

War-time demands have further emphasized the ability to maintain high uniform standards of quality on a mass production basis. Under the stimulus of War effort, advanced types of machinery, and improved manufacturing technique, you can count on still better Jefferson Electric products for your post-war needs. Consulting now with Jefferson Electric transformer engineering specialists will save time for you later . . . JEFFERSON ELECTRIC COMPANY, Bellwood (Suburb of Chicago), Illinois. *In Canada:* Canadian Jefferson Electric Company, Limited, 384 Pape Avenue, Toronto, Ontario.

JEFFERSON ELECTRIC

TRANSFORMERS

approximately 16.4 percent ov July, 1943. Production rose fi percent in June, but was still fo percent behind schedule in Jul largely because of a 60- to 90-da lag between the new design on th drawing board and final assemb of the parts.

Serious manpower shortages ex ist in the production of certai component parts for signal equi ment, such as dry-cell batteries an transformers. About 22,000 ne workers will be needed in key ele tronic plants between now and th end of the year, WMC estimate and an additional 12,000 a mont will have to be found for replace ments at the current rate.

About half the present worker are women, according to WMC, an that percentage can be stepped u to two-thirds if they can be re cruited. Chief difficulty in addin to the labor force in this field, WM points out, is that most of the plant center in labor shortage areas— around Chicago; near Philadelphi and Newark; and in the Buffalo Syracuse, and Schenectady areas.

More Batteries. Demand for bat teries, according to the Signal Corps officers who are charged with the duty of procuring all batteries for all the armed services, is still sharply on the upswing. Deliveries of all types of batteries have in creased about two-thirds since the beginning of this year but monthly rates must be increased another 40 percent. The current monthly pro duction of battery cells runs close to a hundred million, which is still far short of what is desired.

Station Sales. FCC has asked Congressional direction as to the policy it should follow in passing on the sale of radio stations where the sales prices are far in excess of the going-concern and physical-prop erty values of the stations and ap pear to involve considerable com pensation for the radio frequencies themselves.

In identical letters to Senate In terstate Commerce Committee Chairman Burton K. Wheeler and to Rep. Clarence Lea, Chairman of the House Interstate and Foreign Commerce Committee, FCC chair man James Lawrence Fly suggested the "tremendously high prices" which radio stations command in the present market indicates the

And now we add *Embossing*
:o make CLOTH serve more people . . . more ways . . .

mbossing is a surface treatment generally applied to coated oth to secure a decorative effect or to simulate a naturally regular surface. One of the most common forms of embossed eatment copies various leather finishes and many so-called imitation leathers" have all of the appearance value and much of the durability of leather and, in addition, are waterproof, non-porous and uniform. Various coarse fabric textures are embossed as well as all-over designs. A combination of embossing with printing (color on high spots) produces unlimited pleasing contrasts.

EMBOSSING

Under pressure a relief pattern is produced in the plastic coating. The cloth structure is in no way damaged or weakened. For certain industrial uses embossing may create lines or marks of functional value.

CURRENT HOLLISTON PRODUCTION includes COATED AND IMPREGNATED FABRICS . . . INSULATING CLOTH BASE . . SEPARATOR CLOTHS rubber, starch-filled, glazed. TRACING AND BLUE PRINT CLOTHS white and blue, ink or pencil. MAP CLOTH, PHOTO CLOTH, self-adhesive. REINFORCING FABRICS. SIGN, LABEL AND TAG CLOTHS, waterproof to take any ink, meet any inking problem. BOOK-BINDING CLOTHS. SHADE CLOTH, impregnated waterproof, opaque, translucent or light proof.

We urge you to consider CLOTH; and invite you to consult with us concerning possibilities and developments for your specific requirements.

The Holliston Mills, Inc.
PROCESSORS OF CLOTHS FOR SPECIAL PURPOSES
NORWOOD, MASSACHUSETTS
Sales Agents in Principal Cities

sellers may be profiting from their lien on a radio frequency which they have been authorized to use under the Communications Act of 1934, but whose ownership under the Act is reserved to the public.

RADIO-PHONOGRAPH PRICING. The price schedule that previously governed manufacturers' maximum prices for consumer-type radio receivers and phonographs has been revoked, and the articles transferred to coverage by the regulation affecting most other consumers durable goods, the Office of Price Administration has announced.

This transfer to coverage was made because the previous regulation covering the articles dealt only with price control problems that were acute in 1942, before civilian production was completely shut off, and is not suited to present conditions. In particular, it does not provide a method for pricing new models of radio receivers and phonographs.

EDUCATIONAL BROADCASTING. FCC has adopted a new application Form 340, to be used when filing an application for construction of a noncommercial educational broadcast station. This form supersedes Form 309 and supplemental Form 313 but Form 309 continues to be used for several classes of broadcast stations other than standard.

Form 340 is expected to be more convenient to applicants desiring noncommercial educational broadcast facilities, and at the same time the form will supply the Commission with additional information concerning the service planned and the technical equipment proposed to be installed. The new application form now available will be used by the many nonprofit educational agenies planning the construction of f-m broadcast stations for the advancement of their educational work and the transmission of educational and entertainment programs to the general public.

REGULATIONS FOR RADIO SERVICEMEN. Information has been compiled by domestic and foreign branch of the radio and radar division of WPB to guide radio repairmen now in business as well as exrepairmen and men discharged from military service. In order that they may

We time the Punch with *Electrons*

. . . so that it "lands" with the *extra* force needed to fill the die.

In this Reed-Prentice Plastic Injection Moulding Machine, granulated plastic material is forced through a heated cylinder into the die at continuous high speed, under high pressure. Photoswitch Electronic Timer T15U actuates controls within the hydraulic system that provide maximum pressure, *at the exact* instant, with the *fractional second timing required* to complete the injection stroke.

Why Electronic Timing is the Best Answer for Split-Second Repeat-Cycle Accuracy

Photoswitch Electronic Timers function with split-second accuracy . . . without fatigue . . . frictional wear . . . or inertia. Electronic operation eliminates clockwork, springs, mechanical clutches . . . all moving parts subject to wear and failure . . . provides consistently accurate control without danger of speed-up or slow-down, and with extremely long life assured. Photoswitch Electronic Timers are used extensively to initiate automatic operation of precision production grinders, millers, profilers and other machine tools; to insure maximum safety and efficiency in X-ray equipment; to provide split-second control in welding, molding, spraying . . . and to afford the high degree of accuracy needed in process control.

Write to
PHOTOSWITCH, INCORPORATED
Cambridge 42, Massachusetts
for Bulletin 900-A.

PHOTOSWITCH
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PHOTOELECTRIC AND ELECTRONIC CONTROLS FOR EVERY INDUSTRIAL PURPOSE

know how to obtain necessa materials to carry on or enter i the radio repair business, they w be guided by specialists in the fi service branch of regional and d trict offices who are familiar w WPB orders and the problems civilian radio in wartime.

Summaries of applicable regu tions include those pertaining creation of an inventory, repla ment of components and tubes, a purchase of tools and test equ ment.

Another pertinent ruling is recent issue by OPA (Office Price Administration) which h restricted gasoline-rationing mi age to those radio repairmen w are working on government- government-agency-equipment.

COMMUNICATIONS FELLOWSHI Training of Latin American en neers in the regulatory and op ating procedures of communic tions in the United States is t aim of a program sponsored the State Department which h allocated $10,000 to FCC for su work. Rules and regulations ha been formulated by FCC to gove the awarding of fellowships to a plicants from other Americ republics.

Fellowships shall be of the i terne-training type which may i clude orientation in FCC office instruction in the engineering d partments; and training in mon toring stations of the Commissio besides visits to other gover ment agencies, private co munication companies, and oth background sources. Rules whic have been established cover qual fications, award of fellowships, a lowances, and expenses.

BUSINESS NEWS

ELECTRONIC MANUFACTURERS ASS CIATION has been formed in Ne York, N. Y. Membership is draw from companies active in the met politan and nearby areas.

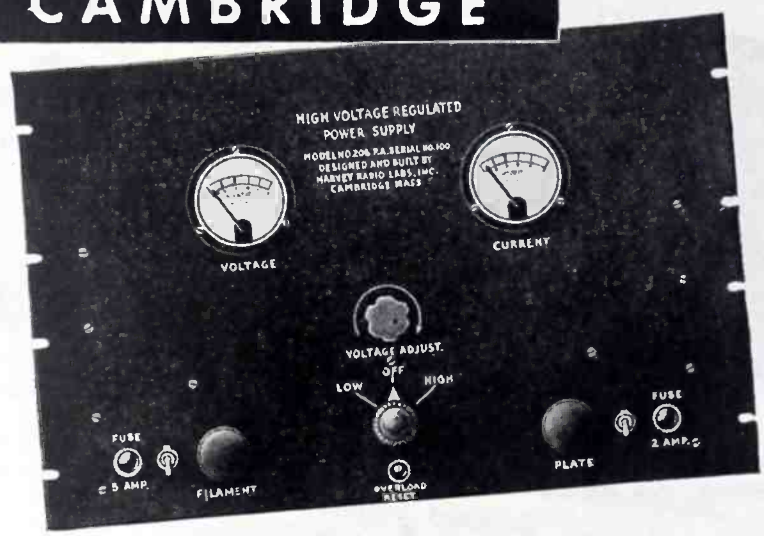
MILWAUKEE INDUSTRIAL DESIGNE has moved to new quarters at 74 North Fourth St. Milwaukee 3, Wi

INTERNATIONAL BUSINESS MA CHINES CORP. and GENERAL ELE TRIC CO. have collaborated on a pr posed network joining Washingto New York, and Schenectady an which will operate in the region be

HARVEY 106 PA
200 to 300 VOLTS

HARVEY
OF CAMBRIDGE

New
HARVEY 206 PA
500 to 1000 VOLTS



for REGULATED POWER SUPPLY

If you're looking for a dependable, controllable source of laboratory D.C. power for operation with pulse generators, measurement equipment, constant frequency oscillators, amplifiers and other equipment requiring a constant flow of D.C. voltage, it will pay you to get in touch with Harvey of Cambridge.

The Harvey Regulated Power Supply 106 PA will meet your every requirement in the lower voltages. It has a D.C. output variable from between 200 to 300 volts that is regulated to *within one per cent.*

The New Harvey Regulated Power Supply 206 PA is for higher voltages. This latest Harvey development operates in two ranges 500-700 at ¼ of an ampere and 700 to 1000 at .2 of an ampere. Both ranges have accurate regulation to *one per cent or better.*

Whatever your requirements, one of these Harvey Regulated Power Supply units will meet them with efficient, dependable performance.

We'd be happy to supply you with complete information on either or both of them.

HARVEY
OF CAMBRIDGE

HARVEY RADIO LABORATORIES, INC.
439 CONCORD AVENUE • CAMBRIDGE 38, MASSACHUSETTS

tween 1900 and 2300 Mc. Facilitie are to be used for relay purpose possibly including television, fm radiotype, and facsimile.

MERIT COIL & TRANSFORMER CORP has completed a new plant at Chicago, Ill., and will combine genera offices with production facilitie there.

AMERICAN TELEPHONE & TELEGRAPH CO. and SOUTHERN BELL TELEPHONE & TELEGRAPH CO. hav been given FCC permission to spen an estimated $6 million on coaxia lines between Atlanta, Ga., an Dallas, Tex.

PENNSYLVANIA RAILROAD ha planned to equip its Harrisburg main-line division with radiotelephone equipment in 300 freight an passenger locomotives and 90 ca booses. Cost has been set at $1 million.

DEJUR-AMSCO CORP. has complete plant No. 2 in Long Island City, N Y. Facilities cover 75,000 sq ft.

NATIONAL RADIO INSTITUTE, Washington, D. C. has completed 30 years of service to the industry.

PRESS WIRELESS INC. has arranged to move its executive offices from Chicago to 1475 Broadway, New York, N. Y.

RCA VICTOR DIV., RADIO CORP. OF AMERICA will introduce the first electron microscope into the laboratories of Australia for war production research. It will be delivered to the Council for Scientific and Industrial Research.

FAIRCHILD CAMERA & INSTRUMENT CORP. has been assigned an approved quality-control rating by USAAF. This means that duplicate Army inspection during detail fabrication will be eliminated and the company will be given full responsibility.

RCA VICTOR DIV., RADIO CORP. OF AMERICA, has finished its millionth Type X crystal which was placed in a gold-plated container for ceremonial purposes.

PRATT INSTITUTE, Brooklyn, N. Y. has announced a forthcoming series of tuition-free ESMWT courses including introduction to radio, radio

For Your Postwar Needs in Connectors and Related Units

If your postwar plans will involve coaxial cable connectors, cable plugs or special design parts of similar nature—we invite your consideration of our products and facilities.

Besides offering a comprehensive line of standard units, Connector Division possesses a unique engineering skill and knowledge in this field that may prove of valuable help and economy to you.

INTRODUCING MINIATURE BATTERY PLUGS

(Illustrations are actual size)

Anticipating the trend to midget devices, IRC presents this new, easy-grip battery plug. Pins are firmly imbedded in molded bakelite to insure positive contact. Side-positioned lead entries reduce strain on soldered connections. Fitting all miniature batteries, these plugs should find wide application in many types of equipment especially in the radio, hearing-aid, medical apparatus, and appliance fields. Available in two-pin or three-pin models. Specifications and samples on request.

Write for Catalog

IRC

***CONNECTOR DIVISION OF**

INTERNATIONAL RESISTANCE CO.

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

***FORMERLY CONNECTOR CORPORATION**

construction and testing, elemen of electronics, industrial electro ics, and u-h-f techniques.

GENERAL ELECTRIC CO., Schene tady, N. Y., has launched a progra which will eventually see all th parts of its electronic activity cer tered in an industrial developme on the outskirts of Syracuse, N. Y Construction of the plant has bee planned for the end of wartime.

KANSAS CITY & SOUTHERN RAIL ROAD has completed an installatio of two-way radiotelephone commun ication along its entire main-lin 560-mile right of way.

RCA VICTOR DIV., RADIO CORP. O AMERICA, has established a com prehensive re-employment progran which will affect the 6000 forme workers serving in the arme forces.

GALVIN MFG. CORP. has installed a two-way f-m radiotelephone com munication system which gives in stant contact throughout the entire length of the Panama Canal.

FORT WORTH ELECTRONICS CLUB has been organized by 19 charter members connected with local industries. Monthly meetings are scheduled.

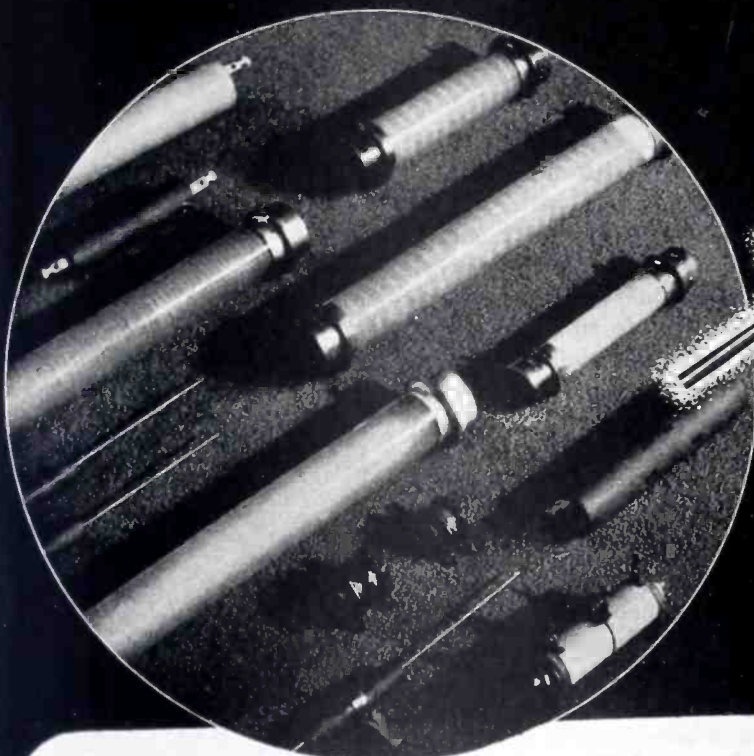
DEFOREST'S TRAINING INC., Chicago, Ill., has listed twelve lectures which are to be given there between Sept. 20 and Dec. 6 on subjects related to industrial electronic engineering. Covered will be fundamentals, rectifiers, thyratrons, measuring, welding, motor control, phototubes, elevator control, x-ray, heating, and lighting.

CANADIAN NATIONAL RAILWAYS has made tests on two-way radio communication in the Montreal terminal area.

COOPER UNION, New York, N. Y., has scheduled a series of engineering courses for evening attendance starting Oct 2. Communications principles, advanced electric circuits, and electrical engineering for other than electrical engineering students are to be included.

NEARLY $9,000,000 worth of equipment would be needed if the FCC were to approve the applications for FM stations now on file.

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

*T.M. REG. U. S. PAT. OFF.

NEW PRODUCTS

Month after month, manufacturers develop new materials, new components, new assemblies, new measuring equipment; issue new technical bulletins, and new catalogs

Vibration Fatigue Testing Machine

MODEL 10-HA IS a vibration fatigue testing machine which is designed to meet all requirements for a fatigue testing machine that will subject parts up to 10 lb in weight to vibration produced horizontally in simple harmonic motion. It has a range from 10 to 55 cps (600 to 3,300 vibrations per minute) which are increased and decreased automatically at a uniform rate.

A 4-page bulletin, No. 610, describes and illustrates Model 10-HA, as well as other vibration machines available from All American Tool & Mfg. Co., 1014 Fullerton Ave., Chicago 14, Ill.

Direct-Recording Electrocardiograph

INSTANTANEOUS, permanent, standard readings may be obtained with this inkless, direct-recording electrocardiograph (Type EPL) which is for use in electro-medical analysis and laboratory research. The instrument is compact, lightweight and portable, and requires no photographic processing. The recorder may be used in conjunction with other equipment for laboratory research. The electrocardiograph

comes supplied with an amplifier and recorder which will give a graphic record between 0.1 and 80 cps at a sensitivity of 1 millivolt and 2 cm total deflection or a range from zero to 80 cycles for 60 millivolts and 2 cm deflection. A high speed writer can be supplied which will extend the frequency range to approximately 200 cycles. The phase correction is such that perfect square-wave response from 0.5 to 80 cycles is realized with the one-millivolt sensitivity connection.

Electro-Physical Laboratories, Inc., 45 West 18 St., New York, N. Y.

Hardening and Quench Table

ILLUSTRATED IS A general-purpose, two-station hardening and quench table used in connection with high-frequency induction heating generators. The unit is suited to a wide variety of machine parts requiring surface hardening or localized heat-

ing. The table has quick-change coil connections so that jobs can be set up in 2 to 3 min to change a heating coil. The unit is flexible enough for low production requirements. An initial timer is provided to indicate the heating time for a new job or a new part and no stop watch or other means of timing necessary. After the initial heatin[g] time has been determined, the tim[er] can be cut out by means of a sele[c]tor switch which is included in th[e] assembly. A 3-stage timer aut[o]matically controls the heating an[d] quenching positions of the cycl[e]. A signal-type pilot light indicat[es] heating is taking place.

Induction Heating Corp., 389 La-fayette St., New York 3, N. Y.

Secondary Frequency Standard

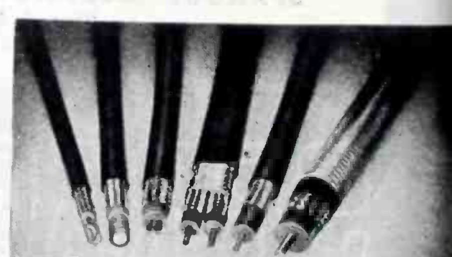
THIS SECONDARY FREQUENCY stand-ard is crystal controlled with a her-metically-sealed MD cut dual-fre-quency crystal. It provides usefu[l] output up to 40 Mc at 1,000-kc

100-kc and 10-kc intervals. It operates from 60 cps, 115 v line. The unit is housed in a sturdy metal cabinet.

The James Knight Co., Sandwich, Ill.

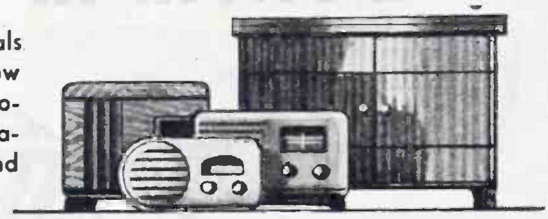
New Type of UHF Cables

NEW SIZES AND TYPES of solid-dielectric coaxial cables, used in uhf and radar equipment for the armed services, have been added to this manufacturer's line of cables. The cables are manufactured in five basic types:

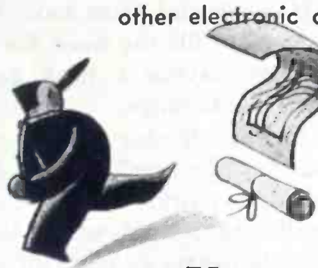


Basic types of high-frequency cables. From left to right: coaxial air-spaced, spiral delay, twin-conductor, dual-coaxial, coaxial solid dielectric and armored coaxial cables

The ECA STORY

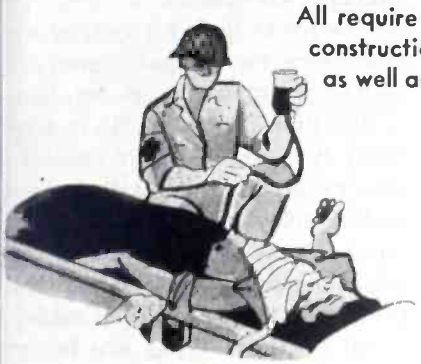


For almost a quarter of a century, most of the principals and personnel of ECA have had the opportunity to grow and expand with electronics. We've had experience producing many different types of highly specialized apparatus — including sound systems, test equipment and other electronic devices.



ECA engineers, designers and technicians are all accustomed to working to exacting laboratory standards. Rich in the fundamentals of radio and electronics, we can approach any problem with full confidence that the ultimate result will prove eminently satisfactory.

Naturally, during these crucial war years, our entire production is devoted to materials needed by the Armed Forces. Much of this equipment is of an extremely delicate and precise nature. All require maximum attention to design and construction to meet the standards of ECA as well as the government.



While devoting our working time 100% to war production, we have not forgotten home front activities. The Electronic Corporation of America is proud that each succeeding war bond drive has been over-subscribed, and we're equally proud of the blood donor award given to us by the American Red Cross.

Regularly at ECA, representatives of management meet with representatives of labor to discuss company policy, to fix production quotas, and to look after the needs of the individual worker. We have found that harmonious labor-management relations stimulate the output, efficiency and progress of our organization.

Under these splendid conditions will future ECA products be manufactured. Modern production techniques, trained personnel and precision laboratory and plant facilities will be utilized to produce superior ECA radios and electronic devices for home, industry and medical science. This, in effect, is the ECA story.

JUST PUBLISHED!

We shall be pleased to send you our new publication on..

What are the prospects for the future? How can America's vast industrial set-up be put to most effective use for a prosperous and abundant economy? What are the joint responsibilities of management and labor? Can small business survive? How can American business and industry achieve additional markets worth at least 25 billion dollars? Is the attainment of full scale employment a wishful dream or an actual possibility? The answers to these, and other vital questions, are supplied in "A Plan for America at Peace." Write for your copy . . . we'll gladly send it to you without charge or obligation.

ELECTRONIC CORP. OF AMERICA

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Listen in! UNCENSORED Commentaries on the News: — Johannes Steel, WMCA, New York, every Monday, Wednesday, Friday at 7:30 P.M. — William S. Gailmor, WHN, New York, Monday through Friday, at 9 P.M. — sponsored by the Electronic Corporation of America.

ECA will offer a new plan of distribution at the Electronic Parts and Equipment Industry Conference in Chicago. Be sure to talk to us about it.

The first of these is called Coaxial. This line includes sizes from in. outside diameter up to and including cables over 1 in. in outsid diameter. Standard designs includ single and double-braided construc tions with standard and armore covering.

Dual-coaxial lines have been de veloped to fill the need for paralle circuits having a high degree o electrical balance.

Twin-conductor lines, sometime called "Twinaz" are balance shielded pairs, usually somewha smaller than dual-coaxial lines, an provide nearly as good an electrica balance.

For low capacitance require ments, there is available a line o coaxial air-spaced cables whicl can be made in any required lengtl and which have capacitances as lov as 8 micro-microfarads per foot.

The fifth type of cable is a spira delay line which is for special tes sets requiring lines with an appre ciable delay or very high imped ances. Some of these lines have in 1-ft. length an electrical equivalen to that of 15 ft of coaxial cable.

All of these types are designed generally, for 50 to 70 ohms imped ance, and the type of cable selected is predicated by power requirement or power loss limitations.

A bulletin called "Intelin Coaxial Cable Impedance Nomographs" is also available.

Intelin Products Div., Federal Telephone & Radio Corp., Newark, N. J.

Alignment Tool

A NEW TOOL FOR precision alignment of padding capacitors in radio receivers and transmitters is Type TL-207 which is available from General Cement Mfg. Co., Rockford, Ill.

Shockproof Relays

THESE RELAYS ARE wound to specifications and are available in single or double pole. They have been subjected to vibration and other tests. A single relay measures 1$\frac{3}{8}$ in. wide, 2$\frac{3}{4}$ in. long and 1$\frac{1}{2}$ in. high.

H. C. Evans & Co., 1528 W. Adams St., Chicago, Ill.

Thermoplastics Welding Machine

THIS MACHINE utilizes high-f quency current to weld many ty of thermoplastics material. It capable of welding about 35 ft minute. The weld created is wat tight, moisture-proof and air-tig The machine itself resembles an

dinary sewing machine, but t welder can be modified to ot physical forms and can be adop as a step in the process of fabri tion, or can be incorporated i other machines. The manufactur state that the machine is not ready for distribution.

Richardson-Allen Co., 15 West St., New York, N. Y.

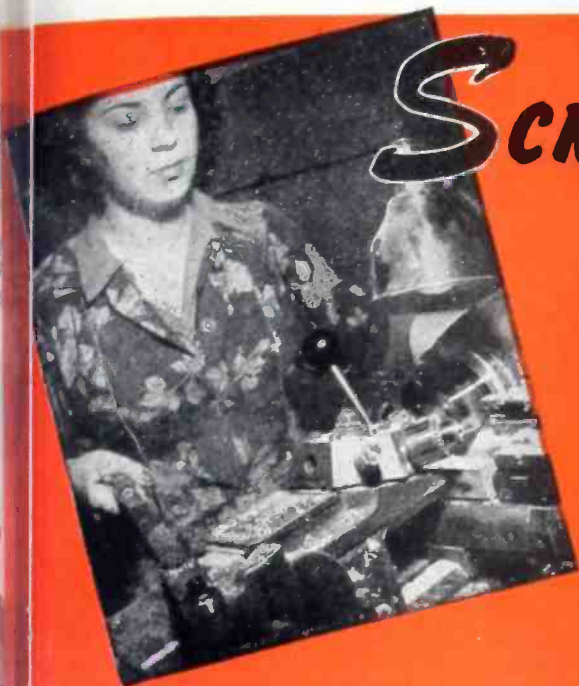
Electron Tubes

AVAILABLE TO equipment manuf turers against WPB rated ord are the following new electr tubes:

1P29 is a gas phototube (viol green sensitive) for colorimet applications. Spectral response curs over the spectral range fr about 4000 to 8000 Angstroms, wi maximum sensitivity at appro mately 4200 Angstroms. Sensit ity at maximum response is 0. microamp per microwatt of radia flux.

3B25 is a half-wave gas rect fier of a hot-cathode type. It xenon filled and is ruggedly co structed to withstand severe vibr tion. It can be operated under co ditions where ambient temper atures of −75 to +90 deg C are en countered. The tube will withsta a peak inverse voltage of 4000 volt and will deliver an average anod current of 0.5 amp.

6AL5 is a miniature twin diod featuring high perveance. It is fo use as a detector in circuits utili



SCREW MACHINE PARTS

FROM PHENOL FIBRE, VULCANIZED FIBRE, LUCITE, POLYSTYRENE OR ANY OTHER SPECIFIED PLASTIC MATERIAL

Producing Screw Machine Parts in large or small quantities is but one of our many specialized functions as specification fabricators. Here, in our modern plant, skilled operators fashion many such parts of all sizes and shapes from many different materials on precision machines which guarantee accuracy to extremely close tolerances.

