NOVEMBER · 1942

electronics

radio, communication, industrial applications of electron tubes . . . engineering and manufacture

"THE MOVING FINGER WRITES—"

Exploring head of electronic surface analyzer records a trace showing irregularities of razor blade edge

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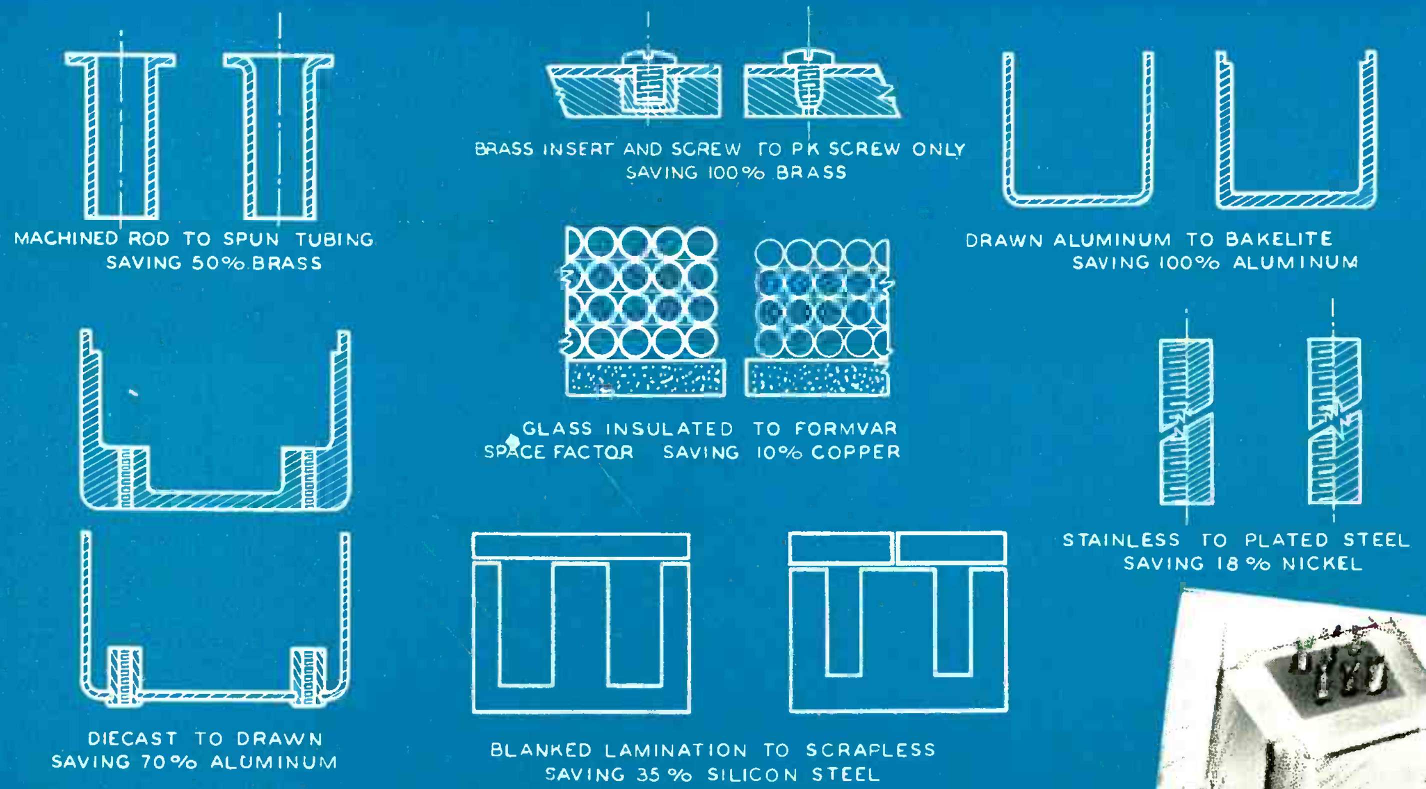

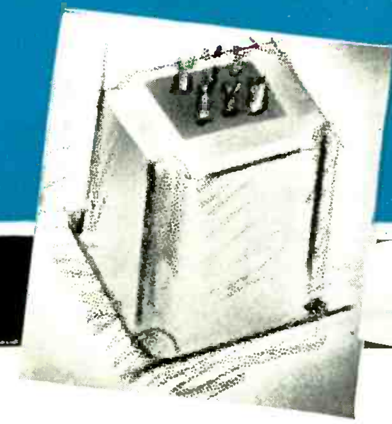

"and it can win or lose the war...

We all know that our greatest problem today lies in material shortages. The bulk of this problem . . . and it can win or lose the war . . . lies in our hands. A waste of materials, particularly critical materials, in an engineering design today, is as damnable as sabotage.

Here are a few cases in our organization:

1. **On one job our redesign combined two pieces of apparatus. The resultant unit, while more efficient, is smaller than either of the individual units. On the basis of projected requirements, the saving in aluminum alone is 500,000 lbs.**
2. **On this job our delivery schedule would have been delayed five months for the nickel iron core material and shielding cases required. Redesign made possible a unit using silicon core material and silicon shields with actually 10 DB less hum pickup than the original.**
3. **In this job substitution of a drawn aluminum housing for a die casting effected an aluminum saving of 70%.**

Designs must be improved constantly. Take a look at that job you have been running and see whether an extruded rod or a spun bushing won't save the scrap involved in a screw machine part. Check with the Government Engineering Bureau involved as to whether they would not allow a change in material to something lower on the critical list. You will be surprised at their cooperation.

Only when you can say to yourself, "There isn't one of my designs left that can be reduced in amount of material or to less critical materials," can you feel that your share in the War Program is effective.

UNITED TRANSFORMER CO.

150 VARICK STREET ★ NEW YORK, N. Y.

EXPORT DIVISION: 100 VARICK STREET NEW YORK, N. Y. CABLES: "ARLAB"

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electronics

CONTENTS
November 1942

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. . . .

To . . . .

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Signed . . . .

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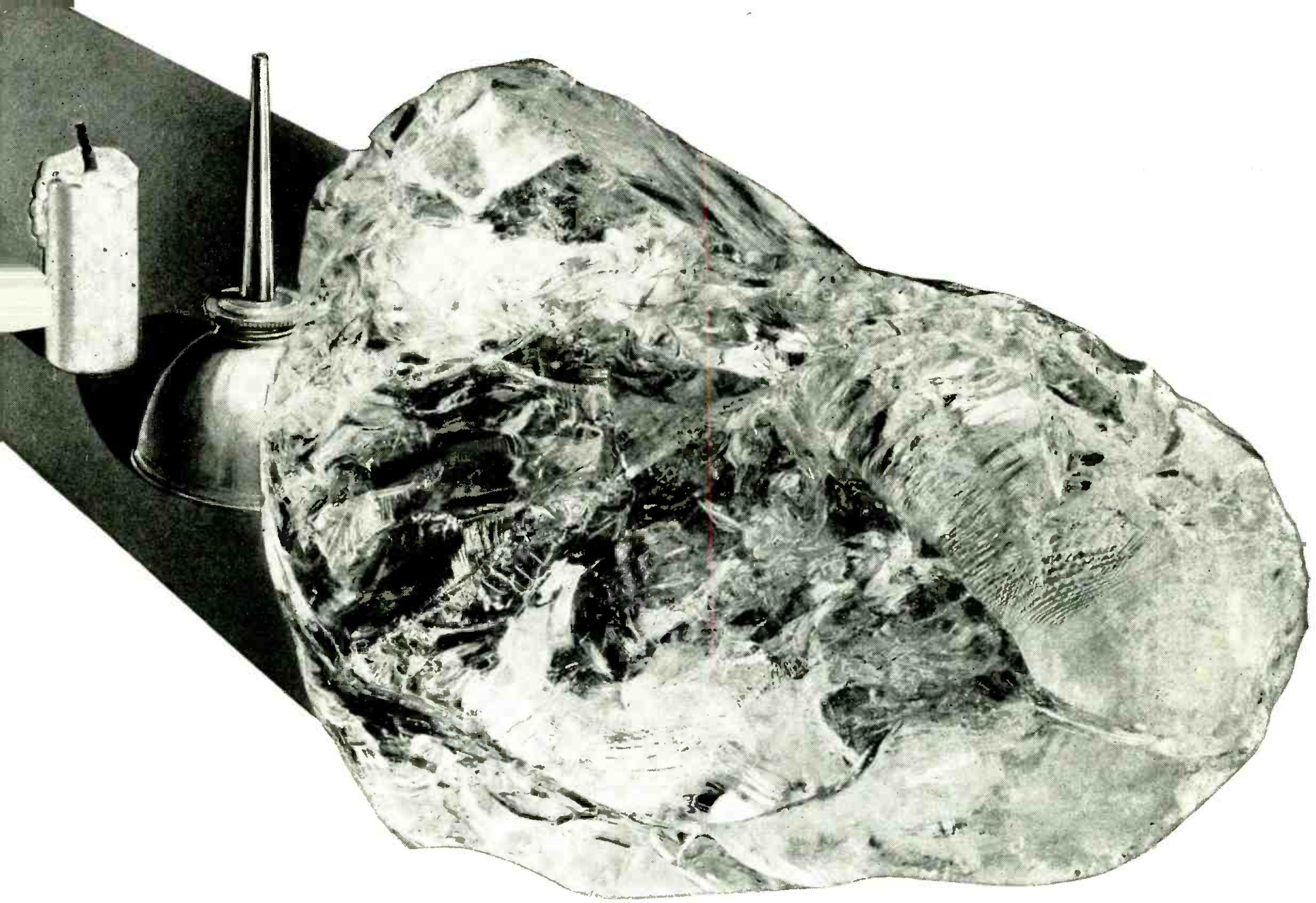

This *permanent* tracing paper is transparentized with *Albanite*

No oil, no wax—but a remarkable new transparentizing agent developed in the K&E laboratories—produces this truly permanent tracing paper! ALBANENE is made of 100% long fiber pure white rags—treated with *Albanite*—a new crystal clear synthetic solid, physically and chemically inert. ALBANENE will not oxidize, become brittle or lose transparency with age.

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Make ALBANENE "prove it" on your own drawing board. Ask your K&E dealer or write us for an illustrated brochure and generous working sample.

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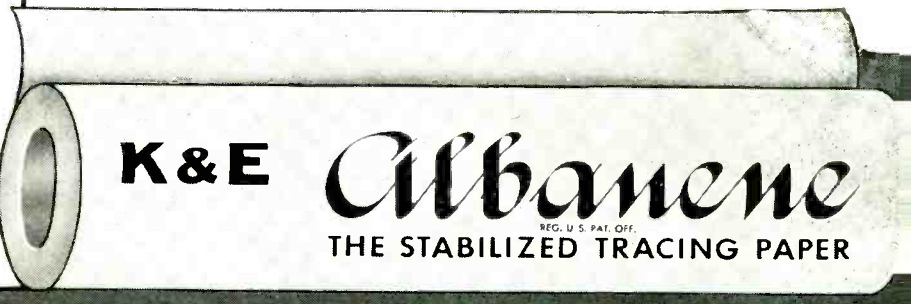
VEGETABLE OIL, chemically unstable, oxidizes easily. Papers treated with vegetable oil become rancid and brittle, turn yellow and opaque with age.

ALBANITE is a crystal-clear synthetic solid, free from oil and wax, physically and chemically inert. Because of this new stabilized transparentizing agent Albanene is unaffected by harsh climates—will not oxidize with age, become brittle or lose transparency.



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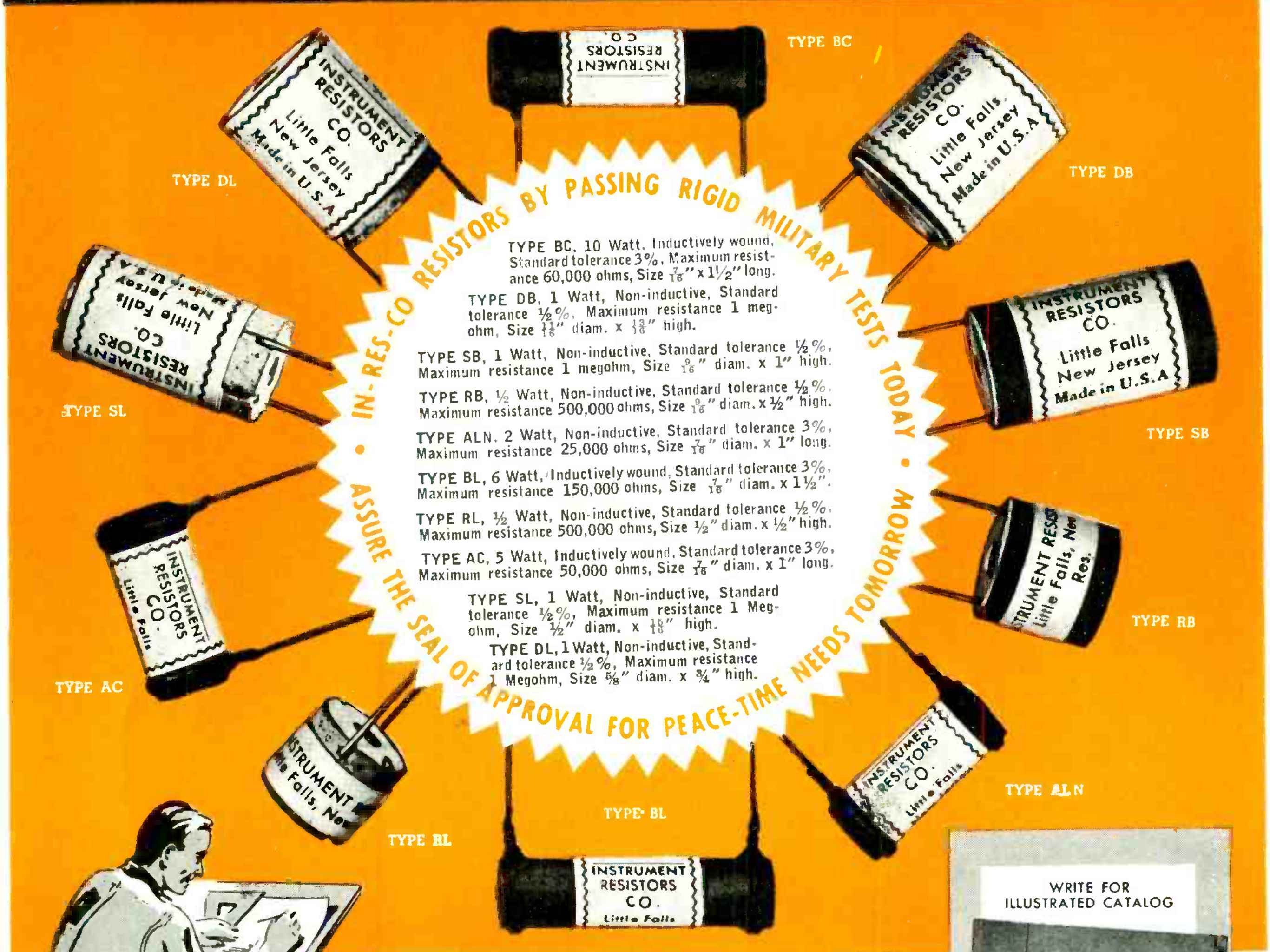
Here are ten good reasons *why you can plan ahead...now!*



Post-War Planning Is Simplified With These Application-Designed Resistors

The electrical and dimensional advantages of these specialized resistors—products of Instrument Resistors Company—are diversified and numerous. All have been proved by actual use in ordnance and essential industrial applications.

That is why you can do your future designing and engineering now. You can be confident that these fixed and adjustable resistors, meter shunts, choke coils, meter multipliers, solenoids and special coils will meet your most exacting requirements.

Illustrated above are ten of these precision components—each application-designed to function efficiently under varying conditions. Each represents a definite reason for dependable operation in your products of the future.

By specialization, IN-RES-CO resistors effect substantial production economies which permit custom windings at stock prices. For large quantities on short notice . . . specify IN-RES-CO resistors.

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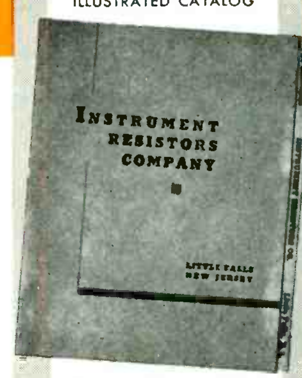

16 page catalogue will be sent promptly on request without obligation. Our engineers are available for collaboration in the solution of your resistor problems. Write today.

INSTRUMENT RESISTORS COMPANY
25 AMITY STREET, LITTLE FALLS, NEW JERSEY

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To man's stature in 8 years

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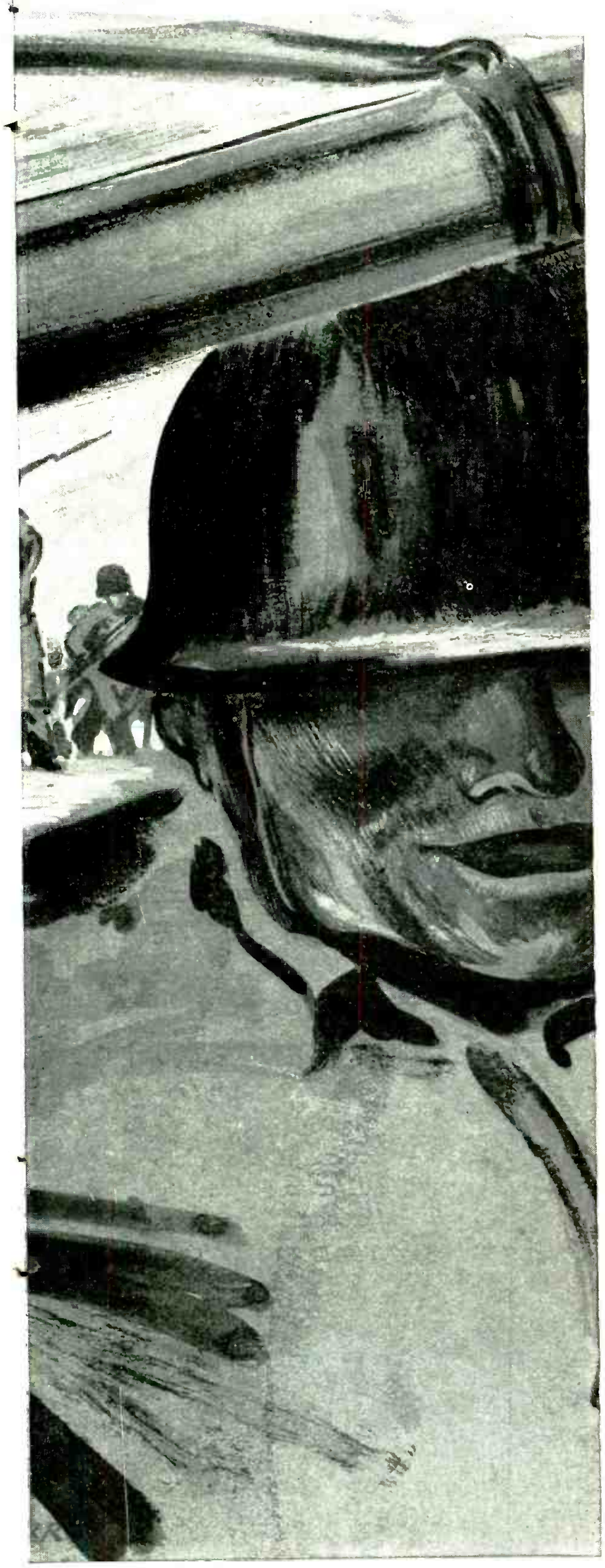
That which is past is gone and irrevocable, and wise men have enough to do with things present and to come.
BACON



SINCE PEARL HARBOR!

Superior might have done more
All Industry could have gone further
Every Government Agency set up to direct War Production hoped to do better
All U. S. Services—Army, Navy, Marines, Air Corps—expected more to be accomplished . . . *BY NOW*

★

But why cry about what might have been?

★

Let us follow Bacon's philosophy and be wise enough *"to do with things present and to come."*

★

With eyes front and no looking back our objective is more easily reached. Let us act like men, be vigorous and do away with petty things.

SUPERIOR

SUPERIOR TUBE CO., NORRISTOWN, PENNSYLVANIA

THE BIG NAME IN SMALL TUBING *for Uncle Sam!*

Tubing from 5/8" OD down...SUPERIOR Seamless in various analyses. WELDRAWN Welded and drawn Stainless. BRAWN Welded and drawn "Monel" and "Inconel". SEAMLESS and Patented LOCKSEAM Cathode Sleeves.

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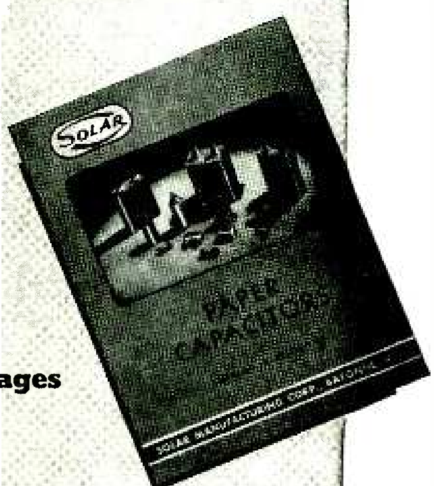
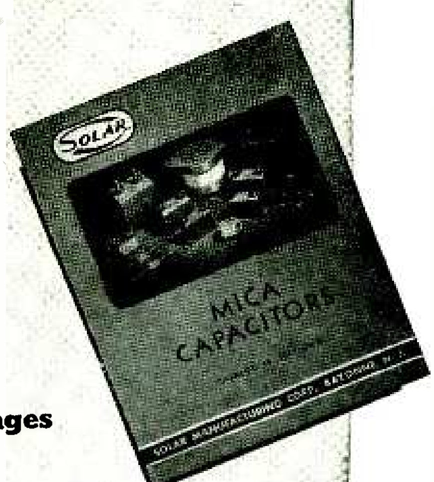
CAPACITOR GUIDES
FOR BUSY ENGINEERS . . .

32 pages



48 pages



32 pages

These new catalogs will help every engineer! They have been specially designed so that "he who runs may read" — and will simplify your capacitor-preference problems. Your letterhead request will immediately obtain any or all of the three catalog sections shown.

ELECTROLYTIC CAPACITORS:

Thirty-two page Catalog 12 — Section A. Complete illustrations and descriptions of both wet and dry electrolytics for every purpose. Includes special constructions, such as low-temperature types for Government and industrial requirements.

PAPER CAPACITORS:

Forty-eight page Catalog 12 — Section C. Complete illustrations and descriptions of all types of paper capacitors, including oil types, for broadcast and transmitting circuits. Also incorporates special types for unusual electronic applications.

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Industry color-coding standards are clearly defined in separate Solar Form MCC-1, available to all capacitor users.

SOLAR MFG. CORP. **Bayonne, N. J.**

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★ As the war goes on, the American engineer looks better and better. He has done some resoundingly important things, that may even dictate the future of the world.

He is an old friend of ours and we are glad to see him the center of admiration. For nearly 30 years we have worked with him adapting laminated plastic material to electrical insulation, mechanical and chemical uses.

Together we have produced better airplane pulleys and machined parts, better instrument panels, better insulation for ignition, radio and all types of electrical circuits, better rayon equipment and plating parts.

Now, in war, we are doing together things we didn't know how to do before, but which will be available and valuable when the last gun has been silenced.

FORMICA
INSULATION COMPANY
4661 SPRING GROVE AVENUE
CINCINNATI, OHIO

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Centralab *now Serves Itself and the Industry with STEATITE*

CENTRALAB has added a new plant of large capacity for the production of glazed and unglazed STEATITE.

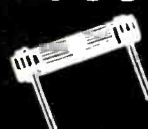
This highly critical, strategic material is an important factor in the operation of ultra high frequency equipment.

Centralab's STEATITE plant is in a position to furnish coil forms up to 5 inches diameter and pressed pieces to approximately 6 inches square. The same high standards of excellence will be maintained in this department that have characterized every other Centralab product during the past decades. The Centralab Ceramic department that has been in existence since 1930 has built up an extensive engineering, production and laboratory background to ensure a product of the highest quality that fully meets military specifications.

STEATITE is an extremely dense non-porous ceramic of high mechanical strength with low loss factor and low dielectric constant. It can be fabricated in various cylindrical and flat shapes by extrusion or pressing. Centralab is also equipped to engineer and manufacture other grades of ceramics.

CENTRALAB — Division of Globe-Union Inc., Milwaukee, Wis.

1930 Centralab pioneered a fixed resistor of "hard-as-stone" ceramic material.



1936 Centralab added a temperature compensating fixed condenser of ceramic material.

1940 Centralab added a trimmer condenser with temperature compensating characteristics

Ceramics by Centralab

1942 Centralab added a STEATITE plant to take care of its own needs and those of the industry.

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Transformers for Radio, Sound, Public Address, Television and Geophysical Applications

THERMADOR

A FAMOUS NAME IN ELECTRICAL PRODUCTS

A New Name in TRANSFORMERS

THERMADOR is well known in the field of electrical appliances—well known for engineering and quality built into numerous products serving the electrical industry all over America. Thermador now expands its services into the field of transformers.

Thermador combines the machinery, dies, equipment, inventory and many of the personnel of the well-known Los Angeles Inca Division of Phelps-Dodge Corporation with the facilities of their modern plant and now offers the industry transformers for radio, sound, public address, television and geophysical applications.

THERMATITE TREATED TO WITHSTAND HUMIDITY and EXTREME HEAT

Thermador transformers are Thermatite treated, which is a well tested and approved form of impregnation. This treatment, proved on thousands of transformers under severe climatic conditions, gives these units the resistance to constantly withstand extreme conditions of humidity and heat. This is particularly important at this time with their widened use in foreign countries where extreme temperatures and humidity exist.

ON SCHEDULE DELIVERIES AFTER NOVEMBER 1, 1942

Thermador transformer division is in complete and efficient operation and in a position to bid on priority requirements.

EXPERIENCED ENGINEERS AT YOUR COMMAND

Consider Thermador Electrical Manufacturing Co. your source of assistance in engineering and production of transformers to meet your specific requirements.

THE THERMADOR TRANSFORMER LINE Included in the Thermador Transformer line are audio, auto, geophysical, bias supply, bridging, cathode modulation, coupling, driver, field supply, filament, high fidelity audio, input, midget plug-in audio, mixing and matching, modulation, output, plate, power (combined plate and filament), television and tube-to-line transformers. Also manufactured are filters, chokes, and reactors (audio and equalizing).

THERMADOR TRANSFORMERS

THERMADOR ELECTRICAL MANUFACTURING CO.
5119 S. Riverside Drive, Los Angeles, Calif.