Send us the specifications for your *next* screw machine requirements and let us prove to you that we can produce these parts *better . . . faster . . .* and *more economically!* We have a large stock of standard materials on hand at all times—all of which meet Army, Navy and Air Corps specifications.

Specification Fabricators of

GLASS BONDED MICA, PHENOL FIBRE, VULCANIZED FIBRE, RUBBER, ASBESTOS, CORK, CORPRENE AND OTHER MATERIALS

Precision
FABRICATORS, INC.
112 N. FITZHUGH ST., ROCHESTER 4, N.Y.

ranch Offices: NEW YORK: 420 LEXINGTON AVE., DETROIT: 14319 STRATHMOOR AVE. PHILADELPHIA: 6710 HOLLIS ST., CHICAGO: 4317 RAVENSWOOD AVE.

ing wide-band amplifiers. It [illegible] low internal resistance and will g[illegible] an increased signal voltage fron[illegible] low-resistance diode load. E[illegible] diode unit can be used indepe[illegible] ently of the other or combined [illegible] parallel or full-wave arrangeme[illegible] This tube is an Army-Navy p[illegible] ferred type.

6F4 tube is an acorn triode of t[illegible] heater type intended for use p[illegible] marily as an oscillator at f[illegible] quencies up to about 1200 Mc. [illegible] features are high perveance a[illegible] reduced lead inductance. At mo[illegible] erate frequencies (in class C osc[illegible] lator service with 150 volts [illegible] plate) a single 6F4 tube is capal[illegible] of giving a power output of a[illegible] proximately 1.8 watts. At 1200 M[illegible] and with 100 volts on plate, approx[illegible] mately 45 milliwatts can be o[illegible] tained.

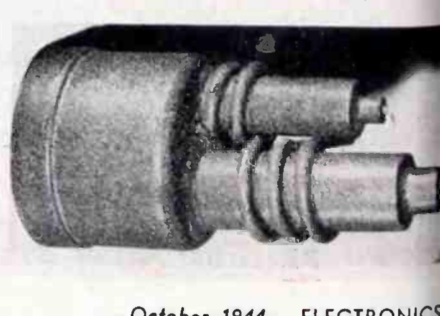
Radio Corporation of Americ[illegible] Harrison, N. J.

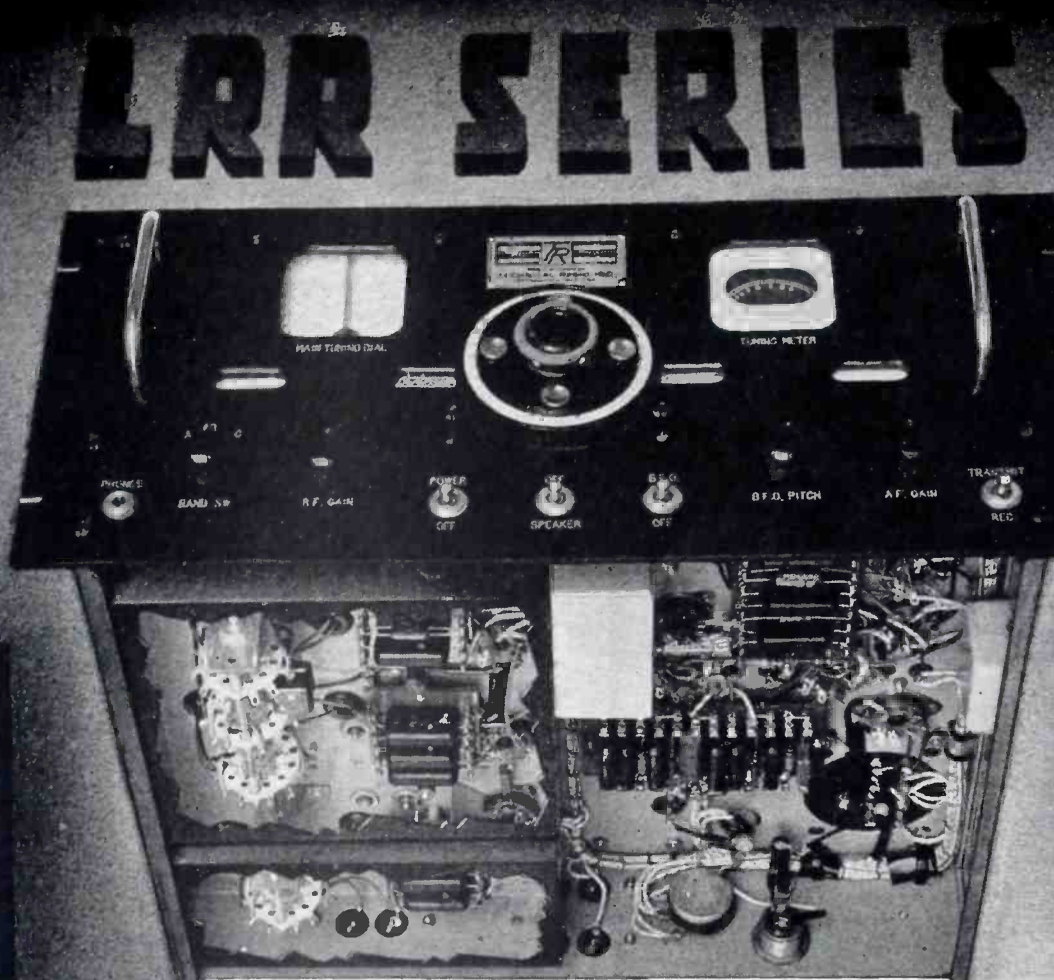
New Tubes

THREE NEW TUBE TYPES availab[illegible] include 6AK5, which is a shar[illegible] cutoff r-f pentode; the 6AL5, a v[illegible] twin diode; and the 6AQ6, which [illegible] a double-diode-triode. These tube[illegible] are being manufactured in accord[illegible] ance with WPB-authorized produc[illegible] tion schedules and are availabl[illegible] from Hytron Corp., Salem, Mass.

Miniature Diffusion Pumps

DESIGNATED AS Type VMF, thes[illegible] small, compact metal pumps pro[illegible] duce a vacuum of 10^{-6} mm of hg[illegible] They are for use with the new-style rotary exhaust machines in which a diffusion pump moves around with each tube, as well as for portable electron microscopes and similar apparatus. The pumps utilize a fractionating principle which does not require any liquid air trap. Heat transfer problems are eliminated by a boiler design. The units are normally cooled by water, but special air-cooled models are also available. The pumps are available in three





VIEWED FROM ANY ANGLE— QUALITY PREDOMINATES!

ALL COMPONENTS ON TERMINAL BOARDS THAT USE DOUBLE BARRIER TERMINALS—EASY SERVICE

TERMINAL BOARDS VACUUM IMPREGNATED WITH FUNGICIDE VARNISH–MOISTURE PROOF

VINYLITE AND GLASS INSULATED WIRE–FUNGICIDE TREATED

PLATING AND PAINTING THAT WILL WITHSTAND NORMAL SALT SPRAY TESTS

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AUDIO TRANSFORMERS ARE IN HERMETICALLY SEALED CASES

F. C. C. APPROVED FOR LOW RADIATION FROM H. F. OSCILLATOR –

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TECHNICAL RADIO CO.

275 NINTH ST., SAN FRANCISCO, CALIF., U. S. A.

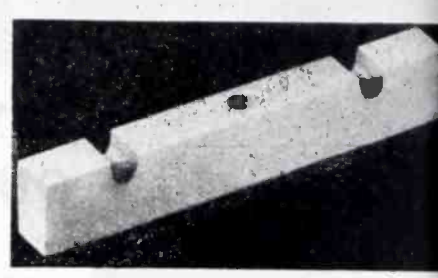
EXPORT AGENTS: FRAZAR & HANSEN, 301 CLAY ST., S. F., CAL.

different sizes: VMF-6 measures 2¾ in. in diameter and 6 in. high; VMF-20 measures 5¼ in. in diameter and 9½ in. high; and VMF-10 which measures 7¾ in. high, 3⅞ in. wide, and weighs 25 lb. Other characteristics of type VMF-10 are speed 10 liters/sec. at 10^{-4} mm hg; ultimate vacuum 1x x10^{-6} mm hg with Octoil-S; required forepressure 0.125 mm hg; heater power 135 watts.

Distillation Products, Inc., Rochester, N. Y.

H-F Coil Supports Made of Nylon

PRINTLOID, INC., (91 Mercer St., New York 12, N. Y.) have issued a release in which they say that it is expected that when the supply of Nylon becomes sufficient for all needs, it will make its appearance in the form of rods, sheets and tubes, just as most other plastics. As a prelude to such production, DuPont recently produced a small quantity of Nylon in sheet form.



These sheets were made experimentally in small moulding presses by laboratory methods. Federal Telephone & Radio Corporation required a quantity of high frequency coil supports for some equipment they were producing. Printloid, Inc., fabricated these parts out of the new experimental sheets. Printloid will welcome inquiries concerning Nylon for electronic and other vital war uses.

Hermetically-Sealed Leads

THESE LEADS ARE constructed of Pyrex glass with Kovar electrodes and Kovar metal collars. They may be used in transformers, capacitors, coils, filters, and any other component requiring good lead-termination. A variety of standard sizes and shapes are available, and any shape or size can be furnished upon specification. The leads have high dielectric strength and are practically immune to thermal or me-

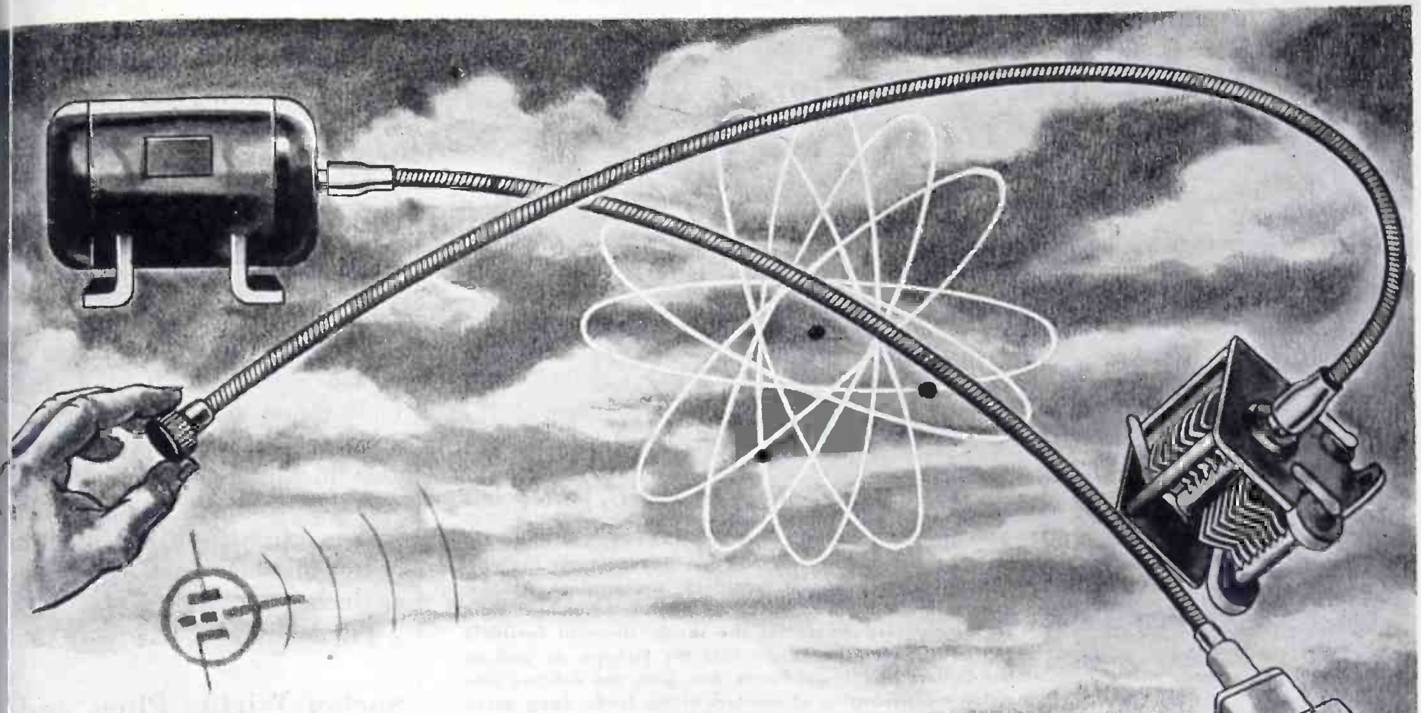
chanical shock. They are co pletely free from absorption moisture and humidity, and t surface of the glass insulator pr vides maximum water-sheddi properties. The electrode and c lar are easily soldered, brazed

welded to a unit enclosure. Anoth feature claimed for these leads that the use of Pyrex and Kov form an absolutely gas and moi ture-tight chemical bond, so th internal gas pressure may be mai tained in units using them. Th bond also minimizes the stress an strain of severe temperatu changes.

Electrical Industries, Inc., 4 Summer Ave., Newark 4, N. J.

Resin-Bonded Plywood Tubing

PLYTUBE IS THE NAME of a plywoo tubing fabricated from thin ve neers and a thermosetting syntheti resin. According to the manufac turer, laboratory tests show tha weight for weight, Plytube wil carry a heavier load than steel tub ing. Urea Formaldhyde is the mate rial used as its bonding agent though Phenol may also be used Veneers, selected for their overall strength, are built up so that stress

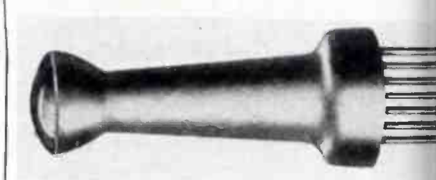


and strain in any direction a upon the total columnar grain fib of the veneer layers. Plytube water, flame, splinter and rot pro It has low electrical conductivi is dimensionally stable under e treme temperature ranges, and especially suitable for use in su zero weather. Among the ma types of products made from Pl tube are radio antenna masts whi measure up to 90 ft high, and a tennas and instrument covers f aircraft. The material is also ava able in any reasonable lengths straight tubing. Inside diamete measure from ½ to 18 in. Wall thic nesses measure from 0.05 to 0.50 an inch.

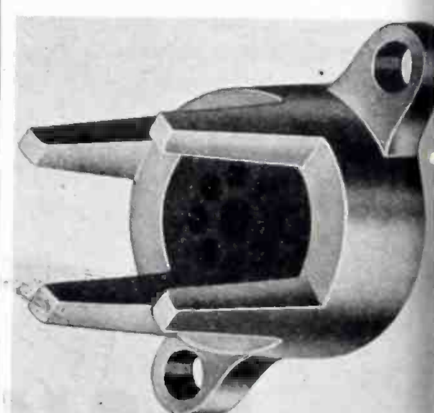
Plymold Corp., Lawrence, Mass.

Socket Wiring Plugs and Tube Pin Straighteners

TWO PRODUCTS available from th manufacturer include a miniatu socket wiring plug which is plugg into a socket during wiring to ke the socket soldering lugs proper aligned. The plug is designed minimize tube failure due to gla



strains when tubes are plugge into sockets. The plug is made i one piece, of a zinc base alloy. Th pins are made of stainless steel.

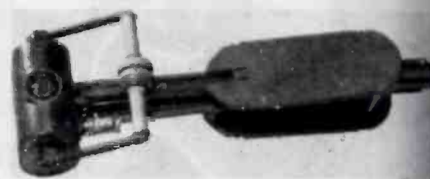


The tube pin straighteners for miniature tubes also have a zinc base alloy. The inserts are made of either hardened tool steel or of stainless steel.

Radio Accessory Div., Star Expansion Bolt Co., 147 Cedar St., New York 6, N. Y.

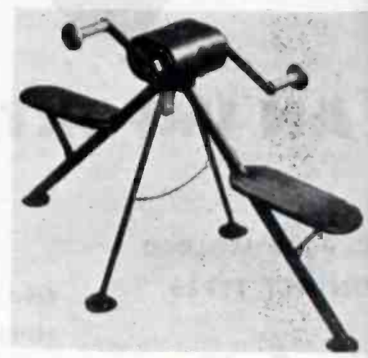
Railroad Dynamotors, and Hand Generators

THESE DYNAMOTORS are for use in communications systems for railroad use. They are designated as Magmotor series, and utilize a permanent magnet instead of field coils. The units are rated 28 v dc input, and have an output of 350 v at 100 ma. The dynamotors are equipped with precision-fitted ball



bearings to eliminate all end thrust and play occasioned by train motion and vibration.

This manufacturer also has available a new type hand-generator which has a maximum output of 10 watts. It is a permanent magnet

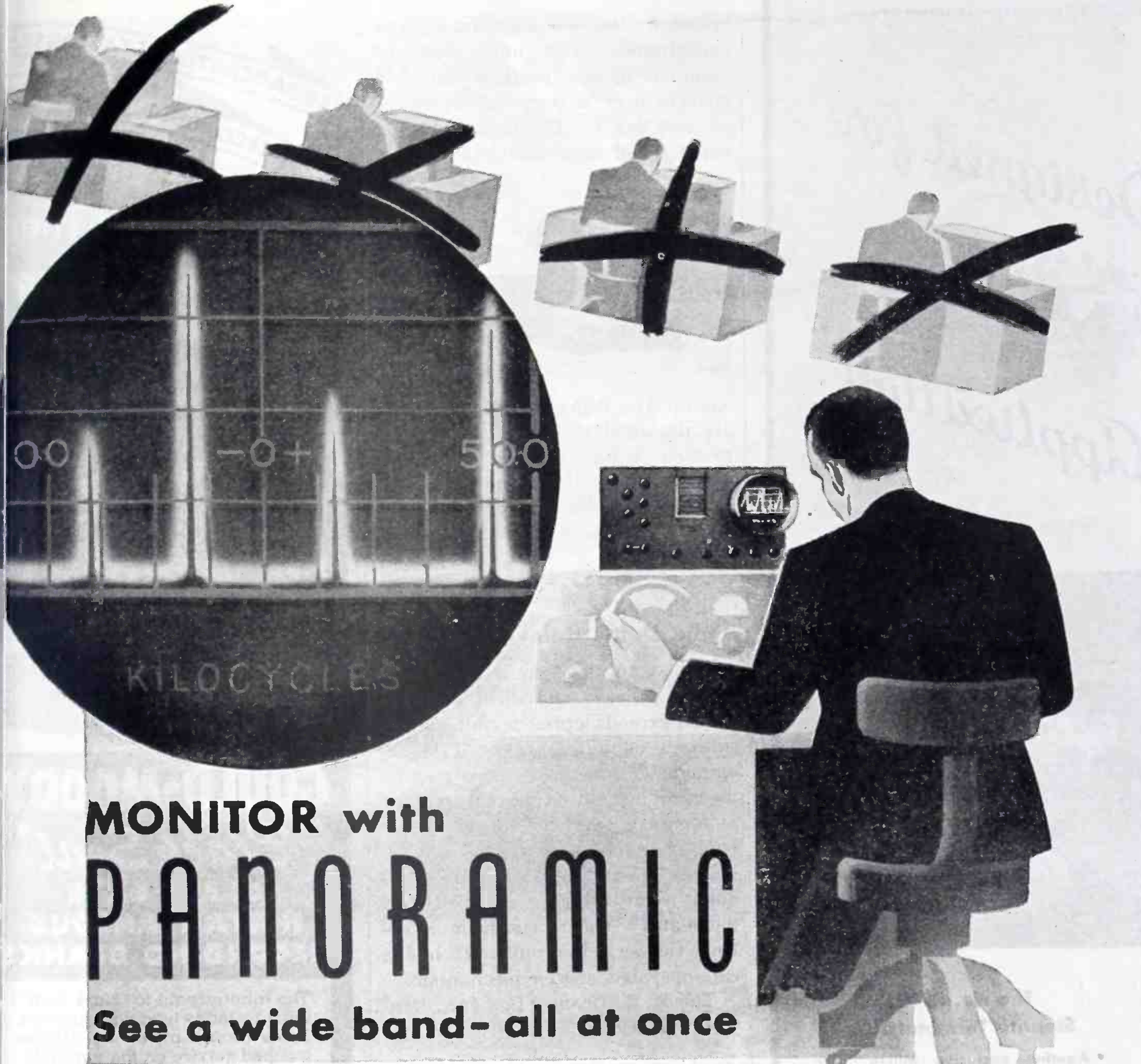


hand-generator which requires no outside electricity to operate. The cranks have been improved to prevent breakage due to operational leakage. A shatterproof unit enclosed with the meter, tells the operators when the output is being held to the correct value.

Carter Motor Corp., 1608 Milwaukee Ave., Chicago, Ill.

Radio Noise-Suppression Capacitor

COMPACT AND LIGHTWEIGHT Pyranol radio noise-suppression capacitors are especially designed to reduce noise voltage (particularly at higher frequencies) from generators, inverters, motors, and other equipment. The capacitors are of the thru-stud type with a terminal at each end. One line of a d-c or a-c power circuit can be fed through the unit, thereby reducing internal inductance and resistance, and in-



MONITOR with PANORAMIC

See a wide band– all at once

In the typical monitoring station—up to the present time—each received signal has required the active attendance of an operator and a receiver—the operator turning the dials ceaselessly and recording the signals on the air. With the aid of PANORAMIC RECEPTION, however, just one piece of equipment can do the work of many. Because PANORAMIC RECEPTION SHOWS ALL SIGNALS ON A GIVEN BAND OF THE RADIO FREQUENCY SPECTRUM SIMULTANEOUSLY, one operator can cover wider bands of the spectrum with more accuracy and less operator fatigue. Without dial manipulation, he can see immediately open channels and intermittent signals. Moreover, the patterns on the screen tell him the frequencies of the stations; their stability; their signal strength as they reach him; whether the station is AM, FM, or CW; and the type and extent of interference.

In monitoring, as in direction finding, navigation, production, and laboratory procedure, PANORAMIC RECEPTION is becoming an indispensable timesaver. Its unique capabilities will offer new solutions to your industrial and laboratory problems. Allow one of our engineers to explain how PANORAMIC RECEPTION may be used to your best advantage.

New and interesting booklet "From One Ham to Another." Available on request. Fully illustrated.

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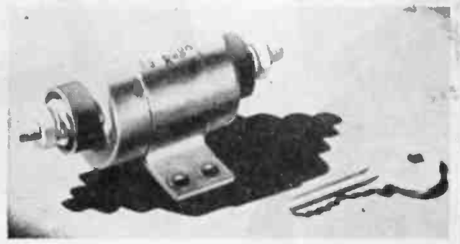
creasing filter efficiency for a given capacitance. The units can be mounted in any position and will operate over a temperature range of ±50 deg C. The capacitors are rated 0-100 amp, 250 v maximum



a.c. or d.c., 0.55 microfarad. They are designed to meet exacting vibration tests required by AAF specifications. Bulletin GEA-4308 contains complete information.

General Electric Co., Schenectady, N. Y.

Time Delay Relays

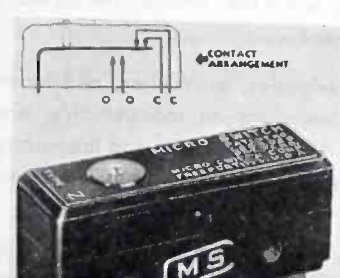
IN ORDER TO OPEN the main control circuit in case an added overload period exceeds a predetermined time interval on a line, Type TD8 accumulative time-delay relay may be used to add the time interval of momentary overload surges occurring in quick succession.

Also available is Type TD5 time-delay relay which will withstand momentary shocks without affecting the switch circuit. It has a cam-operated switch mechanism.

The R. W. Cramer Co., Inc., Centerbrook, Conn.

Split-Contact Switches

THESE DOUBLE-THROW, split-contact switches may be used to switch an operation from a d-c control to an a-c control. Two sets of contacts are mechanically interlinked but electrically isolated. Transfer action is a matter of a few milliseconds.



The switches may also be used to control four isolated circuits by pairs, eliminating the use of relays and other isolating means from the circuit. The switches themselves have two contacts on both the normally open and normally closed side as shown in the accompanying illustration. Outside dimensions are the same as the manufacturer's basic SP switch. Catalog No. BZ-3YT describes pin-plunger types. Types D and S plunger designs are also available.

Micro Switch Corp., Freeport, Ill.

Capacitor Motors

THESE MOTORS (Type J-70) may be used for driving blowers in high ambient temperatures and for powering small control devices of all types. Units are rated 60 cycles, 115 v, single phase, 3400 rpm. They have a low temperature rise. Each

unit weighs 3 lb and measures $3\frac{5}{16}$ in. in diameter, overall length $3\frac{1}{8}$ in., shaft diameter $\frac{5}{16}$ in. Also available are motors which will deliver 1/25 hp and can be wound for 2 or 3 phase. Higher speeds and hp for 400-cycle applications are available.

Eastern Air Devices, Inc., 585 Dean St., Brooklyn 17, N. Y.

Flat Keying Relay

THE CHATTER HAS BEEN removed from Series 200 relays by a new improvement which consists of an energy-absorbing material, sealed within a contact-carrying cage. The compound used is not affected by age, oil or moisture. These improved relays have no bounce and will key up to 150 words per min, or 60 impulses per second. Input is 50 milliwatts. The armature of the units is mica insulated and is suitable for keying a 50-Mc r-f signal. Contacts will carry up to 2 amp.

Kurman Electric Co., 35-18 37th St., Long Island City, N. Y.

Delco Radio Products *Mean Dependability*

All over the world Delco Radio products are in useful service. They prove daily that the name Delco Radio means dependability . . . dependable designs developed with care and imagination; dependable products built with craftsmanship and skill. In radio and electronic equipment, the name Delco Radio stands for engineering vision—manufacturing precision.

MAKE YOUR DOLLARS FIGHT—BUY MORE WAR BONDS

Delco Radio
DIVISION OF
GENERAL MOTORS

Potentiometers

THIS MANUFACTURER announces that they will again be able to supply potentiometers (Type N-103) made of non-substitute materials. Wartime restrictions changed the specifications for control shafts from aluminum to steel in standard sizes of 2⅛ in. lengths, and now the manufacturer is reverting again to aluminum shafts extending 3 in. from the end of a ⅜ in. bushing. Universal fluted mills which simplify filing and allow for all types of knobs will be used.

Centralab, 900 E. Keefe Ave., Milwaukee 1, Wis.

Rubber Latex Insulation

NUBUN IS THE NAME of a new synthetic rubber latex insulation for power and communication cable. It has improved electrical and physical characteristics for applications where replacement, servicing and space are important factors. Other features claimed for it include greater resistance to destructive forces, flexibility, impermeability to water and laminated construction. Nubun insulation is made from a special modification of buna S synthetic rubber.

United States Rubber Co. Rockefeller Center, New York, N. Y.

803 Pentode Tube

MASS PRODUCTION of Type 803 pentode tube for military and priority orders is now being done by Taylor Tubes, 2312 Wabansia Ave., Chicago, Ill.

Phenolic Insulating Material

RESINOX No. 7934 is a new phenolic molding compound which may be used as an insulating medium in high-frequency apparatus. It has a low dielectric constant and power factor, low water and moisture absorption (0.03 percent under ASTM tests which call for 24-hour water immersion) and relatively high heat resistance. This new material is mica-filled and is based on a newly developed phenol - formaldehyde resin.

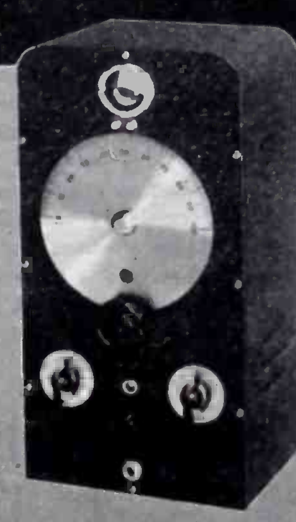
Monsanto Chemical Co., St. Louis 4, Mo.

CHECK TRANSMITTER FREQUENCY IN LESS THAN A MINUTE

THE BROWNING FREQUENCY METER, used by police and other emergency radio facilities for the past five years, is still the best meter for such services — because it was specifically designed for them. The design, which permits determination of any five frequencies from 1.5 to 120 Mc., makes for simplicity of operation which requires less than one minute to check one frequency. All Browning development work aims at specific, rather than broad, uses. Thus, all Browning equipment is best for its particular job. Furthermore, Browning Laboratory facilities are available for study and solution of your own, specific electronic engineering problems. Write for data.

BROWNING

LABORATORIES, INCORPORATED
WINCHESTER, MASSACHUSETTS



NEW BOOKS

Automatic Control Engineering

By Ed Sinclair Smith, *research en-gineer, Eclipse-Pioneer Division Bendix Aviation Corporation. Mc-Graw-Hill Book Co., New York. 3 pages, price $4.00.*

THE AUTHOR has included t material necessary to enable anyo who has studied engineering to u derstand and apply the principles control to any application or pro ess. Considerable attention is giv to terminology. Definitions are pr sented as adopted by the A.S.M. Division of Industrial Instrumen and Regulators, German standarc and the 1941 Temperature Sy posium.

To orient the reader, principl are enumerated which underlie t characteristics of meters and co trollers, lags in plants, main cor ponents of controllers, steady-hun ing performance, transient pe formance, and the application regulators to plants. Although on a few pages deal specifically wi electronic control principles, mu of the non-electronic information vitally essential to engineers seel ing electronic solutions to contr problems.—J.K.

• • •

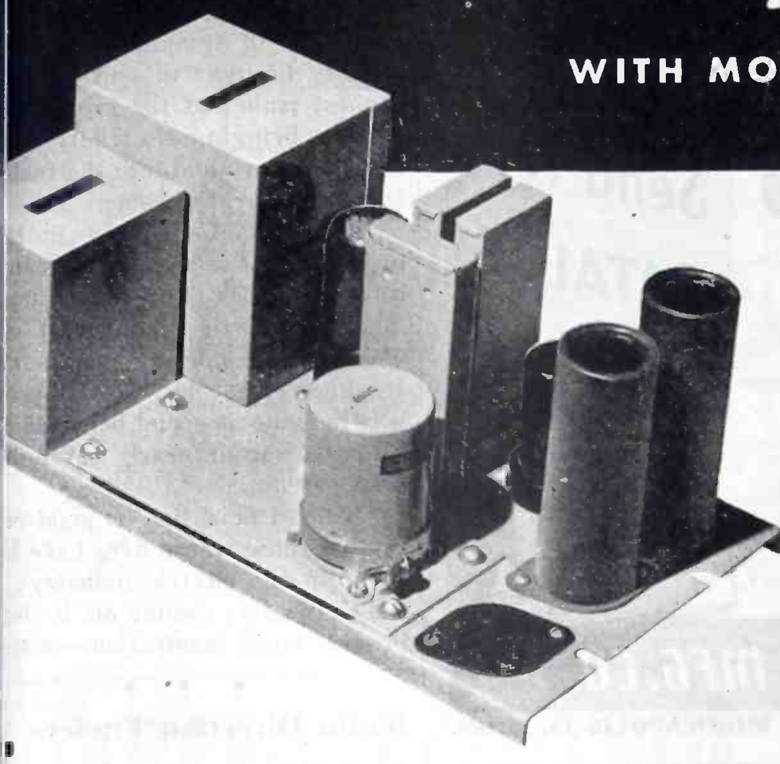
Beloved Scientist, life of Elihu Thomson

By David O. Woodbury, *Whittlese House, New York. 1944. Price $3.5*

ALTHOUGH THE DIVIDING line be tween a scientist and an invento is sometimes narrow, there can b no doubt about Elihu Thomson' place in the world—he was one o our great scientists. This story o David Woodbury's is not only biography of a beloved scientis with an eager, creative mind which respected other minds; it is the story of the electric light, the arc lamp, the transformer, of dynamos and motors, electric welding, metering of electric current and voltage and power, of voltage regulators. For Elihu Thomson lived in an age of golden opportunity, as a contemporary (and often a competitor) of Edison, Brush, Bell, Westinghouse, Tesla, Röntgen, Marconi, Sprague, Lodge, Pupin. The book is also

102 SERIES *Amplifiers*

WITH MOUNTING ACCESSORIES



TYPE 102-A—Two stage—Fixed gain 55 db. Input impedance 30, 250 or 600 ohms; output impedance 600 ohms. Frequency response 30-16,000 Cycles ± .5 db. Power output + 26 VU with less than 1% harmonic content. Requires external power supply 275 Volts DC 30 M.A., and 6.3 Volts AC .75 Amps. When a 102 Series Amplifier is used in conjunction with a 101 Series Amplifier, the latter is capable of supplying the necessary power.

he 102 Series Amplifiers consist of four dif-rent amplifiers available simply by changing small input panel on the master chassis. Except r the input panel, they all have the same trans-ission characteristics. Designed for the highest pe audio service, they will meet frequency mod-lation requirements as to frequency response, ower output vs. distortion and noise level.

YPE 102-A as illustrated and described above.

YPE 102-B—Three stage—Gain 95 db. Intended for high grade public address installations. Input stage electronic mixing.

TYPE 102-C—Three stage—Fixed gain 95 db.

TYPE 102-D—Two stage—Input impedance 600 ohms and bridging. Fixed gain 600 ohm input 61 db. Bridging input fixed gain 45 db.

The 3A Mounting Frame, requiring 10½ inches rack space, will accommodate up to THREE 102 Series Amplifiers and is suitable for wall mounting cabinet or rack and panel installations.

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the story of the foundation of th General Electric Company and c its early days; of Charles Coffin an E. W. Rice, Jr.

The book is also the story c many patent dogfights; and of mercenary who seemed bent o making the days of the scientis inventor Thomson unhappy. It i the story of imagination and i genuity brought to service on th highest plane; of the great adven ture of bringing electricity out o the laboratory and into the factory the street car, the home.

Elihu Thomson's place in thos great days is secure; he was inter ested in theory as well as practice he worked with the utmost care weighing, pondering, measuring He knew what he was doing; h was humane; a social being as wel as possessor of nearly seven hun dred patents.

"Beloved Scientist" is good read ing for those whose lives have been spent in the electric industry; fo the youngsters coming on, it shoul provide much inspiration.—K.H.

• • •

Radio Direction Finders

By DONALD S. BOND, *McGraw-Hil Book Co., New York 18, N. Y. 194 287 pages, 162 illustrations, pric $3.00.*

THIS BOOK, the third in the Mc Graw-Hill communication series edited by Beverly Dudley, is the first published in this country ex clusively on the subject of direction finders. The author, an experienced engineer in the field of direction finder design, writes specifically for electrical engineers and others hav ing a broad engineering training and little if any experience in this particular specialized field. The au thor has made available in usable and organized form as much of the existing technical data on the de velopment of direction finders as could be crammed into a volume whose size is not so great as to dis courage a busy engineer in need of information. Application of the subject matter to specific problems is illustrated by means of examples worked out in the text.

The book starts out with a chap ter giving general information and standard test procedures on direc tion finders. These data are tied in with data usually taken in mak ing performance measurements on

communications receivers. A goodly part of the material is in handbook form. Chapters on wave propagation, directive antenna systems, aural null direction finders, performance characteristics of loop input circuits, visual direction finders and radio navigational aids comprise the main body of the text. A rather complete description of the Mark I aircraft automatic direction finder is included in the chapter on visual direction finders. A mathematical appendix is included wherein the derivation of some of the formulas not derived in the text are to be found.

The many footnote references and bibliographies at the end of each chapter should facilitate further study on the part of those in need of additional information.—W.O.S.

• • •

Foundations of Wireless

By M. G. SCROGGIE. *Published by Iliffe & Sons, Ltd., Dorset House, Stamford St., London, S. E. 1., 4th ed., 1943, 358 pages, price 7s, 6d.*

A COMPLETE NEW EDITION of a well-known British basic textbook on radio.

Twenty-one chapters are provided and a simple listing of their headings indicates the logical treatment of the subject: an outline of broadcasting, elementary electrical otions, capacitance and inductance, alternating currents, a-c circuits, the tuned circuit, the triode valve, oscillation, the transmitter, detection, the single-valve receiver; reaction, radio-frequency amplification; screened valves, selectivity in the r-f amplifier, audio frequency and output stages, designing a receiver, the superheterodyne and its frequency changer, tuning circuits in the i-f amplifier, automatic controls, power supplies, radiation and aerials, and transmission lines. The preface explains mathematical formulas and symbols for readers having no technical training.

Although most of the terms used are standard for both British and American practice, there are some few variations that would be unfamiliar to readers on this side of the Atlantic. To overcome this there is a two-page appendix that lists terms and their equivalents, with distinctively American expressions printed in italics.—K.S.P.

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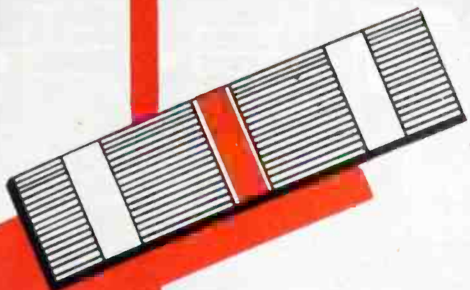

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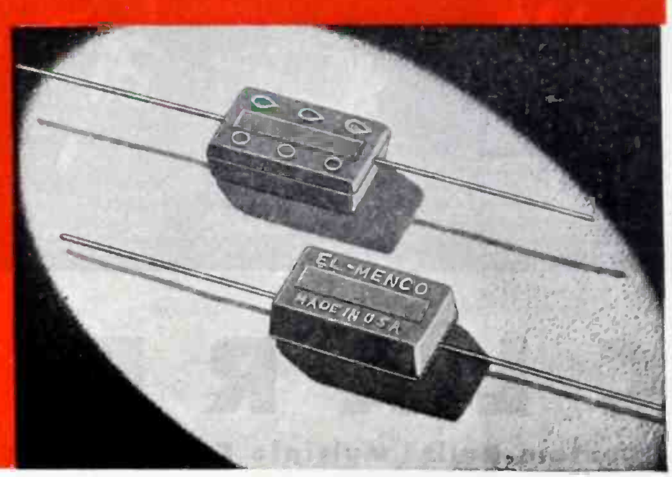

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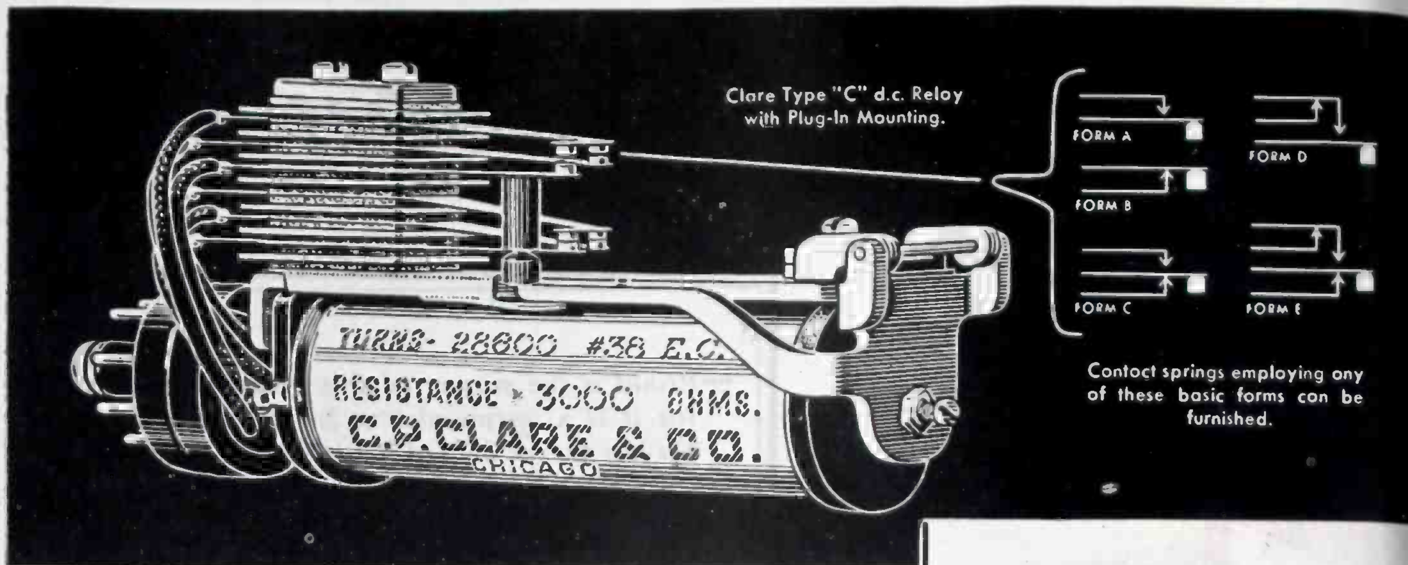

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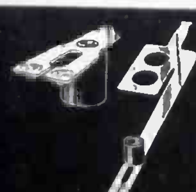

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These are wound on a spool assembly which consists of a coil core equipped with spool heads and acetate or bakelite winding washers. Both coil core and spool heads are insulated from the wiring. Coils are usually wound with enameled copper wire but 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.

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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.

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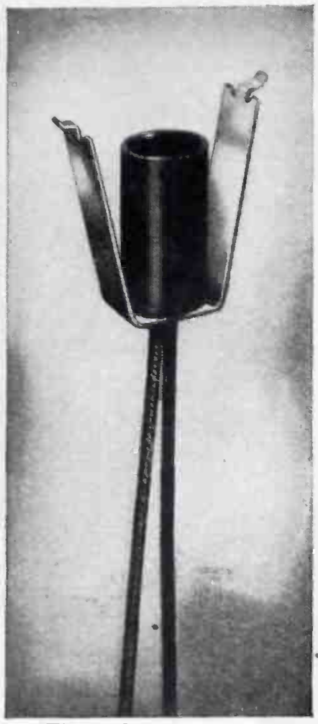

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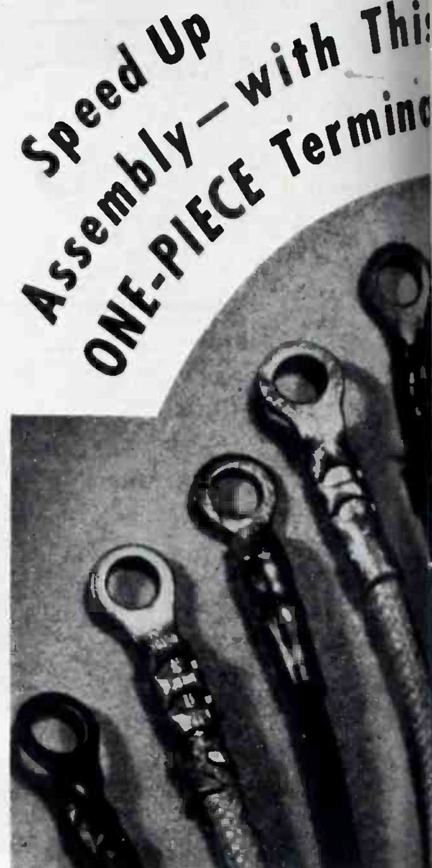

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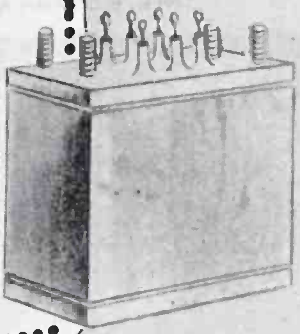

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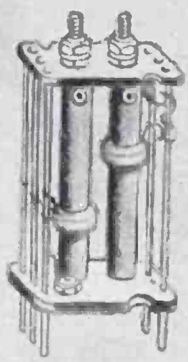

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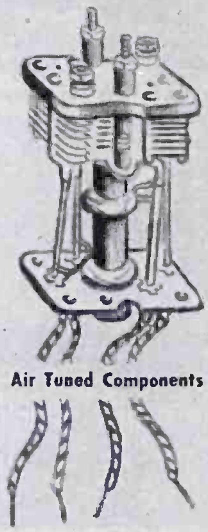

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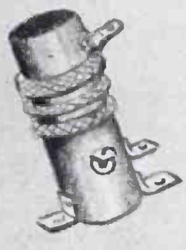
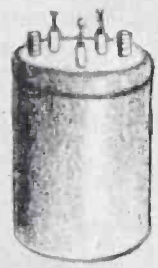


Conventional R.F. Oscillators



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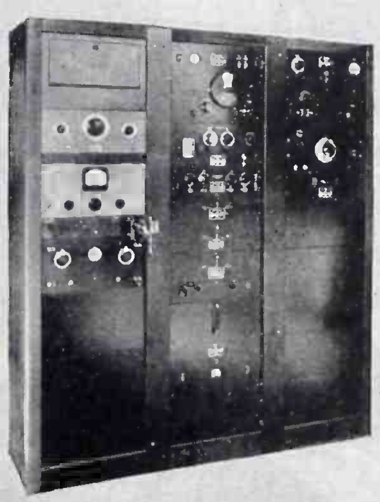

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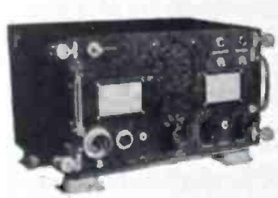
Comco Model 127-AA, similar to Model 170, available for 278 Kc. operation. Frequency range 200 to 550 Kc.



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We are ready, at War's end, to do a big job for the big use to which radio communication will be put. We can work with you *now* on your engineering and design, developing equipment which we are set up to manufacture . . . or we can help you adapt our standard Comco civilian equipment to your requirements.

COMMUNICATIONS COMPANY, Inc.

Manufacturers of Radio and Electronic Equipment

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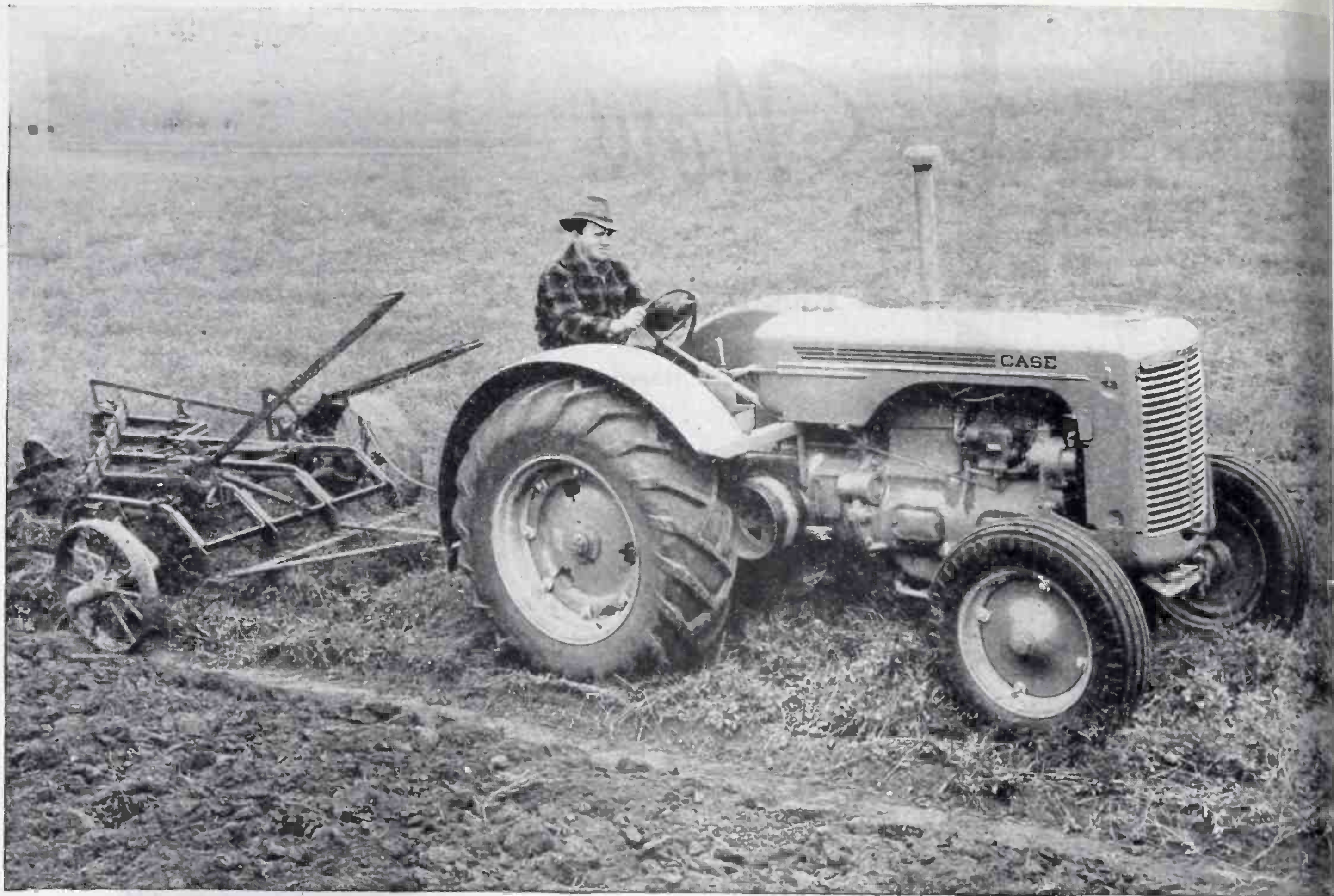

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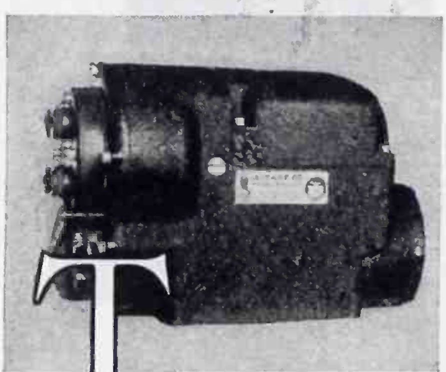
Sparked by the world's most powerful magneto



THIS heavy-duty tractor, made by J. I. Case Company, is performing equally important work whether pulling four plows on a farm, or pulling giant planes around airports.

It is equipped with a Case Magneto which, chronoscope tests show, produces a spark of longer life than any other magneto. And it is built for constant heavy-duty strains—dustproof, moistureproof, and salt-air proof.

Naturally, the Case people are proud of this precision-built magneto. But no more so than is The Wheeler Insulated Wire Company, Inc. For we at Wheeler supply the coil windings which help make this the world's most powerful magneto.

For the 35 years of its existence, Wheeler Insulated Wire Company, Inc. has devoted its entire manufacturing capacity to a comparatively few customers. *But they have been mighty good customers!*

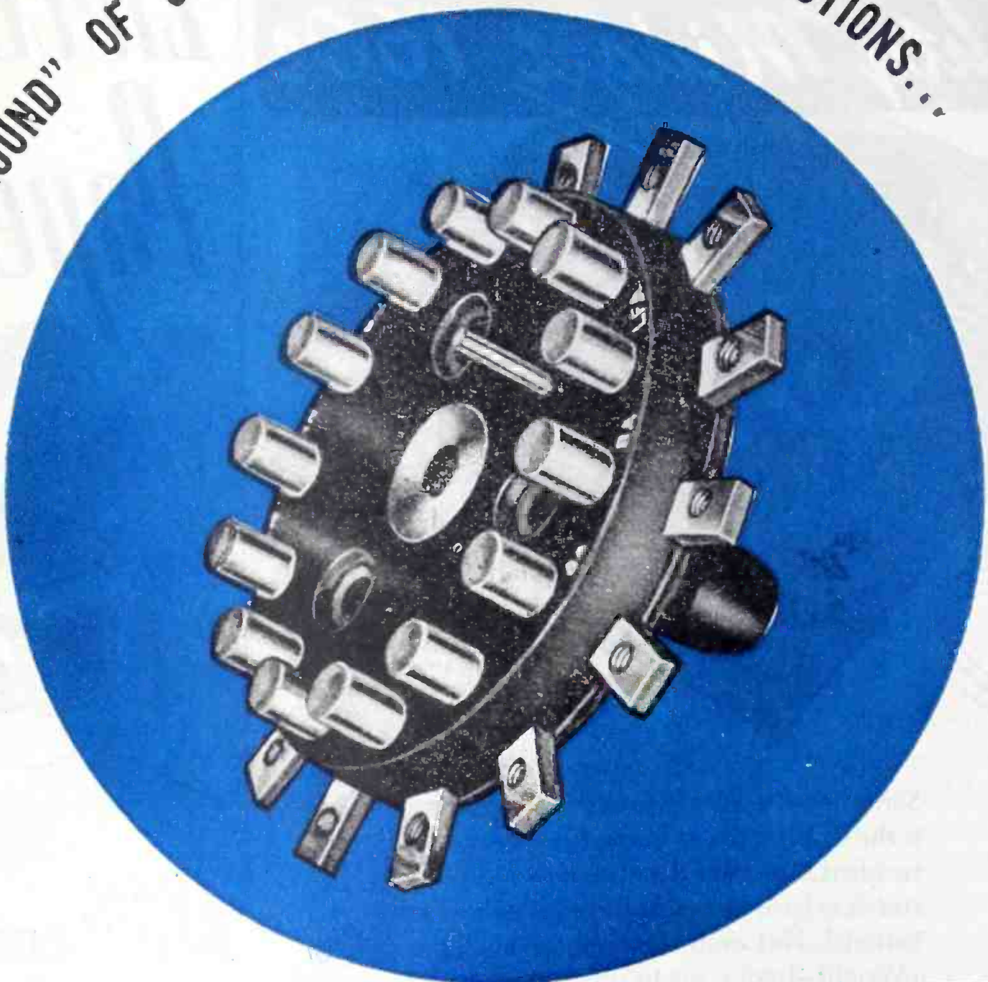
Wartime demands have greatly expanded our production capacity, and we hope to have many new customers for Wheeler products when Victory permits.

The Wheeler Insulated Wire Co., Inc.

BRIDGEPORT 4, CONN.

Manufacturers of Magnet Wire . . . Litz Wire
Coil Windings . . . Transformers

A "MERRY-GO-ROUND" OF CONTACT POINTS, WIRE CONNECTIONS...



—AND A BRASS "RING"! . . . but by no means a molder's joy-ride. This switch body comprises a circular arrangement of 15 cylindrical contact points extending vertically—a circular arrangement of 14 wire connection terminals extending horizontally—1 brass bushing centrally positioned. The extremely high-impact-strength plastic material specified for molding this assembly in place and into one flawlessly formed unit contained large pieces of fabric in the formulation . . . and, therefor, difficult to handle. By coupling the transfer method with experienced molding know-how, Consolidated successfully converted the blue print into the plastic part illustrated—with no distortion to the 30 inserts . . . and with no material over-flow. Do you have like problems? We are at your service! Contact our home office or nearest branch.

Consolidated MOLDED PRODUCTS *Corporation*

309 CHERRY STREET, SCRANTON 2, PA.

New York, 1790 Broadway • Bridgeport, Rocky Ridge Drive • Cleveland, 5713 Euclid Ave.

Detroit, 550 Maccabees Bldg. • Chicago, 549 W. Randolph St.