REPRESENTATIVES—Les Logan, 530 Gough St., San Francisco, California
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"Seven Leagues Ahead"

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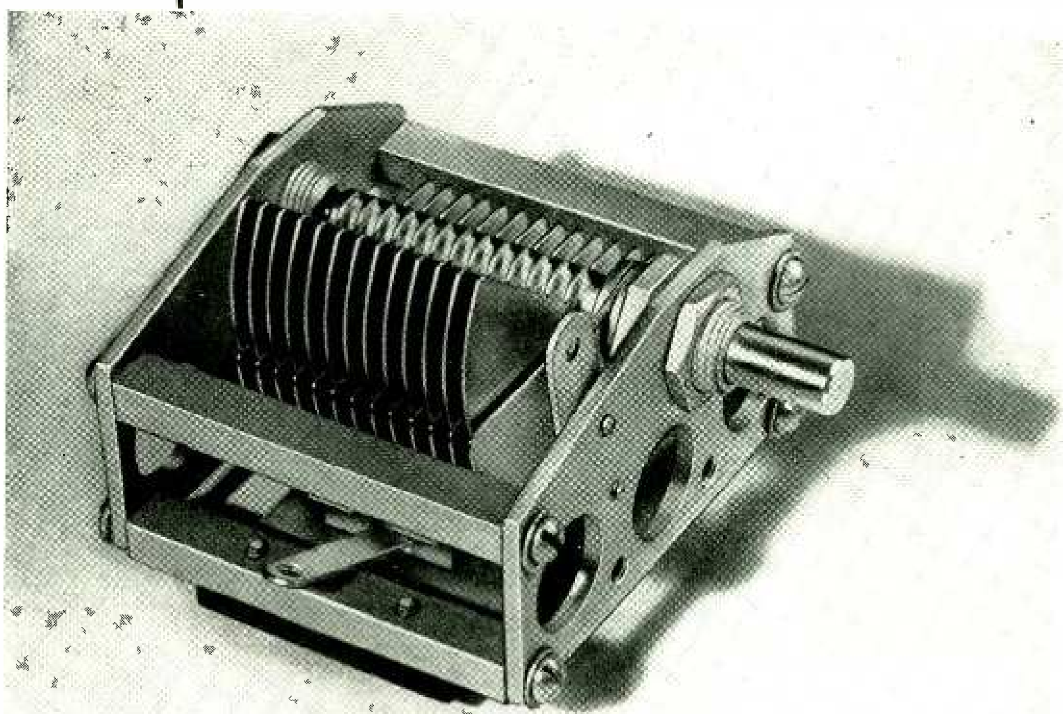
PRECISE CONTROL



Typical precision midget condenser

HAMMARLUND variable condensers are used for precise frequency control in the most advanced transmitting and receiving apparatus the world has ever known. We are proud that our products meet and maintain such high standards as are required in modern military equipment.

THE HAMMARLUND MANUFACTURING CO., INC.
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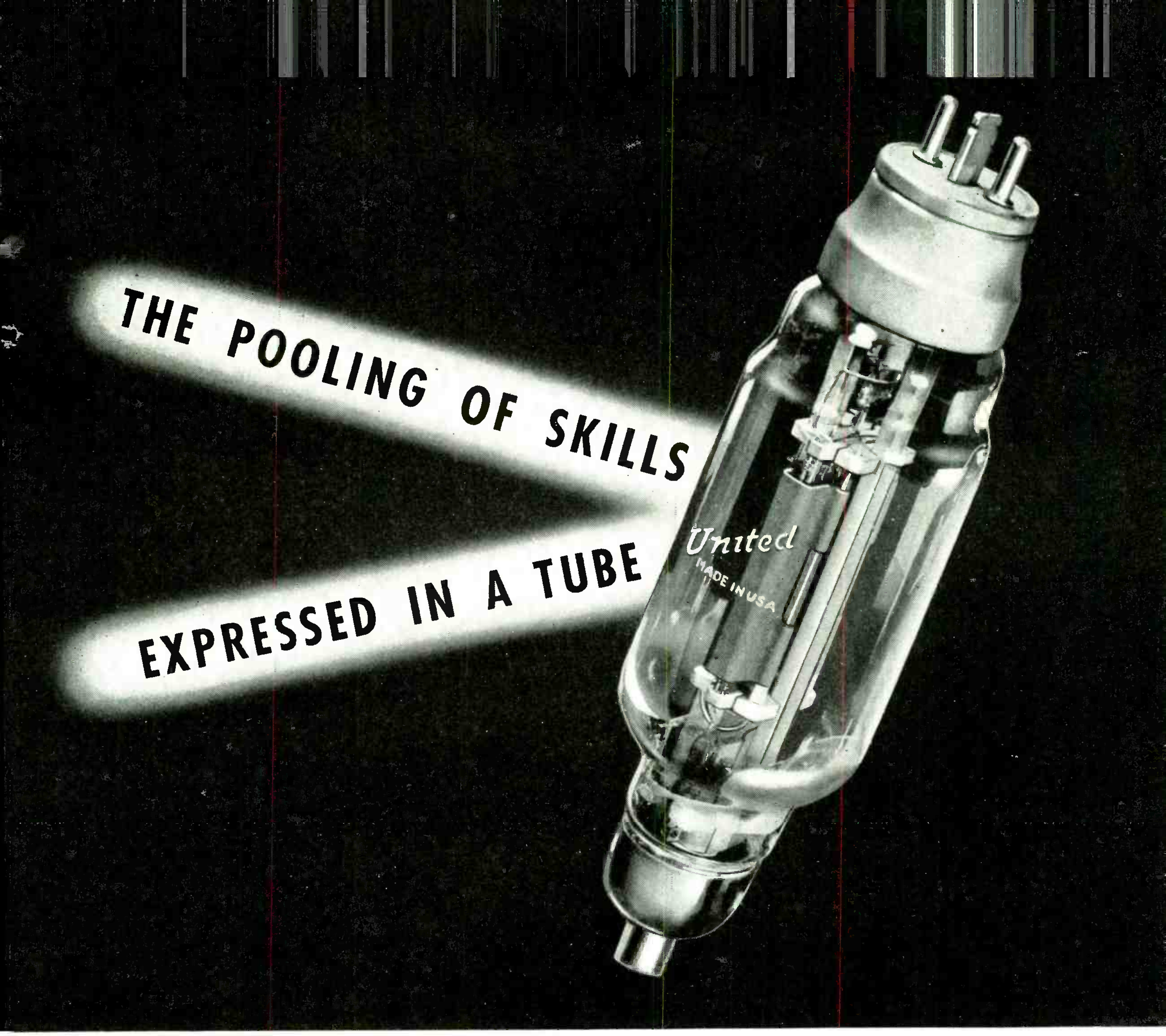

LONG BEFORE "UNITED" symbolized the might of Nations at War, the term possessed a vital significance in electronics.

"United" expressed the vision of a company that undertook to pool, under one roof, the skills of distinguished technicians, engineers and craftsmen, specializing solely in transmitting tubes.

Under the scrutiny of these electronic specialists have come scores of transmitting tubes, built to a degree of precision, hitherto unknown.

Today, the products of "United" are performing flawlessly in key sockets in countless transmitting instruments of our armed forces. Tomorrow—tempered under the fire of war—"United" products of advanced technical design will meet the exacting post-war requirements of Radio Communications, Physiotherapy and Industrial Electronics. Look for the name "United" on each tube.

UNITED ELECTRONICS COMPANY

NEWARK NEW JERSEY

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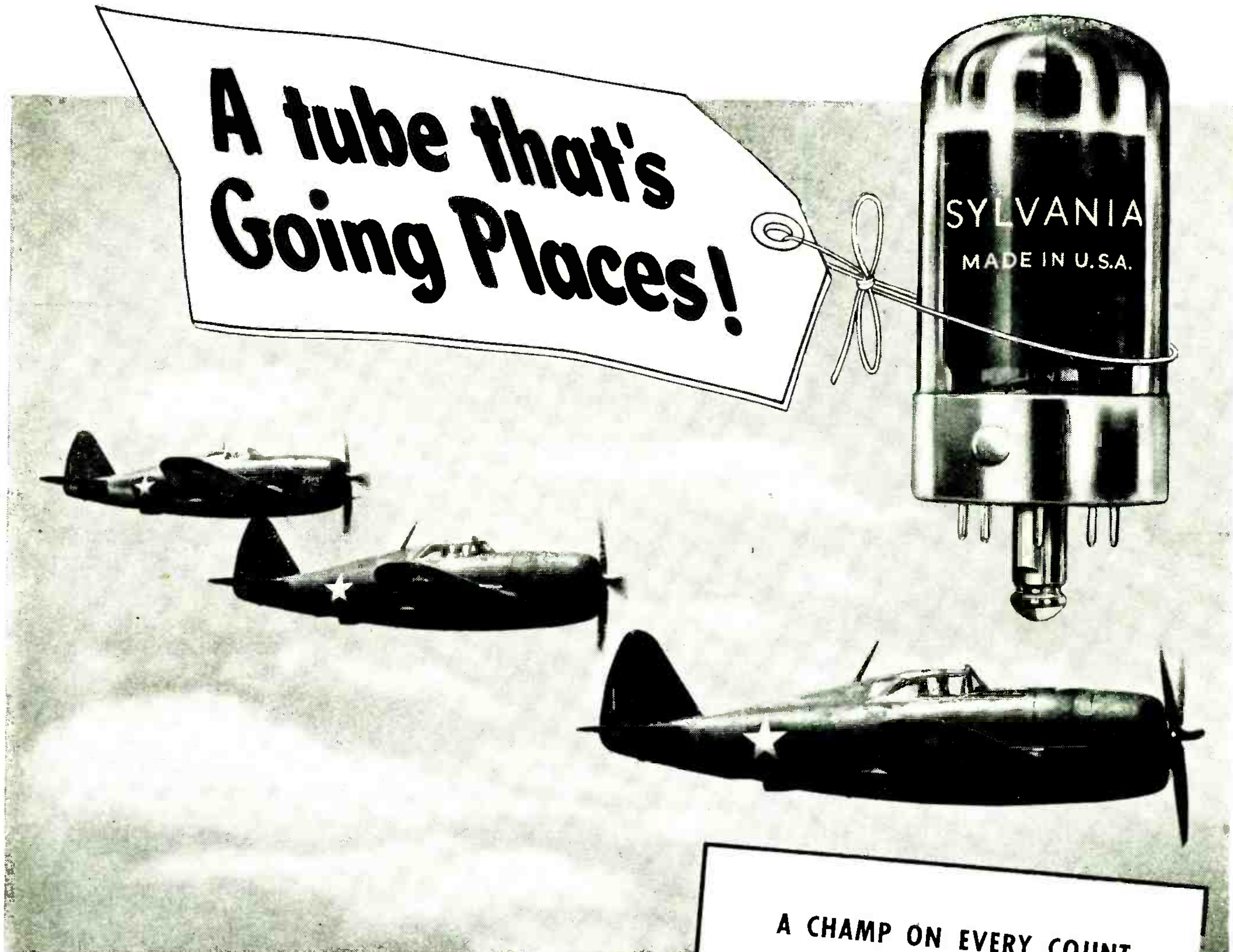

A CHAMP ON EVERY COUNT

1. **LOCK-IN LOCATING LUG**—*also acts as shield between pins.*
2. **NO SOLDERED CONNECTIONS**—*all welded for greater durability.*
3. **SHORT, DIRECT CONNECTIONS**—*fewer welded joints—less loss.*
4. **ALL-GLASS BASE**—*low loss and better spacing of lead wires.*
5. **NO GLASS FLARE**—*unobstructed base for internal shielding.*
6. **IMPROVED MOUNT SUPPORT**—*ruggedly mounted on all sides.*
7. **GETTER LOCATED ON TOP**—*shorts eliminated by separation of getter material from leads.*
8. **NO TOP CAP CONNECTION**—*overhead wires eliminated.*
9. **REDUCED OVER-ALL HEIGHT**—*space saving.*

THE radio tube you see here is called the Lock-In. It's a good tube and a tough one. It better be!

For the Lock-In is in the thick of things on every war front. In the upper skies with the bombers, in the dizzy maelstrom of desert conflict, in the bedlam of large-scale encounters of tanks, jeeps, armored cars —wherever the fighting is heaviest—this robust tube is depended upon for vital radio reception.

In electronic and high-frequency applications, too, the Lock-In is stoutly meeting today's heavy assignments.

And as we study it under these grueling tests, we learn things about the Lock-In that hold promise— after the war—of an even finer and better product for peacetime use.

RADIO
TUBE DIVISION

SYLVANIA ELECTRIC PRODUCTS INC.

Formerly Hygrade Sylvania Corporation

EMPORIUM, PA.

Incandescent Lamps, Fluorescent Lamps and Fixtures, Radio Tubes, Electronic Devices

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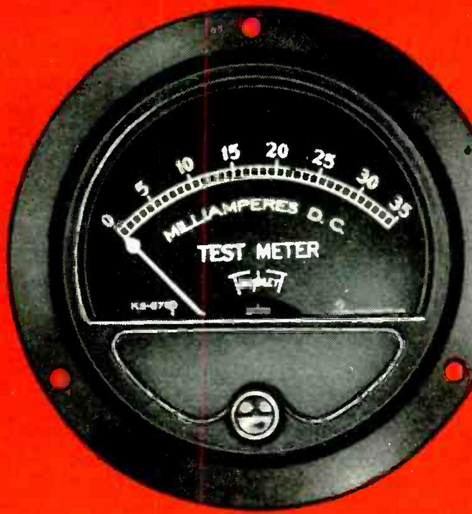
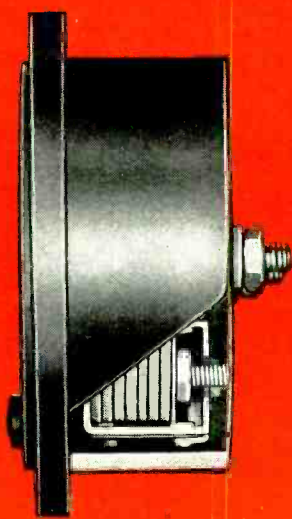
When Space is at a Premium

TRIPLETT *Thin Line* INSTRUMENTS

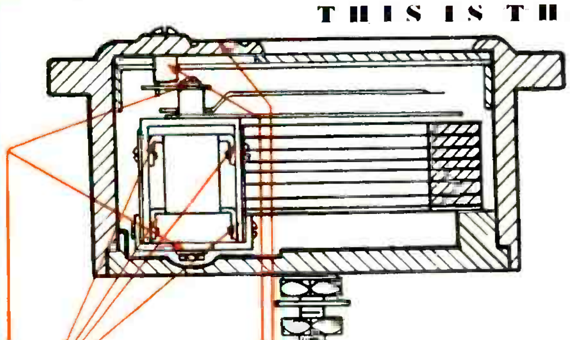


Full size of Instrument. Note deep shroud for glass protection—and "Quick-Look" Scale.



This molded case contains *full size* Triplett Mechanism. Rugged Construction—Compact Convenience.

THIS IS THE INSIDE STORY

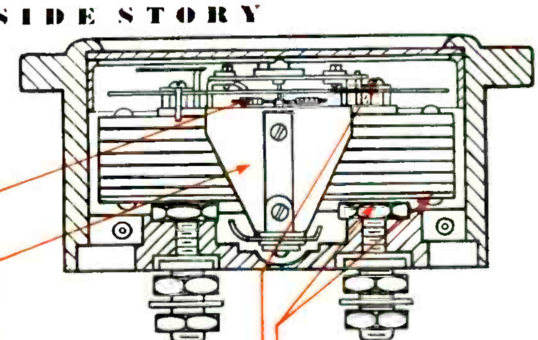


1 Four-point Core Support

2 Full Metal Bridges on Top and Bottom

3 Bezel Shroud Eliminates Unwanted Glare

4 One-piece Formed Spring Zero Adjustment



5 Balanced Frame Construction

6 Solid Balance Cross with Screw-type Balance Weights

7 Four-point Rigid Magnet Clamping

8 Separate Dial Mounting Independent of Top Bridge

Thin-Line Instruments also have Standard Large Coil Triplett Movements. Furnished with Osmium pivots for special requirements. All these features make for greater rigidity under vibration; greater permanence of calibration; greater user satisfaction.

TRIPLETT *Thin-Line* memo

PLEASE INSERT INITIALS OF YOUR EXECUTIVES

FOR CIRCULATION TO...

Triplett Thin-Line Instruments meet rigid requirements for dependable performance. Though occupying minimum space they are *not* miniatures. Mechanisms are standard size with emphasis on excellent performance over long periods. Standardized installation. Made in three styles of cases — Molded, Metal Wide Rim and Metal Narrow Rim.

Triplett Thin-Line Instruments, available for many industrial applications, can be depended upon for precision performance in limited space. For full details write for "Triplett Thin-Line Bulletin".

THE TRIPLETT ELECTRICAL INSTRUMENT CO., BLUFFTON, OHIO, U. S. A.

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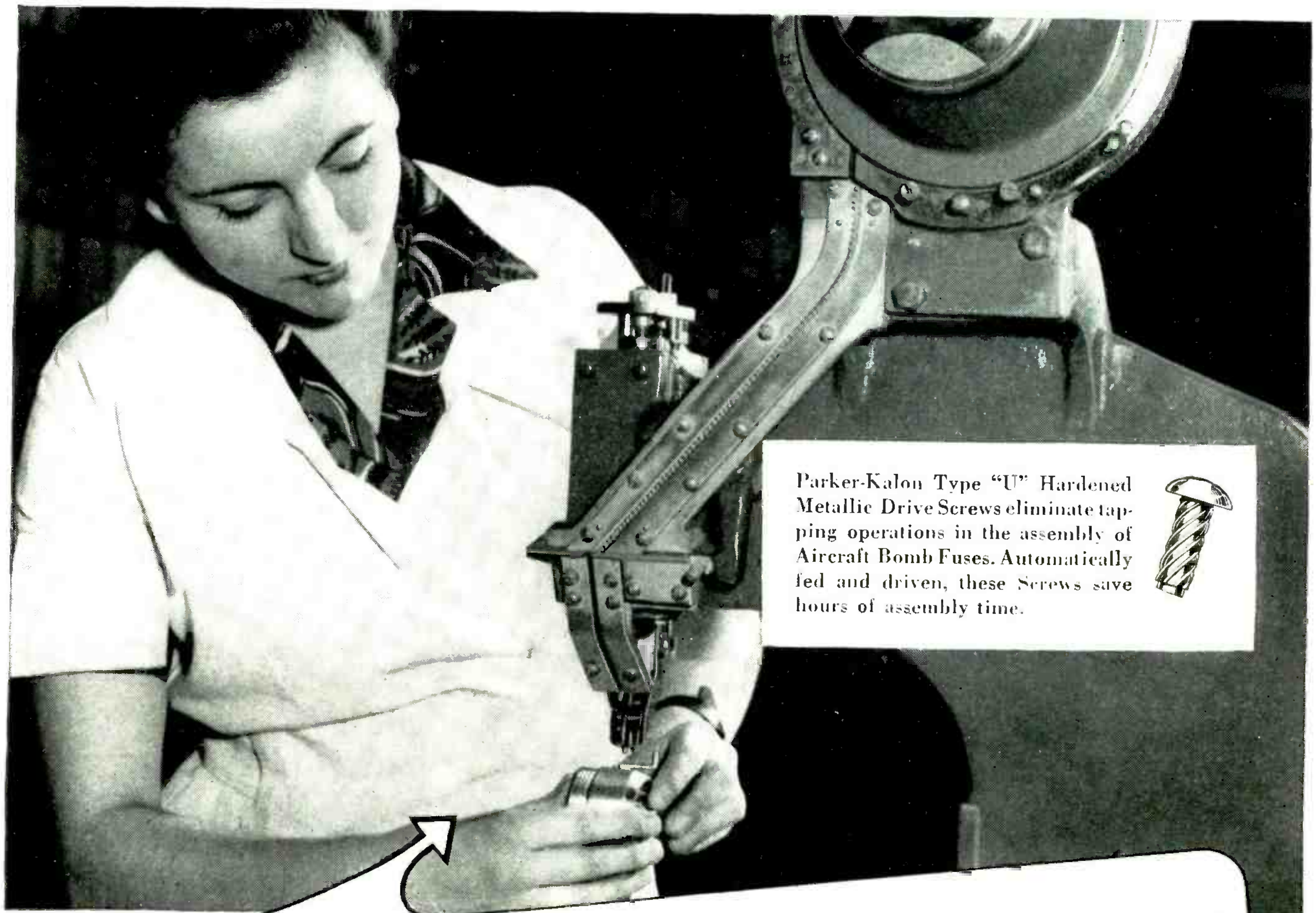

Saving Operations ON IMPORTANT WAR ASSEMBLIES... WITH THE RIGHT TYPE OF P-K SELF-TAPPING SCREW!

No matter what you're producing for the fighting forces – bomb fuses, field kitchens, gun sights, radio transmitters, machine guns or range-finders – there's a type of Parker-Kalon Self-tapping Screw that will help you *save operations* and cut *assembly time!* No matter what material you're working with – plastics, die castings, sheet steel, aluminum, bronze or brass – Parker-Kalon Self-tapping Screws will give you stronger fastenings, *while eliminating costly, time-consuming tapping operations.* You'll gain valuable time, too, when you cut out the fumbling that goes with using bolts and nuts – when you put P-K Screws on the job instead of trying to rivet in hard-to-get-at-places!

Parker-Kalon's rigid control over screw quality is another time-saver to war-busy industries. Every Parker-Kalon Self-tapping Screw is guaranteed to drive easily and hold tight! "Doubtful screws" – screws that *look all right* but fail to *work right* have been eliminated by the Parker-Kalon Laboratory's thorough check-up routine.

Call in a Parker-Kalon Assembly Engineer to study your fastening problems – chances are that he can quickly help you find ways to speed up your assemblies with the proper use of Parker-Kalon Self-tapping Screws. Parker-Kalon Corporation, 192-194 Varick Street, New York, N. Y.

PARKER-KALON
Quality-Controlled
SELF-TAPPING SCREWS

Give the Green Light to War Assemblies

SELF-TAPPING SCREWS FOR EVERY METAL AND PLASTIC ASSEMBLY . . . AND OTHER FASTENING DEVICES

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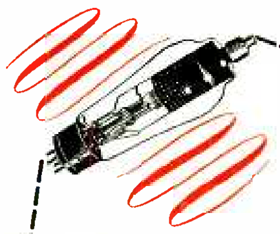

PUTTING ELECTRONICS TO WORK

OUR NO. 1 JOB TODAY

You who know the important jobs electronics are doing today, realize that our No. 1 job is to supply the Army, Navy and War Industries with the tubes required to win this war.

Westinghouse technicians in research, engineering and manufacturing are working round the clock to meet the schedules and anticipate future requirements.

YOUR NO. 1 PLAN FOR TOMORROW

These same Westinghouse technicians will be richer in electronic knowledge and experience and prepared to apply the magic of electronic tubes to your peace time problems, when the war is won.

And Westinghouse electronic tubes will be available for all types of electronic applications, designed and manufactured by men who know how to put electronics to work.

Westinghouse

ELECTRONIC TUBES

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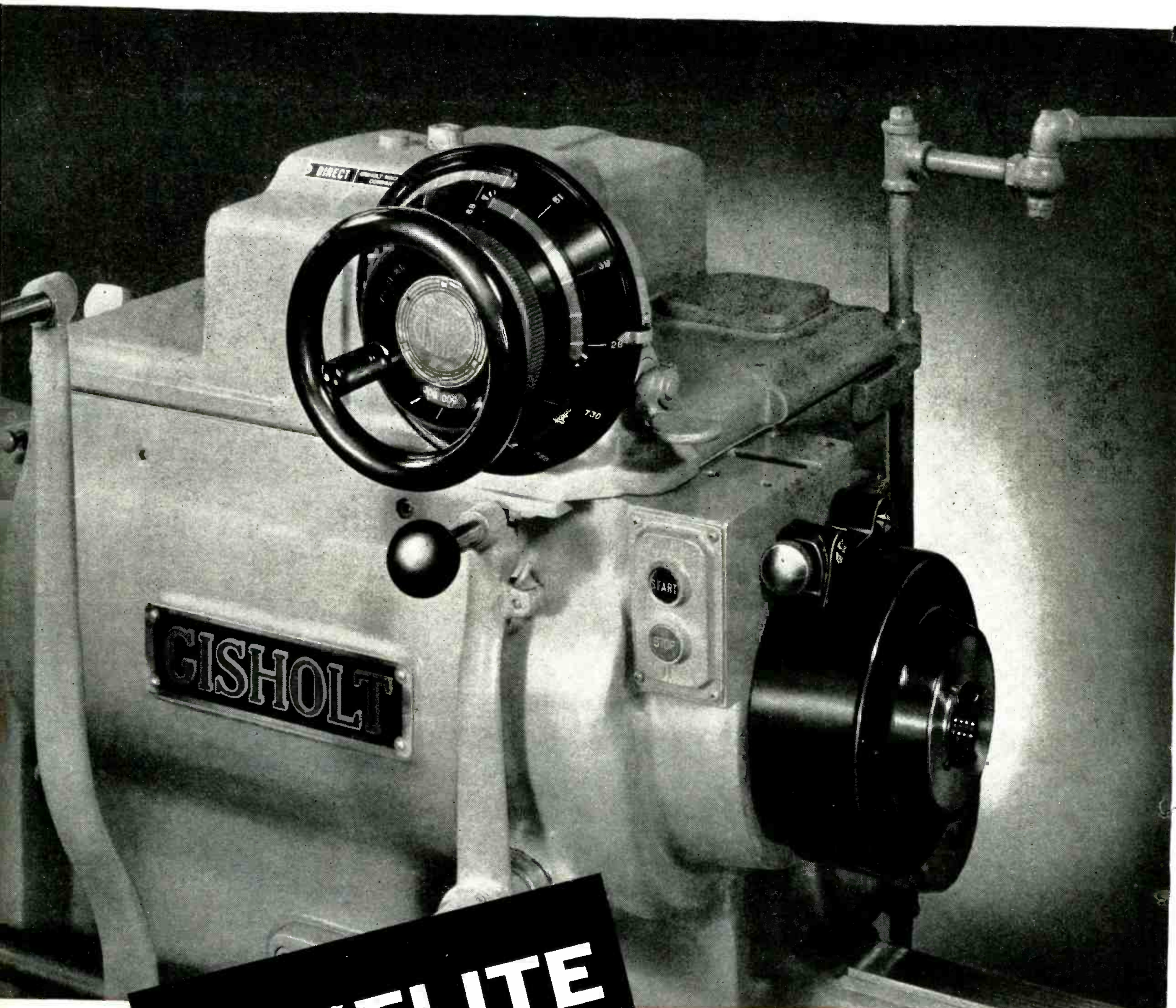
6 PLASTIC PLUSSES



BAKELITE

The word "Bakelite" and the identifying products Symbol are registered trade-marks of Bakelite Corporation

PLASTICS HEADQUARTERS

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

3 WAYS Can Help You Speed

1. LITERATURE ON "DO'S" AND "DONT'S" OF PLASTICS... Helpful technical booklets containing data on types and forms of BAKELITE plastics, and the most efficient methods of fabrication. This literature will help you to choose the right plastic for each job, save time and avoid errors.

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FOR HEAVY-DUTY MACHINE TOOL PARTS

IMPACT RESISTANCE . . . FAST PRODUCTION . . . ARE TWO OF MANY ADVANTAGES GAINED BY GISHOLT

THE REDESIGN FOR PLASTICS PRODUCTION of speed-selector dials and chuck guard on the Gisholt lathe brought about numerous improvements typical of those often made when BAKELITE plastics supplant other materials. And, equally important, the use of plastics released strategic materials for other essential purposes.

First, and most important gain, is the fact that the parts, molded in a few minutes from BAKELITE plastics, are immediately ready to use. Time-consuming drilling, reaming, tapping, and enameling are completely by-passed.