YOUR BLUE PRINT IN PLASTIC

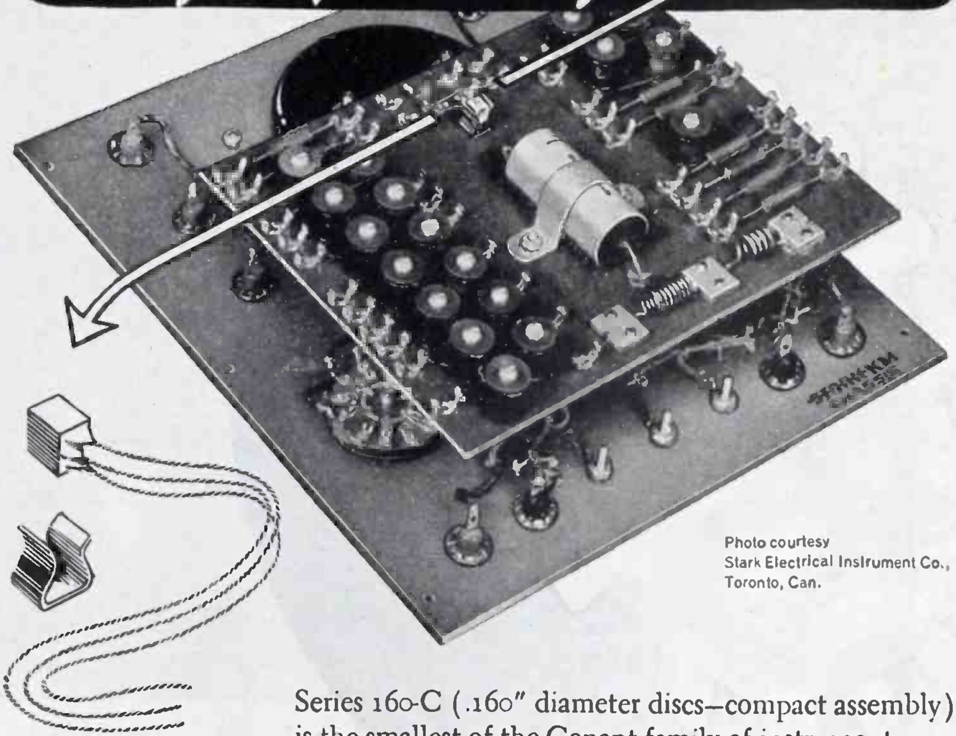
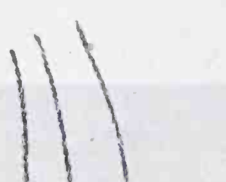
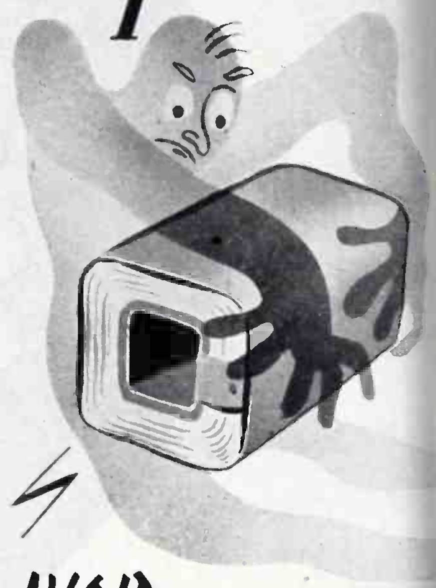
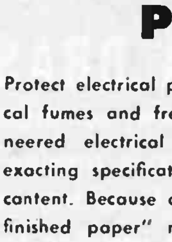
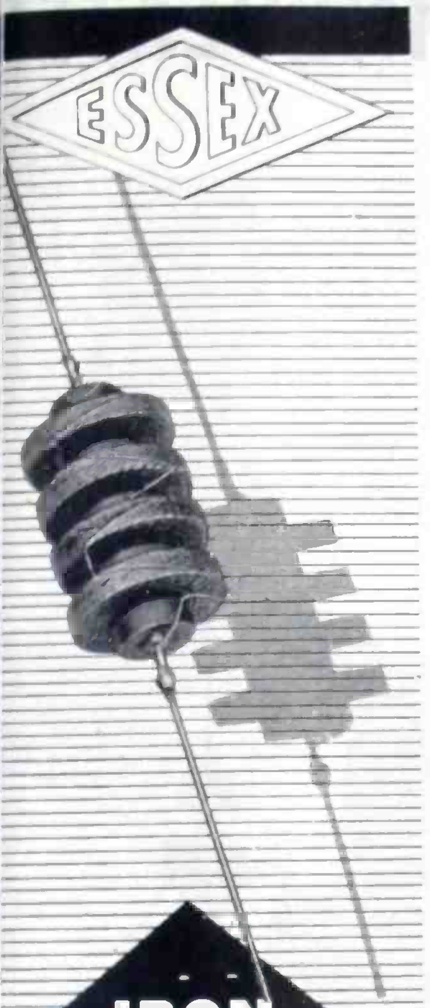


Photo courtesy
Stark Electrical Instrument Co.,
Toronto, Can.









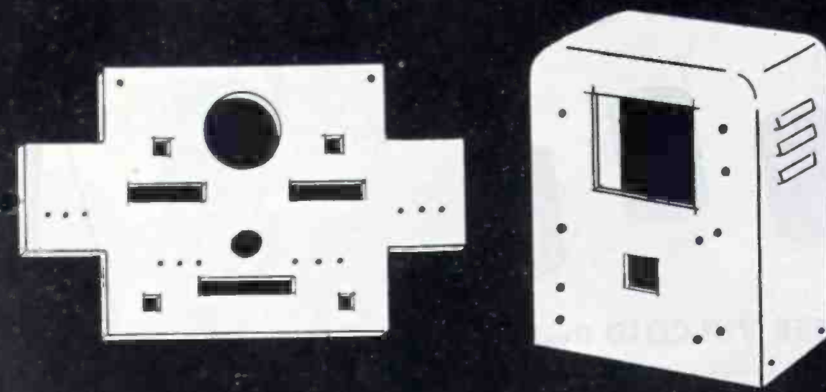
IRON CORE R.F. CHOKES

- **Physically compact**
- **High Q**
- **Available in standard inductances of .5 mh, 1.0 mh, 2.5 mh, 5.0 mh, 10 mh.**
- **Inductance tol. ± 3%**

Write for data sheet.

Precision manufacturers of all types of IF and RF coils, chokes, and transformers.

ESSEX ELECTRONICS
1060 Broad St., Newark, N. J.



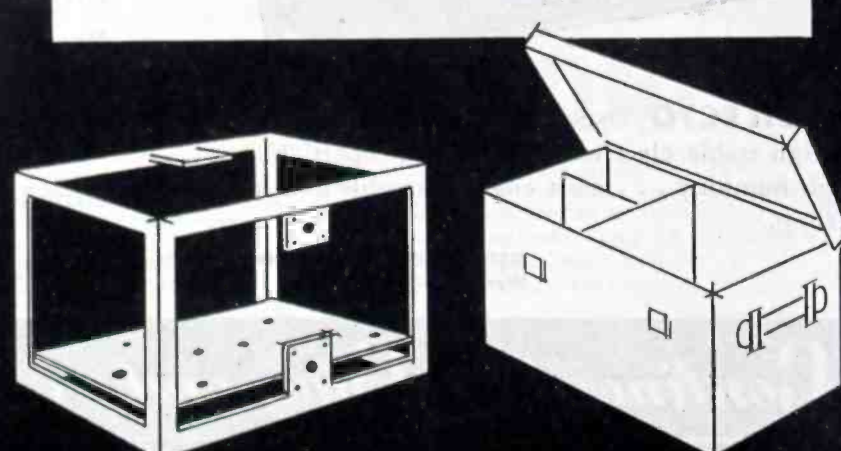
What are Your

PRECISION METAL WORKING REQUIREMENTS?

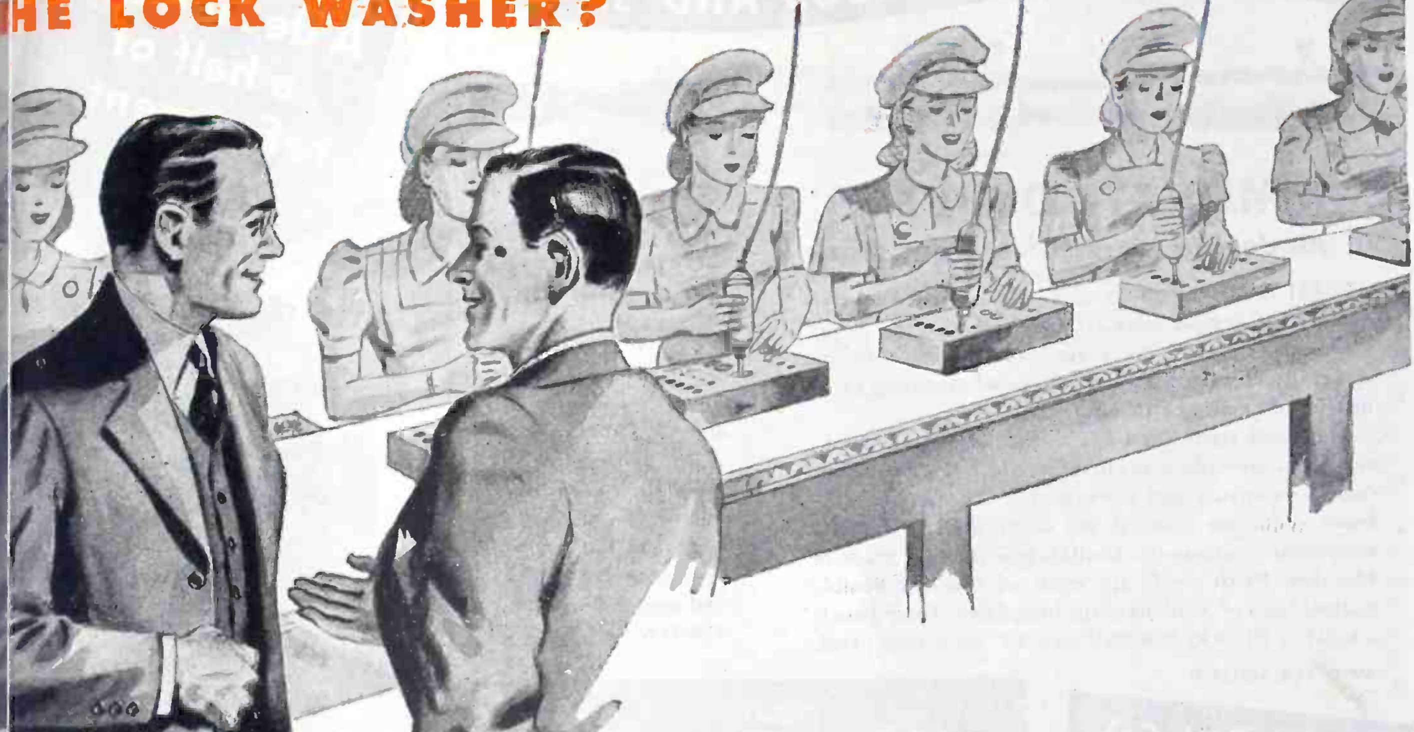
Do you require versatility—the ABILITY to do sheet metal work, stamping and fabricating—the ABILITY to build metal boxes and cases in a wide variety of sizes—to build cabinets, chassis, odd shaped flat pieces, strips, panels, housing, etc.? Do you require the ABILITY to do *precision* work to extremely close tolerance? What about the ABILITY of helping work out a design or design change that can save up to thousands of dollars and speed delivery of many weeks?

If the answer to any of the above questions is YES, write us for further information or consultation on specific jobs.

PORTER
METAL PRODUCTS COMPANY
490 JOHNSON AVE. • BROOKLYN, N. Y.



HOW DO YOU KNOW THEY WON'T "FORGET" THE LOCK WASHER?



THEY CAN'T "FORGET" WITH SEMS FASTENER UNITS!

● The Sems Fastener Unit is a combination of a pre-assembled Shakeproof Lock Washer and Screw . . . a lock washer is on *every* screw, and it can't drop off!

Using Sems Units makes the entire assembly operation faster and more efficient with the assurance of locked-tight parts. Sems Units help solve many other assembly line problems especially by eliminating unnecessary, time-wasting operations. Shakeproof Engineers can prove these advantages and show you the most practical way of using this fastening on your products. Write today . . . a field engineer will consult with you immediately!

SEMS FASTENER UNITS

Reg. U. S. Pat. Off.

Pre-Assembled Shakeproof Lock Washer and Screw

Worker can't "forget" the lock washer • Lock washer can't drop off • No lost or wasted lock washers • Only one unit to handle • Saves time • Speeds assembly

Write for Free Test Kit No. 23

SHAKEPROOF inc.

"fastening Headquarters"

Distributor of Shakeproof Products Manufactured by ILLINOIS TOOL WORKS
2501 North Keeler Avenue, Chicago 39, Illinois
Plants at Chicago and Elgin, Illinois
In Canada: Canada Illinois Tools, Ltd., Toronto, Ontario

Los Angeles Office
5670 Wilshire Blvd., Los Angeles 36, Calif.

Detroit Office
2895 E. Grand Blvd., Detroit 2, Mich.

Other Shakeproof Products Include:

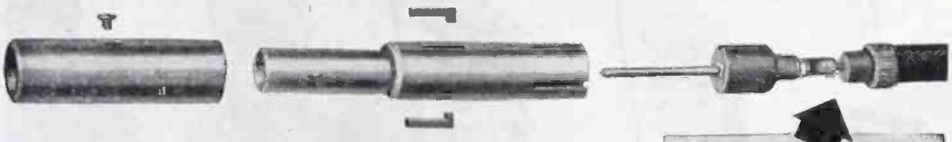
Shakeproof Lock Washers with Exclusive Tapered-Twisted Teeth

Shakeproof Type 1 Thread-Cutting Screws for Metals

Shakeproof Type 25 Thread-Cutting Screws for Plastics

Shakeproof Quick Fasteners . . . for Immediate Opening and Locking

ANDREW COAXIAL PLUGS AND JACKS



IMMEDIATE DELIVERY

in moderate quantities from stock

ANDREW coaxial plugs and jacks are used as connectors for flexible coaxial lines, and fit many of the standard Army and Navy approved cables. They are especially useful where a simple panel mounting plug-in type of connector is required.

Machined from brass bar stock, these sturdy plugs and jacks provide a positive connection between the outer conductors and between the inner conductors. Inner conductor contacts are silver plated to obtain maximum conductivity. Insulation is the best grade of Mycalex. Patch cords are made of low-loss flexible coaxial lines of 72 ohms surge impedance. Patch panels consist of 24 jacks mounted on a 19" relay rack panel.

ONLY ANDREW offers this easy accessibility for soldering.

You don't have to solder through a window to install on ANDREW plug or jack. Just remove one screw, slide the sections apart with your fingers and solder. This is a new improvement invented and used exclusively by ANDREW.

WRITE FOR BULLETIN NO. 31

ANDREW CO.
363 East 75th Street
Chicago 19, Illinois

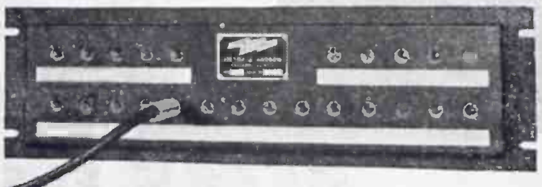


Illustration shows panel with patch cord in place.

*After Victory

"Children! Turn off your book and go to sleep!"

TOMORROW's "five-foot shelf of books" may well hold thousands of volumes of this sort—books on micro-film, projection on screen, wall or bedroom ceiling. Educators especially can use them to make study books more enjoyable. The equipment to make and project such books will call for infinite precision...available on a *mass-production, low-cost* basis.

That has been our preoccupation for the last thirty years and war has only intensified the lessons we've learned about mass production of close tolerance on an efficient basis.

Like many producers for the war effort, we have completed the initial phase of our war program. Adjustments now make it possible to a limited extent to invite inquiries for production of precision parts for future delivery.

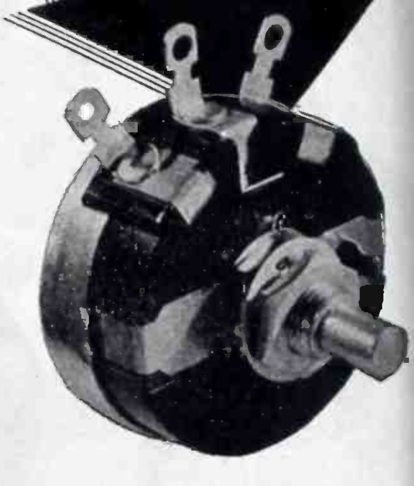
(*Below*) A few of the many thousands of our precision parts that help "Keep 'em flying and fighting."

ERICSSON ESTABLISHED 1911

Let's all back the attack — Buy EXTRA War Bonds

ERICSSON
SCREW MACHINE PRODUCTS CO., INC.
25 LAFAYETTE STREET, BROOKLYN 1, N. Y.

A decade and a half of refinement...



CLAROSTAT WIRE-WOUND *Controls*

★ This latest Clarostat Type 58 wire-wound rheostat or potentiometer is a still tougher control. And provably so. It copes with extreme vibration and mechanical abuse, fully matching its electrical ruggedness. Note these refinements:

Metal locating pin. Will not break or tear off.

Metal strap grounds metal cover. Keyed cover will not loosen or turn. Fully dustproof.

Bushing keyed into bakelite casing. Cannot slip or turn when locking nut is tightly drawn up.

Center rail and terminal in one piece. Direct connection between winding and "L" and "R" terminals.

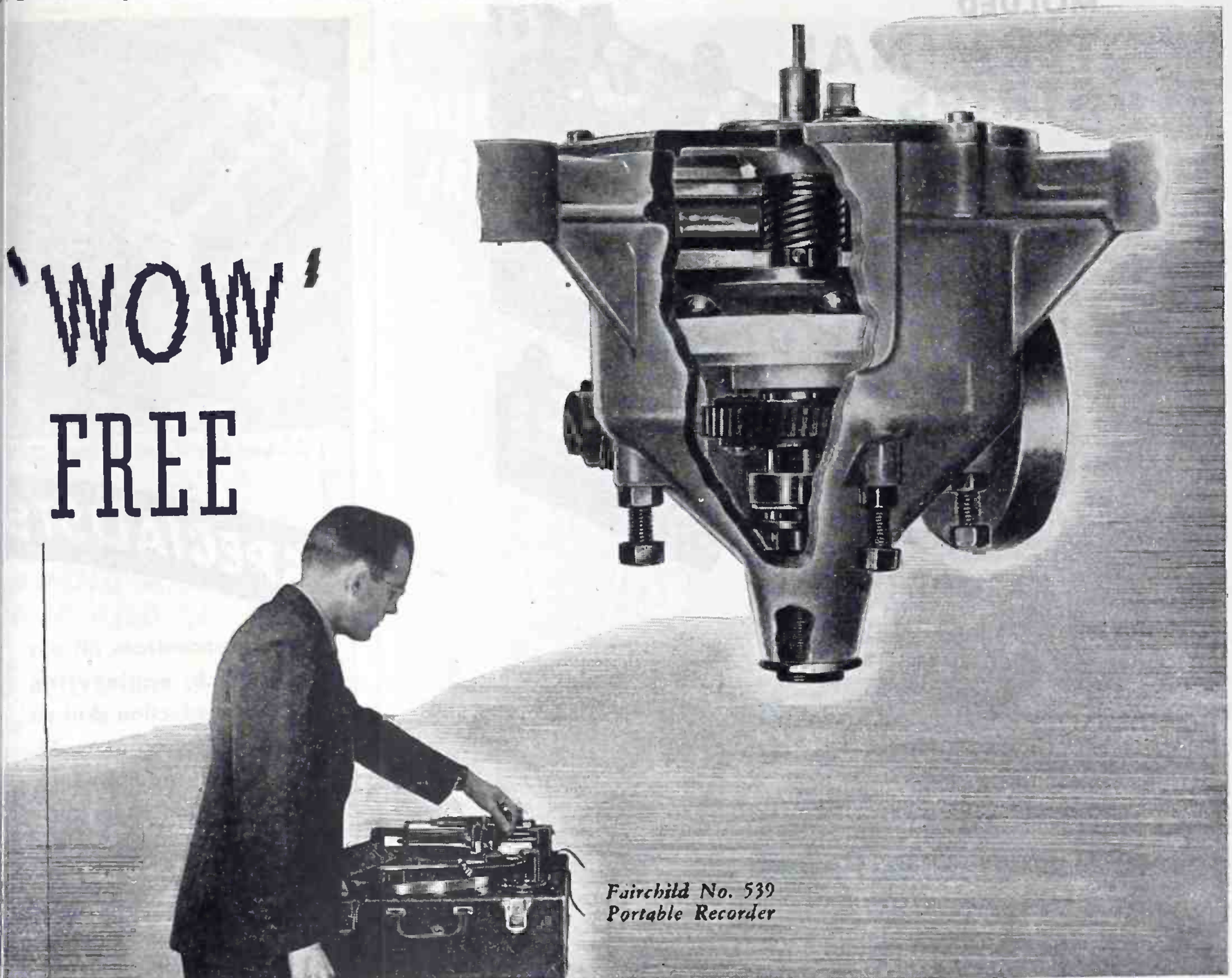
1500 v. breakdown insulation between winding and shaft.

★ Write for Literature

CLAROSTAT *Controls and Resistors*

CLAROSTAT MFG. CO., Inc. · 285-7 N. 6th St., Brooklyn, N. Y.

'WOW' FREE



Fairchild No. 539 Portable Recorder

at the critical 33.3 rpm speed

OW' is the direct result of variation in turntable speed. ts positive elimination — particularly at the critical 3 rpm speed — calls for the positive Fairchild drive.

The Fairchild turntable is driven direct from the center. e 33.3 rpm speed is obtained by a 54 to 1 gear-and-worm luction of the 1800 rpm synchronous motor speed. The nness of the speed is obtained by a carefully calculated ding of the drive mechanism to keep the motor pulling stantly; by careful precision control of all drive alignments t might cause intermittent grab and release; by carefully intained .0002" tolerances in all moving parts.

The 33.3 rpm speed is translated into 78 rpm by a precision friction-ball-race stepup.

The Fairchild No. 539 Portable Recorder is equipped with the positive Fairchild drive. It was developed to meet the exacting needs of radio and communications for studio-quality recording in the field. And it is built with mechanical skill — skill long practiced in .0002" tolerance production of aerial cameras, aircraft sextants and aircraft computing gun sights.

Descriptive and priority data are available. Address *New York Office*: 475 — 10th Avenue, New York 18: *Plant*: 88-06 Van Wyck Boulevard, Jamaica 1, N. Y.

SOUND EQUIPMENT

FCI

Fairchild **CAMERA AND INSTRUMENT CORPORATION**

Announcing the Highest Quality the Smallest Size 2-WATT Resistor

The new Type HB Insulated Bradleyunit, just put into production, matches in dependability and appearance the Allen-Bradley Type EB ½-watt and the Type GB 1-watt fixed resistors, which are recognized by engineers as "tops" in quality for all radio and radar applications.

The new Allen-Bradley 2-watt insulated resistor can be safely used up to its listed rating . . . you do not have to derate this resistor, irrespective of its application. Note the test data given below.

The Type HB Bradleyunit is available for early delivery in R. M. A. standard values from 10 ohms to 0.47 megohms, in tolerances of 5, 10, and 20 per cent.

Substitute this new 2-watt resistor in your equipment, and gain space, improve dependability, and reduce rejections.

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis.

TYPE HB BRADLEYUNIT PASSES ALL TESTS

Will meet American War Standard tests including salt water immersion test and Army and Navy 200-hour salt spray test AN-QQ-S-91. Under Continuous Load Test of 175% load for 100 hours, or 100% load for 1000 hours, resistance change will be less than 5%.

Maximum continuous load at 40°C. ambient temperature is 2 watts. Max. continuous RMS voltage drop -1000 v. Max. momentary peak voltage drop -2000 v.

A-B Quality

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

QUALITY

Presto is taking Orders for Post-War Deliveries

NOW YOU CAN PLAN AHEAD

As a station manager, you have probably been getting reports from your engineers saying that your transcription recording and playback tables are nearing the end of their useful life.

Like your car and other pre-war mechanical equipment they are showing the effects of four or more years of hard, continuous service during times when replacement parts have been hard to get, some of them inferior substitute materials, and when skilled personnel has not been available for proper operation and maintenance.

YOU CAN BE AMONG THE FIRST to get your station equipment back in shape if you place your order for new turntable equipment now. Presto will assign your order a preference number based on the date and time of the postmark on your order. This number will appear on our acknowledgement.

NO PRIORITY NEED BE FURNISHED as no shipments will be made until the military demand for equipment is completely satisfied and priority restrictions are removed. When that time comes, your Presto preference number will take the place of a government priority in determining the delivery of Presto equipment.

NO DEPOSIT IS REQUIRED. Simply fill out the Presto post-war order form. If you need more information, send for the complete Presto catalog. Be assured that any improvements that may be added in our post-war products will be included in the equipment you receive. There will be no major changes in Presto equipment during the first year or two after the war because until that time our engineering department will be devoted entirely to war work. The fully developed equipment designs that gave you service during the long war period should, we believe, be adequate for the time immediately after the war. You will, however, receive the benefit of our experience in manufacturing recording and reproducing equipment for military service which we have gained during wartime.

WHY ARE WE TALKING ABOUT "POST-WAR" NOW?

It may seem premature until you know these facts:

1 Since early in 1942, Presto, like all other electronic equipment manufacturers, has been 100% in war work. This has meant manufacturing a variety of equipment needed more critically than recording equipment.

2 At the same time, the military demand for sound recording and reproducing equipment has been far beyond any prudent estimate we could have made.

3 Shortages have occurred continually in parts, principally motors, rubber parts and aluminum castings, as well as in labor, which have further impaired our efforts to keep shipments of our standard recording equipment up to date.

4 As a result, our backlog of orders is such that many orders received now, even those bearing AA-1 priorities, may not be shipped for eight to twelve months. By that time, government priorities may not be necessary.

Your order now will help us to plan our production schedule in advance for various types of equipment, resulting in speedier deliveries for you.

Your order, placed today, will not become binding on either of us until we give you firm price and delivery quotations based on post-war material costs and labor conditions. If your plans should change after you have placed your order, simply cancel the order and release your preference number to the next in line. That's all there is to it.

WHEN YOU ORDER BROADCASTING EQUIPMENT FOR NEW STATIONS, AM, FM OR TELEVISION, specify Presto transcription recording and playback tables. Many manufacturers of high grade radio transmitters and studio input equipment do not make turntable equipment. Therefore, ask the transmitter manufacturer to include Presto tables. They will pass your requirements on to us. We will deliver when they do.