The impact resistance of these parts is another important advantage. An engineer or designer whose information on plastics is not up-to-the-minute may not realize that there are now available BAKELITE molding materials with impact strength up to 2.7 ft-lb. energy to break (Izod). For the parts shown here, the material used has a flexural strength of 10,000 lb. per sq. in., and a tensile strength of approximately 8,000 lb. per sq. in.

But, BAKELITE plastics' advantages do not stop there. Consider also such advantages of weightsaving, dimensional stability, self-contained color, and others listed at the right, and you will realize the contribution that plastics can make to many essential industrial applications.

When You Write "PLASTICS" on a Blueprint

If, in your war production, there are places where BAKELITE plastics can replace strategic metals, or supply flexibility, durability, dimensional stability, and resistance to impact, moisture, or chemicals, by all means enlist the co-operation of our Engineering Staff and Development Laboratories. Make certain, when you write "plastics" on a blueprint, that you have selected the right materials and the correct fabricating techniques to save time and materials, and to avoid costly errors.

BAKELITE CORPORATION, 30 East 42nd St., New York, N.Y.
Unit of Union Carbide and Carbon Corporation

UCC

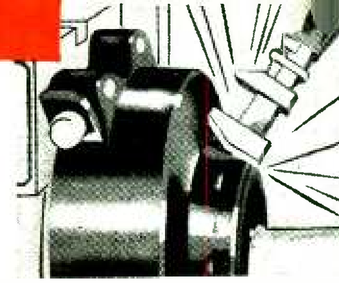
"BAKELITE" PLASTICS HEADQUARTERS Production and Conserve Strategic Materials

2. GEARING OUR LABORATORIES TO YOURS . . . Bakelite Laboratories offer a two-fold service. They are ready to help you utilize present plastics in war production. They will also develop new formulas to help solve the problems of highly specialized requirements.

3. FIELD WORK ON "FRONTLINE" JOBS . . . Located at important industrial centers throughout the nation, Bakelite Field Engineers are ready to give prompt service to manufacturers engaged in war production. Fully qualified, they can frequently solve production problems on the spot.

IMPACT RESISTANCE

This BAKELITE plastic chuck guard will withstand heavy impact blows. Yet its weight is only one-fourth that of its predecessor.

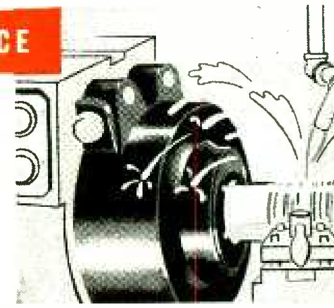


LIGHT WEIGHT

Light weight is an important advantage in this 12-in. handwheel. Had heavier material been used, it would have added momentum to the turn of the wheel, causing it to spin beyond the desired position.

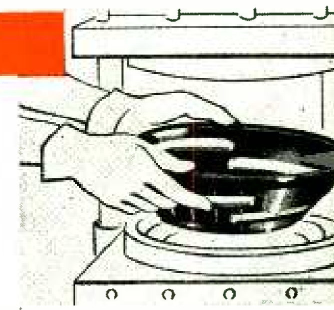
CHEMICAL RESISTANCE

These Gisholt parts are unaffected by cutting oils, greases, and alkalies. Constant handling will not mar the lustrous finish of the speed selector. Moisture will not corrode the parts.



FAST PRODUCTION

Parts can speedily be molded from BAKELITE plastics usually in a few minutes. Generally, they are ready for use as removed from the mold, thereby avoiding drilling, reaming, tapping, enameling, and other finishing operations.

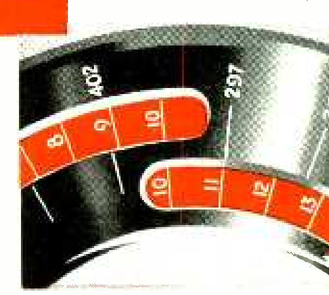


DIMENSIONAL STABILITY

The BAKELITE plastics employed for the Gisholt parts are noted for their dimensional stability. They, therefore, are adapted to mass production of parts which are interchangeable. Also, the accuracy of the fine calibrations will be maintained despite temperature changes, long term aging, or exposure to moisture and chemicals.

LEGIBILITY

The legibility of markings on the speed selector has been improved two ways. First, the inner dial is molded in a bright red. The color is integral with the material and will not chip off or lose its brilliance. Second, the intaglio calibrations are formed in the molding process, and then filled in with white pigment insuring maximum legibility from any angle.



GET "HEADQUARTERS HELP" ON PROBLEMS RELATING TO PLASTIC MATERIALS, DESIGN, AND FABRICATING TECHNIQUES

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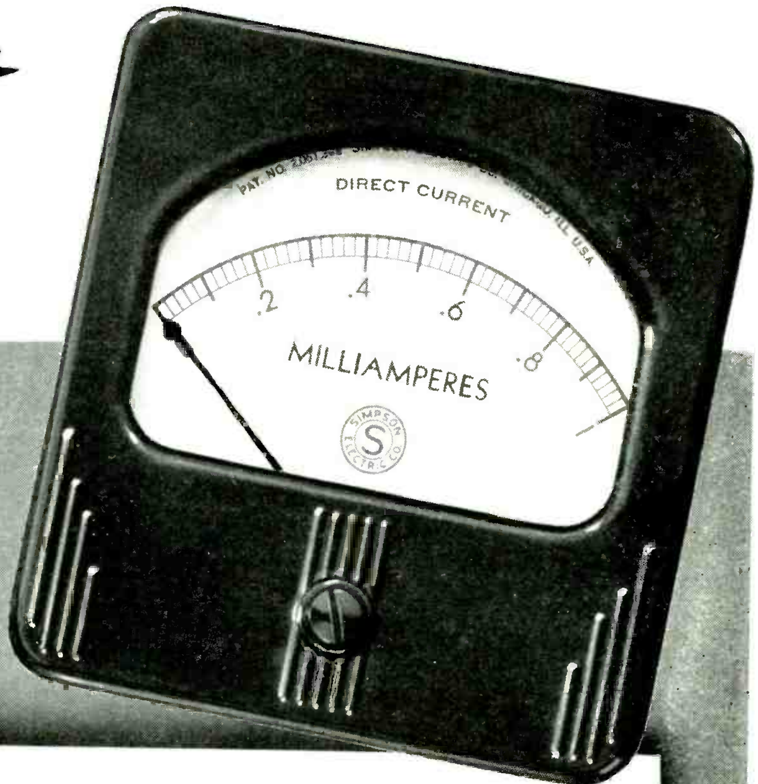
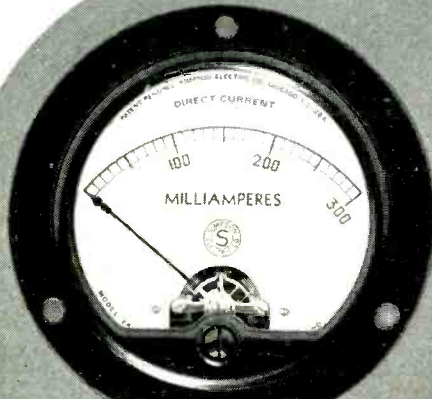
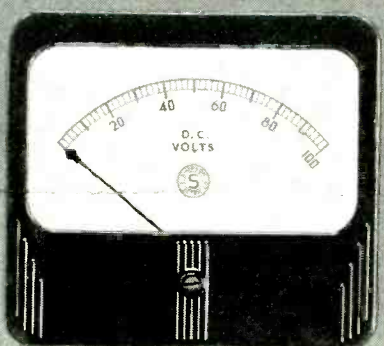
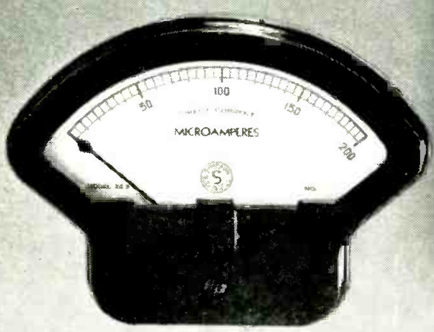
On Merit Alone-









THE name Simpson is a distinguished one in the design and manufacture of electrical instruments. It stands for know-how, and skill, learned through long years of experience.

But people don't buy *names* today; they buy *products*. And that's the real reason why Simpson Instruments have skyrocketed to success so rapidly.

Born of experience that reaches way back into the history of electrical instruments, they offer such important betterments as a full bridge type movement with soft iron pole pieces. Men who know instruments know that such a movement is inherently more accurate and rugged. As produced by Simpson, this finer design achieves its finest expression . . . with all the economies of standardization and straight-line production.

If your need for instruments is vital enough to give you the right to buy, it is vital enough to rate the best. To those who have learned to measure instruments on merit alone, that means Simpson.

SIMPSON ELECTRIC COMPANY
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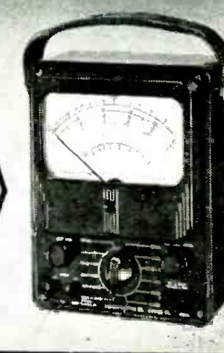
MODEL 260
High Sensitivity Tester

● A typical example of Simpson leadership. Ranges to 5000 volts, both AC and DC, at 20,000 ohms per volt DC, and 1000 ohms per volt AC. Current readings from 1 microampere to 500 milliamperes. Resistance readings from ½ ohm to 10 megohms. Five decibel ranges, —10 to +52 DB.



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INSTRUMENTS THAT STAY ACCURATE

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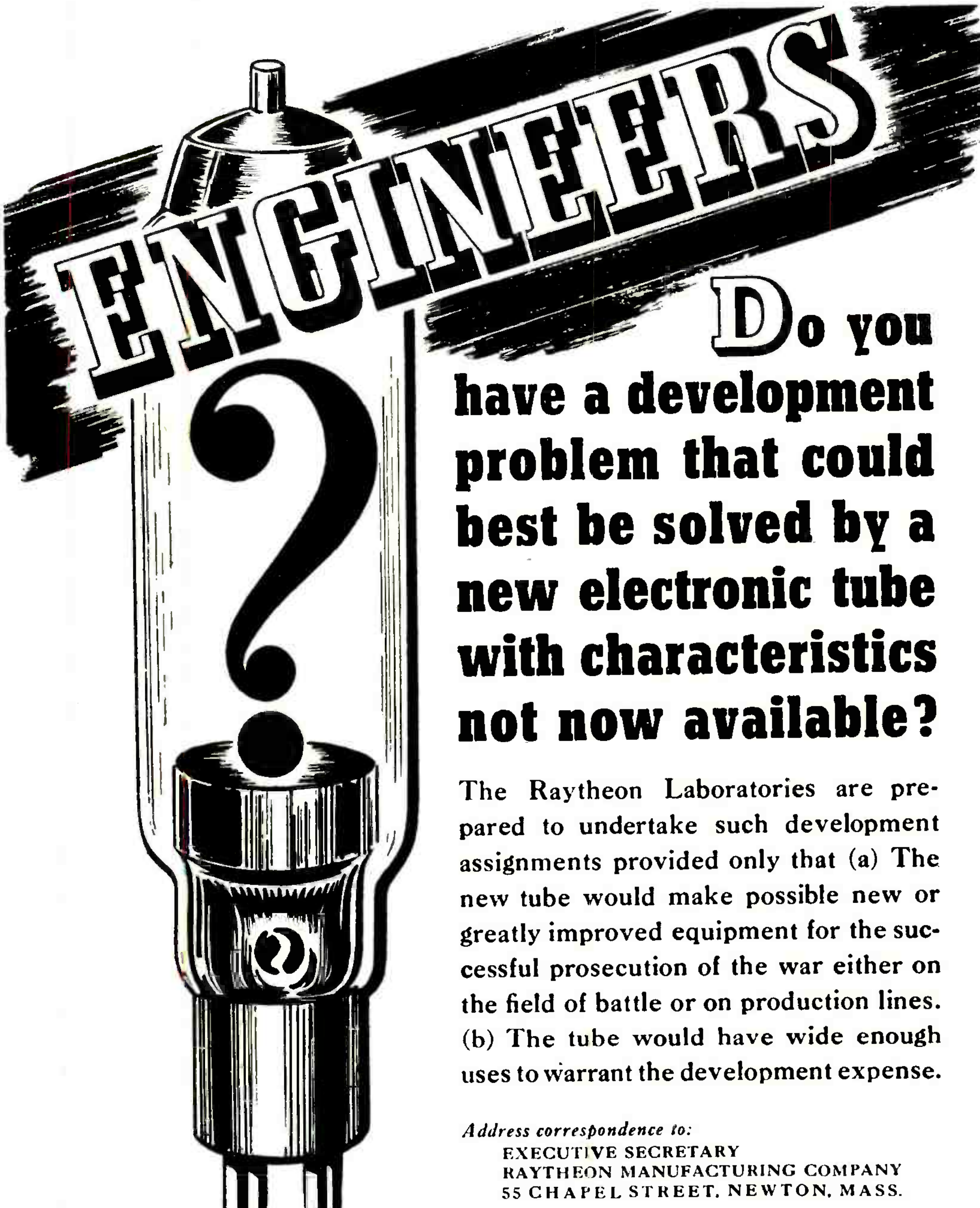

Do you have a development problem that could best be solved by a new electronic tube with characteristics not now available?

The Raytheon Laboratories are prepared to undertake such development assignments provided only that (a) The new tube would make possible new or greatly improved equipment for the successful prosecution of the war either on the field of battle or on production lines. (b) The tube would have wide enough uses to warrant the development expense.

Address correspondence to:
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RAYTHEON MANUFACTURING COMPANY
55 CHAPEL STREET, NEWTON, MASS.

ENGINEERS WANTED! Raytheon's vital wartime assignments are in the field of electronic development. Have unusual opportunity for engineers who want to be connected with important war assignments. At Raytheon you would work with some of the best known research specialists on tubes and equipment. Write SPECIAL ENGINEERING PERSONNEL.

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Waltham, Massachusetts

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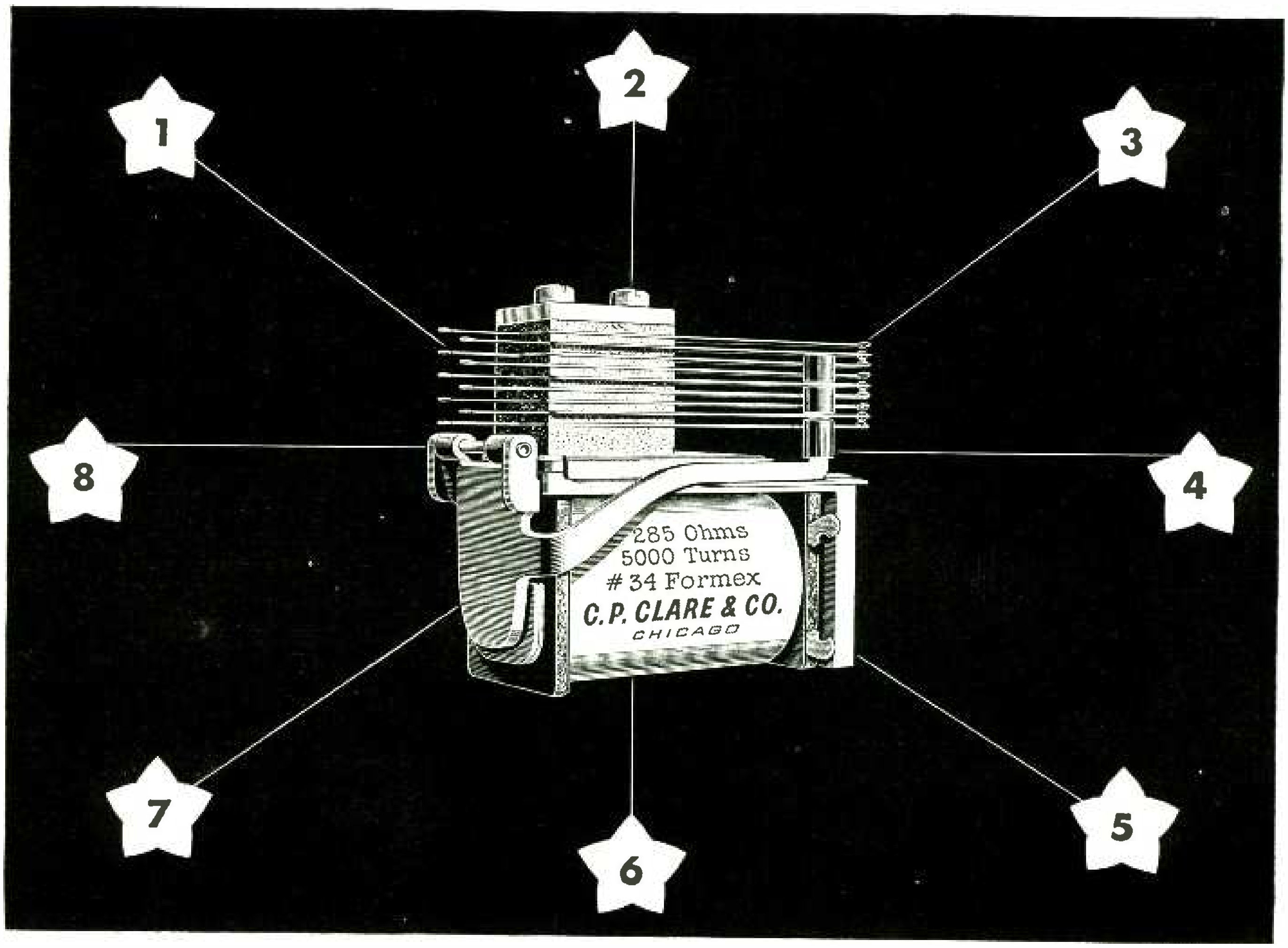

☆☆☆☆☆☆☆☆ An Eight Star Feature Relay "Custom-Built" for Absolute Dependability

This Clare Type G a. c. Relay is designed to insure absolute dependability in service . . . It measures only 2½" long by 2¼" high by 1¼" wide, and weighs only 6½ ounces . . . It is replete with features that insure dependability, and has a wide range of application. It has the following outstanding features:

1 Clare Relay illustrated shows pile-up of nine springs. Relay can be supplied with as many as twelve springs in a single pile-up.

2 Spring pile-up insulators of special heat treated Bakelite provide more favorable characteristics than triple "X" Bakelite and permits punching without cracks or checks. It has minimum cold flow properties and low moisture absorption content. The pile-up assembly is locked together under hydraulic pressure. Insulators are held in place with two flat or filister headed screws of high tension steel.

3 Contacts of rare metals or special alloys are available in sizes from .062" to .1875" diameter, flat or hemispherical. These contacts are "over-all" welded to nickel silver springs by a special process, making them an integral part of the spring, thereby reducing contact pressure to the minimum and providing for rapid heat dissipation. Long contact life is assured.

4 Spring bushing insulators are made of Bakelite rod under a patented process. Hard rubber bushings generally employed are similar in appearance, but inferior in wearing qualities and will not pass heat cycle requirements on many applications. Strong, hard, long-wearing Bakelite bushings are essential where heavy contact pressures are employed or where vibration exists.

5 The heel piece is made of magnetic metal carefully annealed and cadmium plated, and is so constructed that it is adaptable for plug-in mounting, thereby permitting easy servicing and replacement.

6 Coil core laminations are made of low loss silicon iron. Copper shading piece is securely fastened in the square, slotted armature end of coil core. Coils are carefully wound to exact turns on precision machines. Lead-out wires are securely soldered; entire coil is impregnated with Glyptol.

7 Armature of this relay is made of magnetic metal carefully annealed in precision ovens, and is cadmium plated to withstand a 200-hour salt spray test.

8 Armature bearing consists of a stainless steel rod operating in a hard brass yoke with great bearing area.

This relay, like all Clare "custom-built" relays, is recommended for specific applications where hard service, long life, and dependability are absolute "musts." Regardless of what your relay problem may be, Clare can supply a relay to solve that problem. The "custom-built" idea enables you to reduce your over-all relay cost and simplify your designing. It insures better and more dependable performance. Clare engineers will gladly assist you. And we will be glad to send you our catalog and handbook. Address: C. P. Clare & Co., 4719 West Sunnyside Ave., Chicago, Ill. Sales engineers in all principal cities. Cable address: CLARELAY.

CLARE RELAYS

"Custom-Built" Multiple Contact Relays for Electrical, Electronic and Industrial Use

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TURBO INSULATION is on a triple offensive

☆ Three types of insulation to safeguard the service-efficiency of your product or equipment—each "indexed" to meet the requirements of specific applications — are on 24-hour duty to ward off the destructive elements of heat, moisture, alkalis, acids, fumes, sub-zero temperatures, etc.

Keep your materials card file up-to-date. Enter the advantageous dielectric and physical properties of the various TURBO insulations for ready reference when problems arise. You'll find TURBO a dependable, efficient, ally.

FLEXIBLE VARNISHED OIL TUBING-

meeting the all-purpose requirements of a sleeve insulation to stand guard against breakdown, moisture absorption—all commonly encountered acid and oil influences.

VARNISHED GLASS TUBING-

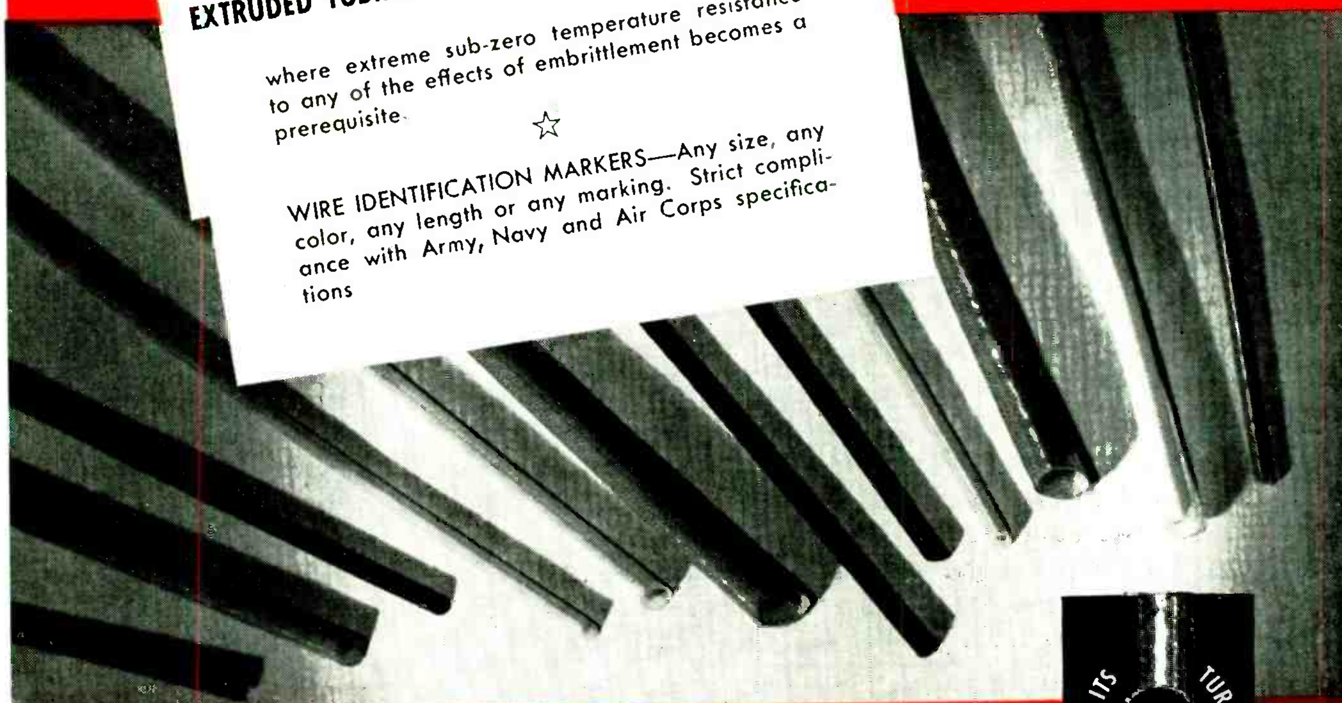
for those applications where extremely high heat resistance becomes the above-all consideration.

EXTRUDED TUBING-

where extreme sub-zero temperature resistance to any of the effects of embrittlement becomes a prerequisite.

☆

WIRE IDENTIFICATION MARKERS—Any size, any color, any length or any marking. Strict compliance with Army, Navy and Air Corps specifications



IF ITS TURBO · IT SAFE-GUARDS ·

For proof ask for samples of each also for new specimen board and list of standard sizes. There is no obligation.

Turbo

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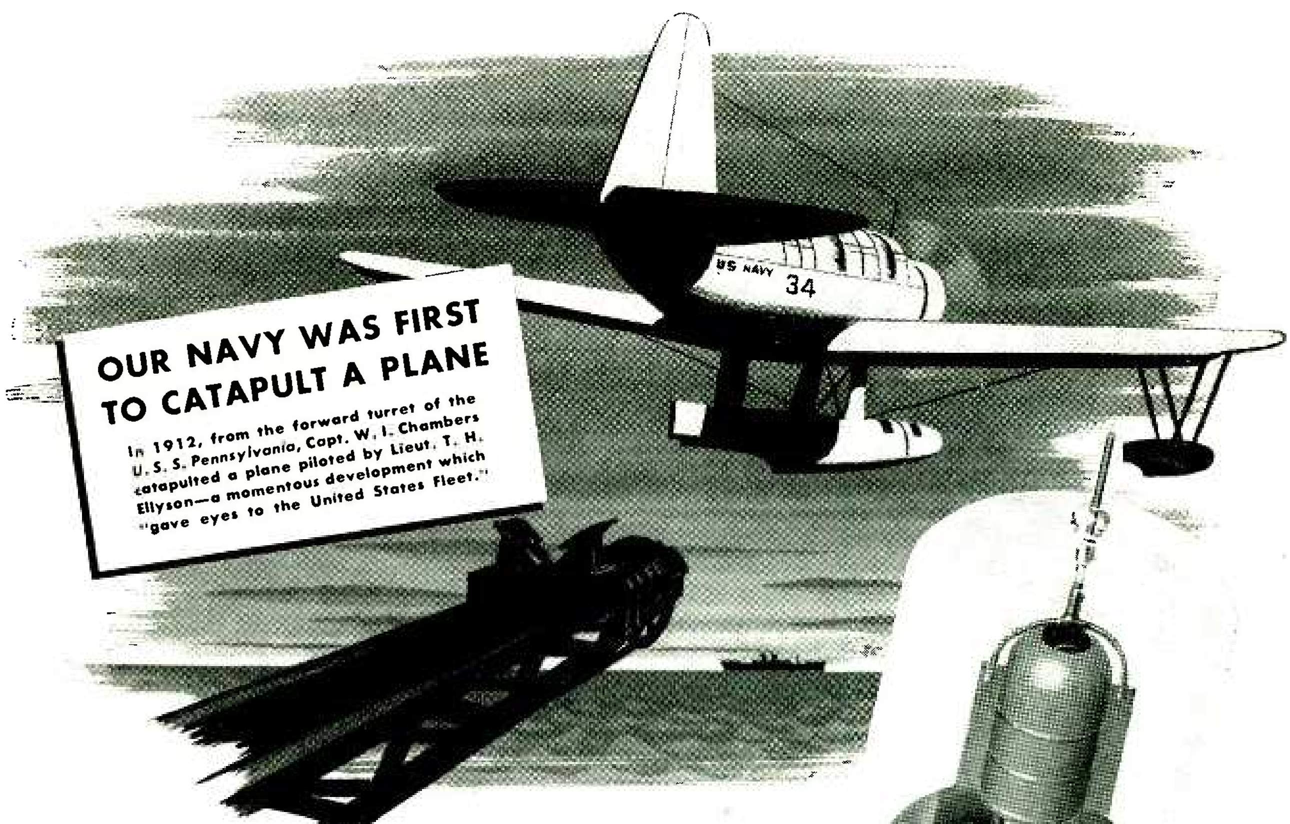
PIONEERS...in war and peace



GAMMATRON WAS FIRST TO BUILD A TANTALUM TUBE

Just as the modern catapult is basically the same as its historic predecessor, the Gammatron tubes of today continue to give the electronic industry the fundamental benefits of tantalum grids and plates.