WRITE TODAY FOR THE PRESTO POST-WAR ORDER FORM

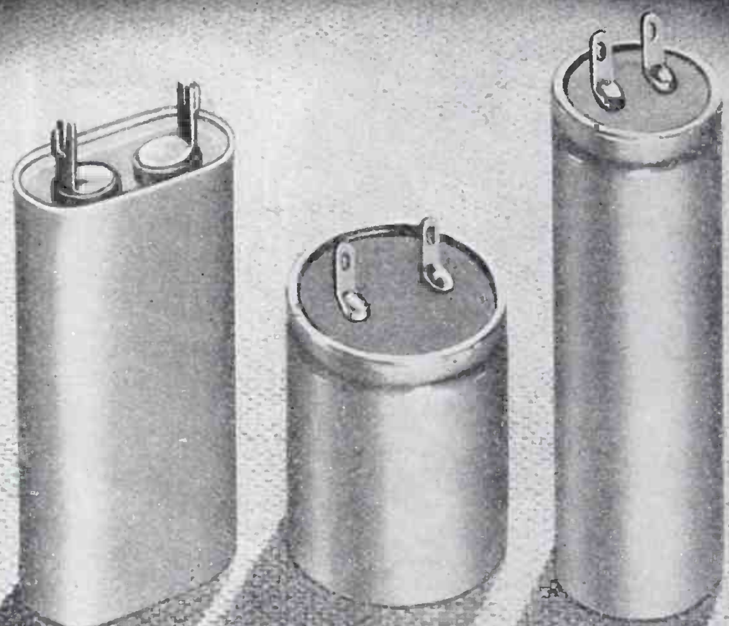
Complete catalog sent on request

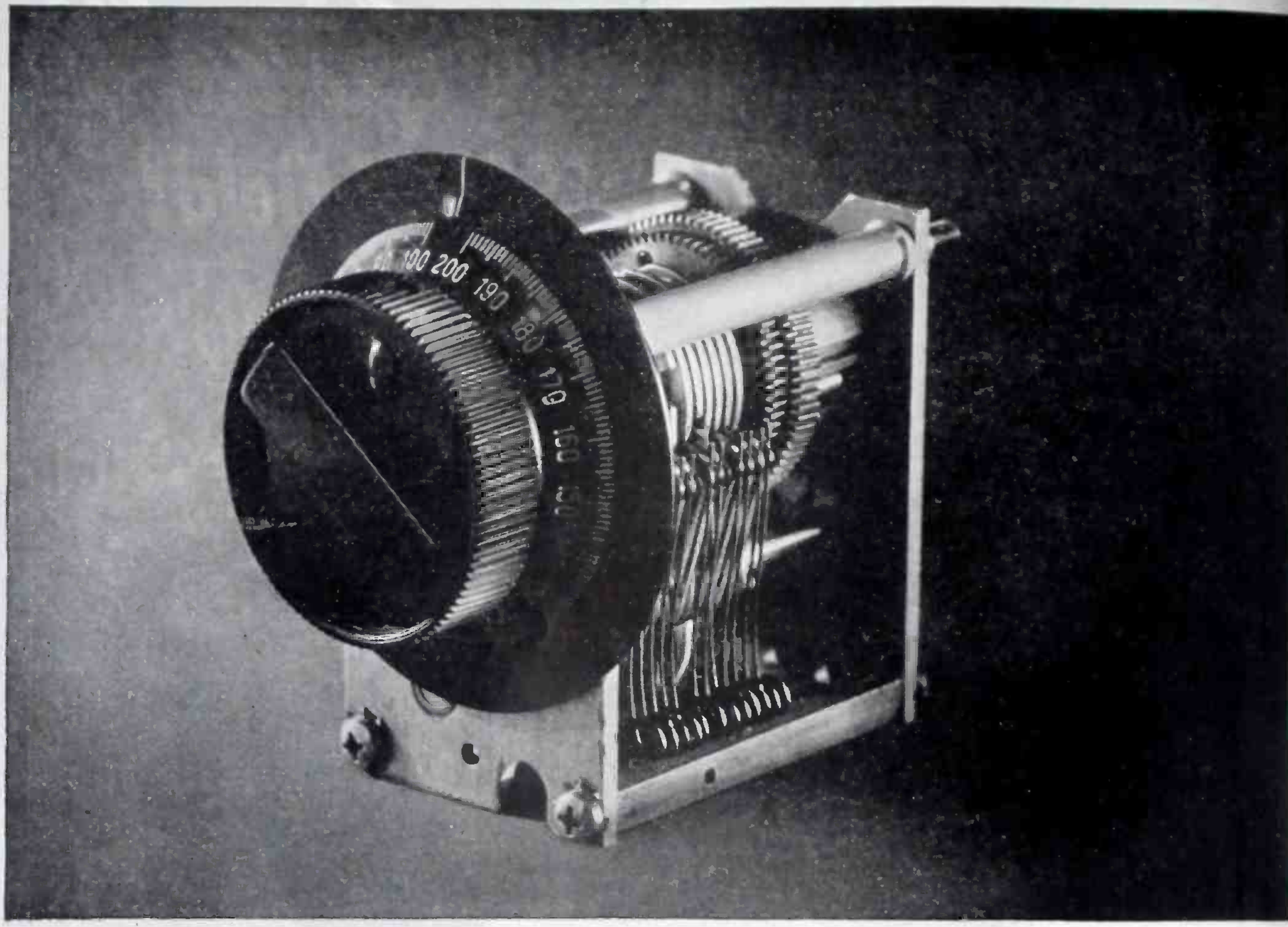
PRESTO RECORDING CORPORATION

242 WEST 55th STREET, NEW YORK 19, N.Y., U.S.A.

Walter P. Downs Ltd., in Canada

BACK THE ATTACK—BUY WAR BONDS





COLLINS AUTOTUNE*

The Key to Precision Control

THE Autotune was conceived and engineered by Collins many years ago. It was the result of a growing dissatisfaction with slow, haphazard methods of tuning radio equipment and a persistent effort to improve them.

What is it? How does it work?

The Collins Autotune head shown above is a mechanical device for turning a control shaft and stopping it precisely at any one of several pre-determined positions.

The Collins Autotune system consists of a number of Autotune heads, all driven by a single electric motor, each quickly and simultaneously repositioning a separate and non-interrelated tuning shaft to new settings chosen in advance by the operator. At the touch of a button or flip of a dial, the Collins transmitter or receiver is thus completely and exactly tuned to the wanted channel in a matter of seconds.

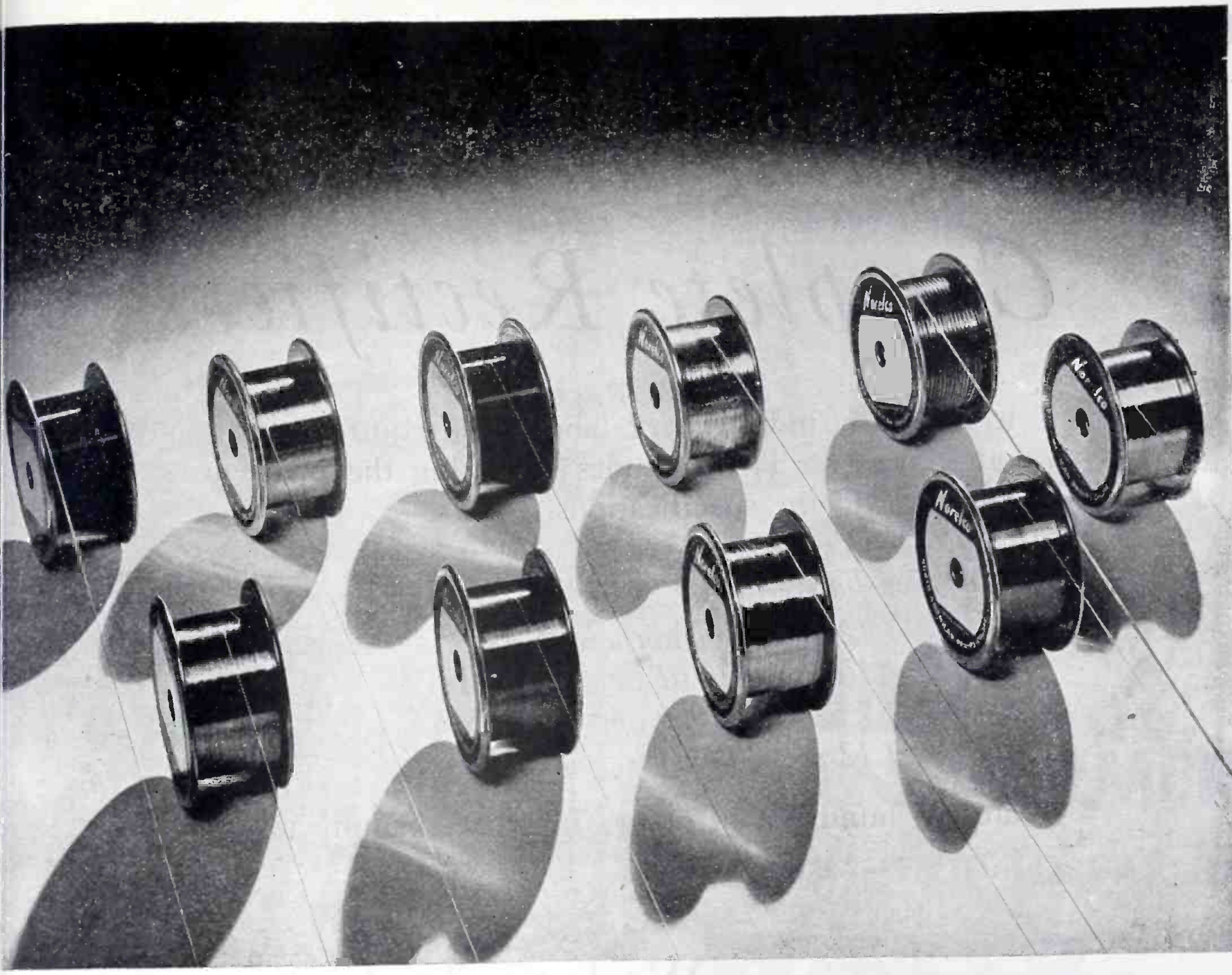
Collins communications equipment, Autotune controlled, was adopted by American Airlines, Braniff Airways, Tropical Radio Telegraph Co. and others long before the war. Reliability has been demonstrated through the years under all service conditions.

The Collins transmitter design and the Autotune have proved so advantageous to the Armed Services that military authorities have requested other large companies, in addition to Collins, to build them. The Collins Radio Company, Cedar Rapids, Iowa.

ARMY E NAVY

COLLINS

*U. S. Patents issued and pending.



Why we are known as FINE WIRE SPECIALISTS

Drawing fine wire with rigid requirements of close tolerance, perfect roundness and faultless surface condition is an every day production accomplishment at North American Philips.

If your specifications call for fine wire below .003 diameter in silver, nickel, copper, aluminum alloy, resistance wire, or plated wires up to .010 such as gold, copper and nickel on silver, tungsten, molybdenum, alloys, etc., we solicit your inquiry.

Manufacturers who have come to us with their problems usually remain as steady customers. They look upon North American Philips as *fine wire specialists* because we have:

- **Efficient equipment designed by us to meet our own exacting specifications.**
- **Superior craftsmanship.**
- **A specialized engineering service.**
- **Knowledge of processes and techniques developed by a technical organization with a background of over fifty years' experience in its fields.**

An increasing number of manufacturers are finding our specialized skill of great value in helping them meet wartime production schedules with low losses. Why not bring us *your* fine wire problems?

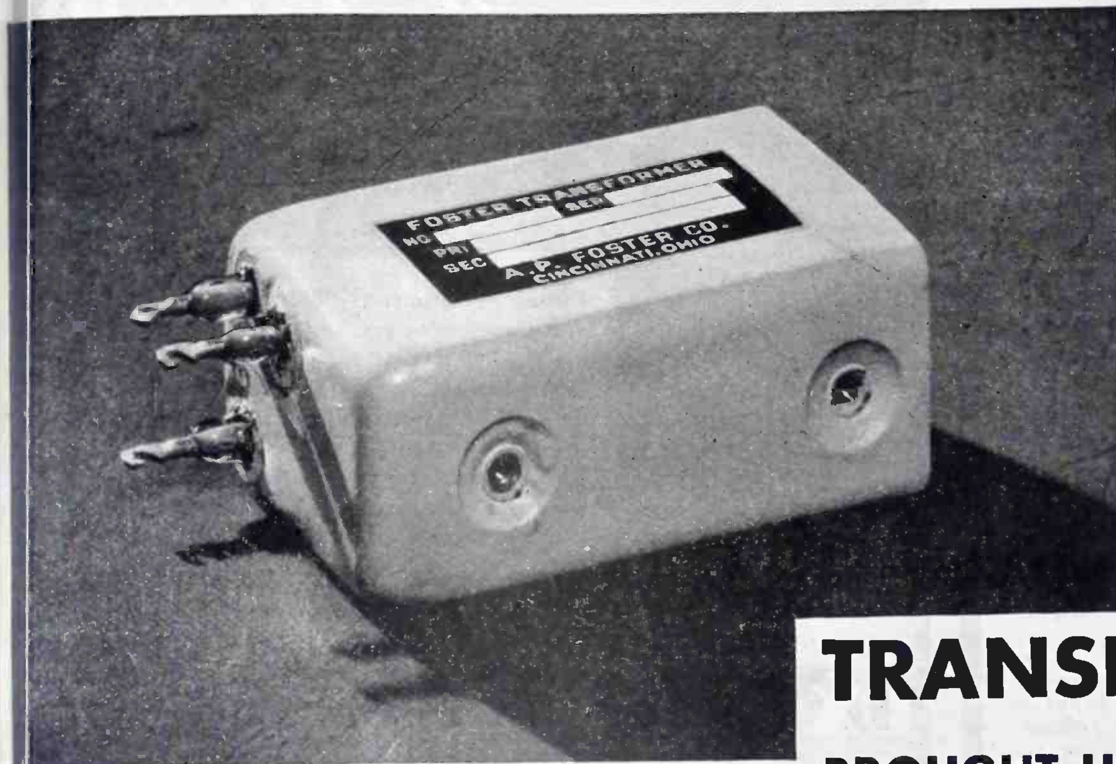
NORELCO PRODUCTS: In addition to fine wire and diamond dies for our own drawing, we make: Tungsten and Molybdenum products; Quartz Oscillator Plates; Amplifier, Transmitting, Rectifier and Cathode Ray Tubes; Searchray (X-ray) Equipment; X-ray Diffraction Apparatus; Medical X-ray Equipment, Tubes and Accessories; Electronic Measuring Instruments; High Frequency Heating Equipment. • When in New York, be sure to visit our Industrial Electronics Showroom.

Norelco *Electronic Products by* **NORTH AMERICAN PHILIPS COMPANY, INC.**

Reg. U. S. Pat. Off.

Dept. EC-10, 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.)

RE-DESIGNED "TO ORDER"



TRANSFORMER
BROUGHT UP TO PAR BY
FOSTER

Some weeks ago a manufacturer brought this unit, as then being supplied to him, to Foster Engineers for examination. Performance of the original model of this transformer had failed to meet a certain high standard of minimum inductance and maximum resistance. Foster re-designed it, met the exacting specifications, somewhat reduced its over-all dimensions, yet kept the new Foster model interchangeable with the old—no costly changes were required in the product of which this transformer is a part.

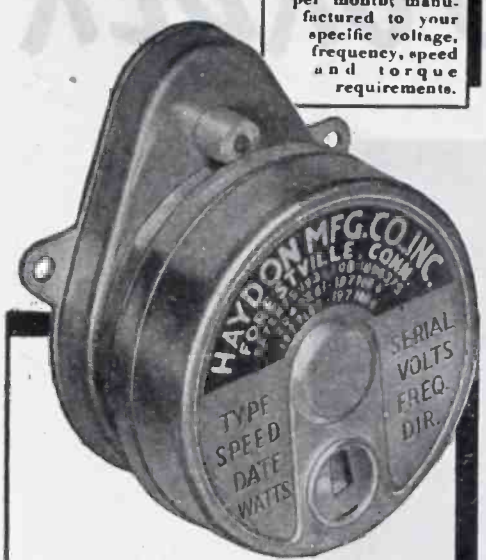
It is another example of Foster skill and experience in designing and building transformers for specific requirements that will be of great value in the post-war world of electronic equipment. Our experience covers close tolerance vibrator transformers, output transformers, microphone transformers, saturable reactors, power transformers, audio filters and reactors . . . designed and custom-built to the most exacting individual requirements.

SPECIALISTS IN BUILDING TRANSFORMERS SINCE 1938

A. P. FOSTER COMPANY

TRANSFORMER ENGINEERS & MANUFACTURERS
719 WYOMING AVENUE, LOCKLAND 15, OHIO

AC TIMING MOTOR
Available 450 RPM (or faster) to 1 REV. per montbt manufactured to your specific voltage, frequency, speed and torque requirements.



TIME IS PRECIOUS— PLAN TODAY FOR TOMORROW

Timing is vital today—indispensable tomorrow!
Compact, rugged and with extreme flexibility, Haydon timing motors lead the field. Manufactured to your specific voltage, frequency, speed and torque requirements, they are available with brake for instant stop—reversible, and with shift device for automatic reset.
Whatever Your Timing Problems May Be... our timing engineers are ready and willing to help you solve them—Just drop a line to our Timing Engineering Service Department.

DC MOTOR
Reversible—compact—light in weight—7 segment commutator—low reactance rotor winding—alnico field—totally enclosed.

As makers of the most complete line of Synchronous Timing Motors, Haydon Manufacturing Company offers a complete TIMING ENGINEERING SERVICE

Haydon
MANUFACTURING COMPANY • INCORPORATED •
Forestville, Connecticut

HIGH "Q"s for MIDGETS
Available in DX Isoso-Loops

During peacetime, as the World's largest loop aerial manufacturers, our job was to build the highest "Q" loop for every size and kind of radio receiver. If you make midgets you get the same DX Isoso-loop quality that goes into the large consoles. All of our present day efforts are devoted to making DX Xtals but we would like to discuss your post war receiver plans with you.

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

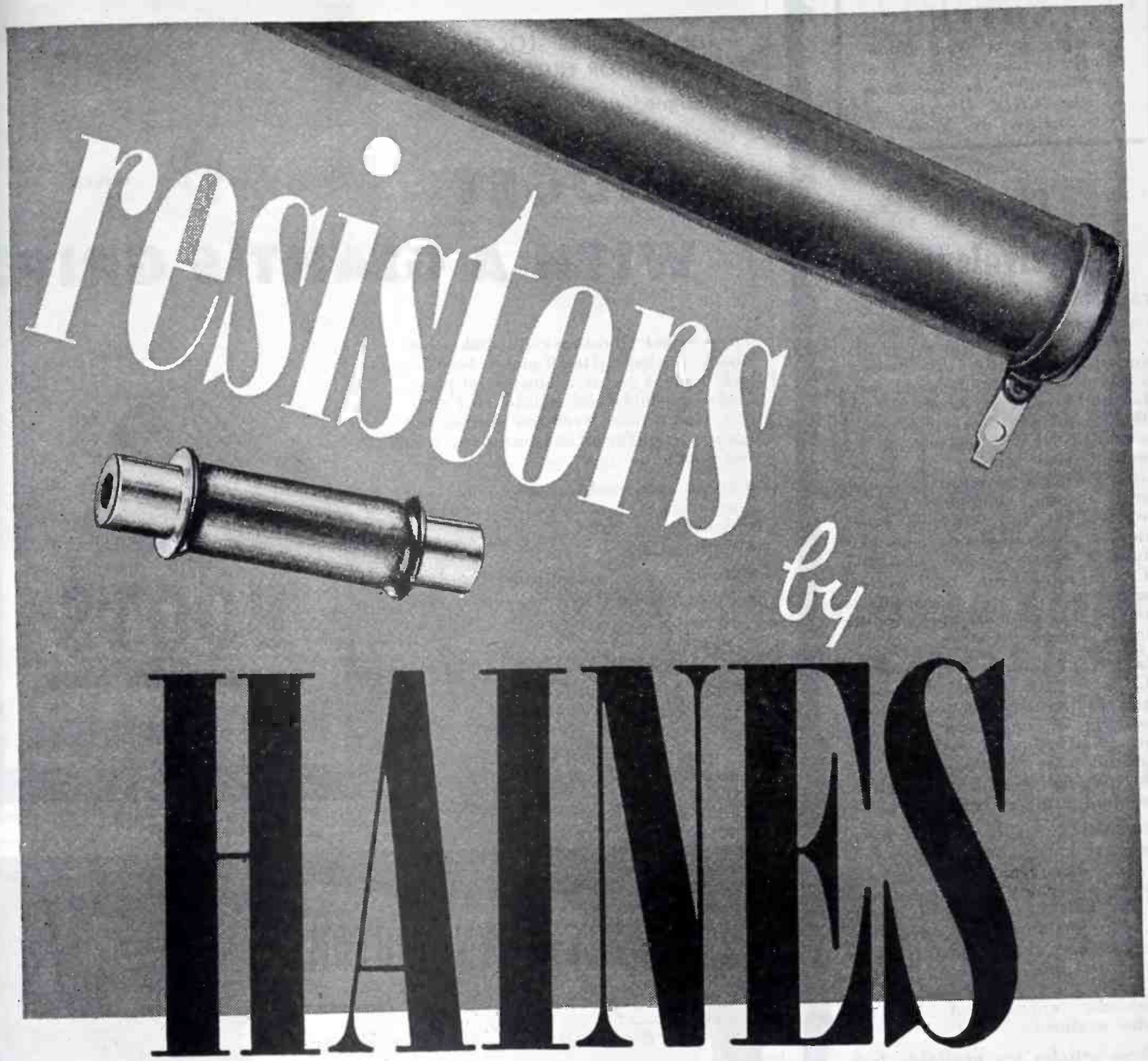
DX XTALS
"the heart of a good transmitter"
TRADE MARK

Quality AND LOTS OF IT

★ Transformers for Combat

In Active Service Over the Entire Globe

DINION COIL COMPANY
CALEDONIA, N. Y.



WE *proudly offer to the industry the rich experience and resources of an organization peculiarly fitted to supply you and advise you on resistance problems. Call upon us freely—without obligation.*

The latest HAINES catalog shows current models in lead, lug and ferrule type resistors, available for prompt delivery. Send for a copy of this valuable catalog.

We extend a cordial invitation to meet us at the EPEI Conference

Booth 139, Stevens Hotel

CABLE ADDRESS HAINMANCO

HAINES M. C. FOR PRECISION

TELEPHONE EVERGREEN 8-0036

HAINES MANUFACTURING CORP.

"Electronic Components"

248-274 McKIBBIN STREET

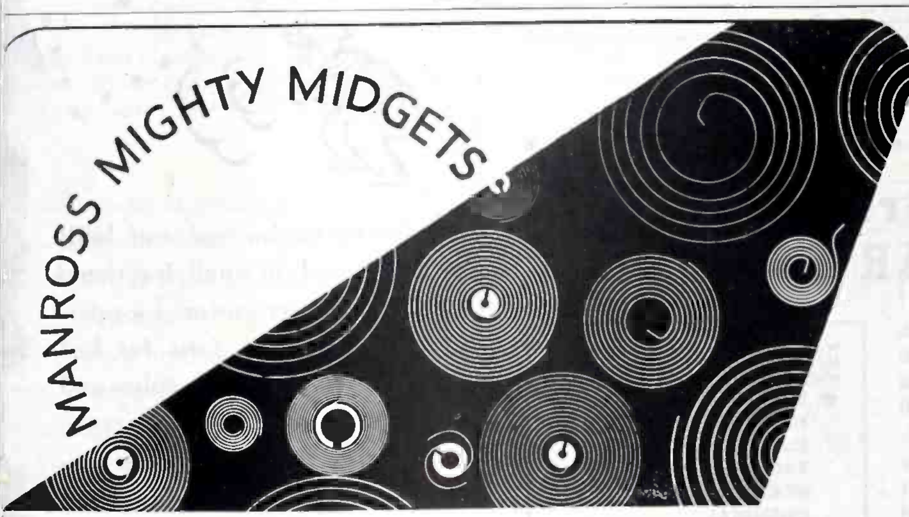
BROOKLYN 6, N.Y.

COAT TURNTABLES
with
Cellusuede FLOCK

For high acoustical value, for a rich velvety finish at low cost, for ease and economy in application—you'll find Cellusuede Flock the ideal material for coating the turntables on phonographs. And this is only one of the thousand ways to use this versatile material! Cellusuede can be applied to almost any surface by sifting or spraying, and there is a wide selection of brilliant, eye-catching colors from which to choose. Rayon or Cotton Flock is available for immediate shipment.

Write for Color Card. Samples and Prices

CP
Cellusuede Products, Inc.
ROCKFORD, ILLINOIS



The Standard for Accuracy and Performance

For instruments, indicators, relays, switches—there are no finer springs than Manross hairsprings. Get the benefits of sound experience in design and modern research in materials.

Send for Brochure of Specifications and Design

HAIR SPRINGS

F. N. MANROSS & SONS
DIVISION OF ASSOCIATED SPRING CORPORATION
BRISTOL, CONNECTICUT

PRECISION PARTS

The Ace Precision Metal-Working Plant.

HAVE AN ACE UP YOUR SLEEVE FOR POST-WAR

How about that post-war product you have been rolling around in your mind? Let Ace help you plan its construction and production. Ace has a complete service offering many real advantages to anyone considering products that involve small parts and assemblies requiring stamping, machining, heat-treating, or grinding.

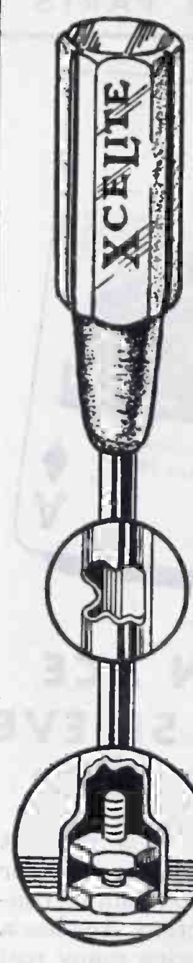
Here under one roof are the ingenuity and modern equipment to help you design that product of yours . . . make the necessary tools and dies . . . and put it into production. Furthermore, on certain products, we have a complete sales and merchandising staff to put it on the market, if you so desire.

As a veteran of World War II on the production-front and three-time winner of the Army-Navy "E" Award, Ace has acquired the knack of machining delicate parts to incredible accuracies—and doing it fast, on a mass-production basis. In terms of peace-time production, this speed-with-accuracy offers important competitive advantages. Have an Ace up your sleeve. Plan with Ace now.

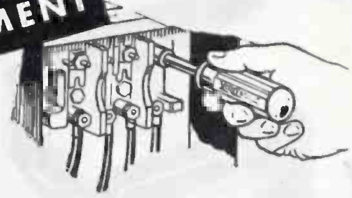
ACE TRADE MARK

ACE MANUFACTURING CORPORATION
for Precision Parts

1255 E. ERIE AVE., PHILADELPHIA 24, PA.



ON SWITCHBOARDS...
PANEL EQUIPMENT



... MAKE EASY WORK OF NUTS IN TIGHT PLACES

with **XCELITE** HOLLOW SHAFT NUT DRIVERS

A real expediter of jobs on radio panels, telephone and power switchboards. The hollow shaft slips over protruding studs; accurately machined socket accommodates two nuts. Genuine shock-proof XceLite handle. Shafts insulated if desired. Seven sizes, from 5/16" to ⅝" (nut sizes). Priorities required—sales restricted. Ask your hardware, radio or mill supply dealer or write Dept. C.

PARK METALWARE CO., INC.
ORCHARD PARK NEW YORK

XCELITE

BACK THE ATTACK—KEEP THE WAR BONDS YOU BUY

ENGINEERS ....

Are You Concerned With YOUR POST WAR FUTURE ?

The Federal Telephone & Radio Corporation, the manufacturing unit of the International Telephone & Telegraph Corporation with its multiple business activities extending to all parts of the civilized world, will accept applications from experienced men for immediate employment with almost limitless post war possibilities. These positions should interest those with an eye to the future and whose interest lies in forging ahead with this internationally known organization whose expansion plans for post war are of great magnitude covering all types of radio & telephone communications. Advancement as rapid as ability warrants. Majority of positions are located in the New York area!

We need the following personnel! Men with long experience or recent graduates considered.

- ENGINEERS
  - ELECTRONICS
  - ELECTRICAL
  - RADIO
  - MECHANICAL
  - CHEMICAL
  - TRANSFORMER DESIGN
- SALES AND APPLICATION ENGINEERS
  - PHYSICISTS
  - DESIGNERS
  - DRAFTSMEN
  - TOOL DESIGNERS
  - TECHNICAL WRITERS

Look Ahead With Federal!

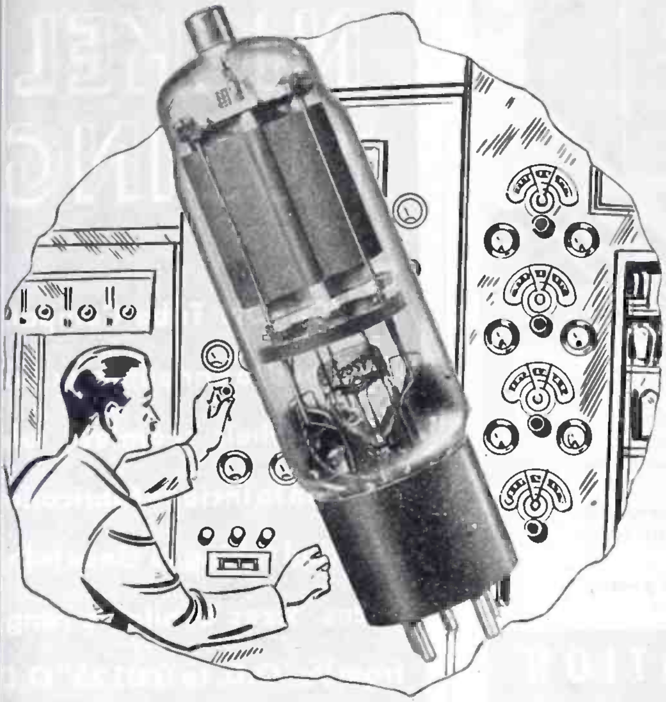
If inconvenient to apply in person, write letter in full, detailing about yourself, education, experience, age, etc., to Personnel Manager

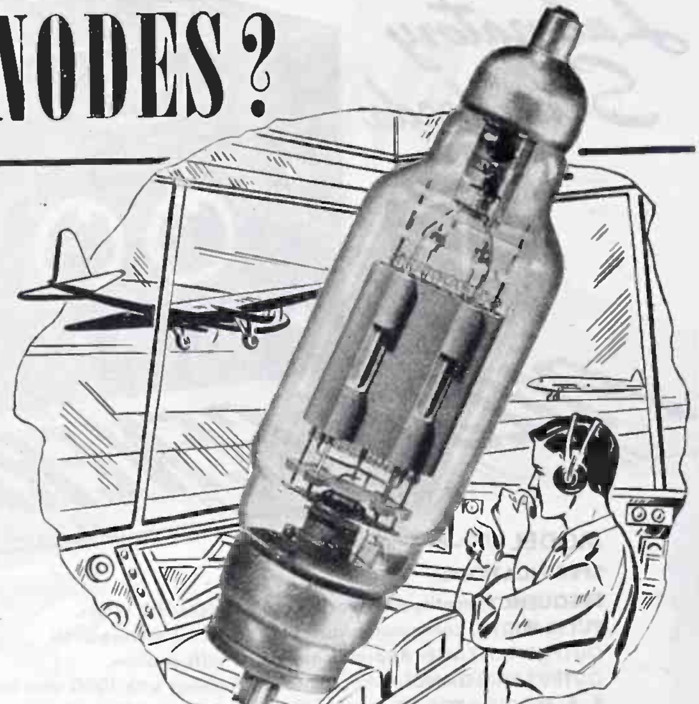
FEDERAL TELEPHONE & RADIO CORP.
39 Central Avenue
EAST NEWARK NEW JERSEY

We've engineered and built thousands of small, fractional H.P. blower motors for operating cooling fans for hot spots such as radio tubes and transformers in many types of aircraft and radio installations. Competent engineering and precision manufacturing facilities assure volume production of small motors designed to your exact performance specifications—for any job that requires compact, lusty, dependable power. Tell us your requirements.