Tantalum has the lowest gas content of any metallic element. Moreover, once tantalum is de-gassed, it actually absorbs any gas later released, thus eliminating the usual getter. This enables Gammatrons to withstand severe overloads without going soft.

The skill and ingenuity of Heintz and Kaufman engineers, plus tantalum construction, means that Gammatrons continually provide more efficient tubes at lower cost.

When peace comes, Gammatron research engineers will announce many new and distinguished electronic tubes which are now being developed in silence.

GAMMATRONS...OF COURSE!

HK-257 BEAM PENTODE

OPERATING DATA

RF Power Amplifier, Class "C" Unmodulated

	Maximum Rating	Typical Operation
Power Output	—	235 Watts
Driving Power	—	0 Watts
DC Plate Volts	4000	3000 Volts
DC Plate Current . . .	150	100 M.A.
DC Suppressor Voltage	—	60 Volts
DC Suppressor Current .	—	3 M.A.
DC Screen Voltage . .	750	750 Volts
DC Screen Current . . .	30	8 M.A.
DC Control Grid Voltage	−500	−200 Volts
DC Control Grid Current	25	0 M.A.
Peak RF Control Voltage	—	170 Volts
Plate Dissipation . . .	75	65 Watts

Write for full data

HEINTZ AND KAUFMAN LTD.
SOUTH SAN FRANCISCO CALIFORNIA U. S. A.

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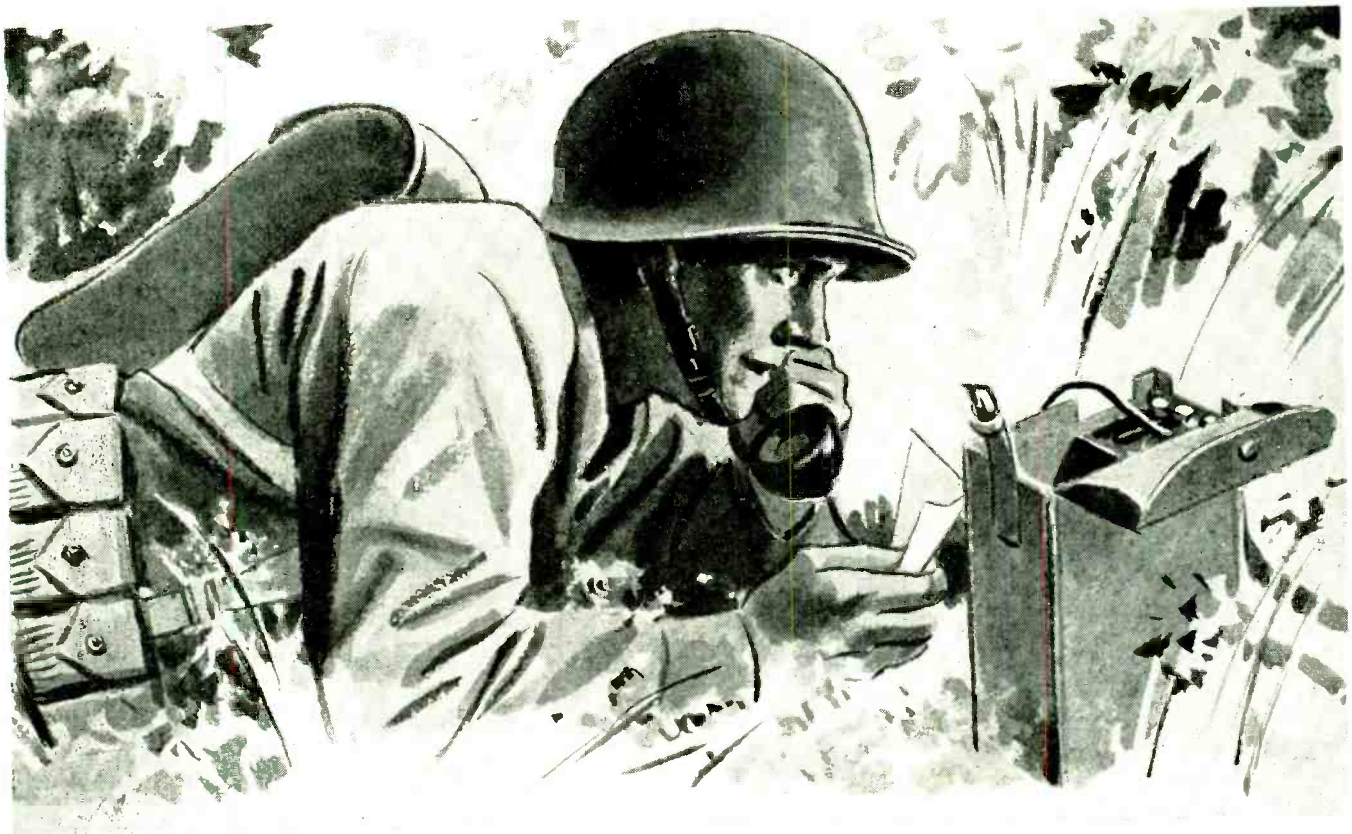

NO TIME FOR REPLACEMENTS WHEN YOU'RE MILES AWAY FROM "THE SUPPLY BASE"

. . . give your product maximum reliability by using C-D Capacitors

When you're miles from headquarters you can't call for replacements. Utmost reliability in communications equipment is essential. You can give your product that degree of reliability by using C-D capacitors. The most important raw material used in C-Ds is the accumulated "know how" of 32 years devoted to the making of finer capacitors exclusively. When a design calls for capacitors, C-Ds are the first choice of the industry because C-D built-in "capacitor dependability" is a familiar story to engineers who do their own checking.

As the materials used in capacitors are under control, we are permitted to produce only against those orders carrying the necessary Preference Rating Extensions. Should you be unable now to enjoy the finer performance of C-Ds we look forward to serving you when Victory has been won.

C-D DYKANOL BY-PASS CAPACITORS

Type **DY**

These capacitors are designed to fill the need for dependable capacitors of fractional capacities that will operate efficiently in r.f. and a.f. bypass, audio frequency coupling and a.c. circuits under all humidity conditions and at temperatures up to approximately 80°C. Features of these capacitors are:

- Impregnated and filled with non-inflammable, non-explosive Dykanol assuring long life, small size, lower power-factor.
- Supplied with special pressure-sealed terminals and hermetically sealed in non-corrosive non-ferrous containers.
- Conservatively rated, these units will safely operate at 10% above rated voltage.

For further details write for Catalogue No. 160T
Cornell-Dubilier Electric Corporation
South Plainfield, New Jersey.... Factories in five cities.

Cornell Dubilier capacitors

MICA • DYKANOL • PAPER • WET & DRY ELECTROLYTICS

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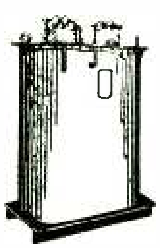
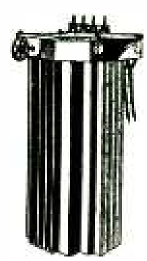
SOME day when we have fulfilled our Government obligations, we will be in a position to tell you fully the amazing story of the improvements that are being made in AmerTran products—today.

Today, wherever the new AmerTran products are being installed in connection with the war effort, electrical men are realizing that AmerTran is producing transformers that are *new* —new in electrical design, new in mechanical features, new in efficiency and economy.

True, we have placed entirely at the disposal of the Government and customers with high priorities our new and greater plant capacity, our new and increased manufacturing facilities. But, as for the past 41 years, we are still glad to extend to you without obligation, the advice of AmerTran Engineers to help you secure the best results from your present equipment, to help solve today's problems of operation and maintenance, and to plan for your future needs in electronic and radio applications.



AmerTran modulation transformers and reactors, oil-immersed type, for large broadcast transmitters.



AmerTran RS plate transformers and reactors, oil-immersed type, for all large installations.

AmerTran W plate transformers and reactors for all small and medium installations.

AmerTran transformers are manufactured to meet your exact electrical and mechanical requirements.

AMERICAN TRANSFORMER COMPANY, 178 Emmet St., Newark, N. J.

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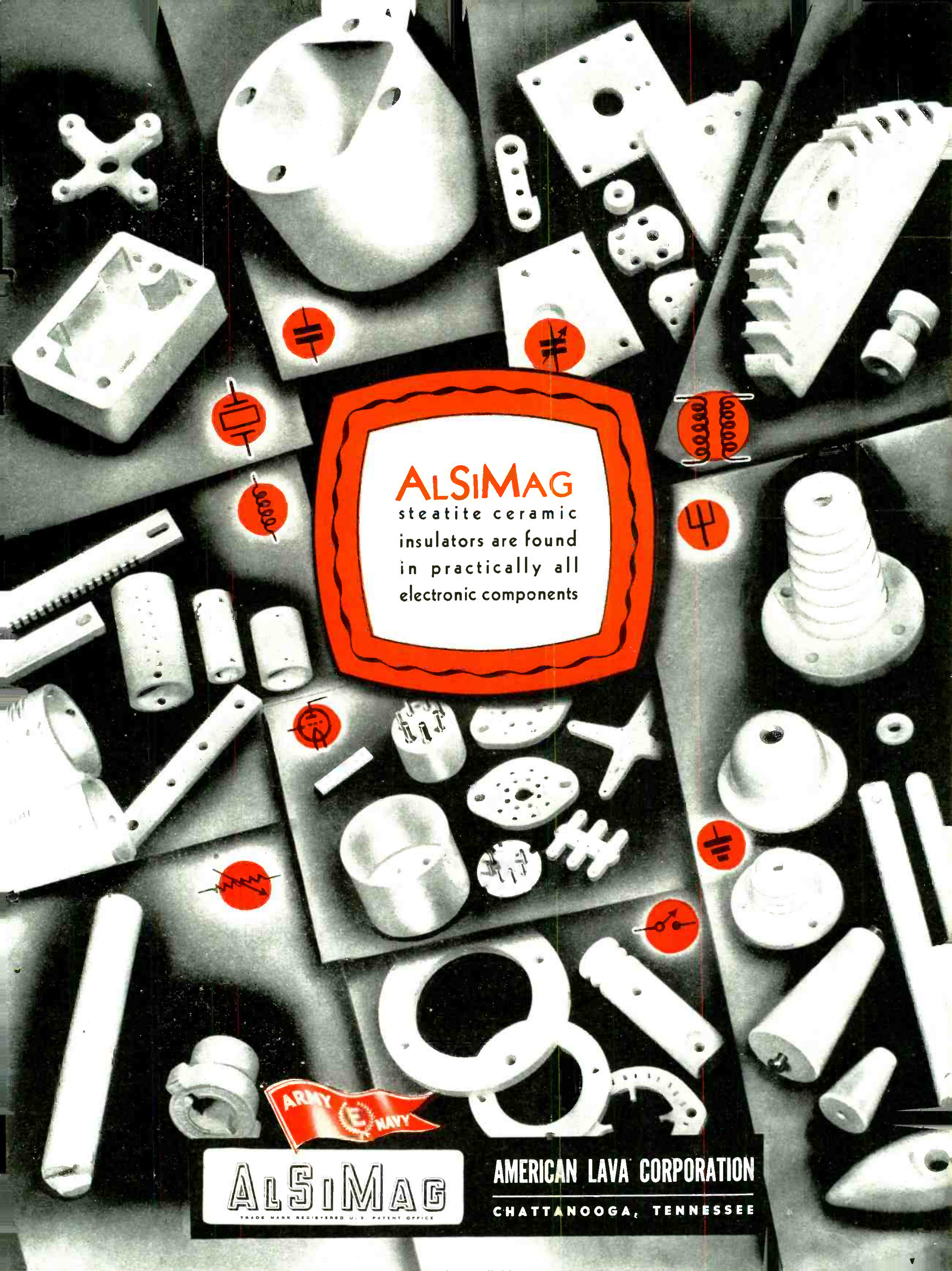

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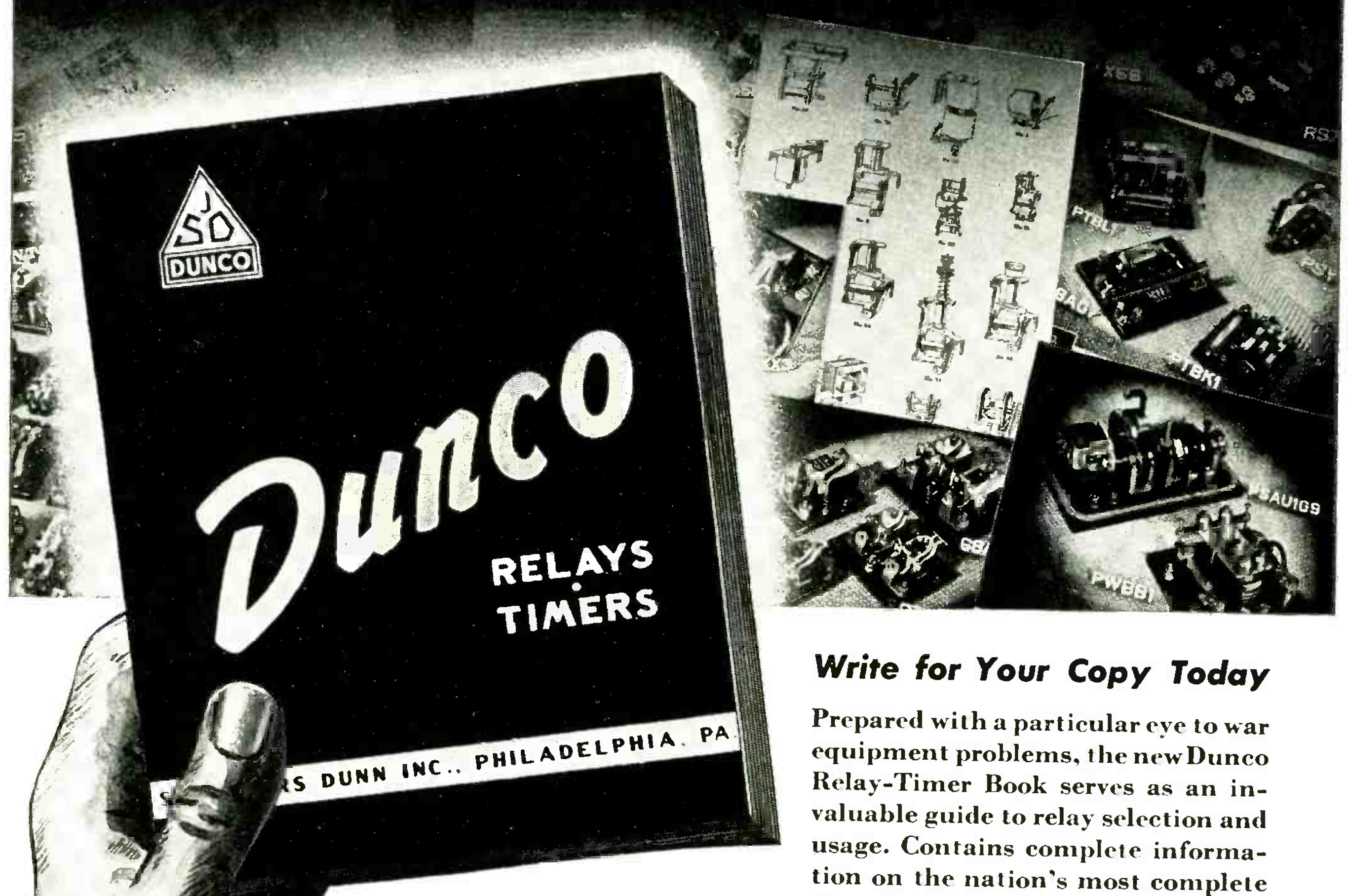

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Prepared with a particular eye to war equipment problems, the new Dunco Relay-Timer Book serves as an invaluable guide to relay selection and usage. Contains complete information on the nation's most complete line of high quality relays, timers and solenoids, as well as many helpful pointers on the application and use of such components. Your copy gladly sent upon request. Please mention company connection.

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- Instrument Controlled
- Mercury Contact
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- . . . plus countless adaptations and specials

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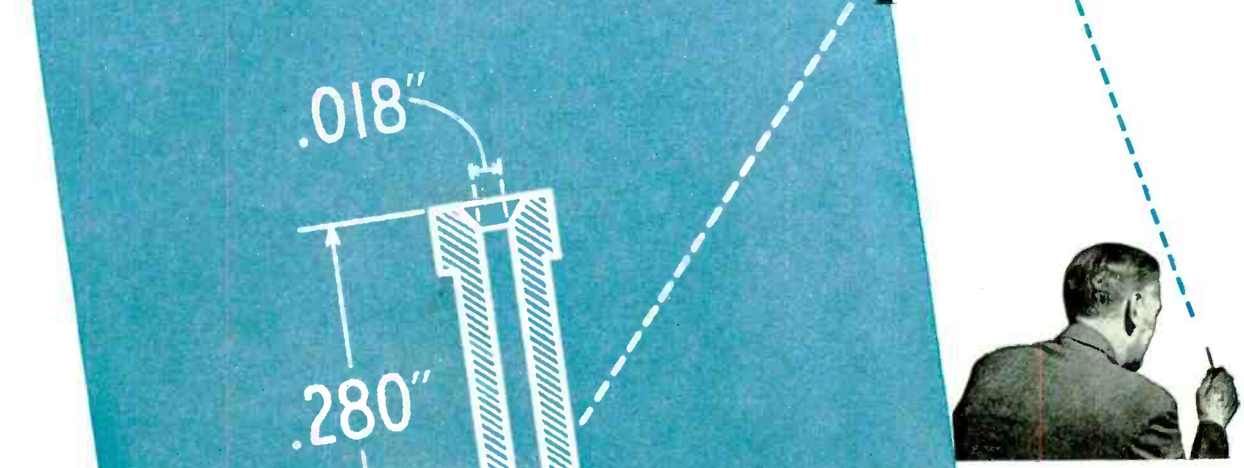
Meet the man who performs the miracles in plastics



This will give you an idea of what can be done by custom molders. It is a communications part of Lumarith. It is .280" long. It comes out completely formed with a true .018" hole through the center. No finishing necessary. Rate of production: 100,000 a day. Formerly took 3 months.

The Custom Molder

The newcomer, seeking plastic molded parts, must become a little dizzy as he looks at the plastics advertising. In his attempt to find out how to start—and where he gets the finished product, he must wonder what part each company plays.

In one advertisement, he sees a picture of a finished molded piece. If he writes to the company, he finds they don't make anything like it. . . . In another advertisement, he sees an injection molding machine. If he writes to the company, he finds they don't mold anything.

The confusion exists because the plastics material manufacturers don't say enough about the important work of the custom molders. So we undertake this program of explanation to speed your work from *start* to *finished* product. . . . The sequence of events is as follows:

1. You tell us what qualities you want in the finished molded part—such as impact strength at various temperatures; resistance to water, salt water, acids or solvents; light transmission; dielectric strength, etc., etc. and etc.

Our engineers and scientists select the Lumarith Plastic that will give you the results.

2. Our sales engineers put you in touch with the available custom molders best equipped to mold the piece by injection, compression, transfer or extrusion.

3. The custom molder gives you a quotation.

4. We work with the custom molder in furnishing the Lumarith formulation that suits all factors of the production technique worked out in relation to dies, heat, pressure and speed.

Remember, success with plastics depends upon the right plastic and the right man at the machine.

We welcome your inquiries and questions.

LUMARITH *Plastics*
REG. U. S. PAT. OFF.
Lumarith Molding Powders (Cellulose Acetate)
Lumarith E. C. Molding Powders (Ethyl Cellulose)

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the first name in plastics

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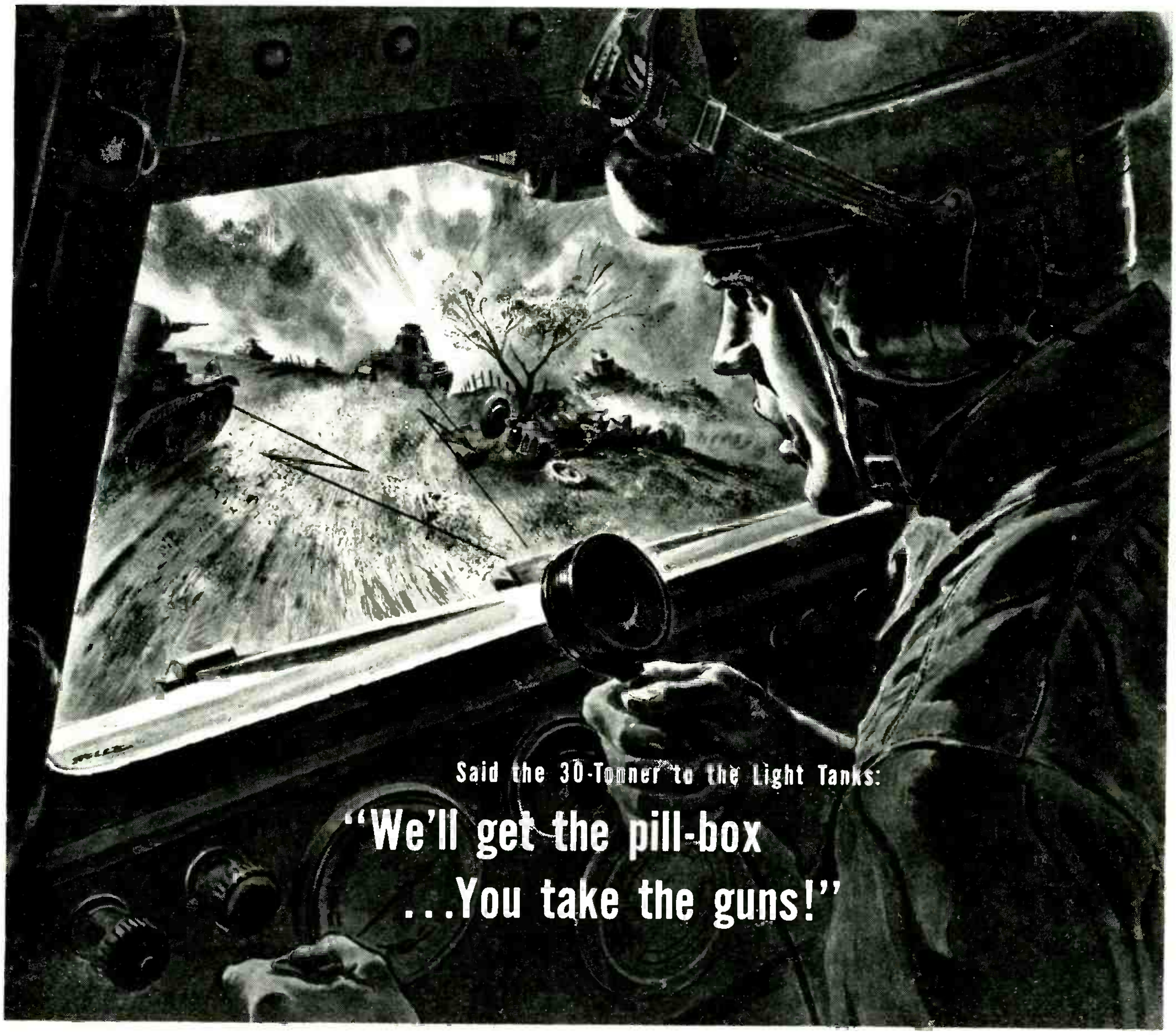

They work together better...
because they can talk together

From the inside of a tank
Clattering hell-bent
Over tough terrain
It's everyday business
To have a conversation
With other tanks in your outfit
Half a mile away.

Yes, Uncle Sam's new tanks
Can talk with each other
Right in the middle of the fight
By means of modern
Radiotelephones.

That's important to the tactics
Of this lightning-fast war
In which you must learn
To expect the unexpected
At any time . . .
And only close *teamwork*
Can win battles.

Modern communications equipment
Designed and manufactured
By I. T. & T. associate companies
Is helping Uncle Sam
Coordinate his fighting forces
On land, sea and in the air.

The broad peacetime experience
Of I. T. & T.
In the field of communications
Is proving its value in time of war.

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IT&T

Associate Manufacturing Companies in the United States
International Telephone & Radio Manufacturing Corporation
Federal Telegraph Company

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Why We Roll Out the BARREL SPRING

SPRING NEWS

FIGHTING SPRINGS

Springs are at war! Hunter is making springs for many important units of our forces battling against the Japa-Nazis.

Armament manufacturers are turning to Hunter for help in designing fighting springs as well as the making of springs, to their own specifications. Hunter can help you now.

SPRING MAKING is a science, as interesting and exact a science when you delve into it as chemistry, physics or engineering. As an elementary example of what we mean, consider for a moment the case of the barrel spring. The barrel spring is a member of the compression spring family—but there is a wide range of forms and applications within the barrel spring group itself. For example, they can be designed as in the illustration below, so that the coils nest neatly within themselves in order to save space by reducing the effective solid height.

So much is obvious. Not as simple are the important calculations for determining the gradient of the spring, that is, the pounds per inch of deflection, and for finding the shearing stress in the coil, for each of the many types of springs. Here the knowledge of a specific spring maker such as Hunter, fortified by practical experience and a fund of laboratory research, speeds the right answers. Now, with production racing against time, and in the future, it will pay you to buy "science in springs" because there is only *one* right spring for the job.

HUNTER

Science in Springs

HUNTER PRESSED STEEL COMPANY, LANSDALE, PENNA.

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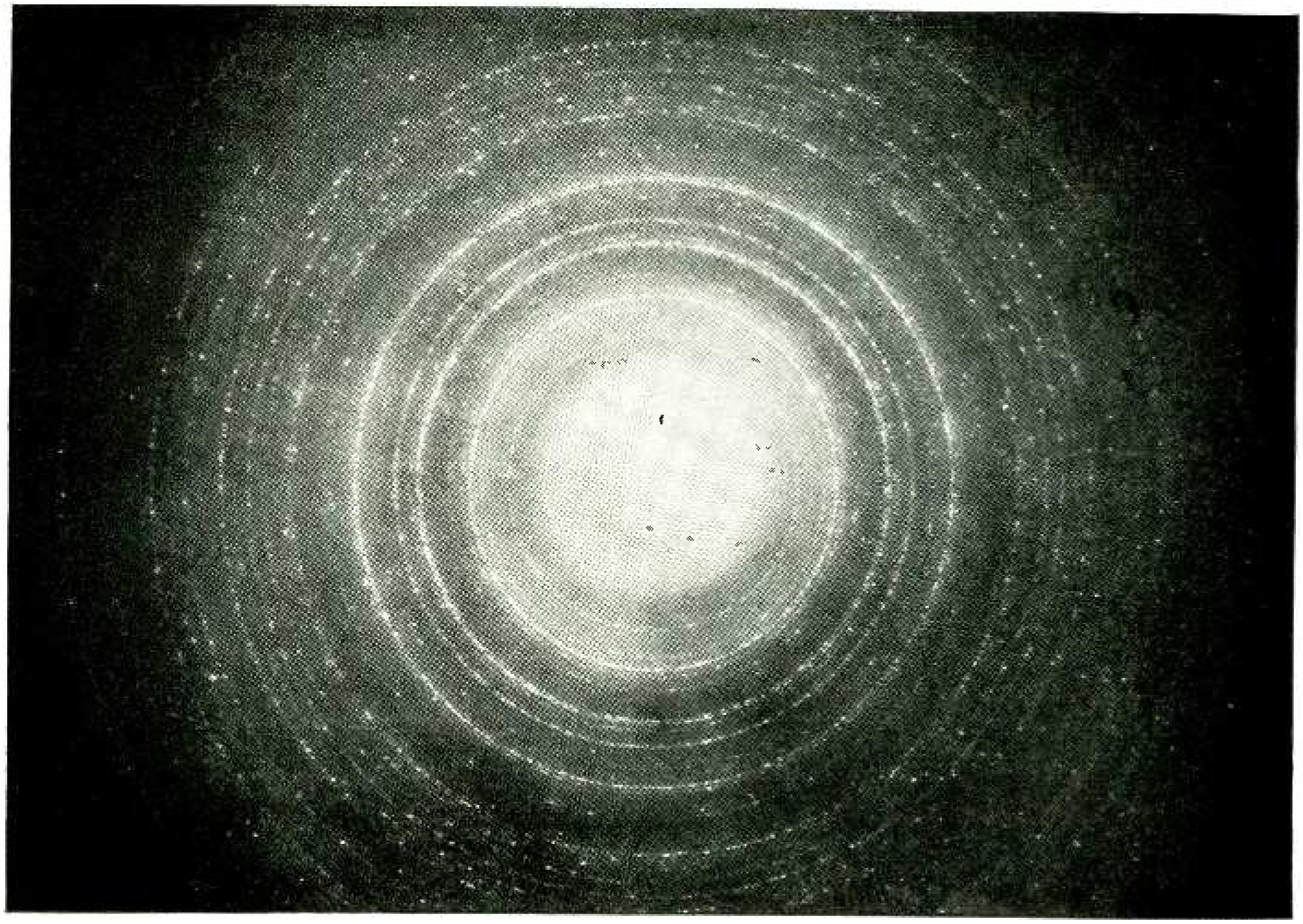

A NEW ELECTRONIC SUN!

The famous RCA Electron Microscope has a new attachment—a diffraction camera, so that man's eye can see the enormously magnified structure of an infinitesimal object and actually determine its atomic design.

The *atoms* are not seen but the new adapter *finds out where they are*. The revealing picture looks like the midnight sun. But in reality this is not a picture of anything. It is the spirit of the crystal structure—an assembly of complex clues from which the mathematical detective can determine how the atoms take their orderly arrangements in various substances.

Scientists call the picture a diffraction pattern—a pattern from electrons, which found their way through the crystal lattice—that invisible, exquisite arrangement of atoms which nature fashions from humble table salt to the lordly diamond. It is a set of concentric circles, some diffuse, others sharp. From the dimensions of the circles and the intensities, the arrangement of the atoms in the material is determined, so that the crystal structure can be identified and analyzed.

Thus, RCA Laboratories open new and unseen worlds for exploration as the Electron Microscope coupled with the new diffraction camera sees deeply into electronic and submicroscopic realms.

BUY U. S. WAR BONDS EVERY PAYDAY!

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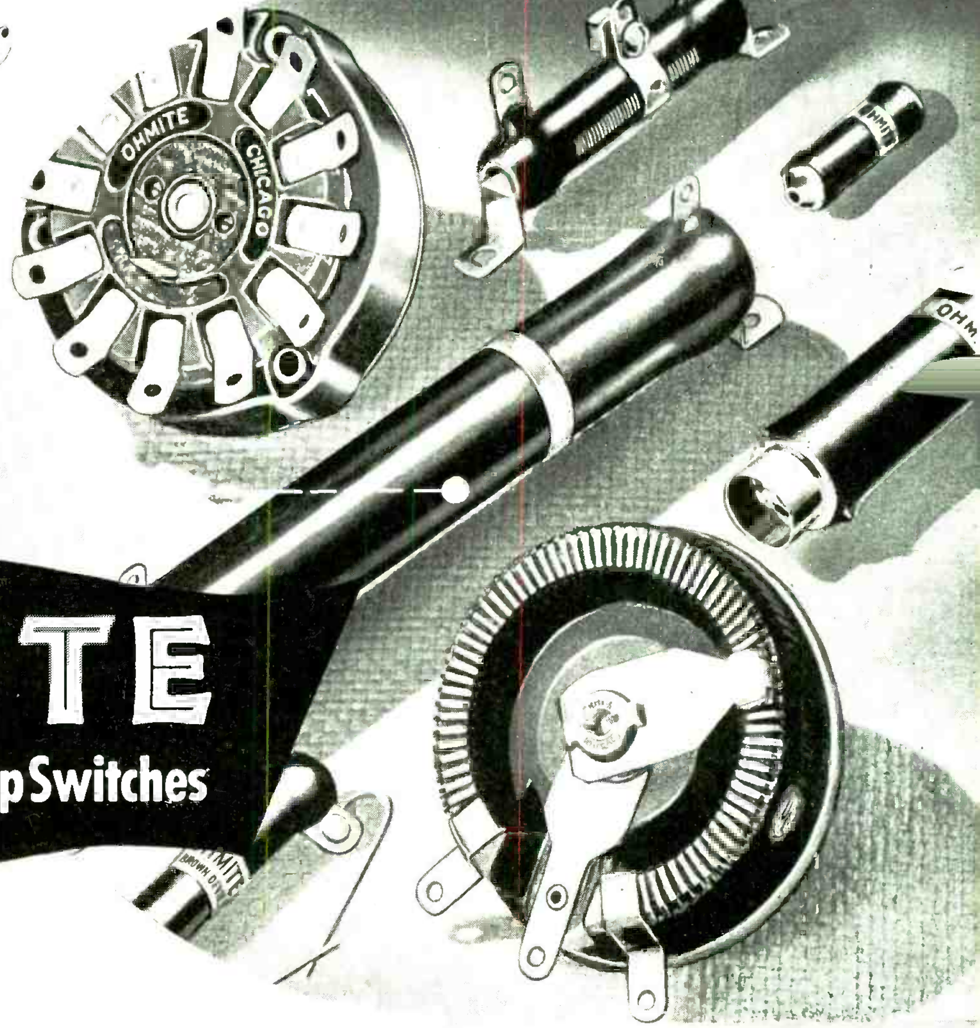
Smooth, Electronic Control with . . .



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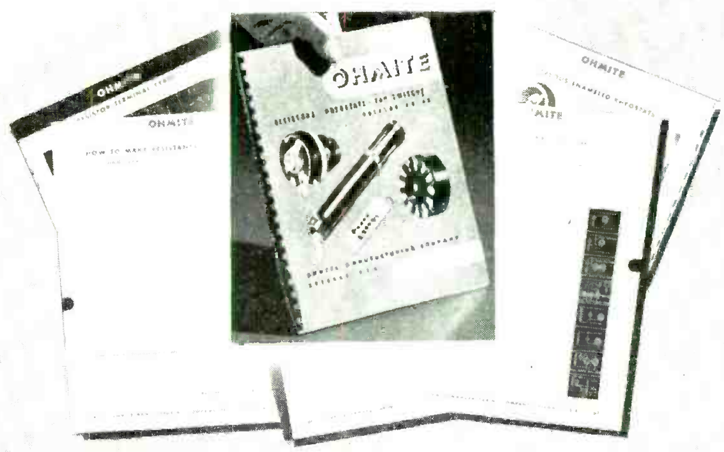
Rheostats · Resistors · Tap Switches

MANY of you now engaged in vital war work have long been familiar with the dependability of Ohmite Products. Their wide use in planes, tanks and ships, in walkie-talkies and field units, in communications, test apparatus and other electronic equipment, gives you added assurance in dealing with today's resistance-control problems. It is also the best assurance for their application in the development of new devices to defeat the enemy and build for tomorrow's peace. Units produced to Government specifications or engineered for you.



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Write on company letterhead for complete Catalog and Engineering Manual No. 40. Helps expedite the solution to resistance problems. Gives valuable information on the selection and application of rheostats, resistors, tap switches, chokes and attenuators. Contains useful reference tables, dimensional drawings, important engineering data and a manual of resistance measurements.

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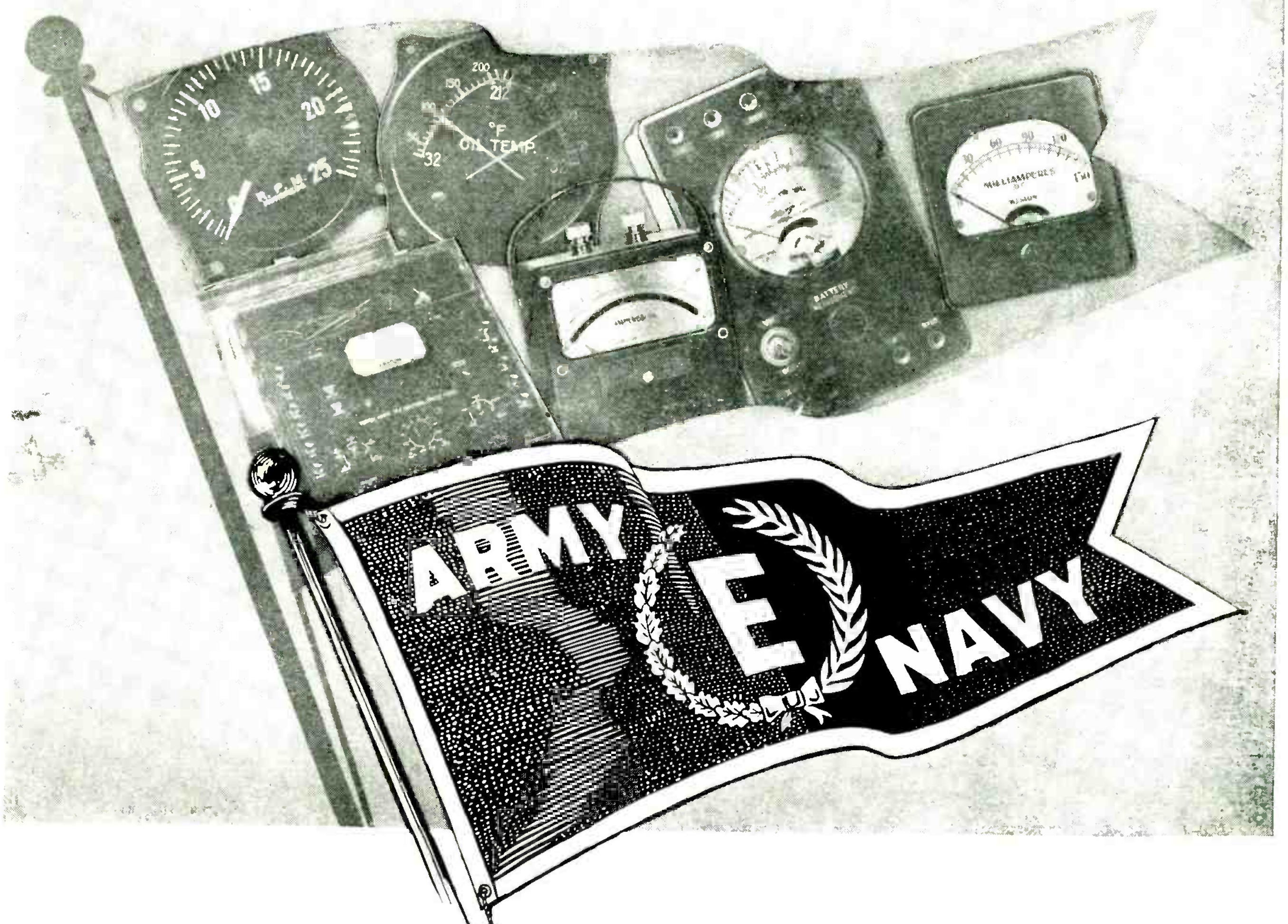

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"On LEADERSHIP rests the responsibility for getting things done."

Only short months ago, the instrument goal in this mechanized war seemed unattainable. In almost unbelievable quantities instruments were needed for our huge plane program—for a two-ocean navy—for tanks, guns and walkie-talkies — for our arsenals and factories — and for countless new devices of war.

To approach this goal meant far more at WESTON than the mere addition of factory and laboratory equipment, and the usual worker-training program. It meant imparting to untrained hands the skill and instrument sense which ordinarily takes years to acquire. For it's this rare instrument sense, backing up sound engineering, which has been responsible for WESTON'S continued leadership.

This "E" award to the workers at WESTON—the first to any group in this specialized field—means recognition of their efforts in striving to attain the goal in numbers, while never relinquishing the WESTON quality ideal.

And to our courageous fighting men everywhere, it conveys the assurance that they can depend on the men and women at WESTON to continue furnishing the essential instruments in ever increasing quantities . . . *until victory is won.*

WESTON ELECTRICAL INSTRUMENT CORPORATION, NEWARK, N. J.

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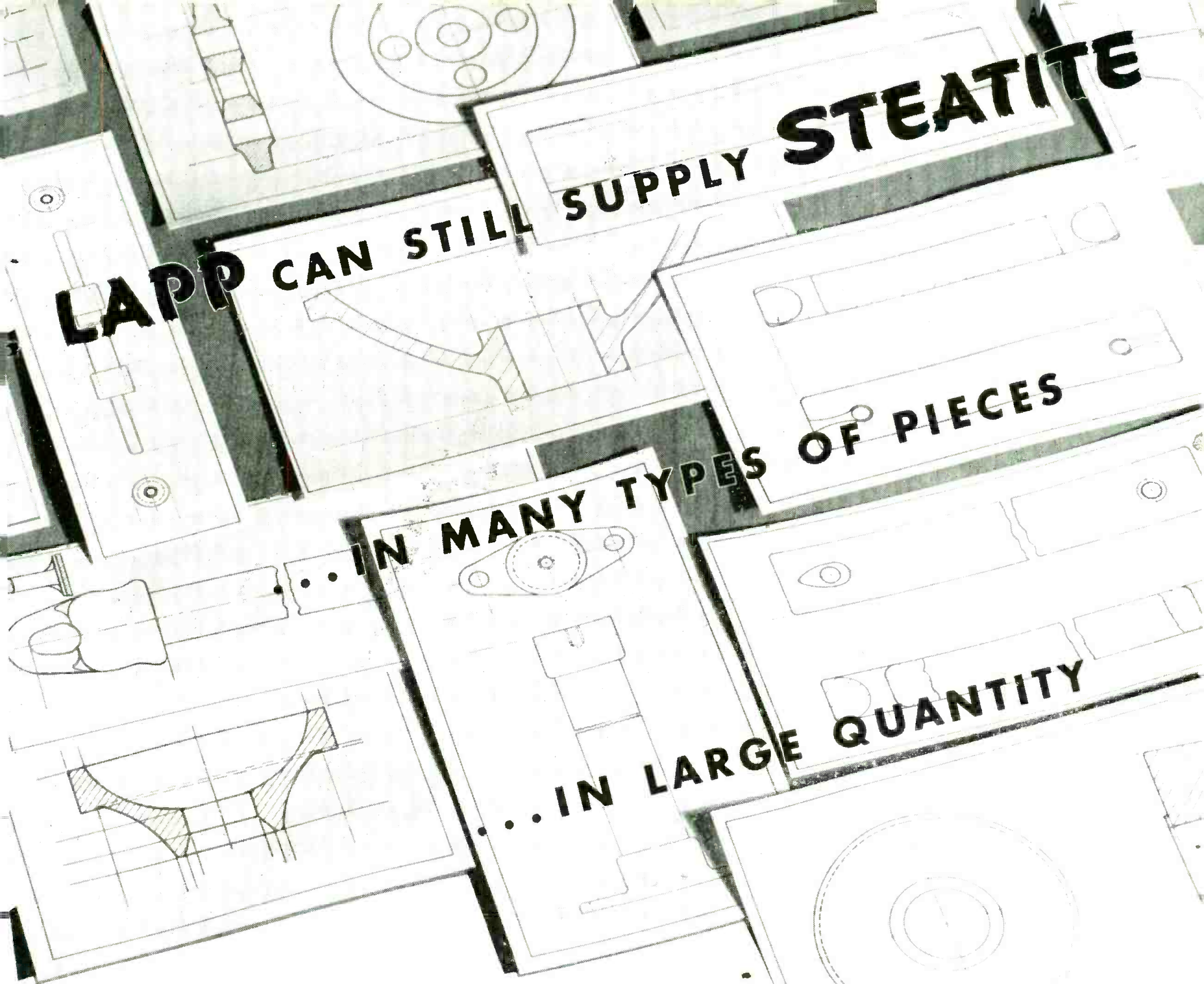

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As a leading manufacturer of high-voltage insulators and porcelain pieces, Lapp facilities are adequate for production of high-quality ceramics in large tonnages. The development of Steatite production techniques was undertaken aggressively by Lapp more than four years ago. Shrinkage, glazing and firing problems peculiar to Steatite have been solved. Electrical characteristics are assured by complete testing facilities including a high-voltage radio frequency generator. For production of Steatite pieces for which Lapp processes are suitable, Lapp offers almost unlimited capacity. *Don't be misled by talk of a Steatite shortage until you find if Lapp can make the pieces you need.*

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Exclusive features of this compact power rheostat assure you 25% more capacity for handling possible overloads,—and consequently more heat dissipation—less temperature rise without taking up more space. The deeper winding form gives more wire, more surface area.

Our patented contact system, completely enclosed in the body of the rheostat, makes possible a maximum depth of winding space for any given back of panel space. The metal-graphite contact shoe, molded on a coiled pigtail, is the sole sliding electrical contact. It travels smoothly on the inside circumference where the turns of wire are most closely spaced. Each turn is a separate resistance step.

The terminals are *rugged screws* integral with the body of the rheostat,—another exclusive advantage.

There are no organic parts to char, in this metal—porcelain vitreous enamel construction. All live parts are enclosed to eliminate many dangers and possible short circuits.

This rheostat is designed to give full protection from dirt and mechanical damage, as well as maximum ventilation.

Eight standard sizes in a wide range of resistance values—tandem fittings—tapered windings, etc.

We offer many other types of rheostats and resistors with important exclusive advantages. Please consult us.

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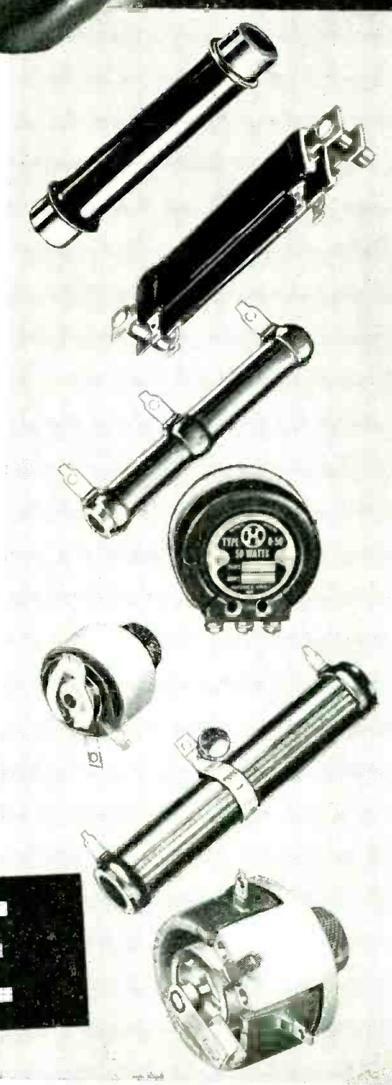
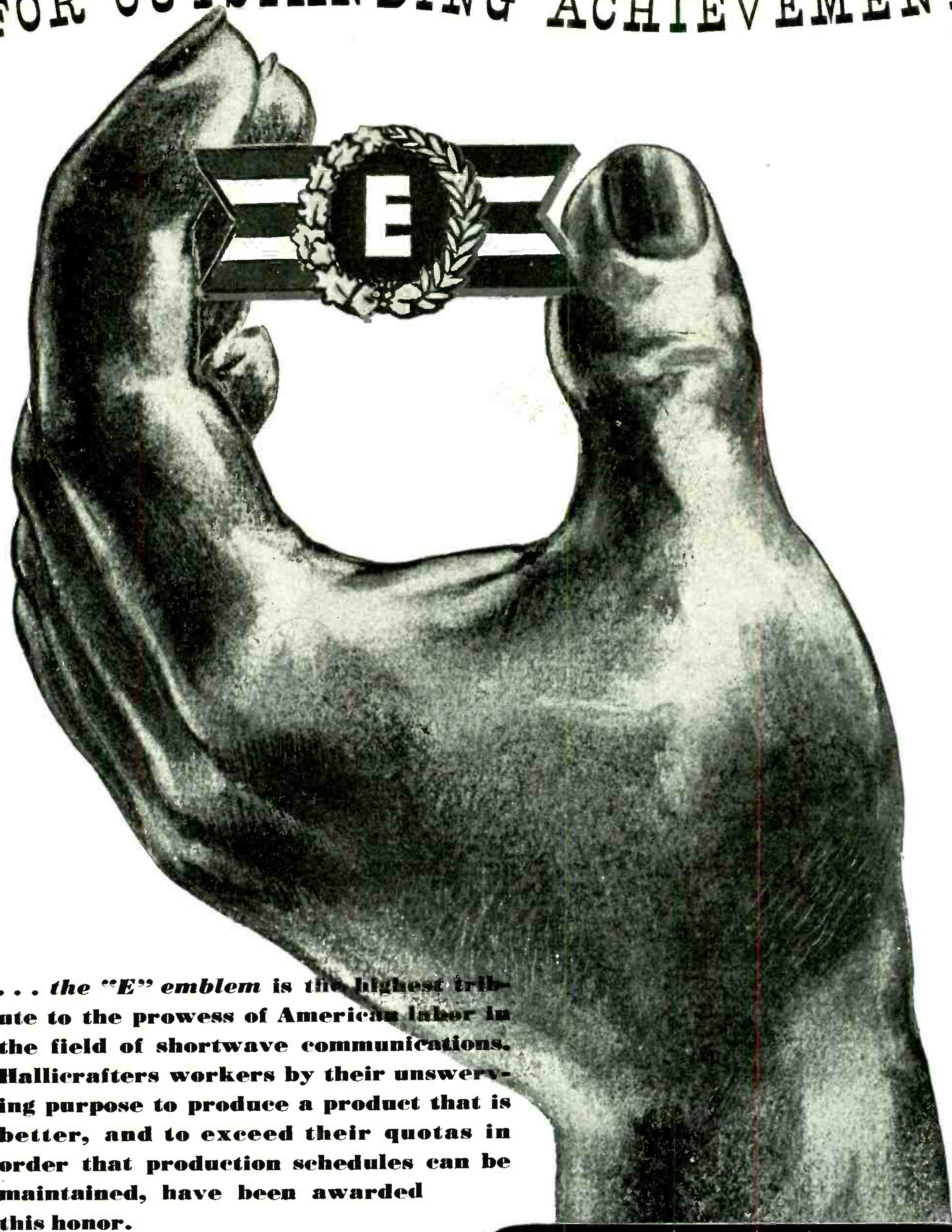


HARDWICK, HINDLE

FOR OUTSTANDING ACHIEVEMENT



. . . *the "E" emblem* is the highest tribute to the prowess of American labor in the field of shortwave communications. Hallicrafters workers by their unswerving purpose to produce a product that is better, and to exceed their quotas in order that production schedules can be maintained, have been awarded this honor.

The accumulative electronic experience gained by Hallicrafters employes will be a dominant factor in future peace time production of advanced designs in shortwave communications receivers.

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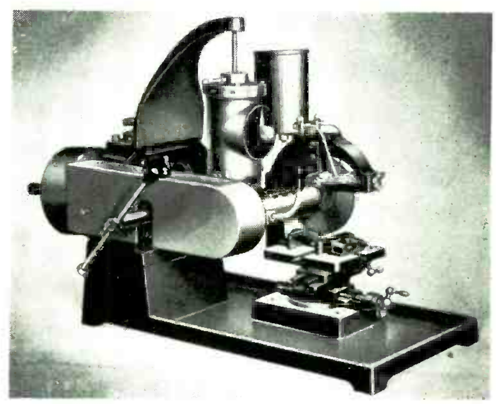
THE NEW DI-MET RIMLOCK Diamond Abrasive Cut-Off Wheel

Above are shown test samples of quartz cut with the new Di-Met RIMLOCK blade on a standard model 80 Felker Di-Met Quartz Cutting Machine. Over 700 wafers were sliced, averaging four square inches of surface area each!

RIMLOCK is new and different. High cutting efficiency is obtained by a new process of bonding the diamonds in either a copper or hard steel blade.* A better diamond pattern, plus rigid bonding without crushing the diamonds, makes this a faster, freer, longer-lived cutter. Due to the RIMLOCK'S exceptionally free-cutting action and low feed pressure, accuracy and parallelism are assured with excellent surface finish.

If you're looking for top performance in your quartz cutting operations, try the new Di-Met RIMLOCK! It's competitively priced and a great performer on all quartz Piezo crystal cutting applications.

*For those preferring a more rigid, fast cutting blade the hard steel RIMLOCK is recommended. For slightly less speed but with a softer action and increased life, choose the copper RIMLOCK.



Model 80
Di-Met Quartz Cutting Machine with Hydraulic Retardant on Down Feed

FELKER MANUFACTURING CO.

BOX 208 • TORRANCE, CALIFORNIA

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MANUFACTURERS OF DIAMOND ABRASIVE WHEELS

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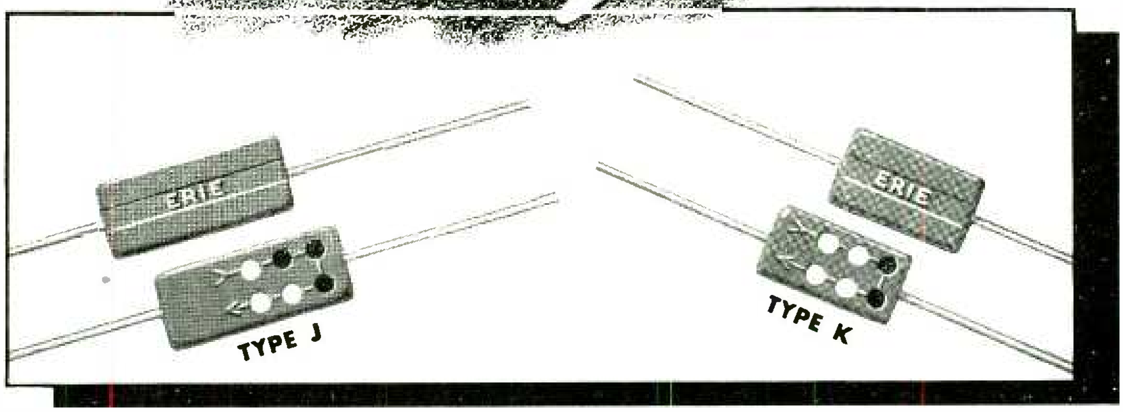
NEW *Design* CHANGES



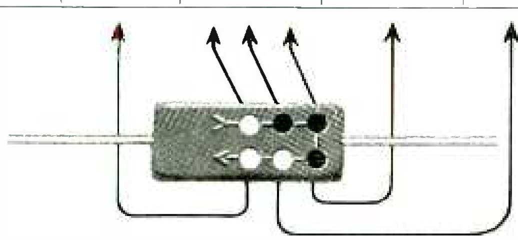
...*in* ERIE SILVER MICA CONDENSERS

NEW molding dies for Types J and K Erie Silver Mica Condensers have been installed which now provide space for the RMA standard 6 dot color code on the back of the condenser. All future production will be molded in this way. The illustrated table below shows how easily all pertinent information (capacity, decimal multiplier, tolerance, voltage rating) on any Erie Silver Mica Condenser can be obtained by simply reading in the direction of the molded arrow. Space is also provided in the new molded cases for stamping customer's part number on the face of the unit, if this further identification is necessary.