Small Motors, Inc.
1318 ELSTON AVE., CHICAGO 22, ILLINOIS
Design • Engineering • Production

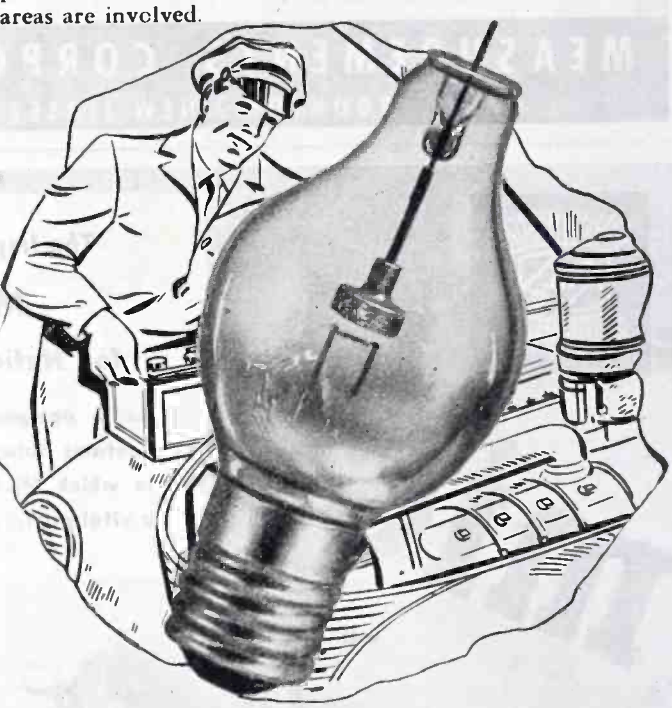
WHY GRAPHITE ANODES?





FOR PREVENTION OF LOCAL OVERHEATING
In the Pliotron modulator-amplifier (WL-849) for broadcast radio and aviation control stations, the graphite anode prevents local overheating and distortion where large areas are involved.

FOR DIMENSIONAL STABILITY
Three grids make it imperative that the anode in this air-cooled RF power amplifier and oscillator (WL-803) should not change shape, and hence the tube's characteristics, while operating. Graphite gives the anode this essential stability.



FOR DISSIPATION OF EXCESSIVE HEAT
This Rectigon 289416—workhorse rectifier tube for garage and home battery chargers for over 30 years—must get rid of a tremendous quantity of heat. Its graphite anode handles the heat with ease.

THESE PHYSICAL PROPERTIES of graphite—nearly perfect lack body radiation, negligible coefficient of expansion, nd excellent heat conductivity—dictate its use in the nodes of the three electronic tubes illustrated.

The tubes are but a few of the many in which "National" High Purity Graphite anodes and other tube omponents are specified. And the physical properties nentioned are but a few of those which make graphite a basic material for a wide variety of industrial and communications electronic tubes.

"National" electronic graphite of unmatched purity s available for your requirements. For information on lectronic graphite and other "National" graphite products, write to our nearest Division Office.

Keep your eye on the infantry . . . the doughboy does it!

The word "National" is a registered trade-mark of National Carbon Company, Inc.

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

UCC

General Offices: 30 East 42nd Street, New York 17, N. Y.
Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

Today it's different...

Job Seeks Man!

Right now, instead of trained executives looking for jobs, the jobs are looking for them! Industry *really* needs men who understand the basic principles *behind* today's spectacular production record—men with the ability to *guide* that effort.

Countless opportunities await these men, and their services will continue to be valuable during the years after the war is won.

The very practical, time-tested law of supply and demand is working overtime for the production man who knows the principles of: Cost Finding, Production Control, Purchasing and Storing, Factory Organization, Personnel Management, Advertising and the other major functions of business and industry.

Thousands must be trained

The demand for such men far exceeds the supply. Thousands more must be trained to fill this vital need. This training must include not only the subjects related to their jobs of today, but also the fundamentals underlying *all* business. A foundation is thus laid for the future, and efficiency is improved by adjusting particular tasks to the over-all picture. And remember—post-war America will mean opportunity to the man whose knowledge encompasses all of the principal divisions of business and industry.

The Alexander Hamilton Institute can give you this added training which will enable you to do your present job better, and prepare you for the more exacting business and industrial requirements of the post-war world.

There is a scientific quality about the Institute's training which appeals to technical men. It is basic, broad in scope and fits well into a busy, war-time schedule. It further provides access to the thinking and experience of the nation's famed industrialists.

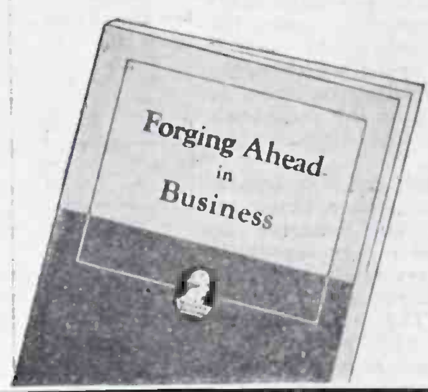
Noted Contributors

These men realize the desperate need for such training in the production world of today, and for that reason contribute their help. Among the noted contributors are: Frederick W. Pickard, Vice President and Director, E. I. du Pont de Nemours & Co.; Clifton Slusser, Vice President, Goodyear Tire & Rubber Co. and Thomas J. Watson, President, International Business Machines Corp.

Famous Inspirational Booklet—FREE!

"FORGING AHEAD IN BUSINESS" is a 64-page booklet which represents the experience of 31 years in training men for success. Today's timely edition, written in the light of recent world-wide developments, can be of immense value to you. It demonstrates how the Institute can give you immediate help in your present position, while preparing you for post-war opportunities. It discusses subjects directly related to the work you are doing now, PLUS other subjects of fundamental value to the business executive.

There are no copies for the merely curious; but to any man of serious purpose, it is sent *free* and without obligation.



ALEXANDER HAMILTON INSTITUTE

Alexander Hamilton Institute
Dept. 195, 71 West 23rd Street, New York 10, New York
In Canada, 54 Wellington Street, West, Toronto 1, Ont.
Please mail me, without cost, a copy of the 64-page book—"FORGING AHEAD IN BUSINESS."

Name..

Firm Name...

Business Address..

Position..

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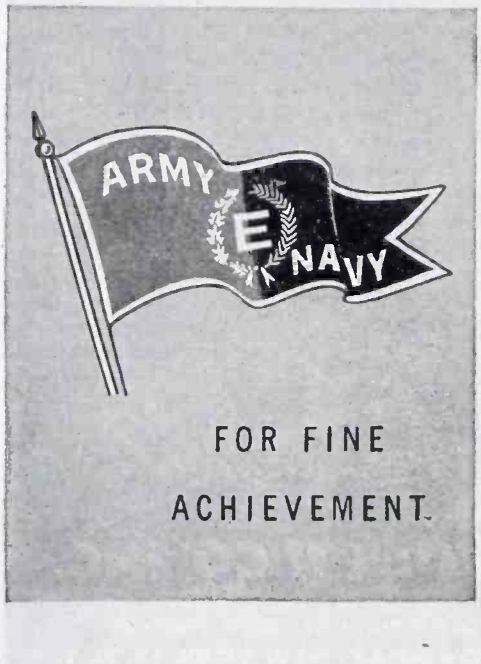
INSPECTION ON THE LINE

MAKING HISTORY IN COMMUNICATIONS



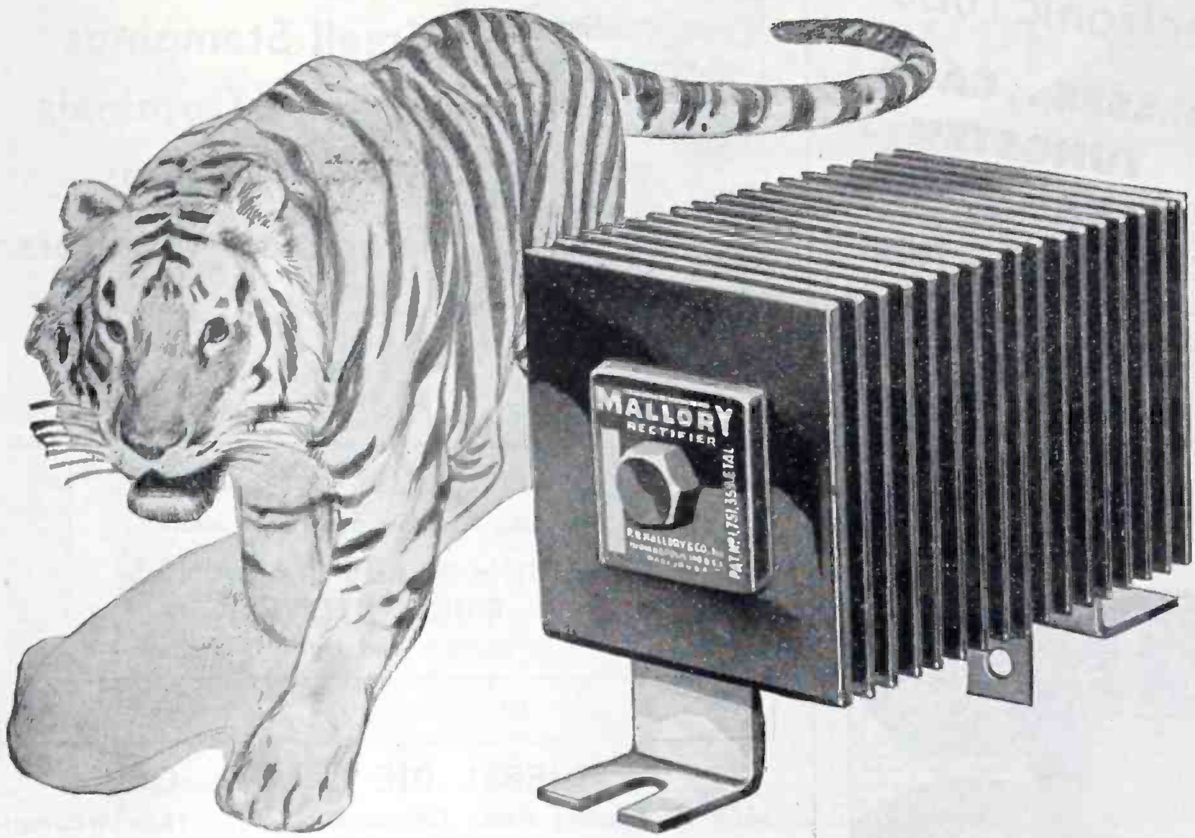
Inspection before assembly, quality control . . . more than that . . . team work from material dispatcher, assembler, inspector, to the girl on the packing line . . . have made possible the fine achievement represented by the Army and Navy "E" Award presented to the men and women of the Universal Microphone Company.

In production of military microphones before Pearl Harbor, Universal had the necessary "know how" for immediate war production. The engineering experience and production efficiency of war production will be reflected in the electronic voice communication components offered by Universal to consumers in the future. Until then — BUY WAR BONDS.

UNIVERSAL MICROPHONE COMPANY
INGLEWOOD, CALIFORNIA

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

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.

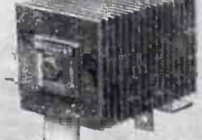
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Buy an Extra War Bond!

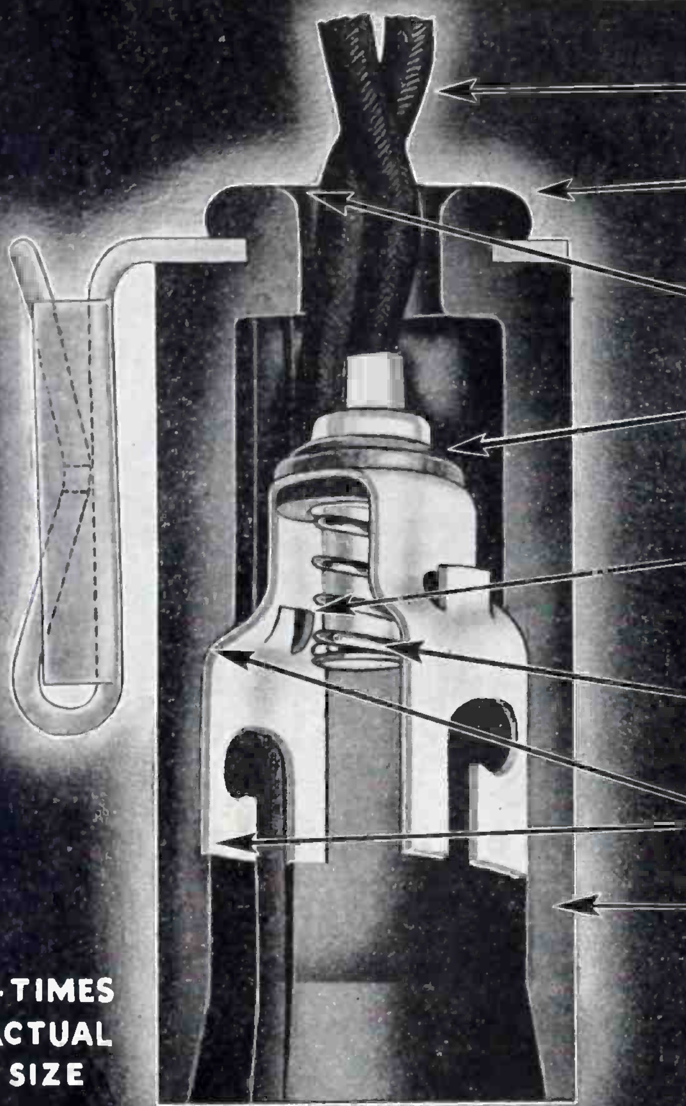
**Rectostarter is the registered trademark of P. R. Mallory & Co. Inc., for rectifier units for use in starting internal combustion engines.*

P. R. MALLORY & CO. Inc.
MALLORY

MAGNESIUM COPPER SULPHIDE RECTIFIERS—
STATIONARY AND PORTABLE D. C. POWER SUPPLIES—
BATTERY CHARGERS AND AVIATION RECTOSTARTERS*



a New and Superior
DIAL LIGHT SOCKET



Tensile strength of leods ond connections for in excess of requirements.

Tough, plostic shell molded oround brocket providing o secure bond with mechonical strength for beyond ony normol requirement.

Rounded edge will not cut or froy wire insulotion.

Voltoge Breakdown between contocts—1200 Volts. Voltoge Breokdown to ground—5000 Volts.

Lug on contoct fits in groove in shell so thot contoct cannot be turned or twisted when inserting lomp.

Center contact mounted so thot it cannot protrude from shell and short on chassis when lamp is removed.

Plastic shell is recessed for contacts, which cannot be pushed or pulled out of position.

Stronger, tougher, neovy walled plostic shell.

A variety of different mounting bracket styles avoilable, suitable for procticolly any mounting.

For Your Present and Post-War Production

40th ANNIVERSARY
1904—1944

This year Lenz celebrates its 40th year of service to the communications industry.

Lenz Diol Light Sockets have olways been known for their superior mechonicol quolities ond electricol chorocteristics.

Now these sockets ore still further improved, with even greoter mechanicol strength. A stronger, tougher plostic shell is ottoched to the brocket with o new type of construction thot provides o virtually unbreokoble bond between shell ond brocket. Its excellent electricol chorocteristics ore mointoined.

Consider these Lenz Diol Sockets for your present ond post wor production. Write for sample todoy.

LENZ

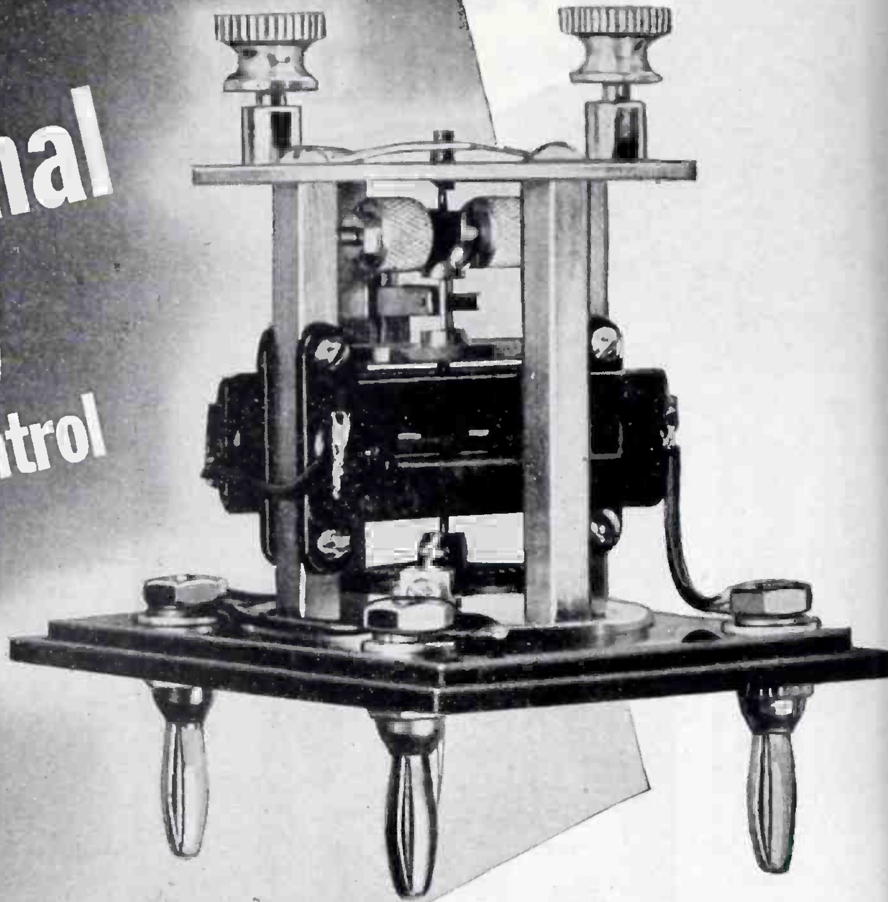
In Business *Since 1904*

LENZ ELECTRIC MANUFACTURING CO.

1751 N. WESTERN AVE. CHICAGO 47, ILLINOIS

ELECTRIC CORDS, WIRES AND CABLES

A Torsional Relay
for remote control



through direct wire transmission or with modulated radio carrier waves

PURPOSE: To control a number of operations in a variable sequence from a remote location where the physical limitations and economic factors, such as distance, dictate the use of only one pair of wires or radio carrier waves.

FEATURES: ***Range*** — 10 to 20 cycles per second.

Sensitivity — Less than 3.0 seconds from impression of a 5 volt 0.0012 ampere current pulse of constant amplitude and at the resonant frequency to which the relay is adjusted.

Selectivity — Resonant frequency plus or minus 2.5% under above conditions for response.

Stability — Excellent over a wide range of ambient temperature and pressure.

Contact Capacity — In controlled circuit, 50 milliamperes.

An illustrated technical bulletin will be furnished on request.

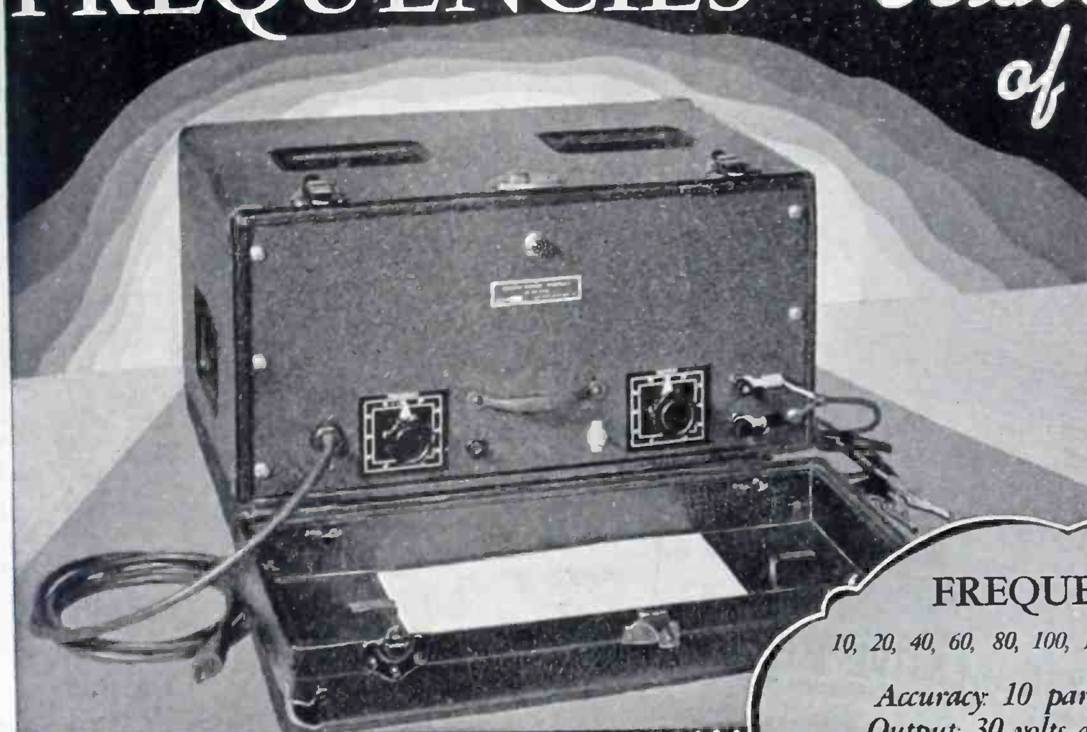
ARMY E NAVY

A-16

WALLACE & TIERNAN
PRODUCTS, INC.

BELLEVILLE 9 NEW JERSEY

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.

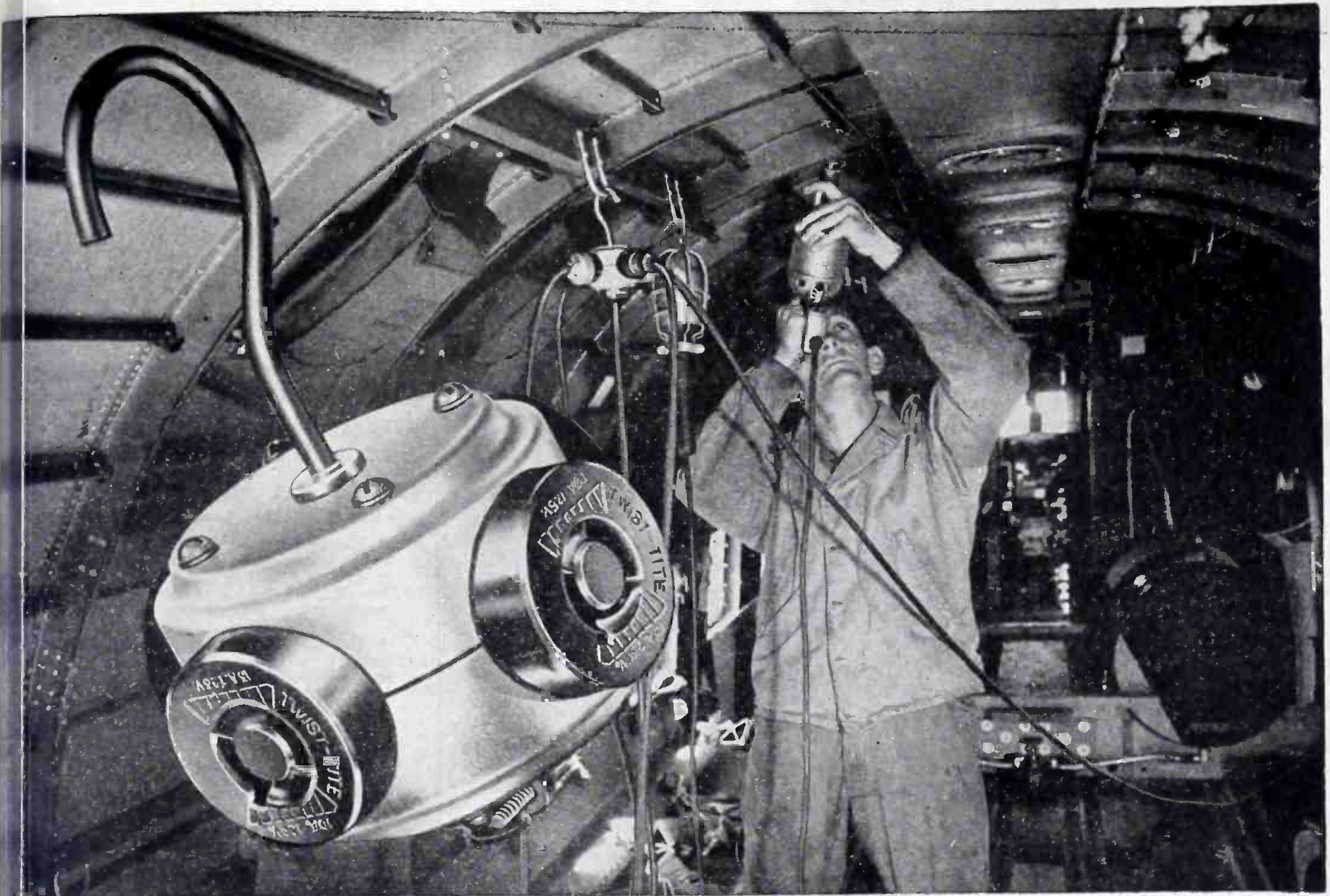
Additional information available on request.

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.



IT SIMPLIFIED A LIGHT AND POWER PROBLEM IN AIRCRAFT BUILDING

Another accomplishment of the Hubbell Development Laboratory, an engineering organization producing electrical sockets, receptacles, switches and connectors to meet the specific needs of any industry.

MASS PRODUCTION of aircraft created the situation where a number of people had to work inside the c..mped confines of aircraft sections . . . each person bring-i.. in a power tool, or light, on the end of a long extension c..d attached to an outside receptacle. The result frequent-ly was an annoying confusion of wires.

A. the request of one of the large aircraft companies, the H..bbell Development Laboratory designed the Four O..let Twist-Tite Cluster Receptacle. With this device a si..gle power line running into the airplane provided a c..venient outlet for four tools. This simplified working c..ditions and made for more efficient production.

T..e understanding way in which the Hubbell Laboratory w..rks is represented by the conveniences designed into this product. They are described below. Similarly, every new product or improvement receives the full benefit of Hubbell's long experience in the design and manufacture of electrical connections. Most of the sockets, receptacles, connectors, plugs and switches now in common use have been Hubbell engineered, wholly, or in part.

If you require a special purpose fitting that has to do with electrical wiring, write to the Hubbell Development Laboratory. One of our technical advisers would be glad to call and discuss your requirements.

APPLICATION SUGGESTIONS WELCOMED. If you believe that the modification of any electrical outlet receptacle, switch, or connecting device will give the product broader application, send your suggestions to the Hubbell Laboratory. Also, if you have any Hubbell products, the uses of which you think are unusual, we would like to know about them. Your ideas may help others solve a problem.

THE HUBBELL TWIST-TITE CLUSTER RECEPTACLE PROVIDES . . .