Due to the increasing shortage of the high grade mica used in the manufacture of Erie Silver Mica Condensers, users of mica condensers are urged to investigate the possibility of filling their requirements with Erie Ceramicons. These ceramic dielectric condensers are available in capacities up to 1100 MMF and in nine standard temperature coefficients, from +120 parts/million /°C to −750 parts/million/°C. Write for complete information describing this product.

TYPES J and K

Color of Dot	Volts	Significant Figure of Dot	Decimal Multiplier	Tolerance	Color of Dot	Volts	Significant Figure of Dot	Decimal Multiplier	Tolerance
Black	....	0	1	...	Blue	600	6	....	6%
Brown	100	1	10	1%	Violet	700	7	....	7%
Red	200	2	100	2%	Gray	800	8	....	8%
Orange	300	3	1000	3%	White	900	9	....	9%
Yellow	400	4	....	4%	Gold	1000	....	....	....
Green	500	5	....	5%	Silver	2000	....	....	10%



The Types J and K condensers, molded in Bakelite, are identified by the standard R.M.A. 6 dot color code, read in the direction of the molded arrow to indicate 3 significant figures, decimal multiplier, tolerance, and rated voltage, as shown in the table above. The unit pictured has a capacity of 500 MMF ±2%, with a voltage rating of 500.

ERIE RESISTOR CORP., ERIE, PA. LONDON, ENGLAND · TORONTO, CANADA.

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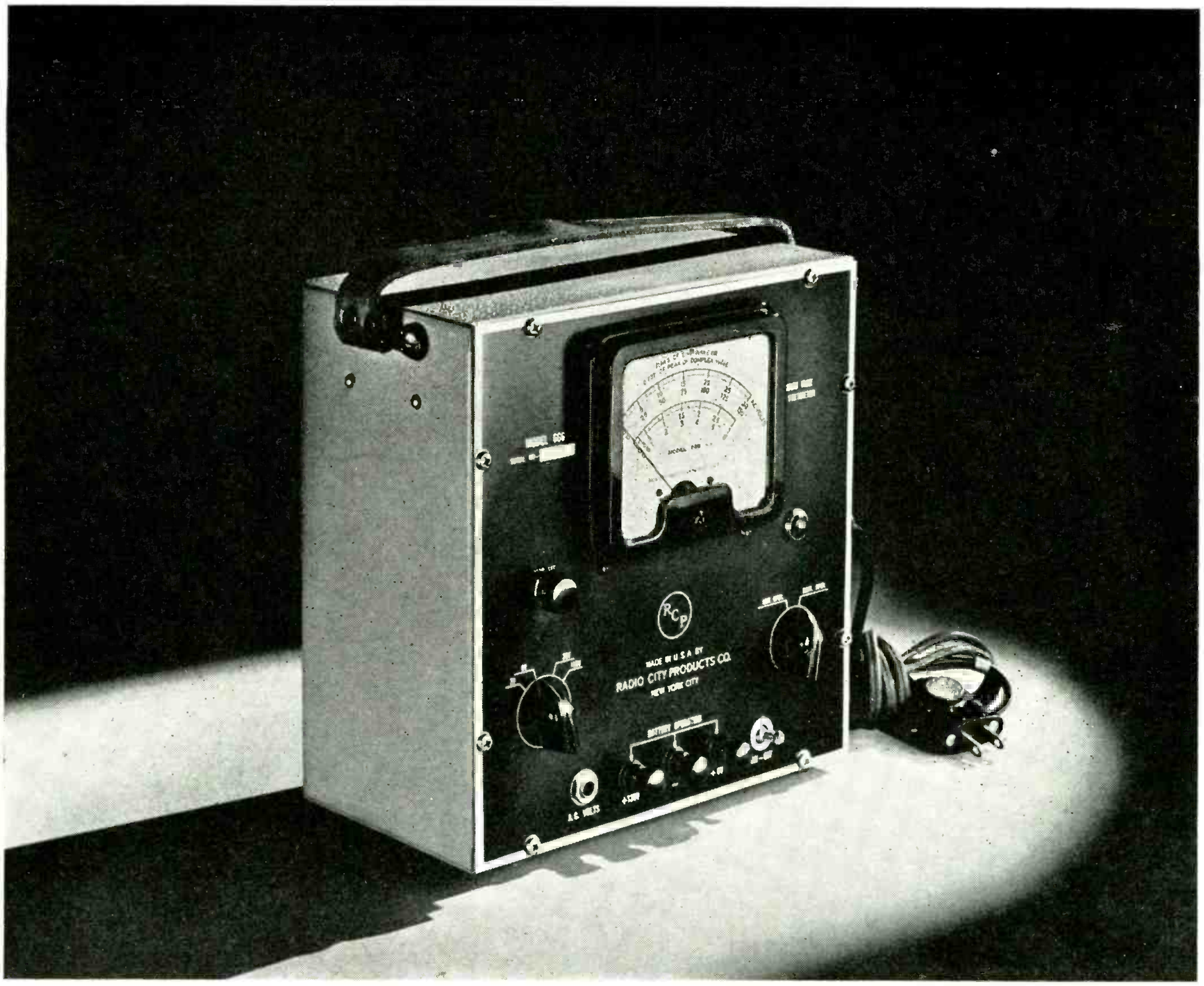

VACUUM TUBE VOLTMETER

Designed for accurate measurements throughout the entire audio frequency range, this instrument has been found exceptionally efficient in the automotive and allied industry for checking noise measurements, loss of r.f. and db in spark suppression devices. Ranges of this vacuum tube voltmeter are 0-3-6-30-150 volts. Tubes used are 6K6GT, 6X5GT and 6H6. In addition a VR105-30 voltage regulator tube is used—eliminating line voltage variations. Input resistance is 16 megohms for all ranges. Model 666 Vacuum Tube Voltmeter is for 105-130 volt, 60 cycle operation. Provision is also made for external battery operation. Switch permits throwing over to battery from line power supply. Meter is a 4½" microammeter with a movement of 0-200 microamperes. Supplied in a grey weather-proof steel case with convenient carrying strap. Size: 9⅜"x 9⅜"x4⅞". Ready for operation $35.50.

Other instruments in the complete line of R.C.P. electronic and electrical test instruments described in catalog No. 126. If you have an unusual test problem—for either production line or laboratory work—our engineers will be happy to cooperate in finding the most efficient and economical solution.

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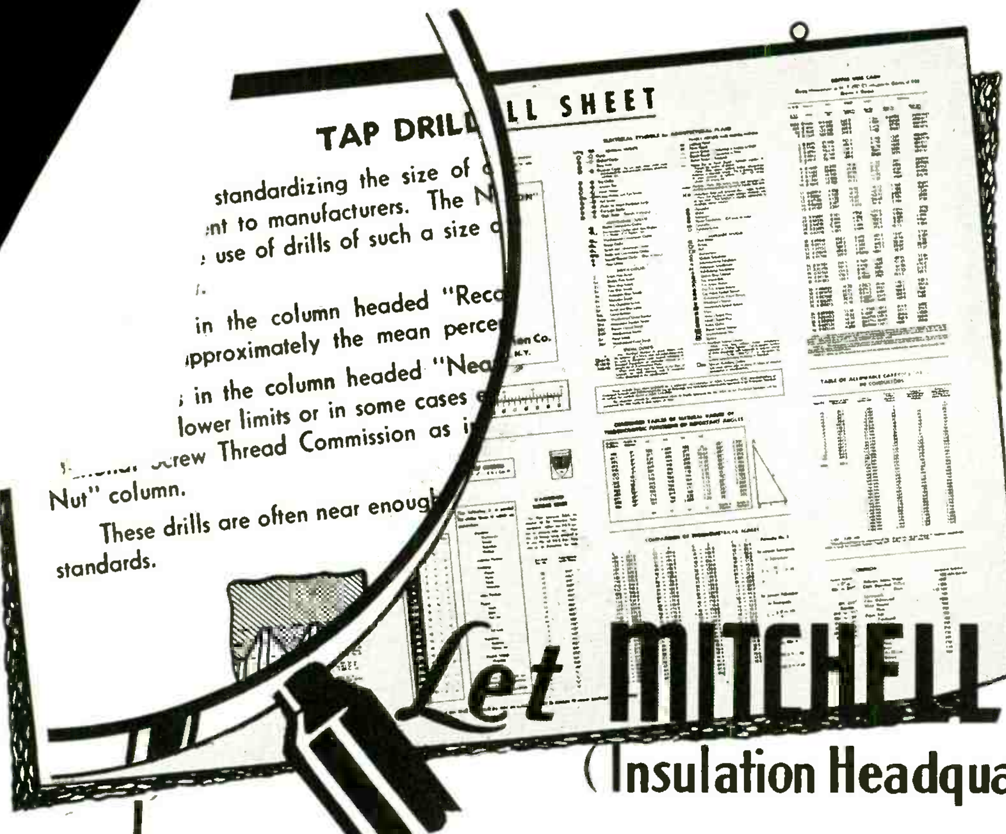

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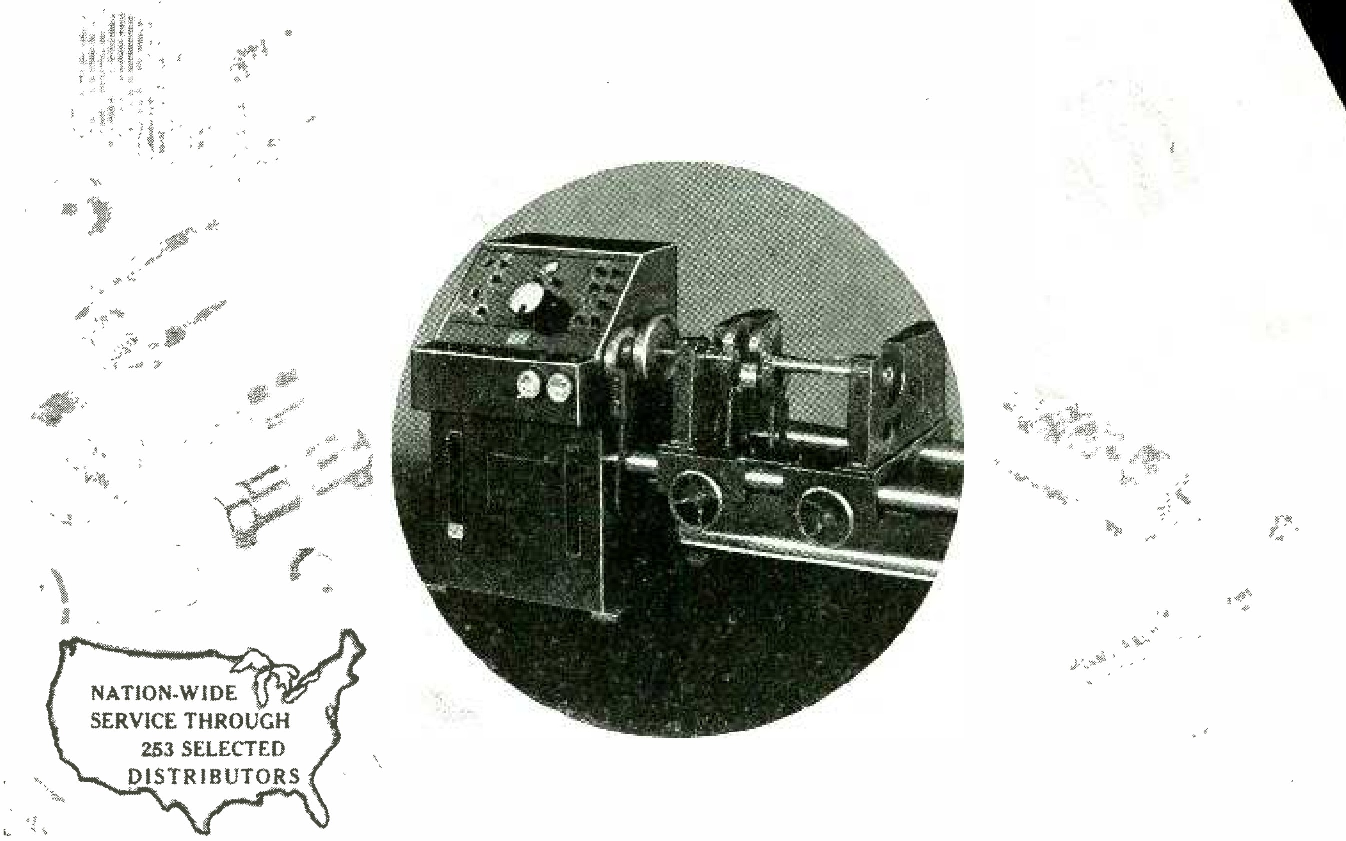
Aircraft Engines Get Their Balance of
Thanks to Mallory Approved Precision Pr



Balancing crankshafts of airplane engines assures longer motor life and less vibration . . . makes fighter planes easier to handle in the air. Thus many airplane engine manufacturers are using Gisholt Dynetric Balancing Machines to help attain more perfect operation and a smoother flow of power from the multi-horsepower engines they make.

Balancing machines made by Gisholt also improve the performance of many other products . . . from tiny motor armatures and small ventilating fans to heavy turbine rotors . . . used in many industries. To control these Dynetric Balancers, ultra-precise electronic parts are needed . . . such parts as the electrical switches supplied by Mallory.

Similarly, a large manufacturer of aircraft engines for both American and British warplanes utilizes many Dynamometer engine test cells . . . equipped with standard Mallory jack switches . . . a Mallory Approved Precision Product obtained in quantity, promptly, through the local Mallory Distributor.

Do you need electronic hardware, condensers, rectifiers, resistors or volume controls? For testing or experimental work? Or perhaps for plane replacements? Or as an integral part of some electrically operated device you plan to manufacture? See your nearest Mallory Distributor.

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Construction—Builder of Bases

America's Great Peacetime Industry Goes to War

PUNCHED through 1,600 miles of trackless wilderness and rivaling the Panama Canal in strategic importance, the Alaska Highway will cut days and dangers from present supply routes . . . to Alaska . . . to the Aleutians . . . yes, to Japan itself!

This job, to be finished soon and well ahead of schedule, is but one example in thousands illustrating how construction sets the stage for our war effort . . . and why the construction engineer is vital to victory.

Back of America's busy production lines, expanding shipyards, growing cantonments and far-flung military bases is a series of swiftly executed construction jobs. Important jobs! *For the construction industry is a builder of bases. Bases for production—for training—for defense—and for attack.*

To conceive and to carry through so tremendous a program in a race against time is typically American. It requires enterprise and the sort of versatility that has been acquired by undertaking every kind of job; from a Boulder dam to a drydock, from a Pennsylvania Turnpike to a housing project, from a Radio City to a railroad tunnel . . . and taking it in stride. War's demands in the eyes of America's construction men, are simply more of the same—for a grimmer purpose, and under heavier pressure.

The civil engineers who develop the necessary designs, the contractors who execute them and the manufacturers who provide the equipment and materials, are as much a part of this war as are the men who face the enemy. The results of their labors are recorded in mounting production figures, and will be indelibly written in the military annals of this war. Those 60,000 airplanes, 45,000 tanks and 8,000,000 tons of shipping that the President asked for in 1942 will be supplied because—and only because—the construction industry did a Herculean plant-building job first—and fast.

This is the fifth of a series of editorials appearing monthly in all McGraw-Hill publications, reaching more than one and one-half million readers, and in daily newspapers in New York, Chicago and Washington, D. C. They are dedicated to the purpose of telling the part that each industry is playing in the war effort and of informing the public on the magnificent war-production accomplishments of America's industries.

Yes, construction, America's great peacetime industry, has gone all out for war. From a normal 6½ billion dollars in 1938, it got into its war stride last year with a 11½ billion dollar volume. And under the impetus of Pearl Harbor, the 1942 figure now promises to reach the unprecedented total of 15 billion dollars. "If buildings would win the war, Hitler would be licked now", said Lieut. Gen. William S. Knudsen recently. Which emphasizes the further fact that the construction industry was the *first* to go to war.

The technical and managerial talent that is accomplishing this mammoth job has had to find its strength and resources within itself. No possibility of "conversion" here! Only years of varied construction experience enabled it to tackle and to achieve the manifold tasks that building for war demands.

Take that cornfield, for instance, that Henry Ford picked for his record-breaking bomber plant. The spring mud was soft and deep when contractors moved in last year. They were entering a race against an almost impossible time limit. Before they could even begin on the plant itself, they had to build roads, lay a 4-mile water supply line and install a complete sewerage system with its disposal plant. But such varied jobs—each big in its own right—merely were antecedent to running up the framework and enclosure for the 60-acre factory itself. Or to using road-building methods to pave a floor that was the equivalent of 25 miles of 20-foot wide concrete highway.

It was a race against the approaching winter, and to win it they had to push their $1,000,000 worth of construction equipment to the limit—day and night. But win they did! It is accomplishments like these that explain how the nation's aviation factory floor space jumped from 18,000,000 to 60,000,000 square feet in

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the past two years . . . why Fortresses and fighter ships are beginning to turn the scales of war in our favor.

"Somewhere in the Southwest" the Army called for a training base. The contractor who answered that call summed up his performance in characteristic fashion: "Beginning without so much as a contour map we had a $10,000,000 project ready for operation within 90 calendar days, and saved 3½ million dollars of the estimated cost".

At another Army camp a contractor assembled a crew of 20,000 men who put together 1,400 buildings in 125 working days, along with a sewer system, a water-supply and a street layout of which many a fair-sized city might be proud. This job swallowed up 2,000 carloads of lumber, and 26,000 kegs of nails. So perfect was the teamwork, from the general manager down through the hundreds of superintendents and foremen to the specialized crews, that as many as seventy buildings were erected in one single day.

But versatility and experience are not the only qualities that the construction engineer has in his tool chest. He has ingenuity, and he needed it when steel, copper, zinc and aluminum had to be used for combat equipment, and were denied him. Great hangars, conventionally of structural steel, were turned out with record-breaking timber arch spans. Reinforced concrete factories were designed to require only 3 lb. of steel bars per square foot instead of the customary 5 lb. Asphalt-impregnated paper was substituted for copper in flashings, cement-asbestos for galvanized steel in duct work. In the face of a materials shortage, he continued to build bases—safely, economically, and on time.

Construction ingenuity, too, is back of the records in Liberty ships, in war housing and a host of other facilities. Indeed, it was the construction industry that stepped forward to assume the bulk of the emergency shipbuilding program, leaving established yards free to handle more specialized Navy work. Naturally, it was easy for civil engineers and contractors to build the shipyards, but building ships was another story. It is a far cry from steel ships to conventional engineering structures, yet, drawing upon their bridge and building experience, the men of construction have turned out ships faster than they were ever built before.

How was this possible? . . . because the construction man sees every job as a new problem, views every precedent as something to be discarded in favor of something better. So instead of assembling the myriad separate pieces of each ship on the ways, he fabricated them into huge built-up sections. These he swung to the ways and welded them into place in a fraction of the time required by old methods.

Again, the demands for wartime housing for workers in industrial areas, at Navy bases, and near Army concentrations, have altered the meaning of "residential construction". The building of individual houses has given way to a form of multiple-unit project that calls for the skilled services of the architect, the civil engineer and the large contracting organization. On one such project, for example, a contractor experienced in large building and bridge construction employed an extensive system of prefabrication and site assembly that made possible the completion of 5,000 houses for war workers within five months.

All these activities, within the United States, parallel the achievements of other industries that serve the men at the front. But construction knows no continental limits. Its men are serving throughout the network of defense bases built in the West Indies, Greenland, and Iceland, and in the offensive bases that are taking form in the jungles and deserts of Africa, the harbors of the Persian Gulf, and the plains and mountains of Australia and Alaska. Already in this war, as in the last one, construction crews, like those at Wake and Guam, have dropped their peacetime tools to fight shoulder to shoulder with their comrades in uniform. Construction follows the flag to the farthest outposts in this global struggle.

* * * *

But while the construction industry thus serves the special needs of the armed forces, it must look after its job at home. It must keep the highways serviceable, the water supply safe, sanitary facilities adequate. There are home chores that cannot be neglected even in war.

And when we finish our No. 1 task of winning the war, the construction industry will again be called upon to help re-establish peacetime employment and to stimulate the normal industrial activities of the nation. It will raze, redesign and rebuild; it will bring modern sanitation to urban dwellers; it will safeguard fertile areas and cities from disastrous floods; it will improve all forms of transportation; it will design and build the facilities that will be needed to reconvert from war to peace. Its vision, versatility, experience and ingenuity will be as indispensable then as they are vital now.

Today it is building the bases that are needed back of every battle-line. Tomorrow it will build for a new and better era. Today it is laying the foundation for the victories that must be ours. Tomorrow it will lay the foundation for the peace that will follow these victories. In war and in peace the construction industry is the builder, the harnesser of nature's forces.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Company, Inc.

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CROSS TALK

► **NOISE** . . . A news release from the War Production Board reminds us of a *Saturday Evening Post* story of a number of years ago. In this piece of fiction were two characters, Tobe and Henney, characterized by the author as "great unshaven louts." This caused no end of amusement among the mutual friends of one Tobe Deutschmann, Canton, Massachusetts, and your editor.

Now it seems that lout Tobe is going great guns making condensers for radar and other military equipment; is acquiring chocolate factories in which to make capacitors; that after many years of pioneering in the use of noise-silencing equipment to cut down the racket produced by electrical appliances—pioneering almost totally without appreciation—Tobe's efforts to reduce man-made static are bearing very large fruit. Is it too much to hope that after the war, radio listeners will no longer be plagued with interference from razors, vacuum sweepers, elevators and other devices so full of electrical noise?

► **SAFETY** . . . On the 18th of August the President issued a proclamation calling upon the National Safety Council to mobilize its resources in leading a concerted campaign against accidents. This campaign aims to prevent loss of production, decrease of efficiency, and human suffering through accidents; and every man, woman and child should do his part in this effort.

Accidents in industry are on the increase. Men new to industrial work are now in factories, inexperienced in the ways of machines. Women now appear in increasing numbers in the same war production plants. They, too, are inexperienced in dealing with machinery. Women, particularly, are prone to suffer industrial accidents. They want to look good, now that they are working among men. They don't want to wear safety goggles or hats. It is surprising the number of woman-hours of work lost due to an elementary thing like open-toed shoes!

Most accidents are minor; but they take an operator away from his machine. They must be decreased to win a war.

► **JUNK** . . . All over the country men and women are taking courses in radio fundamentals, in code, and in methods of maintaining radio equipment in working order. Due to the hurry-up process involved and due to priorities, it has not been possible to amass representative equipment which the students can handle. Thus many a person gets his diploma without having much of an idea what a variable or fixed condenser or resistor looks like.

This all came to light recently when a letter from an AWVS school arrived, wanting to know how pieces of representative apparatus, not necessarily the latest models, could be obtained.

Many laboratories, manufacturers, service organizations and individuals must have lots of old junk kicking around, some of it workable and some of it no longer useful, all of which might be sent to these schools. Manufacturers cannot send samples and so these schools must either get priorities orders and purchase the modern stuff, or they must rely on gifts of older equipment from the outside or they must go without.

Has any reader a good idea on this matter?

► **SCRAP** . . . Release from Philco stating that in the first six months of 1942 this one company salvaged 120 carloads of steel turnings, emphasizes the big campaign now under way to collect scrap. This feat of Philco's is not special, it is the everyday collection of scrap engaged in by all plants. But there is in every plant, as in every dwelling, old stuff kicking around gathering dust and taking up space which could just as well be turned into something to send to the Orient or to Germany in more useful form. American Industries Salvage Committee, 350 Fifth Avenue, New York City, has some suggestions for organizing and carrying out a factory scrap program and it is worth having.

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ARNOLD'S AIM . . . .

To Correct Abuses

As viewed by Thurman W. Arnold, Assistant Attorney General of the United States, who heads the Antitrust Division of the Department of Justice, the release of the country's economy from abuses of our patent system is of paramount importance to the survival of the system of free enterprise.

Both temporary and future needs call for the breaking of powerful domestic and international cartels which he feels have developed under the umbrella of patent privilege and are responsible for shortages in many basic materials today.

The dangers ahead, he points out, are even greater because of the enormous industrial expansion due to the war and the possibility that these large plants may fall into the hands of a concentrated group, thus opening the door to even stronger cartel combinations after the war is ended.

Mr. Arnold emphasizes that it is not his desire to wreck the present system, but rather to prevent the use of patents as weapons to destroy independent business.

"What do you propose to do about this abuse of patents, in which you are so deeply interested?" Mr. Arnold was asked.

"Abuse of patents? What do I propose to do? Do you have any idea of the extent of this abuse? What it has done to the manufacture and flow of commodities in peace time? How it is hindering us in the war? It's a scandal—a downright scandal, which should not and cannot be tolerated. Today we are short of magnesium, optical goods, precision equipment, machine tools, zinc, and rubber. In all these cases, the abuse of the patents has been the primary cause of the shortage."

Then he stopped, reached for his desk pad, reflected a few moments over the neat little square he had drawn and continued in a more thoughtful mood:

"There are two separate problems involved; first, the reform of the patent law itself and second, the method of curbing the abuse of patents which should be applied under any patent law.

"I am not concerned with the patent law as such. By that I mean, there is nothing wrong with the fundamental principle of it. Patent law, like every other law subjected to the cross-fire of bitterly contested litigation gets encrusted with useless technicalities and should be brought up to date. There is nothing unusual in this. The basis of the law is just —the idea of protecting inventors and those who have money invested in inventions. As provided in the Constitution, the purpose of the patent system was 'to promote the progress of science and the useful arts,' with which I concur, absolutely."

Patents Now Most Complex

To show how the problem has increased in complexity, Mr. Arnold explained that the first patents were for simple gadgets, reflecting early stages of American business and economic development. For instance, the first patent on the books of the Commerce Department, issued on July 31, 1790, was for making "pot and pearl ashes." The second one, on August of that same year was "for manufacturing candles, flour, meal." Shortly afterwards there was a patent "for punches for types, etc." and another "for propelling boats by cattle."

Indicating the tremendous development of patents as to number and the processes with which they deal, Mr. Arnold points out that in 1828, the climax of the "gadget era," all inventions for which patents were issued were classified under 15 major headings as compared with 312 major classifications and 35,000 subclassifications today. The growth was so rapid—growth reflecting the advent of steam and electric power, chemical processes, and numbers of manufacturing systems — that the law could not keep up with technological advances. The law simply followed as best it could. Hence the need for revisions, which Mr. Arnold makes plain is not his job.