1. Four outlets which receive all standard plugs.
2. TWIST-TITE feature which prevents accidental pulling out of plugs.
3. Large hook for conveniently hanging up the receptacle.
4. Adjustable grips for cords from .296 to .562.
5. Solderless connections for incoming wires.
6. All parts corrosion resistant.

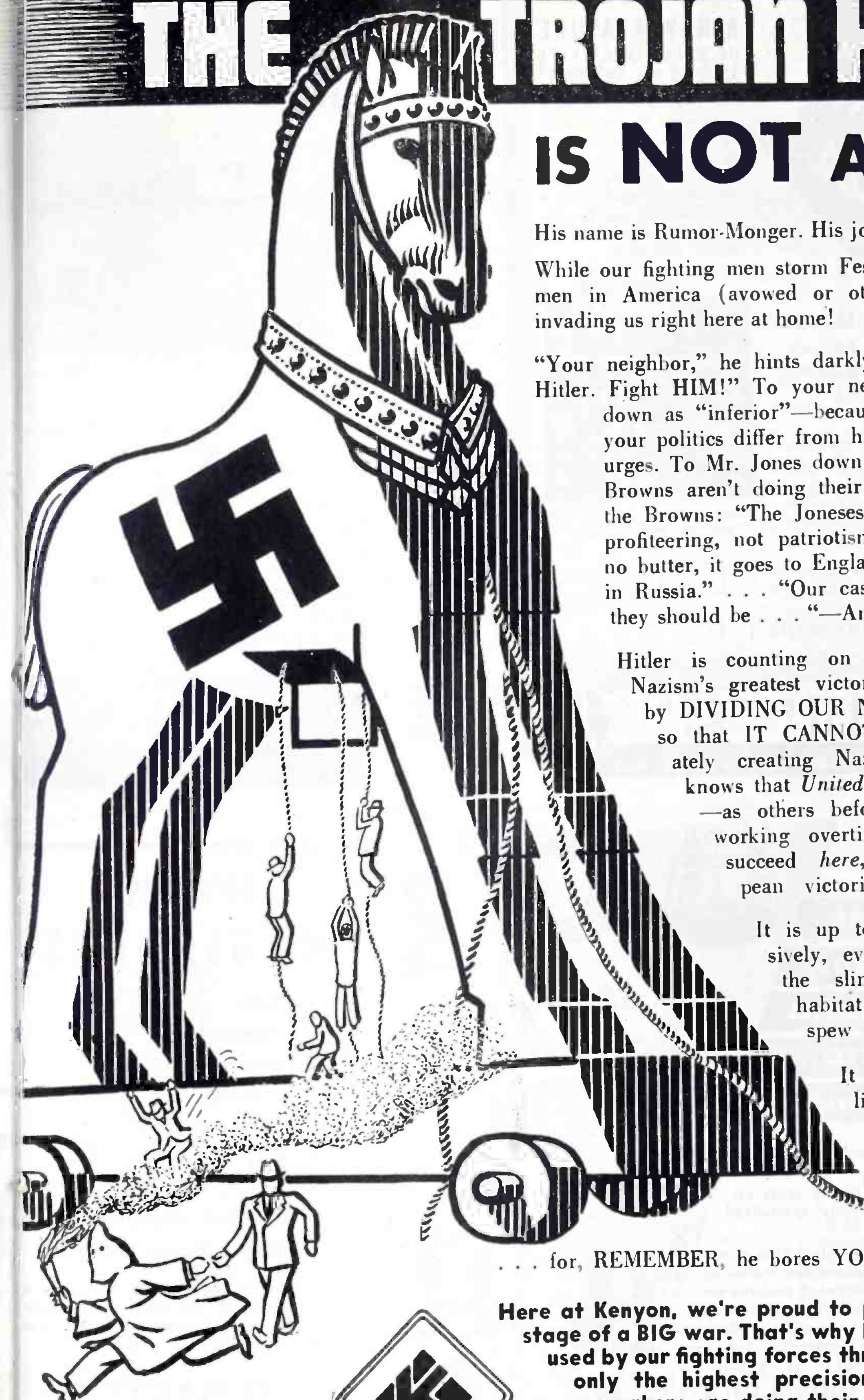
TRADE HUBBELL MARK

HUBBELL

DEVELOPMENT LABORATORY OF HARVEY HUBBELL, INC.

1523 STATE ST., BRIDGEPORT 2, CONN.

THE TROJAN HORSE
IS NOT A MYTH!



His name is Rumor-Monger. His job is to divide us *from within.*

While our fighting men storm Festung Europa, Hitler's henchmen in America (avowed or otherwise) bore from within, invading us right here at home!

"Your neighbor," he hints darkly, "is your real enemy—not Hitler. Fight HIM!" To your neighbor, he slyly builds you down as "inferior"—because your faith, your color or your politics differ from his. "Put him in his place" he urges. To Mr. Jones down the street he whispers, "The Browns aren't doing their share to win the war!" To the Browns: "The Joneses' war efforts are spurred by profiteering, not patriotism . . ." "No wonder there's no butter, it goes to England." . . . "OUR beefsteak is in Russia." . . . "Our casualties are way higher than they should be . . . "—And so on and on, ad nauseum.

Hitler is counting on his Trojan Horse to win Nazism's greatest victory over America, *internally*, by DIVIDING OUR NATION AGAINST ITSELF, so that IT CANNOT STAND—through deliberately creating Nazi-like racial disunion. He knows that *United We Stand, Divided We Fall* —as others before us fell! Therefore, he's working overtime to divide us. Will he succeed *here*, cancelling-out our European victories into American defeats?

It is up to YOU to defeat him decisively, every time he crawls out of the slime which is his natural habitat to rear his ugly head and spew forth his loathesome bilge.

It is up to YOU to throw out his literature, cast out his words, give no credence to the noxious thoughts he seeks to plant in your mind. You can't simply dismiss him as a crackpot or a bore

. . . for, REMEMBER, he bores YOUR COUNTRY from *within!*

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 full share to bring Victory nearer — by turning out top quality transformers *uninterruptedly* — and as fast as possible!

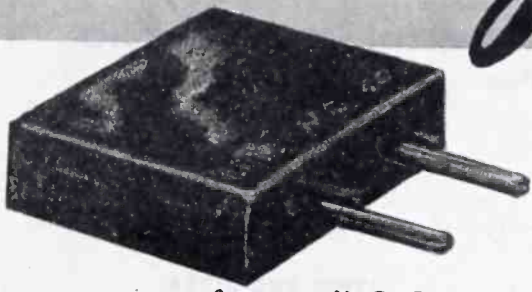
THE MARK OF EXCELLENCE

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

HENRY MANUFACTURING CO.

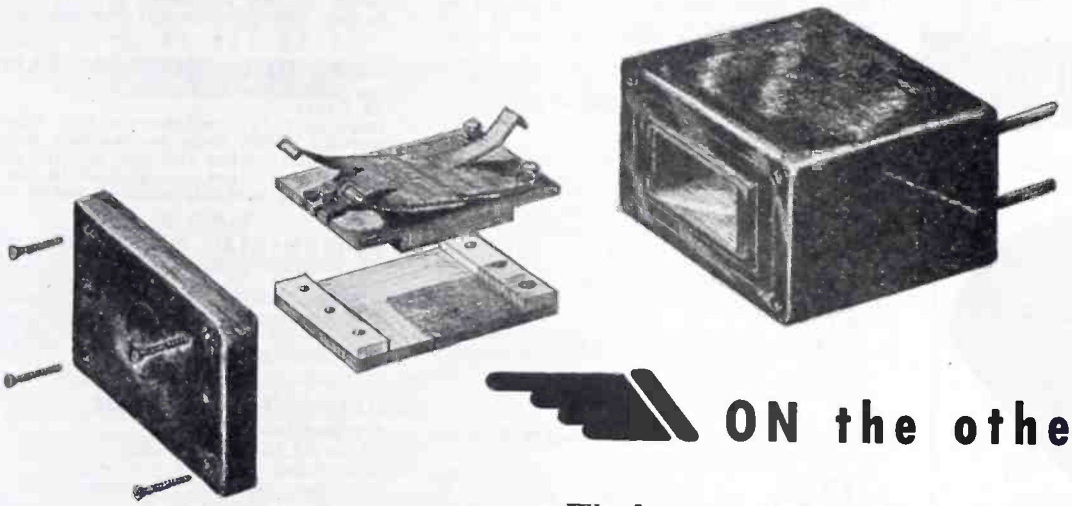
DISTRIBUTORS • MANUFACTURERS • ENGINEERS

Crystals



ON the one hand

We are making precision crystals classified by the armed forces as "difficult to manufacture." Only companies equipped for finest precision work are given these orders. ● Our experience along these lines enables us to do a better job for you and we welcome inquiries from you concerning your regular crystal requirements and special problems.



ON the other hand

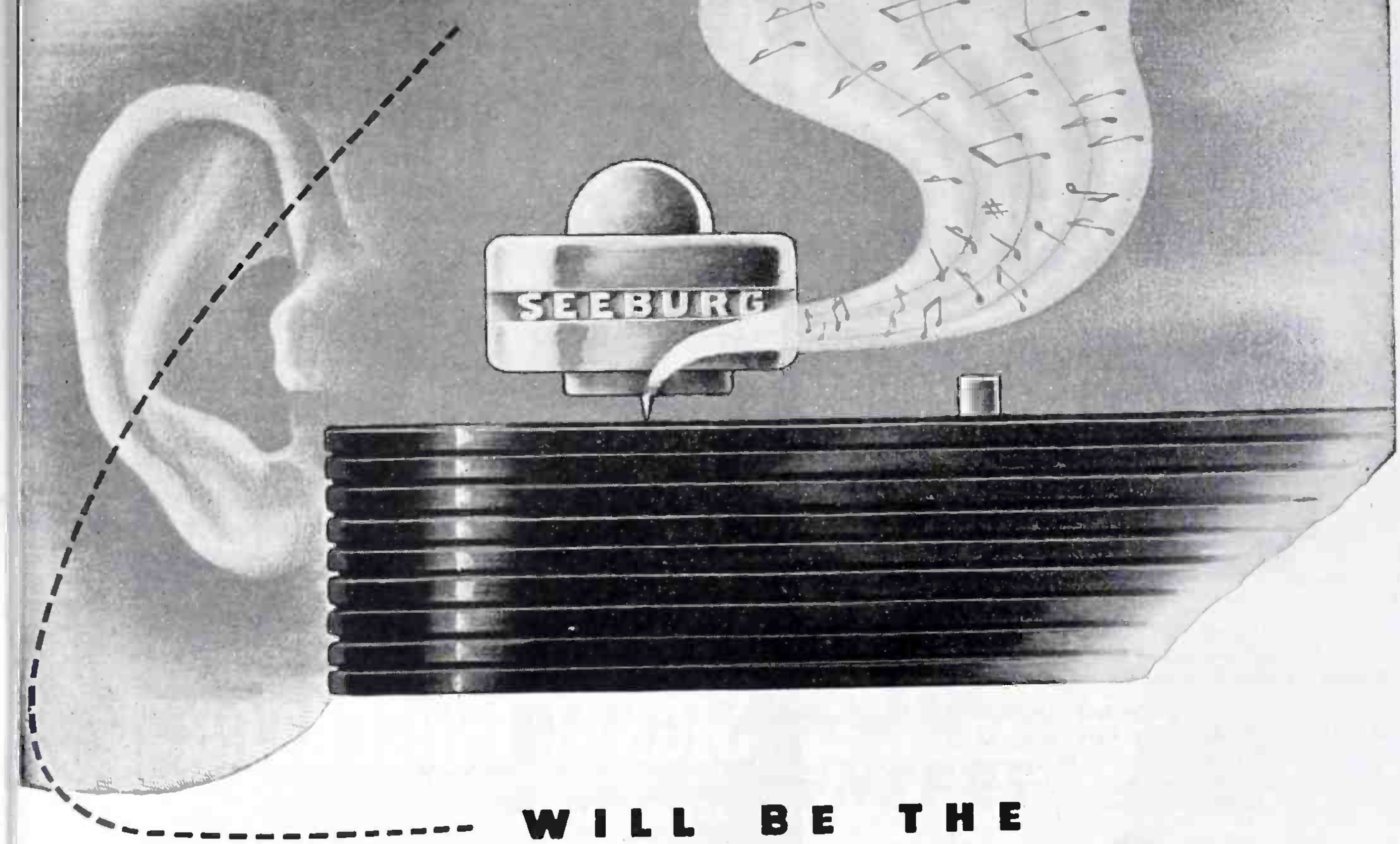
We have anticipated one of your needs in the development of this type HAF precision adjustable air gap crystal. ● Its frequency is continuously variable over a range of 5 KC at 3 MC, available in the frequency range 1 MC to 6 MC. Temperature coefficient is 2 CY/MC/C or less. ● The frequency can be accurately adjusted and locked. The holder has solid stainless steel pins and contact plates. ● Prices are in line with non-adjustable crystals. We are prepared to make immediate deliveries. Write for details.

HENRY *Manufacturing Company*

10860 SANTA MONICA BOULEVARD • LOS ANGELES 25, CALIFORNIA

BOB HENRY . . . W9ARA • TED HENRY . . . W6UOU

SEEBURG RECORD CHANGERS



WILL BE THE

CHOICE OF QUALITY

RADIO COMBINATION

MANUFACTURERS

AFTER VICTORY!

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

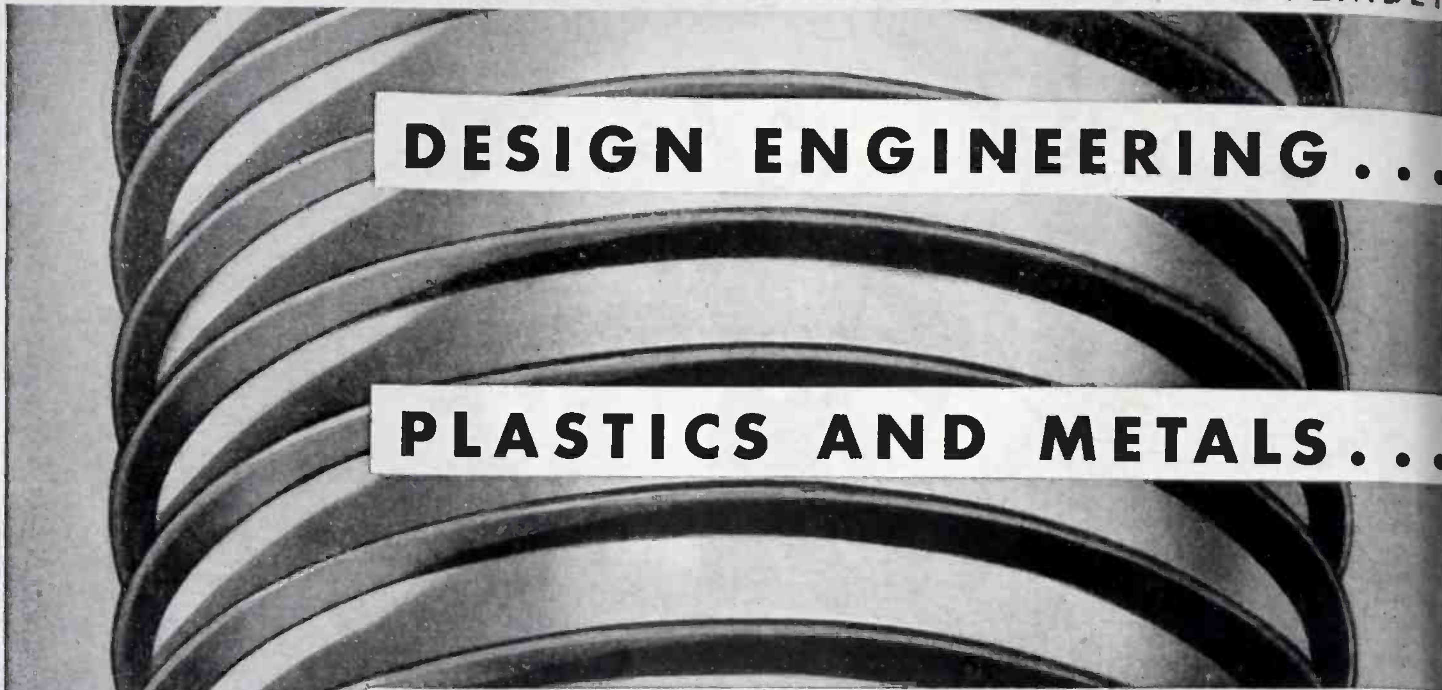
Seeburg

FINE MUSICAL INSTRUMENTS SINCE 1902

J. P. SEEBURG CORPORATION · CHICAGO


Jennings
RADIO
TRANSMITTING TUBES
VACUUM CONDENSERS
ORIGINATORS AND EXCLUSIVE PRODUCERS OF
NEW HIGH VACUUM
VC 50 TO 250
JENNINGS CONDENSERS
TROPICALIZE*
your Equipment with these Modern Electronic Units
Jennings Radio recently announced these new and revolutionary HIGH CAPACITY CONDENSERS. Industry was quick to realize the advantage of these remarkable units.
Jennings Vacuum Condensers and Transmitting Tubes will increase the effectiveness of your newly designed Transmitting and Electronic Heating Equipment.
Today our plant is in large scale production on all of these units, meeting the demands of the newly designed Signal Corps Transmitters and Heating Equipment.
Tropicalize Your Equipment with Jennings Units
OUR NEW CATALOG WILL BE SENT ON REQUEST
JENNINGS RADIO MFG. CO., 1098 E. WILLIAMS ST.
DEPT. E, SAN JOSE, CALIFORNIA
Actual photograph of Jennings Vacuum Condensers in Induction Heating Unit.
* Prevents corrosion and deterioration.

ENGINEERED PLASTICS FROM DESIGN TO ASSEMBLY



Metal rings molded in permanent alignment . . . this is one of many applications in which our design engineers have successfully used plastics with complementary metals. Working with these combinations, they have developed some original techniques which have solved a number of problems for military aircraft manufacturers.

You may never need a molded rotor complete with multiple bi-metal rings, such as we show in this enlarged view. But the design engineering skill, molding experience and facilities that are required for the volume production of such an item might be used to benefit your products—products to be produced for war requirements and/or in the planning stage for postwar promotion.

Regardless of how you may have considered plastics in the past, it is in your interest now to reconsider them for the possibility of new applications. Military requirements for rigidly held tolerances are one of the factors that have brought about improvements in molding methods. These may have a bearing on the performance of your products.

How you benefit the most from our plastics experience and facilities

Call on us in the beginning—*when the product or part is in the idea or design stage.* This gives you full advantage of our plastics experience. From a study of your particular problem, we determine the benefits of molded plastics for the job at hand. Our engineers help in the design development. From the many kinds of plastic materials, we select those that have the desired properties for the specific application and molding process. Calling on us early, you are assured of the right use of plastics and of a design that permits maximum manufacturing efficiency. Write for free copy of Folder File E 10, outlining and illustrating our services.

THE SYMBOL OF ENGINEERING EXPERIENCE AND MOLDING SKILL

REPRESENTATIVES

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805-06 NEW CENTER BLDG.

NEW YORK 1
19 W. 34TH ST.

LOS ANGELES 35
1440 SO. ROBERTSON BLVD.

CANADA
A. & M. ACCESSORIES LTD.
19 MELINDA ST., TORONTO

1405 BISHOP ST., MONTREAL

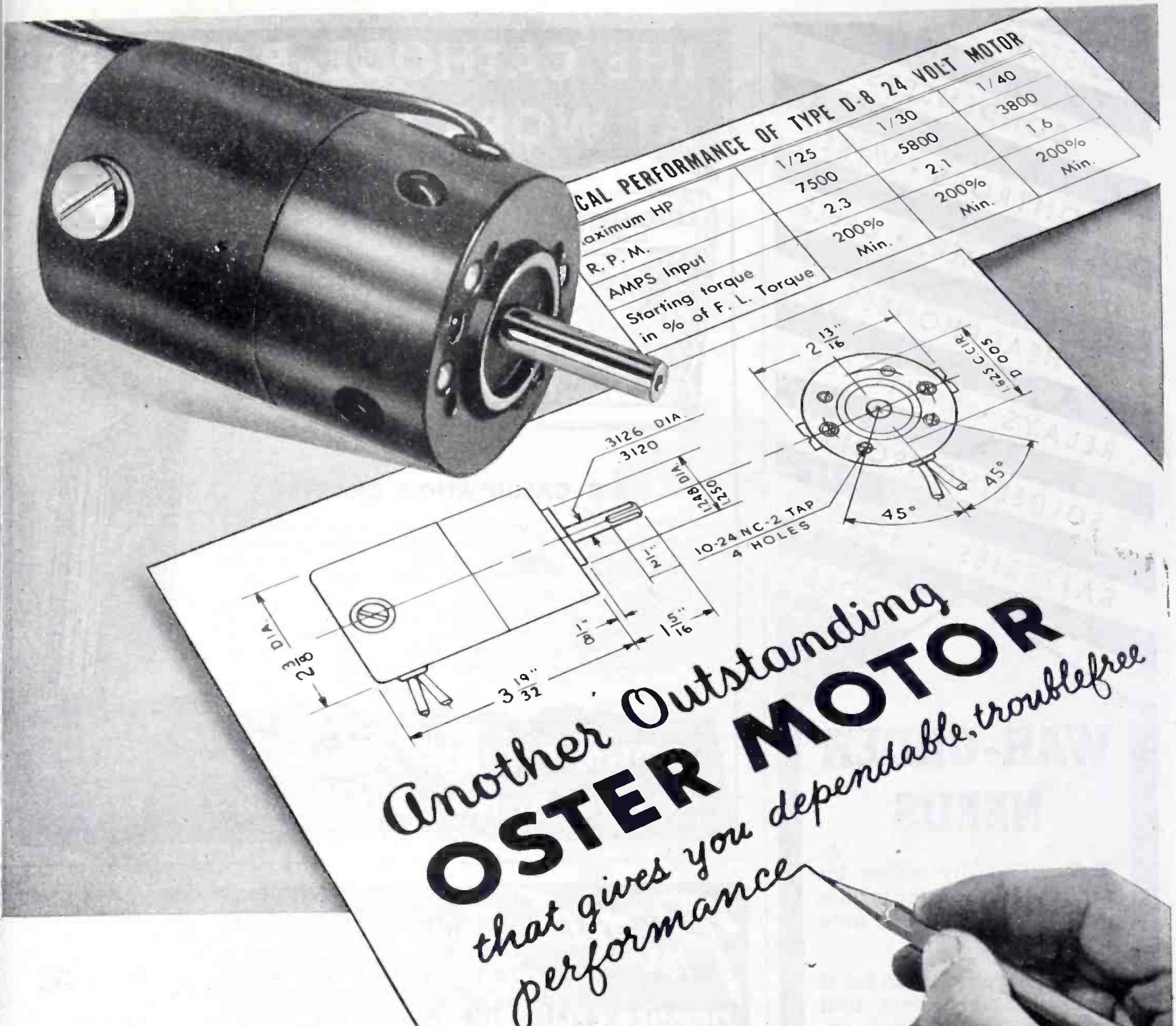
920 SECOND AVE., SEATTLE

PLASTIC MANUFACTURERS

INCORPORATED

STAMFORD, CONNECTICUT

MOLD MAKING • INJECTION & TRANSFER MOLDING • COMPLETE ASSEMBLY



Here are the features of the D-8 Oster Motor that account for its popularity

Housing: Die Cast Aluminum, open construction for natural ventilation. Totally enclosed housings available with reduced motor ratings.

Finish: Black Anodized.

Weight: 1 pound, 14 ounces.

Bearings: High quality single shielded ball bearings lubricated with grease suited for any specific application. Bearing housings fitted with steel inserts.

Mounting: Standard 1¼" Dia. air corps rabbet.

M-19

Brushes: High grade metal graphite of ample size to assure unusually long brush life.

Windings: Available in shunt, series and split series reversible, 12 and 24 V., intermittent and continuous duty. Also furnished with series winding for use on 115 V. AC/DC.

Temperature Rise: 55° C. Maximum frame temp. rise at rated load.

Modifications: Special shaft extensions, mounting arrangements, leads, etc. . . . also furnished for operation in high ambient temperatures and high altitudes.

- **Let us help you fit this or other Oster Motors to your requirements.**

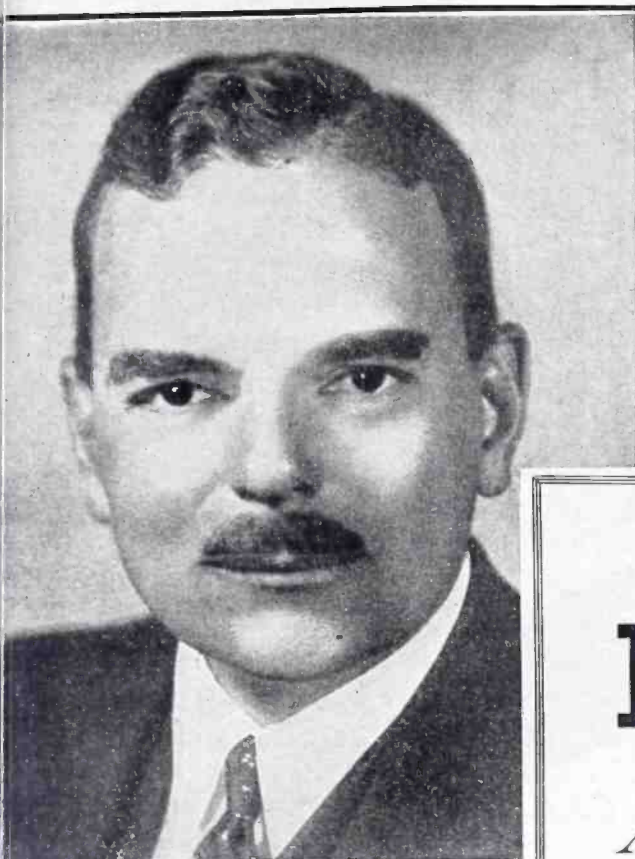
All data and ratings are approximate.

Oster FRACTIONAL H.P. ELECTRIC MOTORS

John Oster Manufacturing Co.

DEPARTMENT L-19 • RACINE, WISCONSIN

JUST PUBLISHED BY McGRAW-HILL



WALTER TROHAN, in the *Chicago Tribune*, says:

> "For those who desire to become acquainted with the Republican candidate for President and what he stands for, this is a must book."

New York Journal-American:

> "a straightforward picture of the Republican Presidential nominee without the usual worshipful embellishments to which most biographers are prone."

MARQUIS CHILDS, in the *N. Y. Herald-Tribune*, says:

> "the Dewey story is here skilfully put together, and to many readers parts of it will be new."

DEWEY

An American of this Century

By STANLEY WALKER

A full-length, authoritative, highly readable study of the Republican candidate, written by a veteran newspaperman. Here is the amazing record of the G. O. P.'s fighting standard-bearer . . . here are his principles and beliefs . . . here we see him at work and at play, in struggle and triumph. Supplemented by 45,000 words of excerpts from Dewey's major speeches and statements. $2.50.

Other McGRAW-HILL *ooks of Current Interest*

Raymond Clapper: WATCHING THE WORLD

Edited and with a biographical sketch by Mrs. Raymond Clapper. Introduction by Ernie Pyle. $3.00.