The most powerful weapon to curb the abuse of patents under any patent law, Mr. Arnold believes, is the withdrawal of patent rights and privileges. He says:

"As I have often stated, I believe the remedy lies in the right of the government to cancel any patent privilege, if the owner has used it as an instrument of business policy to dominate the market, to fix prices illegally, or to destroy independent business. To this end there must be systematic and intelligent prosecution, certainly more of a penalty than a small fine. With the patent intact, the aggressor still has a weapon of potential power."

"Do you favor the setting up of a Patent Commission for the supervision of Patents?"

"No. I have a distinct distrust of too much government. Also I feel that any Commission inevitably takes on the color of that with which it deals. No, the way to handle the problem is by making the principle of the Antitrust laws apply to the patent privilege just as it does to the privilege of incorporation. If a corporation dominates the market for any commodity it may be dissolved. If a patent privilege is used for the same sort of domination it should be cancelled. This principle should be applied case by case. As long as there is an abuse centering around a specific case, we have our feet on the ground and can arrive at a sensible

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# of Patent System

Arnold's Views on Patents Clarified

IN RECENT issues of *The Atlantic Monthly*, Thurman W. Arnold, Assistant Attorney General of the United States, published several articles under the general title "The Abuse of Patents". These articles and other statements by Mr. Arnold have created widespread discussion. In this interview with ELECTRONICS' editors, Mr. Arnold states that the fulfillment of the policies he advocates will correct present abuses of patents, and that the correctives he proposes will react to the advantage of the inventor.

On following pages will be found statements from people on the other side of the fence; from those who believe sufficient safeguards are now available, that changes to the present patent system are not advisable.

Since electronics is a young industry, the role to be played by inventors is most important and whatever affects the patent system of the United States will affect inventors.

conclusion. You understand that the Department of Justice has no powers over patent laws. Its only desire is to see patents operated within their legitimate and legal orbit. This orbit is not decided by the Antitrust Division, but is a matter for district courts, circuit courts, and the Supreme Court. Past illegal conduct is penalized through criminal procedure, which serves as a deterrent against repetitions of such conduct. I believe we should make it too hazardous to violate the law. In this way we can strengthen, not tear down the patent system.

"If a corporation finds itself gradually getting control of a commodity, a procedure should be set up whereby it could submit its patent licensing policy to the Department of Justice, in advance. It seems fair that there should be the right to enjoin without penalty or cancellation of the patents."

As for the inventor, Mr. Arnold feels that he always has had hard going, and should have more material recognition of his contribution. The inventor rarely owns the patent; he is usually an employee. Market domination is not primarily for his benefit nor to increase royalties, but as an instrument of business policy. The more the abuses of patents are overcome, the more he stands to receive from royalties. Since the character of invention has completely changed, Mr. Arnold thinks that possibly the inventor should be subsidized by government research facilities. At any rate, he says that the inventor need have no fear from the present Antitrust program—"not until the Board of Director Rooms of these large corporations have test tubes and cyclotrons!"

For years the field of electronics has been one of the most fruitful preserves for patent exploitation, Mr. Arnold believes. He cites radio as an illustration of patent difficulties.

"It was a reality in 1907 when De Forest invented his vacuum tube, yet 35 years later, over twice the period of the patent grant, it is still monopolized by patents. The history of the industry is one of constant patent litigation, by means of which large corporations have been able to eliminate smaller ones or encompass them into the sphere of their control. The industry has been the subject of Antitrust, public and private. Although initially the pooling of patents in this field may have been to break an impasse, it developed into a situation where a few large corporations divided fields into noncompetitive areas, gained control over the electronic industry far beyond the scope of their patents. And yet all this happened in an industry which has a more liberal licensing policy than we find in many cases."

If the government attempts to tell a manufacturer how, when, where and at what price to sell an article, the business man rebels and makes an accusation of government dictatorship, Mr. Arnold contends. He goes on to say that this is healthy opposition. Yet he asserts that corporations can do this very thing. For example, the ownership of patents dominates the manufacture and sale of incandescent lamps. According to Mr. Arnold, the patents holders fix quotas of licencees, price of lamps to be sold to wholesaler and retailer, all of which it covers under the guise of "agency," and with this power can practically determine to whom lights shall be sold.

"When such restrictions can be imposed on the public, I feel it is an illegal use of the patent privilege. Furthermore, with this power, I feel there has been a conspiracy to restrict the production of electric lighting."

Mr. Arnold waxes wrathful when he discusses the manipulation of patents for the building of cartels which he believes in turn are used and can be used to control the production and prices of certain necessities of life.

(*Continued on page* 158)

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Rebuttal to ARNOLD

BECAUSE of his position as Assistant Attorney General of the United States, his dramatic handling of situations and his undoubted flair for publicity, Thurman W. Arnold has occupied the center of the stage in the current patent controversy.

This does not mean however that he has the stage to himself nor that he has won the battle. Against him and his theories of patent law reform are almost solidly aligned the leaders of patent law in America, the leaders of industry and many of the outstanding pioneers in the field of modern American invention.

This group is strongly opposed to hasty legal reforms on the ground that such reforms might well undermine the patent system itself and at the same time place a heavy discount on inventive genius for the future by depriving the patentee of the rewards accruing from patents or by discouraging financial aid for the commercial development and proper exploitation of patents.

Against hasty action one argument in particular is forcefully advanced, namely that no general overhauling of the patent system should be undertaken until the Patent Planning Commission established by President Roosevelt on December 12, 1941 has submitted its report under the comprehensive directive of the Chief Executive. The report of the Commission will take cognizance of post-war conditions as regards the position of American industry and interrelated patent problems—national and international. This last consideration alone, it is contended, should preclude any piecemeal tinkering with the patent structure at this time.

The Commission is composed of the following: Dr. Charles F. Kettering, Chairman, Vice President of the General Motors Corporation and Chairman of the National Inventor's Council; Owen D. Young, former Chairman of the Board of General Electric Company; Chester C. Davis, President, Federal Reserve Bank of St. Louis; Edward F. McGrady, former Assistant Secretary of Labor; and Charles P. Gaines, President of Washington and Lee University. It will be readily noted that the Commission is representative of inventors, industry, finance, agriculture, labor, and the general public—all of whom have a vital stake in an efficient and progressive patent system. The investigation work is being done under the direction of Dr. Audrey A. Potter, Dean of Purdue University.

"Why", ask Mr. Arnold's critics, "take one man's opinion as to what should be done to the patent system through legislation or otherwise, pending the considered findings of this distinguished group?"

Mr. Arnold, however, has refused to wait. Scores of bills that would radically change the patent structure are now pending before Congress and several, including three of the most important of them, bears the imprint of the Assistant Attorney General and his colleagues in the Anti-trust Division of the Department of Justice. It is significant that neither the Department of Commerce, which is charged with the welfare of industry, nor the patent office are in any way connected with the major pending legislative proposals. One of these is a war measure designed to enable the government to use all patents for the effective conduct of war industry. The need for such an amendment to the existing law is far from being generally accepted, since it is contended that under the war powers and under specific enactments by former Congresses, the government can use all patents. Two of the pending bills, however, are of a permanent nature and it is around them and the drastic changes they contemplate that the main controversy rages. One of the bills in question proposes compulsory licensing and unrestricted licensing, both features to be retroactive as regards patents heretofore granted, and all rights and arrangements made under them. The other measure, it is contended, would virtually establish Mr. Arnold, or whoever should happen to head the Anti-trust Division of the Department of Justice as a virtual czar over the entire patent structure in the United States, making the Division a party to all infringement suits and calling for the cancellation of patents under conditions set forth in the bill. This provision of cancellation of patent rights is of the greatest importance because it is in line with Mr. Arnold's pet theory that a patent is a franchise issued by government and subject to revocation rather than a property right protected by constitutional guarantees.

Action on this body of proposed legislation is temporarily suspended, but it is the confirmed opinion of the opponents of Mr. Arnold's reform theories that there is enough dynamite in the proposed legislation to shake the patent system to its very foundations.

Win the War First

The all important consideration at the moment in the opinion of Conway P. Coe, U. S. Commissioner of Patents, is not the amendment of patent laws but the effective use of patents for the prosecution of the war, the encouragement of new patents and the preservation of the present structure for the future benefit of the country. In a statement specially prepared for ELECTRONICS, Commissioner Coe has this to say: "Patents are both the incentive and the reward of invention. In its turn, invention is the stimulus to material progress, as the framers of the Constitution intended it should be. Down through fifteen decades the millions of our people have benefited by the inspiration and protection they have afforded to the inventors whose genius has given the United States industrial preeminence and preponderance. Every section of our population and every region of our country has profited by the products of our inventors.

"Inventions are more indispensible

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Change in Patent System Not Advisable

MANY arguments are brought up by those who disagree with Mr. Arnold. Among them are some that are time-honored, since the patent system has been under attack off-and-on for many years. Now is not the time to revise the system, some say, but rather let us win the war first. Proposals will harm the inventor, according to others, who feel that the inventor should be free to deal as he wishes with the patent he secures for an invention. Repeated investigations have failed to disclose actual instances of patents being withheld from active use, say others; and still other arguments against Mr. Arnold's proposals revolve around the belief that the present Anti-trust laws are adequate to protect the people from unlawful abuse of the patent system.

in this crisis of war than they have been in the decades of peace. They are meeting the daily needs of manufacture, agriculture, commerce, transportation and communication. They are vital to our armament on land, at sea and in the air, at home and abroad, that we may defeat our enemies and preserve our independence and our liberties. We are now fighting our foes with hundreds of American inventions. Others are coming to us daily from the minds of American inventors who are at once spurred by patriotism and recompensed by patents.

"The lesson taught by these historic facts is that we should be thankful for the system that has done so much for us in peace and that assures to us still more in war. And our gratitude should prompt the preservation of that system for the future."

One of the best known patent authorities in the United States. Karl Fenning* feels very much the same way as does Mr. Coe on the inadvisability of experimentation or innovations at this time.

"Before endeavoring," he said, "to determine what, if any, changes or controls should be placed on patents it is necessary to determine what economic system or theory is to be the basis of our industry after the war. If we are to have a regimented industry we may need cartels such as Germany has and so we may adopt from the German patent law the compulsory licenses which are being advocated. If not, it seems unnecessary to copy Germany in that or any other respects. Probably compulsory licenses under United States patents will be unconstitutional.

"The President has appointed a Patents Planning Commission to determine what, if anything, can be done to better adapt inventions and patents to the situation after the war. It will be well to await the Commission's report before amending the patent laws rather than act on the suggestion of any one man. There is no necessity for amendment of the patent laws because of war inasmuch as the United States can in its sovereign power do anything it desires without regard to the presence or absence of patents."

What About the Inventor?

The fate of the inventor under some of the reforms advanced, such for example as withdrawal or cancellation of patent rights and the subsequent scaring away of capital is causing considerable apprehension. In a recent study made by the National Association of Manufacturers, it was shown that out of 712 inventors, lack of financial support was found to be the inventor's greatest obstacle.

"In general", said Mr. Fenning, "our present patent laws are admirably adapted to encourage the poor man who has invented something entirely new to benefit the public. The occasional improper use should not cause a fundamental change from the constitutional 'exclusive right' granted the inventor. He should be free to deal with his invention as he thinks best without Governmental contact—even by getting the Department of Justice to approve in advance his business arrangements.

"The best way to incite to invention is to show a need for invention. When something new is developed and patented every competitor wants to enter the same field. If the patent is strong and closely held, the competitor must produce an invention of his own to compete, but if he can get a compulsory license there is no incentive to invent a competing device. Thus when one method of producing magnesium was patented, another method of producing magnesium was invented and magnesium is now being produced by both methods.

"No one will invest the needed time, work and capital in developing a new invention if the patent is hedged in so as to give no protection, and even then is subject to cancellation if it protects the new infant industry. Dr. Alexander Graham Bell, the inventor of the telephone, in commenting on the Stanley bill proposing compulsory licensing, stated in a letter of April 12, 1922 that:

> **" 'It is almost too obvious for comment that the existence of such a law would make it practically impossible for the inventor to obtain capital. I cannot think of anything more effectively designed for the discouragement of inventive genius.' "**

Commissioner Coe feels that patent protection is a basic requirement to secure to the public the commercial development accruing from patents. "Speculative capital", he said, "will not back new inventions without patent protection."

(Continued on page 160)

* Former Assistant Commissioner Patents; Special Assistant Attorney General of U. S. 1925-1928; Editor *U. S. Patents Quarterly* since 1929; Professor Patent Law, Georgetown University; Chairman National Committee on Patent Legislation 10 years; Chairman Legislative Committee National Council of Patent Law Assoc. Member Advisory Council, Committee on Patents, U. S. House of Representatives.

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Sounds made by industrial and other equipment may be accurately recorded in the field on instantaneous discs and brought back to the laboratory for analysis. Cutting and playback apparatus is described in detail. A moving film camera operated in conjunction with an oscilloscope and a sound analyzer automatically plots the frequency spectra

Recording MACHINERY NOISE

By H. D. BRAILSFORD

Underwriters' Laboratories, Inc., New York

NOISE characteristics of machinery installed out in the field must frequently be studied during engineering investigations requiring oscillographic observation, frequency analysis and sometimes auditory comparison of two or more machines as well as the usual overall sound level or vibration readings.

In only a limited number of cases is it possible to secure all of the foregoing data on the job. While sound level and vibration meters are portable, the equipment necessary to record frequency spectra and oscillographic data does not lend itself so readily to field use and it is, of course, quite impossible to make aural comparisons between the noises of two or more machines at different locations. In other cases the sounds or vibrations under investigation do not continue for a long enough period to permit a continuous sweep of the complete frequency range.

A research recently undertaken by Underwriters' Laboratories, Inc., involved a detailed study of the noise and vibration of machines installed in the field at widely distributed locations. The problem was solved by transcribing the noise and vibration on instantaneous discs which were subsequently returned to the Laboratory for study. A cathode-ray oscilloscope operating in conjunction with a moving film camera and commercial sound analyzer was used to plot the frequency spectra. It is the purpose of this paper to describe the apparatus and technique.

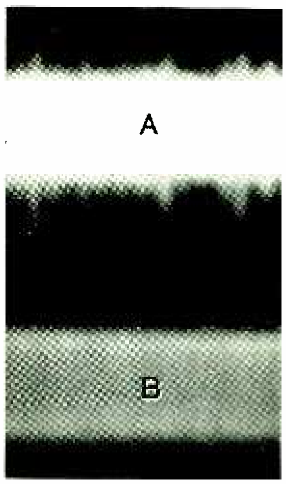

Fig. 2—Oscillograms of the playbacks from a 4000 cps cut made (A) with commercial tension-spring depth-of-cut control and (B) advance-ball control

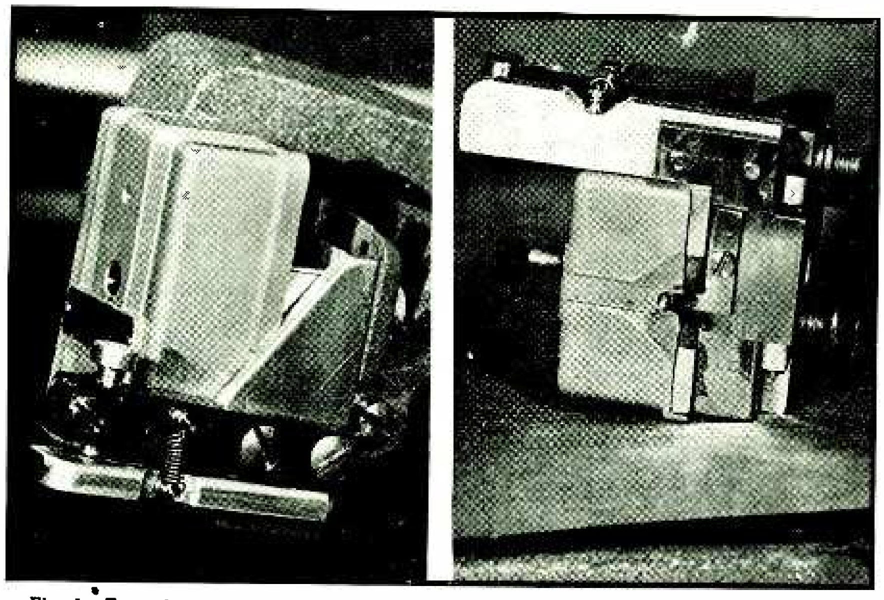

Fig. 1—Two views of a commercial cutting head with advance-ball attachment added to insure uniformity of depth-of-cut

Recording Equipment

Portable disc recording equipment in recent years has been developed to an excellent degree, insofar as the reproduction of speech and music is concerned. Quantitative analysis, however, imposes somewhat more stringent requirements upon the equipment. For the most part, regularly available commercial equipment

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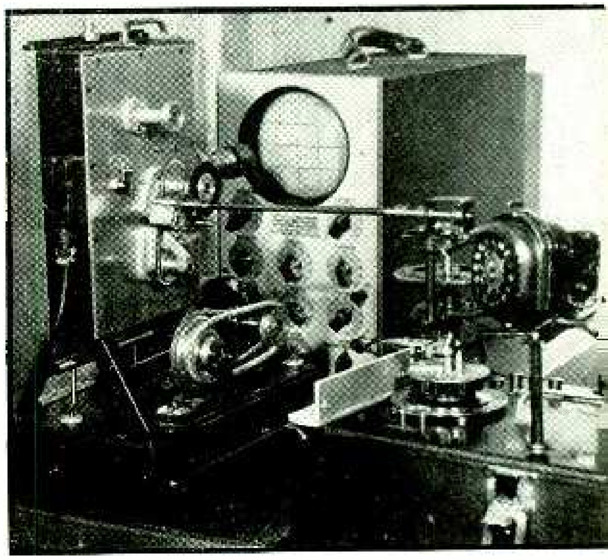
Field equipment consists of a microphone, two stages of a sound level meter used as a pre-amplifier, a single-ended recording amplifier incorporating feedback and an instantaneous disc recording mechanism with a modified cutting head



Laboratory equipment comprises a special playback pickup pictured elsewhere, an equalizer and turntable, the sound level meter again used as a pre-amplifier and the sound analyzer, moving film camera and DuMont oscilloscope shown here

CHARACTERISTICS

was found suitable. In describing specifically the apparatus selected the author does not wish to be construed as implying that other types might not prove equally adaptable to the purpose. Conversely, the alterations detailed are not intended to reflect criticism upon commercial design.

Turntable—The turntable selected was the Presto Type 75-A, a light and compact unit having good speed regulation and low background noise. This machine has a 16 in. cast aluminum turntable, rim-driven by a small synchronous motor. It may be operated at either 33⅓ rpm or 78 rpm. The cutter driving mechanism is of the tangential enclosed type, cuts 112 lines to the inch and may be engaged to cut either inside-out or outside-in. It was found that when cutting at 33⅓ rpm from inside out, no attention was required to prevent the thread from fouling the stylus. The overall response of the equipment was therefore calibrated for this method of operation and all recordings were so made.

Cutter Head—The Presto Type 1-C head supplied with the turntable was found quite adequate when used in conjunction with a suitable recording amplifier. The method of suspension and adjustment for cutting depth, however, required some modification.

On this commercial unit the cut is regulated by the tension adjustment of a small spiral spring which operates to oppose the pull of gravity on the cutter head. It was found that if a disc were at all out of horizontal, an uneven depth of cut would result on opposite sides of the record. Such a recording, when played back, showed objectionable fluctuation in amplitude, particularly at the higher frequencies. For example, a 12 in. disc $\frac{1}{32}$ in. out of horizontal showed amplitude fluctuations of the order of 2 to 3 db at frequencies of 4000 to 5000 cycles. Another disadvantage of the tension spring when using this equipment for quantitative analysis is that depth of cut is in part a function of the groove velocity, tending to increase as the velocity increases, that is, as the cutter approaches the outside of the disc. An improvement in performance was attained by fitting an advance-ball.

The advance-ball attachment consists essentially of a bracket clamped to the rear of the cutter head by the two mounting crews. The bracket carries a pivoted arm capable of vertical adjustment by means of a machine screw. The adjustable arm supports a short vertical sapphire cylinder approximately 0.06 in. in diameter, the lower end of which is rounded and highly polished. The sapphire ball is positioned diagonally ahead of the cutting stylus at a center-to-center distance of approximately $\frac{3}{32}$ in. The spring was retained as a counterbalance to control the loading on the advance ball.

The construction of such an attachment presents no great difficulties and the fundamental mechanical details are shown in Fig. 1. The most important requirements are: first, the attachment should be sufficiently rigid to prevent any vibration of the ball supporting members and, second, the advance ball itself should be positioned as close as possible to the cutting stylus. The improvement in performance is illustrated in Fig. 2, which is an oscillogram of the playback from a 4000 cps cut made without the advance ball *A* and with the advance ball *B*.

Dural-shank sapphire cutting stylii were used. With reasonable care these points have a very satisfactory life.

Recording Amplifier—The recording amplifier was of the single-ended feedback type and the fundamental circuit is one developed by Abend[1] in which the feedback voltage is taken from the secondary of the output transformer. In this writer's opinion, feedback amplifiers are definitely desirable for recording since they have an inherent tendency to suppress resonant

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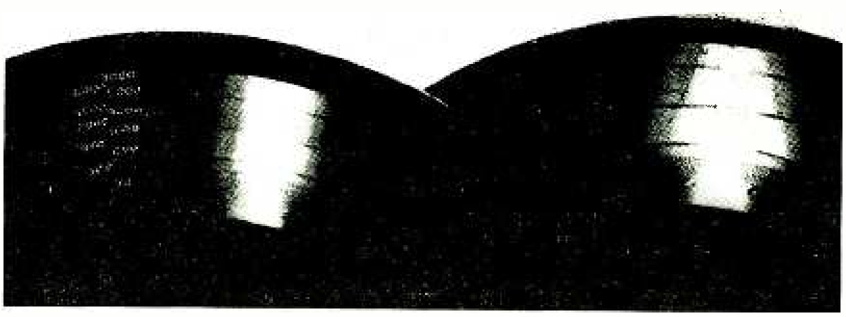

Fig. 3—Light-patterns on two frequency records made by the same cutter, the one at the left through the single-ended amplifier discussed in the text and the one at the right through a commercial push-pull amplifier without feedback

peaks in the cutter head as well as improve the impedance match between cutter and amplifier throughout the frequency range.

The light-pattern on two frequency records made by the same cutter is shown in Fig. 3. The one on the right was cut with a commercial push-pull amplifier; that on the left with the single-ended feedback amplifier of Fig. 4. The cutting conditions were identical for both discs. Note the excellent, nearly flat response from 200 to 7000 cps secured with the feedback amplifier, whereas the push-pull unit shows an almost straight line decline in this range due to the rising impedance of the cutter windings with frequency. The feedback amplifier, operating at about 90 db in the 200-7000 cps range, is down 3 db at 100 cps and 9 db at 50 cps.

A sound level meter, needed in the field for overall sound level readings, was used as the recording preamplifier, a somewhat unusual arrangement so far as this writer is aware but one that has proven extremely satisfactory. An outlet jack was installed in the sound level meter between the second and third amplifier stages as shown in block diagram, Fig. 5. Two stages of hum-free preamplification were thus provided, plus microphone pickup facilities, without extra apparatus.

Playback Considerations

Playback or reproduction from instantaneous discs, particularly in the upper frequency range, is a more difficult process than a cursory review of general literature on the subject might lead one to believe. The cellulose nitrate coating of discs on which the sound track is engraved has two physical properties which impose definite limitations upon the playback device and these are important in the application under discussion.

The first limitation comes about because the coating is relatively soft. When the reproducer stylus rests upon the disc the coating undergoes elastic deformation until a sufficient area is in contact with the stylus to support the weight. If the deformation does not exceed the elastic limit of the lacquer, the latter returns to its original shape upon removal of the load. If the unit pressure exceeds the elastic limit of the coating, a permanent dent will be left upon removal of the stylus. The particular discs selected for use were tested by applying a reproducer stylus with a standard 2.2 mil nose sapphire under different bearing loads while the blanks were rotating on the turntable and noting the pressure at which a visible mark was left upon the surface. This became apparent at bearing loads of the order of 20 grams.

The second disc limitation referred to relates to the elasticity or compliance of the lacquer coating. A lateral reproducer stylus resting in a groove as in Fig. 6 may be considered a vibrating system consisting of mass *M* and compliance C-C_1, in which the effective mass at the stylus point of the vibrating system and the resiliency of the record material form the constants. This system will have a resonant frequency, which is a function of *M* and C-C_1. It is to be expected that at this frequency a peak will result, beyond which response will decline rapidly because the relative motion of the stylus and the lacquer groove will have reversed, the former remaining comparatively stationary and the latter vibrating. This phenomenon does not appear to have received the rigorous analysis its importance deserves. Other than a recent brief mention by Lynn[2], the author has been unable to find any published material concerning this effect.

Reproducer—For the investigation mentioned it was desired to have a reasonably flat overall response characteristic ranging from about 50 cps to approximately 6000 cps. Commercially available units, with which this writer is familiar did not seem to possess satisfactory characteristics for this special purpose. The lightest reproducers offered appeared to have stylus loadings of the order of 30 to 90 grams. One commercial reproducer of the 30 gram class was tested and its response was found to fall off badly at about 3000 cps on a lacquer

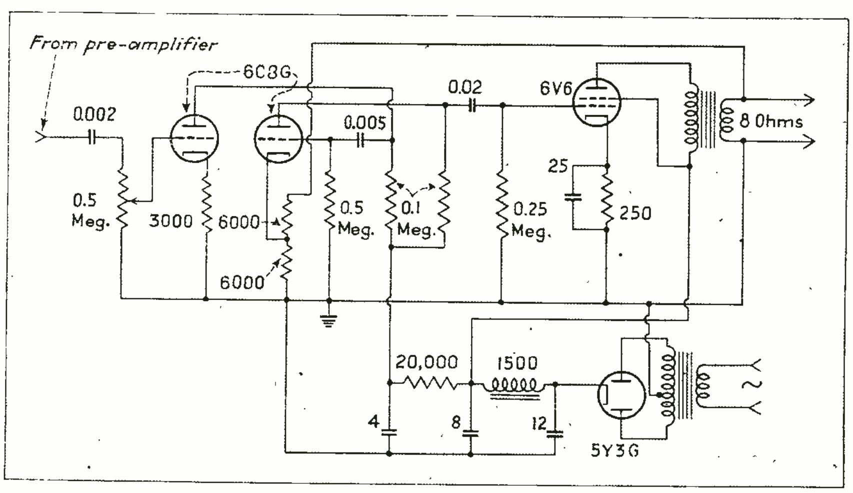

Fig. 4—Circuit diagram of single-ended recording amplifier incorporating feedback. Two stages of a sound level meter are used as a pre-amplifier

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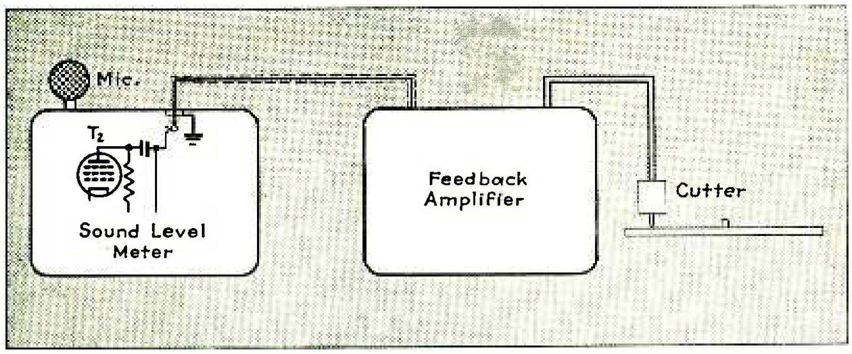

Fig. 5—Block diagram of field recording setup, showing position of auxiliary jack in sound level meter permitting two stages to be used as a pre-amplifier

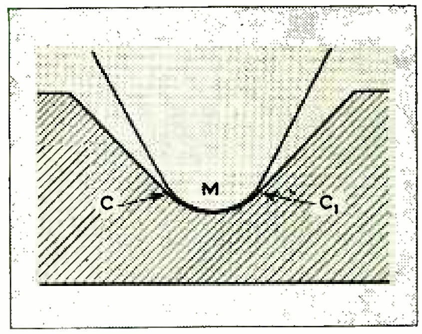

Fig. 6—When playing back lacquer-coated discs the system will have a resonant frequency dependent upon the stylus point mass *M* and the elasticity at points C and C_1

disc, although its performance was good on commercial records.