ASIA'S LAND AND PEOPLES

By George B. Cressey, Syracuse University. A geography of one-third the earth and two-thirds its people, with considerable attention to postwar aspects of geostrategy. $5.50

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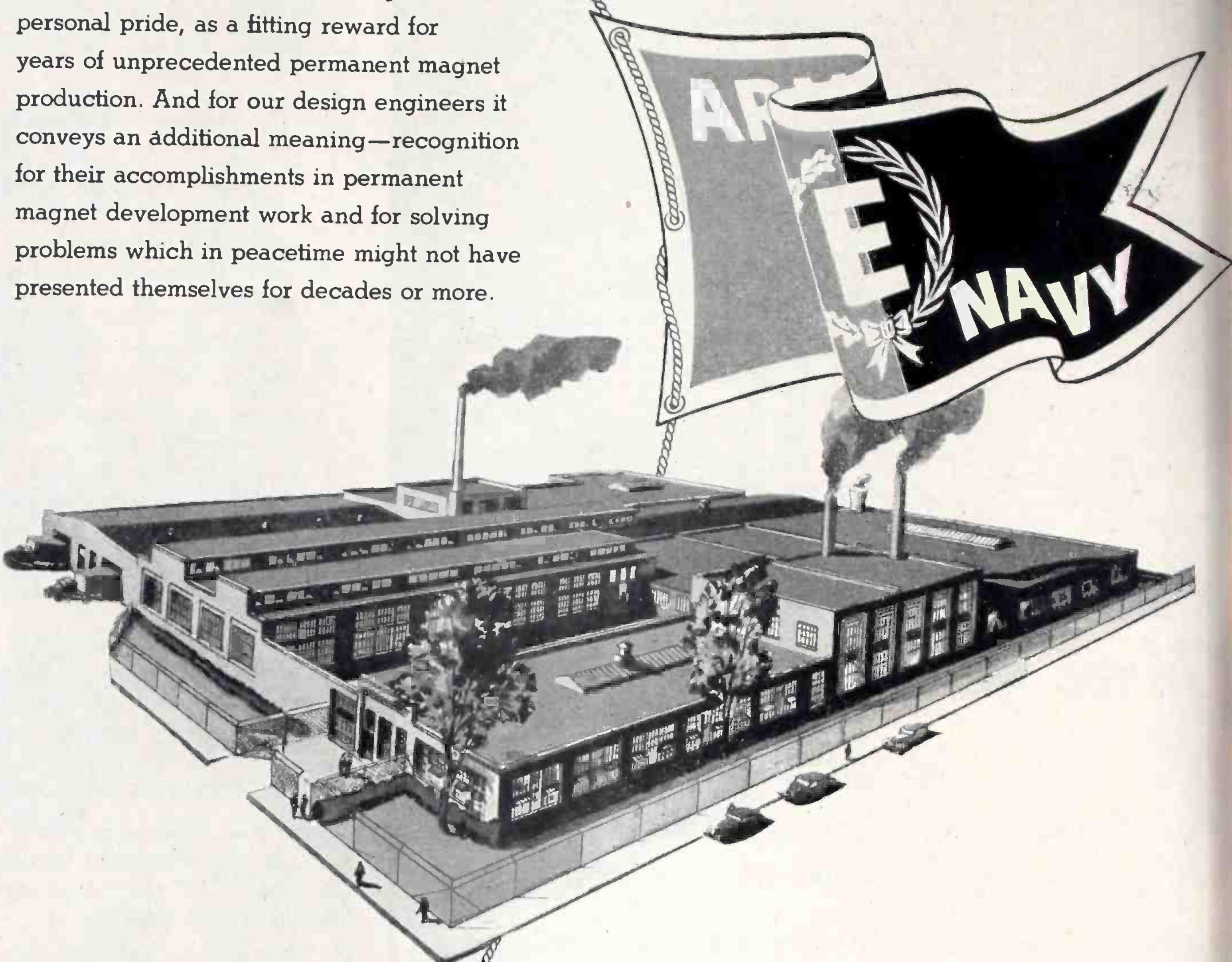

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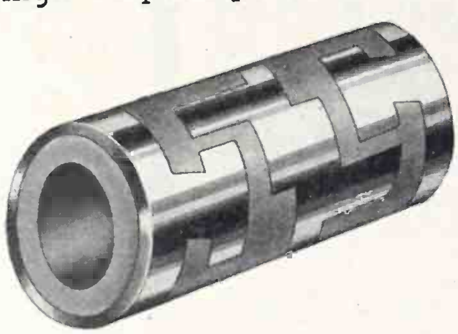

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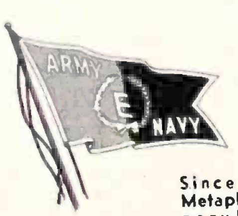

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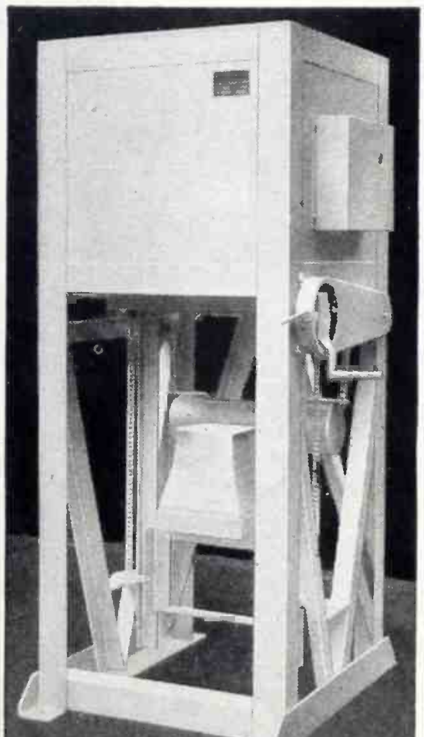

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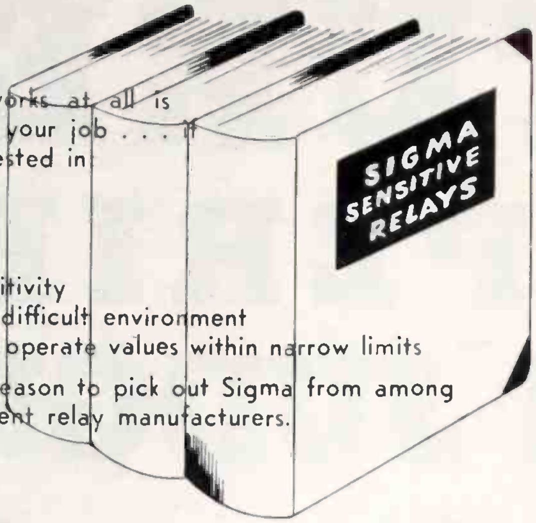

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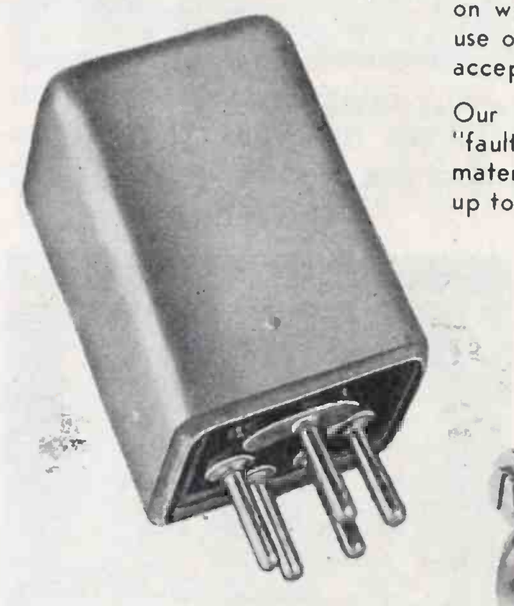

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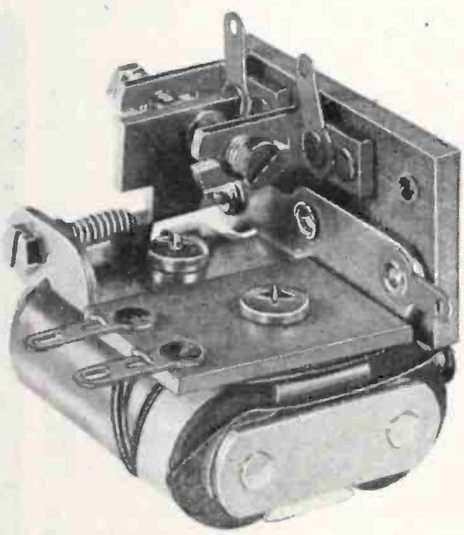

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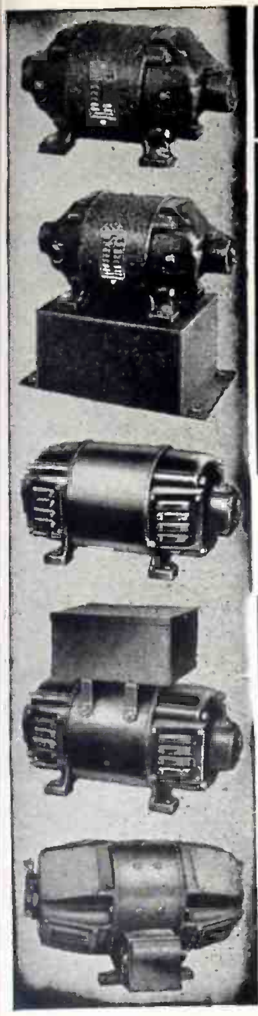

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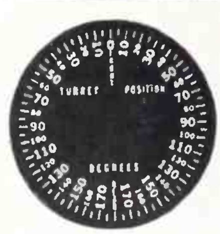

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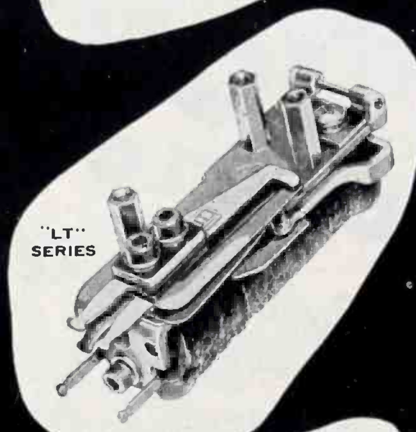

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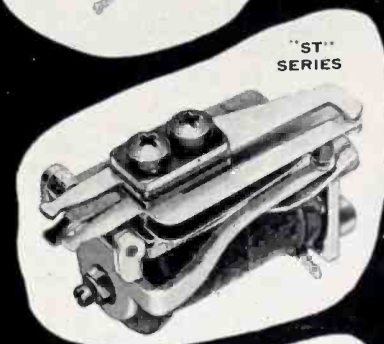

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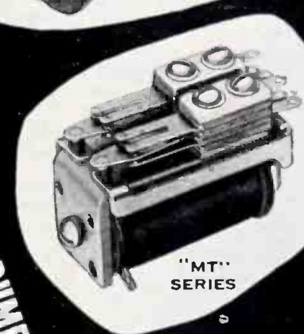

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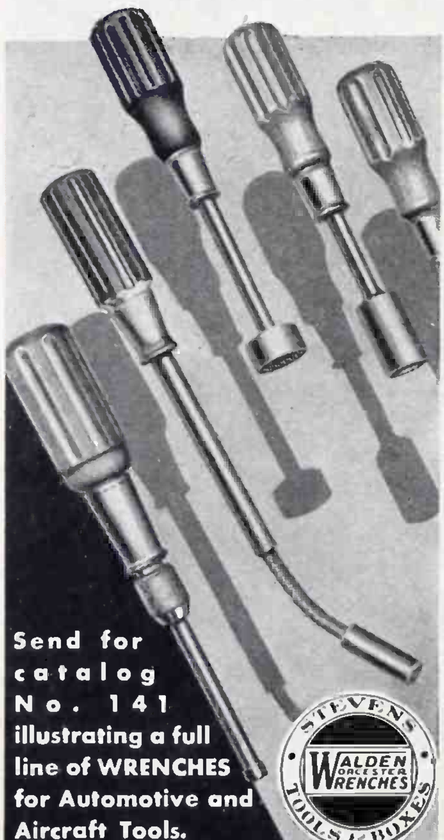

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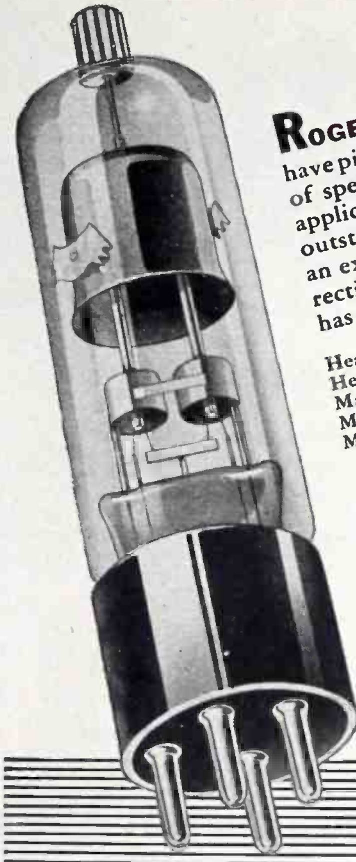

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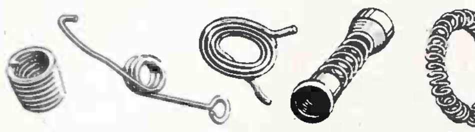

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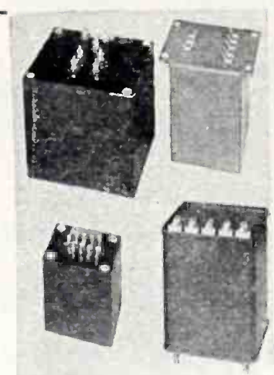

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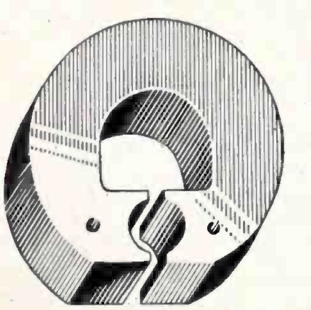

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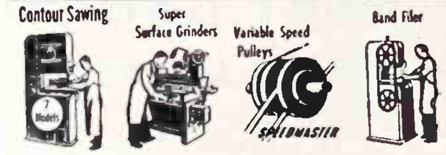

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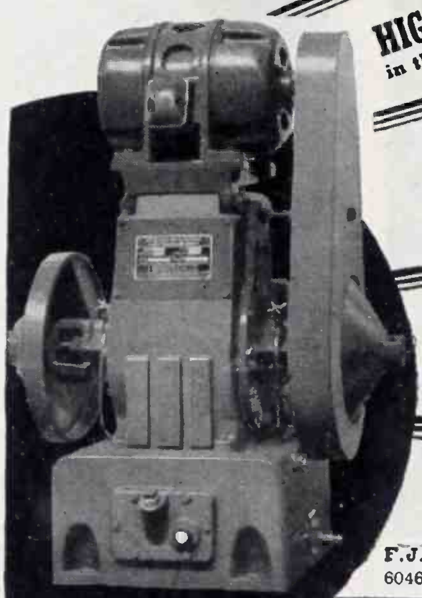

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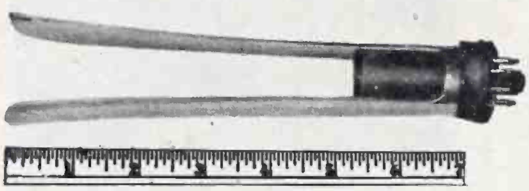

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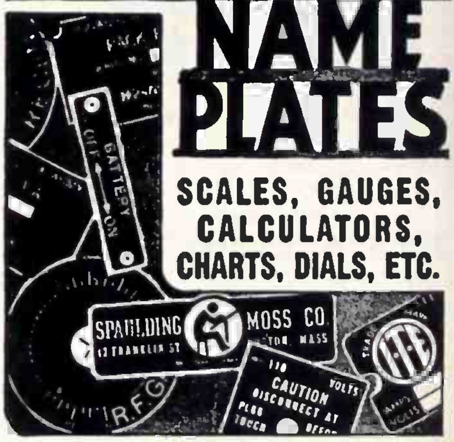

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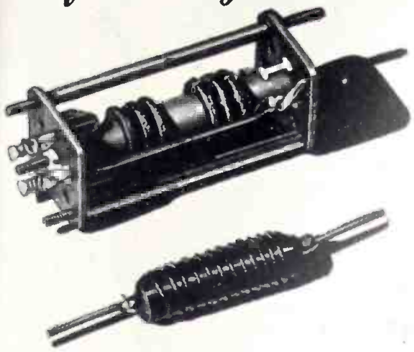

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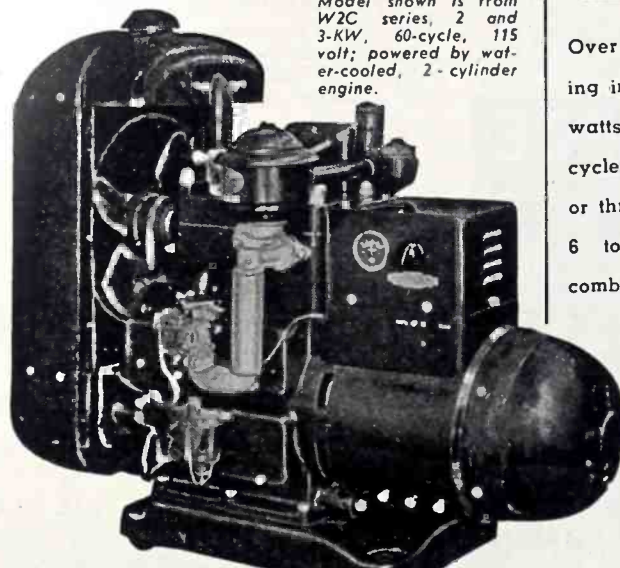

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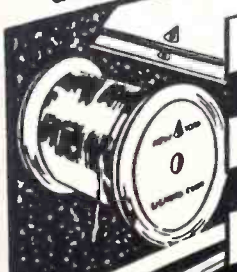

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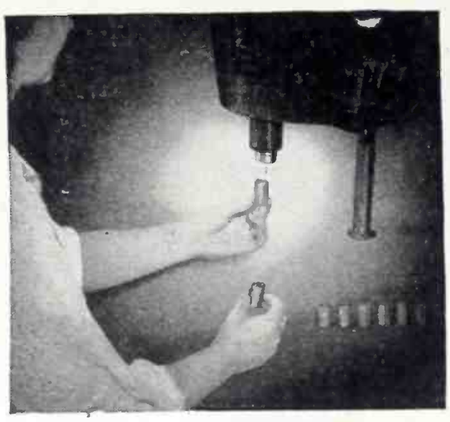

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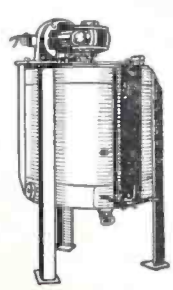

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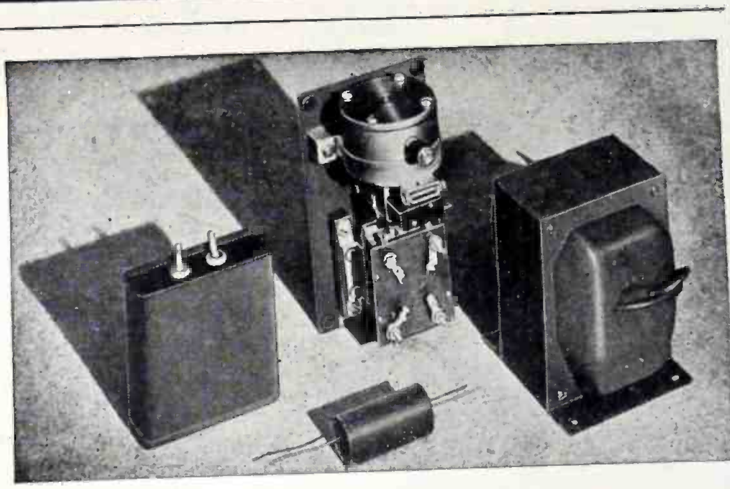

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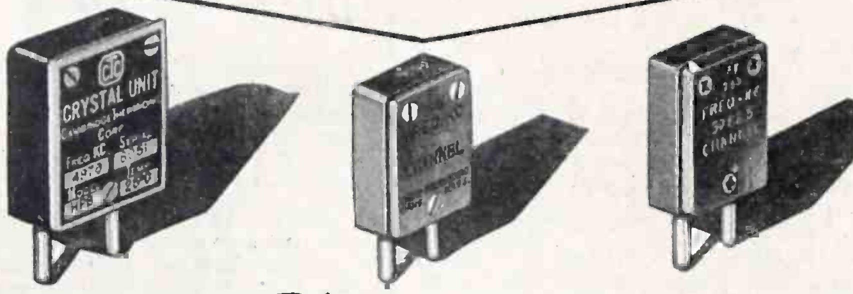

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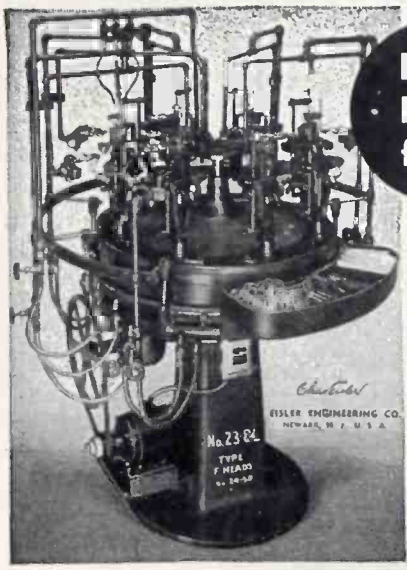

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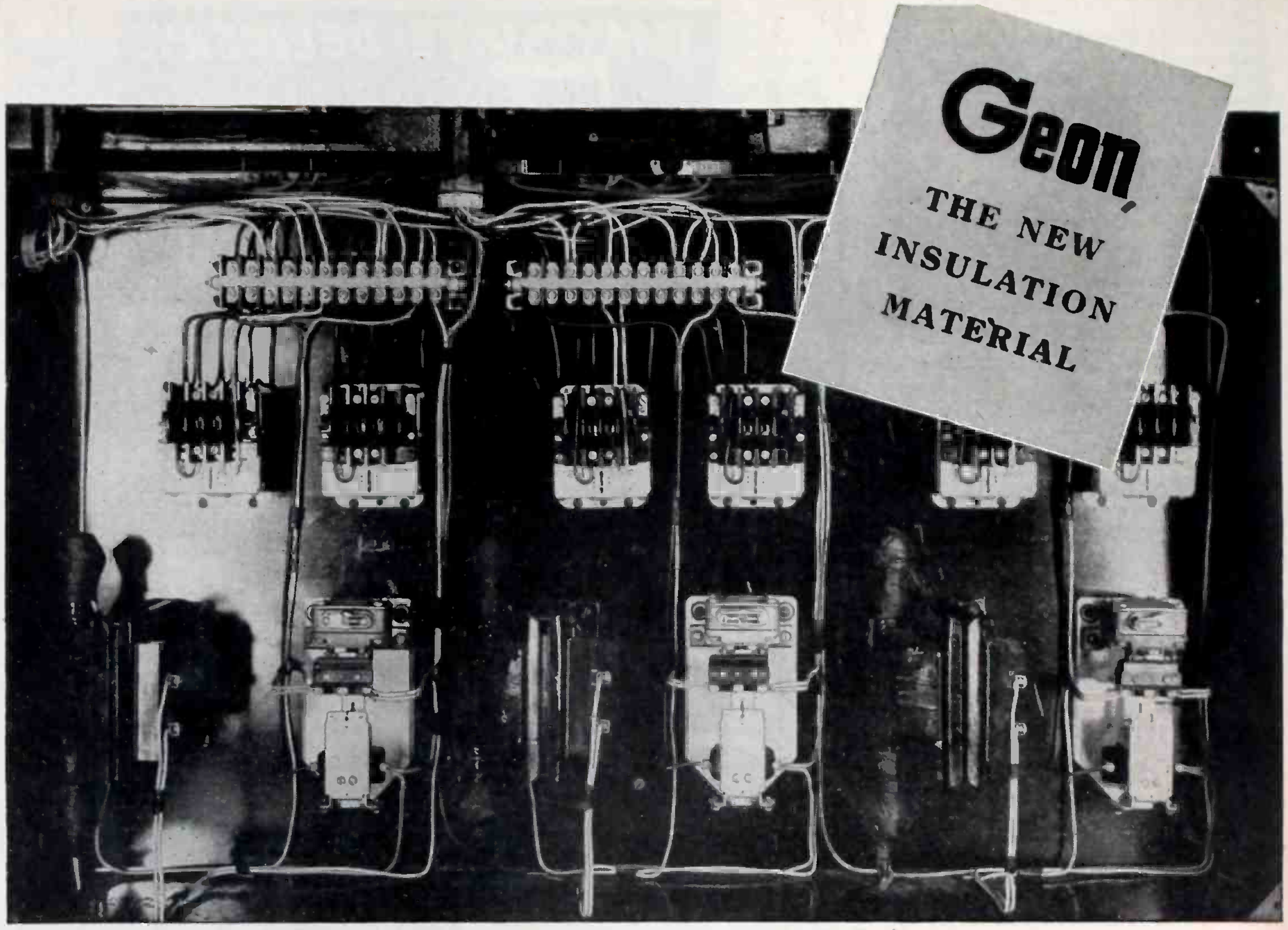

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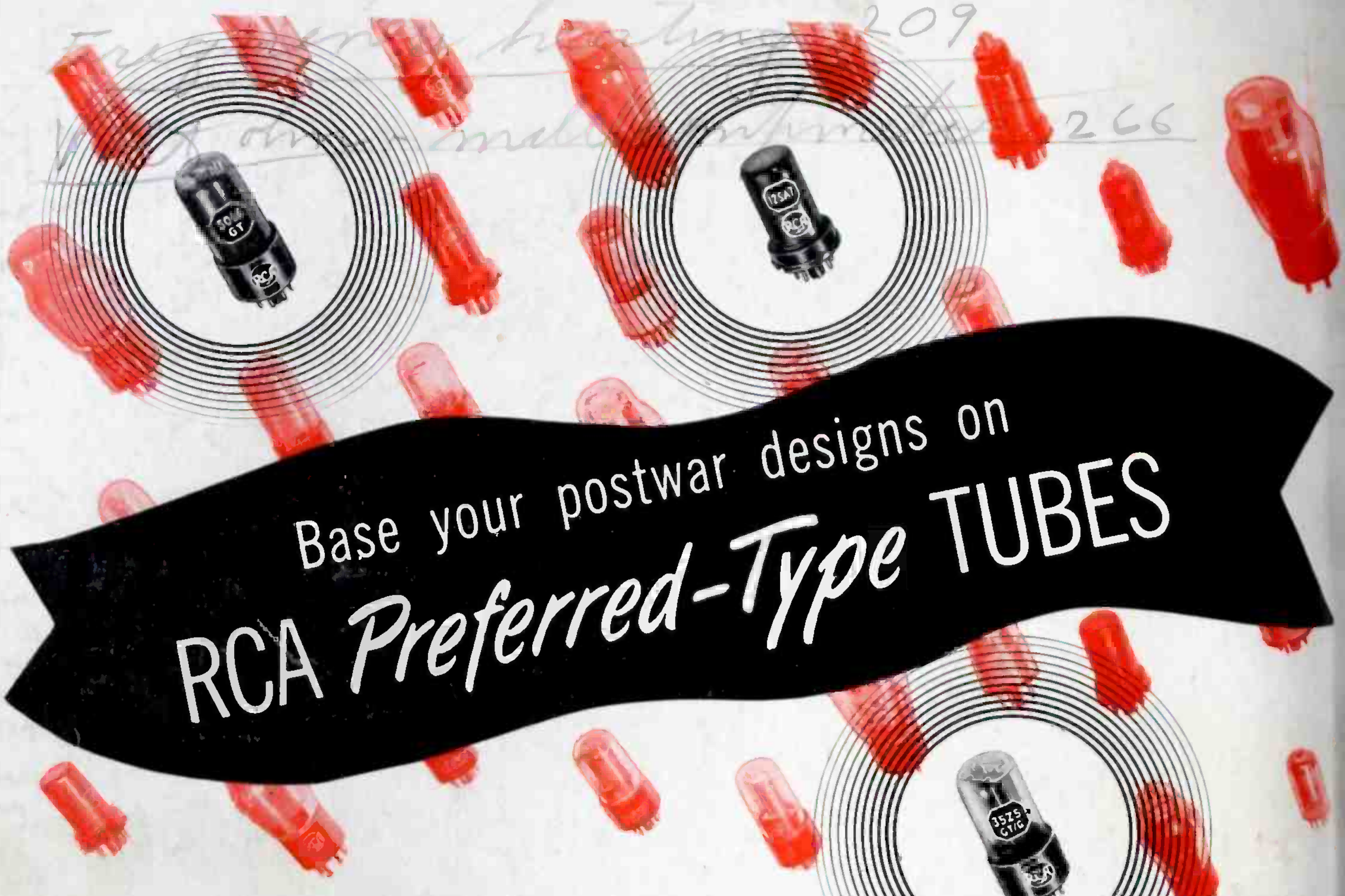

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