A number of lateral reproducers of advanced design, having light bearing weights and light vibrating masses, have been developed in laboratory form and described in various papers.[3, 4, 5, 6, 7] A special reproducer was therefore constructed. The fundamental design is one developed and described by Fleming.[3] In this unit the moving system consists of a small armature of rectangular cross-section pivoted at its upper end, free to move vertically and, at the lower end, laterally.

Two models were constructed. In the first the constants given by Fleming were followed. The armature assembly had a weight of approximately 90 milligrams, the gap between pole faces was 0.050 in. and the head was counterbalanced to exert a stylus pressure of 18 grams upon the record. The resonant peak previously discussed occurred at 4000 cps on the lacquer records and at 6000 cps on a vinylite pressing. A second model, slightly modified, was constructed. The armature size was cut to a total weight, including stylus and lower spring, of 51 milligrams. The gap between pole faces was reduced to 0.035 in. and the head was counterbalanced to track at a pressure of 16 grams. This unit is illustrated in Fig. 7. The resonant peak appeared at about 5600 cps on the lacquer disc and at 7800 cps on the vinylite disc.

It might be wondered why a magnetic rather than a dynamic type of reproducer was chosen. The reasons were: first, ease of construction; second, lower hum level; third, higher output and fourth, and most important, easier impedance match. A one-turn dynamic reproducer would have an impedance of the order of a fraction of an ohm, whereas the magnetic was in this case wound to an impedance of 50 ohms, which matched several of the stock transformers available. Although the upper frequency limit for the unit eventually employed happened to suffice for the immediate purpose, data at hand indicate that no great difficulty would be encountered in building a reproducer of this design to extend to 8,000 cps and perhaps higher on instantaneous discs.

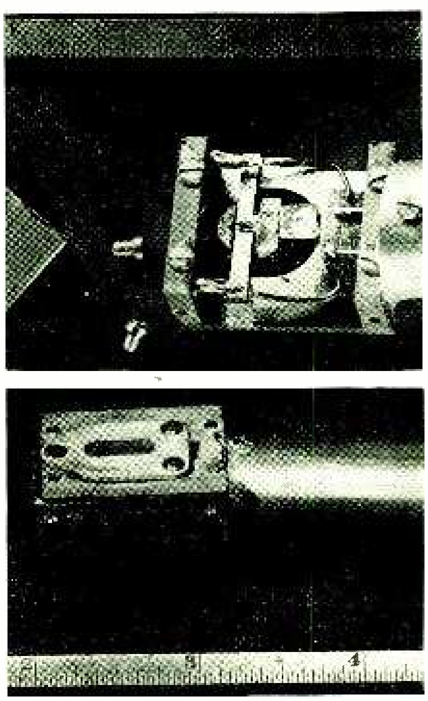

Fig. 7—Open and closed views of the special, lightweight magnetic pickup unit built by the author

The overall response characteristics of the playback system are given in curve *B* of Fig. 8. For playback the reproducer output is connected through an equalizer network directly into the sound level meter. The wave analyzer is connected to the output of the sound level meter in conventional fashion when setting up for analysis.

Overall Response

The equalizer network comprises a matching transformer (50 ohms to grid), the usual resistance-capacitance network to flatten response up to the region of resonance and an inductance-capacitance network to flatten the resonant peak. The constants of this network are not given since they are a function of the characteristics of the matching transformer used. The resonant circuits are quite critical in adjustment. The inductances were provided with Allegheny Electric metal cores having an air gap and the final calibration made by adjusting the gap.

It should be pointed out that the overall calibration of this system is in part a function of the particular type of record used, both as regards the base and the coating material. An overall calibration made flat for an iron base disc was as much as 8 db out when a frequency run was cut on a glass base disc said to be coated with the same formula. It has been the writer's experience that discs of the same grade and manufacture are uniform to a very reasonable degree. Calibration checks were made each time a new batch was purchased but it has not been found necessary to change the equalizer network up to this writing.

Discs have a very reasonable life when played back under the condi-

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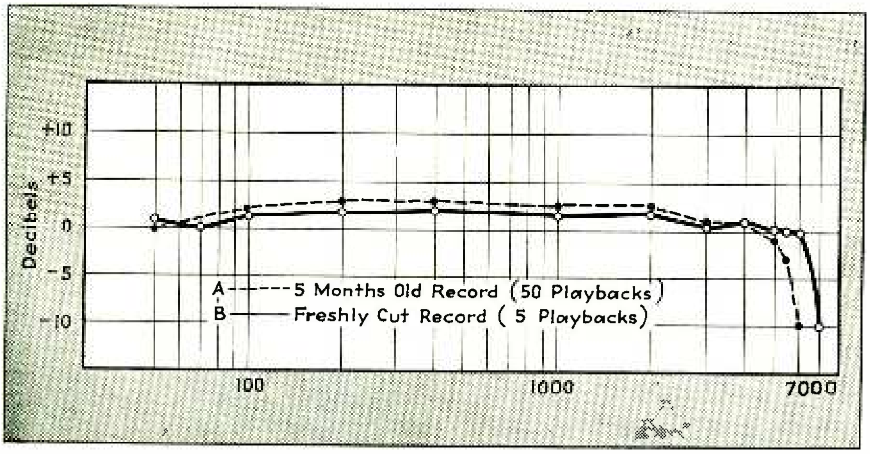

Fig. 8—Overall response characteristics of playback system. Calibration is, in part, a function of the type of disc used

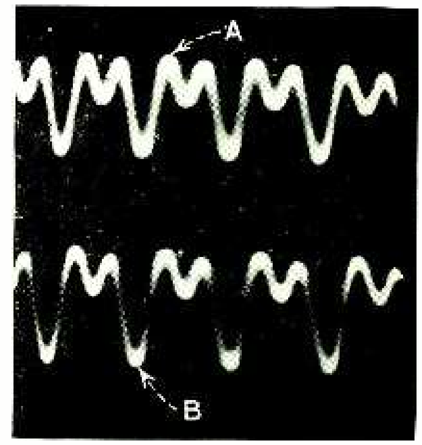

Fig. 9—Comparison of cutter output voltage waveform and playback output voltage waveform

tions described. One frequency record was cut and allowed to age for a period of five months, during which time approximately 50 playbacks were made. A response curve was then plotted and compared to a freshly cut disc. It will be noted in curves *A* and *B* of Fig. 8 that the old disc exhibited a slightly higher output from about 70 cps up to about 2000 cps and fell off rapidly above 5000 cps. The loss in high frequencies is quite understandable but this writer has no explanation to offer for the apparent gain in the middle and lower frequency ranges.

Harmonic Distortion—The overall total harmonic distortion of the system, with 0.25 watts input to the cutter, ranges from about 3.5 percent to about 4.5 percent from 100 cps up to cutoff. Below 100 cps the second harmonic increases and is approximately 7.5 percent at 50 cps.

Figure 9 shows two oscillograms of a complex input voltage, *A*, taken at the cutter terminals, and the playback voltage waveform, *B*, of the resulting cut. Except for a slight phase shift, the oscillograms are in close agreement. On work involving sound, phase shift is generally of little importance since the ear itself is not sensitive to phase distortion. Vibration analysis may or may not require freedom from phase distortion.

Translation Loss—In playing back from disc records the high frequencies are subject to progressive attenuation as the groove speed decreases, that is, as the reproducer moves from the outside toward the inside of the record. This effect, which is due to the fact that the stylus tip has a finite radius, has been adequately covered in previous literature on the subject.[2]

Attachments are available for automatically changing the frequency characteristics of a recording amplifier so that as the cutter head moves from the outside toward the inside of the disc, for example, the gain of the amplifier at the upper frequency range is increased. Such a system, however, entails complications and is not a perfect solution because, as Pierce and Hunt[3] point out, the tracing distortion on a lateral cut record is a function of the square of the recorded amplitude; thus abnormal increase of the driving voltage at the upper frequency range would substantially increase the distortion.

A simple solution was arrived at by cutting, as has been previously stated, from inside out, and, on the playback, sweeping the wave analyzer from the low toward the high frequency range. A total of recording lasting 6 minutes was cut on each disc, starting with a diam-

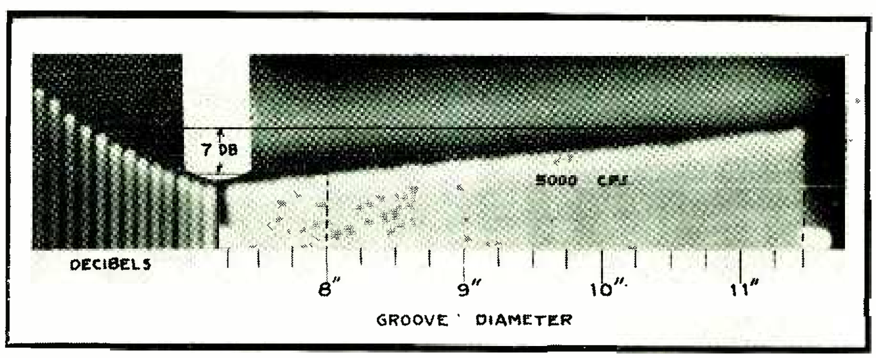

Fig. 10—Oscillographically plotted curve of system's translation loss at 5000 cps. An error of almost 7 db would result if the high frequency range was plotted at the beginning instead of at the end of a record cut from the inside out. A method of minimizing this error is outlined in the text

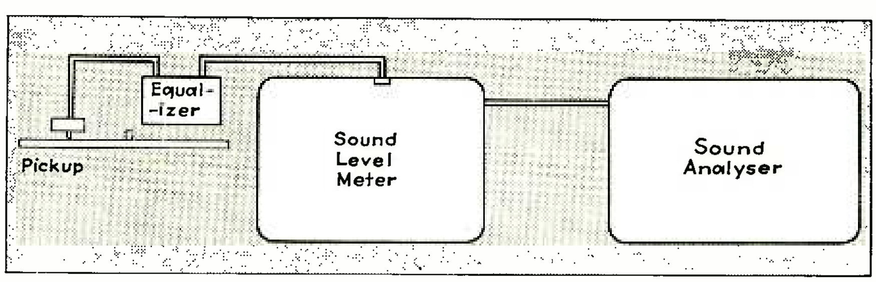

Fig. 11—Block diagram of analyzing setup. The output of the sound analyzer is fed to the oscilloscope pictured elsewhere

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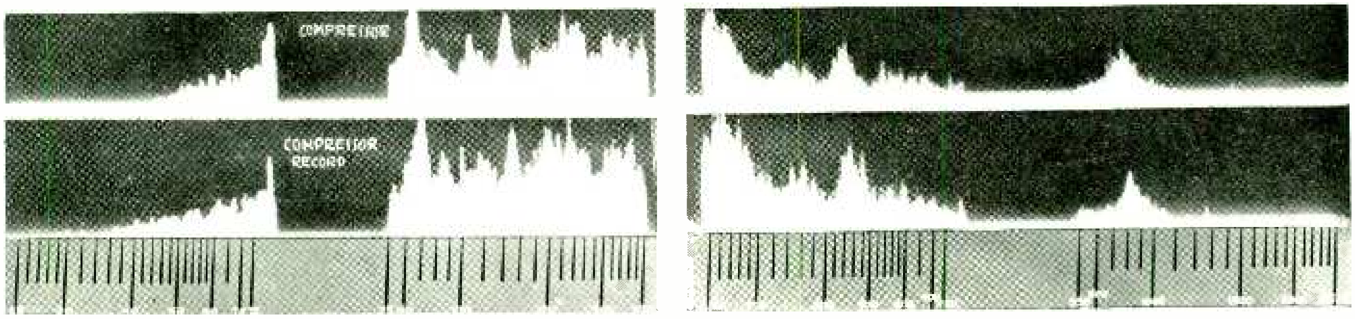

Fig. 12—Vibration noise spectrum of a 60 cps motor-driven air compressor. The top strip was made by means of direct microphone pickup while the bottom strip was made from a recording. The gaps at 75, 250 and 750 cps occur where the sound analyzer was band-switched during laboratory analysis of the overall spectrum

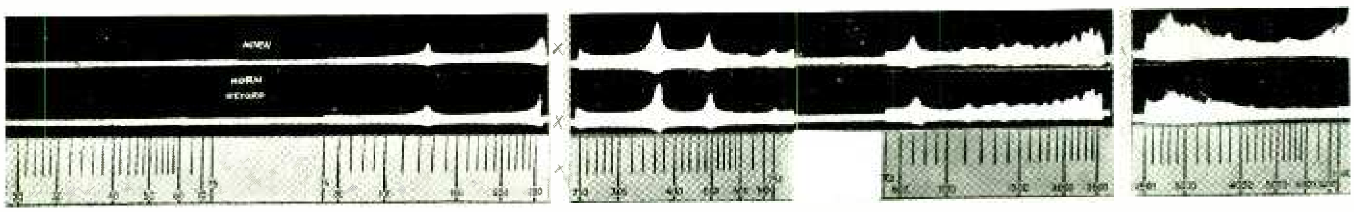

Fig. 13—Sound spectrum of vibrating diaphragm type signal horn, 60 cps line operated. The top strip was made by means of direct microphone pickup while the bottom strip was made from a recording. The gaps at 75, 250, 750 and 2500 cps occur where the sound analyzer was band-switched during laboratory analysis of the overall spectrum

eter of approximately 8.5 in. and ending at a diameter of approximately 11.5 in. The sound analyzer was operated at a speed of slightly less than 1 rpm, and required approximately 5½ minutes to make the complete sweep. The reproducer was started at the inside of the groove and tracked outward as the motor drove the analyzer. Thus by the time the upper frequency range was reached on the analyzer, the reproducer was well toward the outside of the disc. The effect of translation loss was almost entirely counteracted in this manner. An oscillographically plotted curve of translation loss in the system for a 5000 cps frequency is shown in Fig. 10. An error of almost 7 db would result should the high frequency range be plotted at the start instead of at the end of the recording.

Analysis of the Records

Examination of the complex sound track engraved upon the discs was carried out in the laboratory and consisted of analysis by frequency bands, oscillographic observation and aural comparison between the vibration recording or sound recording for the same machine and for different machines. The connection for playback analysis is shown in block diagram, Fig. 11. It will be noted that (except for listening tests) the sounds were not reproduced through a loudspeaker, which would have added a considerable degree of distortion. The most significant data was secured by plotting a complete frequency spectrum of each disc.

There are two commonly used methods of plotting frequency spectra, first: by manual manipulation of the wave analyzer, recording the relative value of the various components and plotting a curve from the data and, second: by employing a motor drive mechanism for the analyzer and connecting the output of the analyzer to a direct current amplifier, which in turn operates the stylus of a mechanical recorder. The recorder chart may be driven in synchronism with the motion of the analyzer dial either through a mechanical interlock or by means of synchronous motors for the two units.

In the present case manual attempts to plot the frequency spectra were unsuccessful. Combination of an unusually large number of individual components, intermodulation effects between components that were not harmonically related, continual phase shift between components, high ratio of unpitched noise in certain frequency band ranges, and the presence of highly damped transients made it impossible to weed out any but a few of the most prominent frequencies. A mechanical recorder was not available and could not be secured under the priority conditions existing. Furthermore, many of the characteristics of the data that made it so difficult manually to plot the curves suggested that a mechanical recorder might likewise prove inadequate. A cathode-ray oscilloscope was, therefore, employed.

Oscilloscope—The cathode-ray oscilloscope is usually associated with the delineation of high speed phenomena. So much attention has been devoted to its development in that field that the usefulness of the instrument for slow speed work has been largely overlooked. The oscilloscope, operating in conjunction with a moving film camera, will do everything that can be accomplished by a mechanical recorder, in addition to which it has inherent capacity to respond to any high speed fluctuations apt to be encountered.

For this type of work the photographic technique becomes extremely simple. High speed films are not necessary and the oscilloscope can be operated at a spot intensity so low that there is no likelihood of scorching the screen even though the beam remains stationary for protracted periods of time. By changing the driving

(Continued on page 164)

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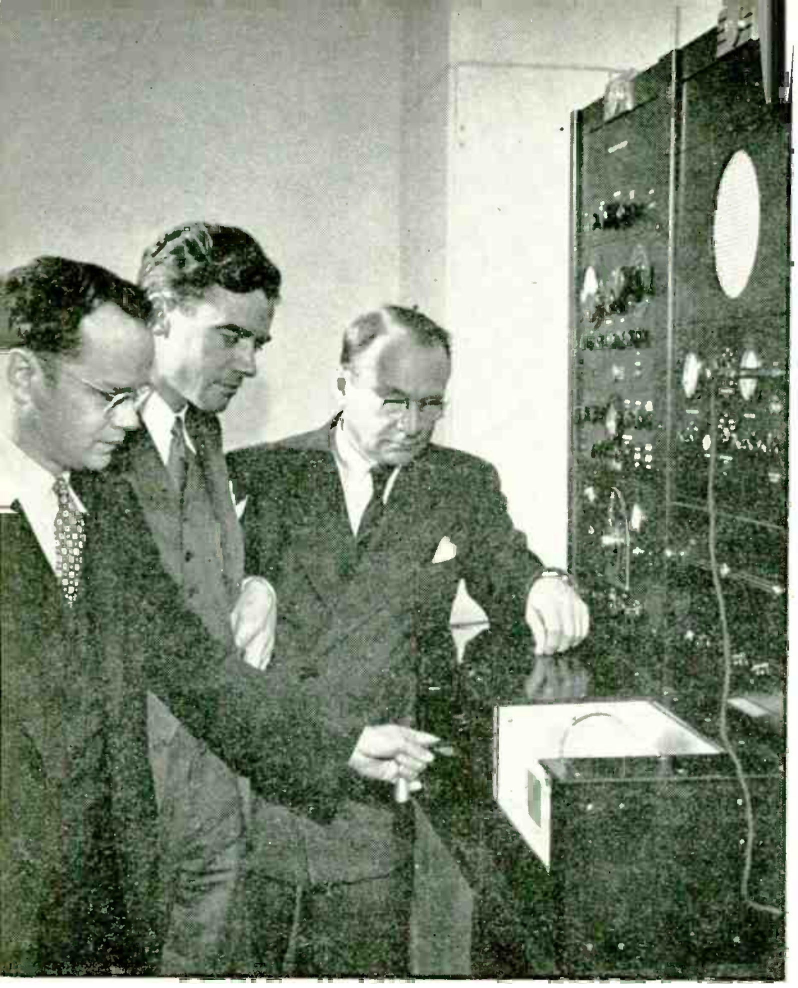
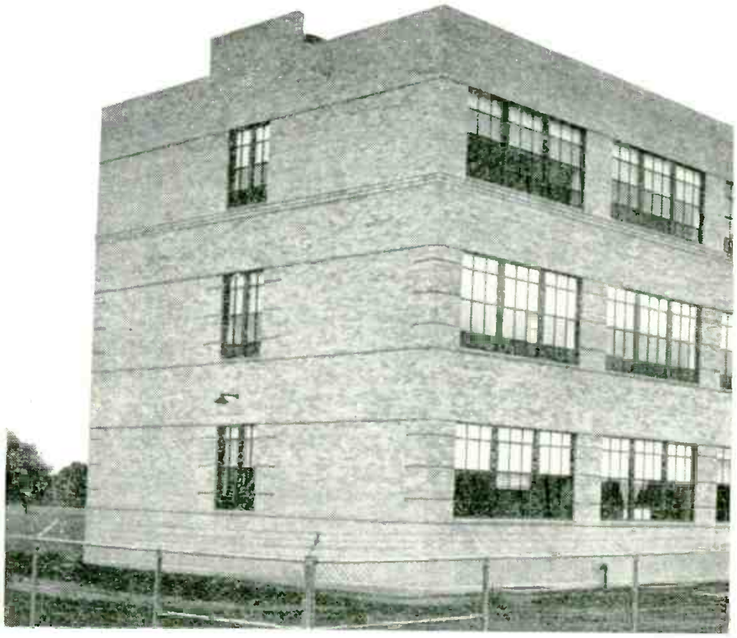


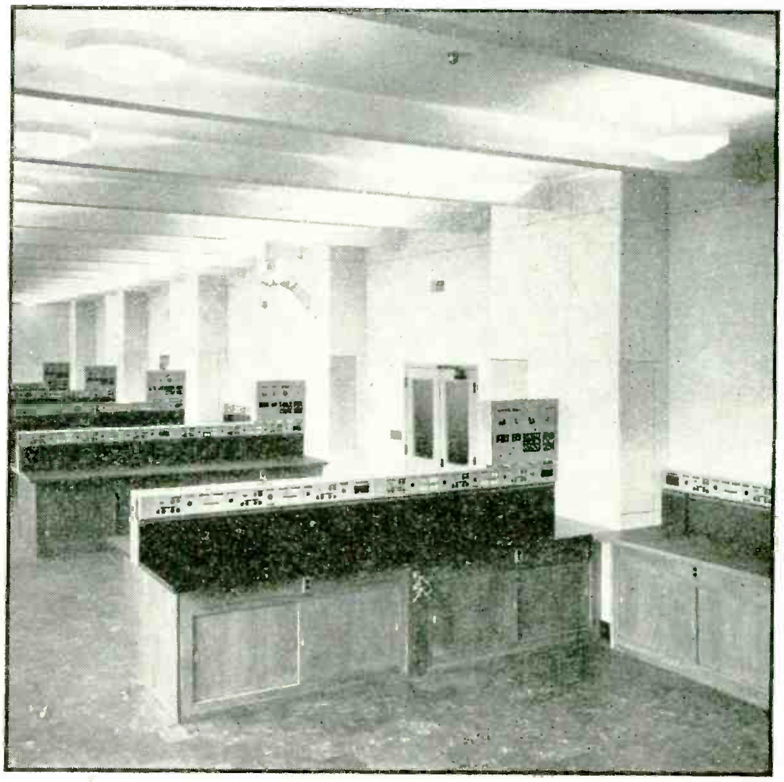
E. W. Engstrom, B. J. Thompson, and V. K. Zworykin (left to right) examining test equipment in the Laboratories

RCA Dedicates New Electronics



NEW laboratories of the Radio Corporation of America at Princeton, N. J. were formally dedicated publicly on September 27. Planned during peacetime as a major contribution to radio and electronics research, and built at a cost of about two million dollars, these laboratories will ultimately house

The Meter Room, a portion of which is shown here, has complete facilities for calibrating the three thousand different meters which are available for the measurement of voltage, current, power, temperature, speed, and other physical quantities



A general view of one of the laboratories. Each laboratory has uniform shadowless lighting of daylight supplemented by modern indirect lights. Each bench has numerous ducts with removable panels along the wall through which voltage and current of various voltage and frequency, as well as other services may be obtained

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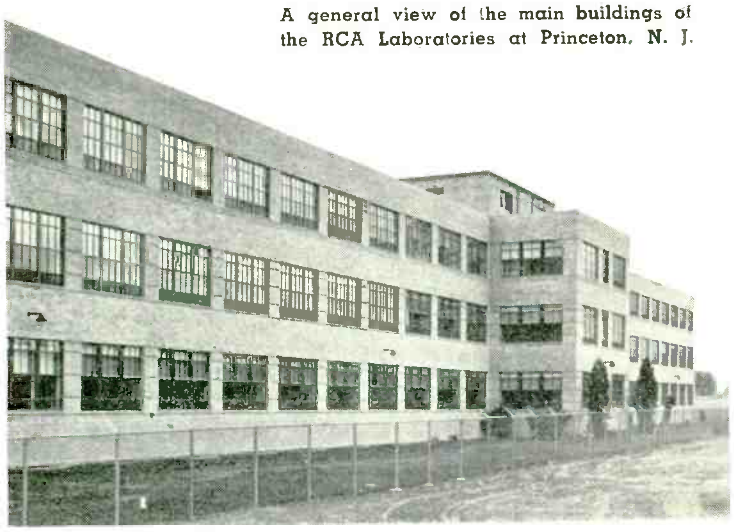
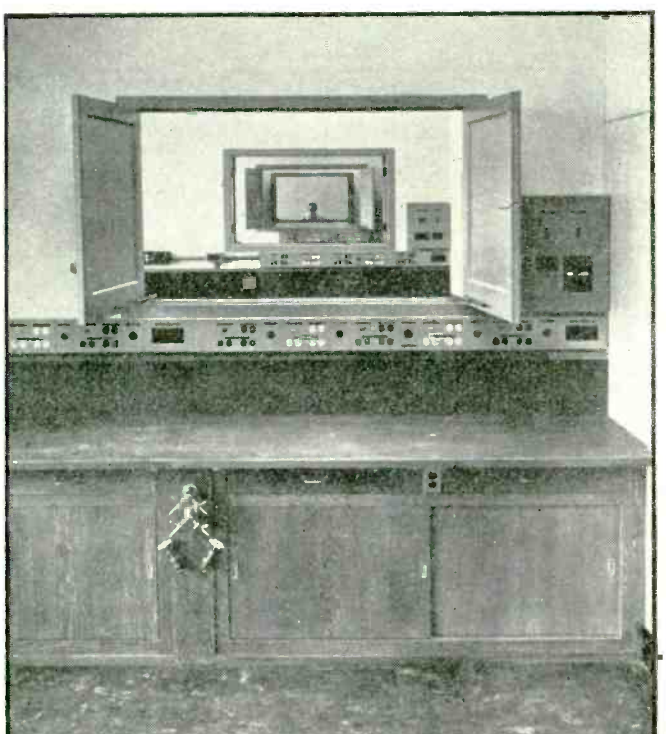
LABORATORIES



A general view of the main buildings of the RCA Laboratories at Princeton, N. J.

Lieutenant General J. G. Harbord and Major General Dawson Olmstead, Chief Signal Officer of the Army, inspecting one of the lathes in the Model Shop

all of the research activities of RCA. Speaking at the dedication ceremonies, Major Gen. Dawson Olmstead, Chief Signal Officer of the Army, said that the laboratories were carrying out a "service of tremendous importance to our government and to the nations who are our Allies in this war."



President Dodds of Princeton University delivering his address at the dedication exercises on September 27. From left to right on the speaker's stand are: Colonel David Sarnoff, Major General Dawson Olmstead, Lieutenant General J. G. Harbord, Commander A. M. Granum, and Otto S. Shairer

Bays in the Optics Laboratory are interconnected by door-like openings in the walls, making possible optical paths of considerable length. Note the electrical outlets above the desk, and gas, water, and air outlets on front of bench

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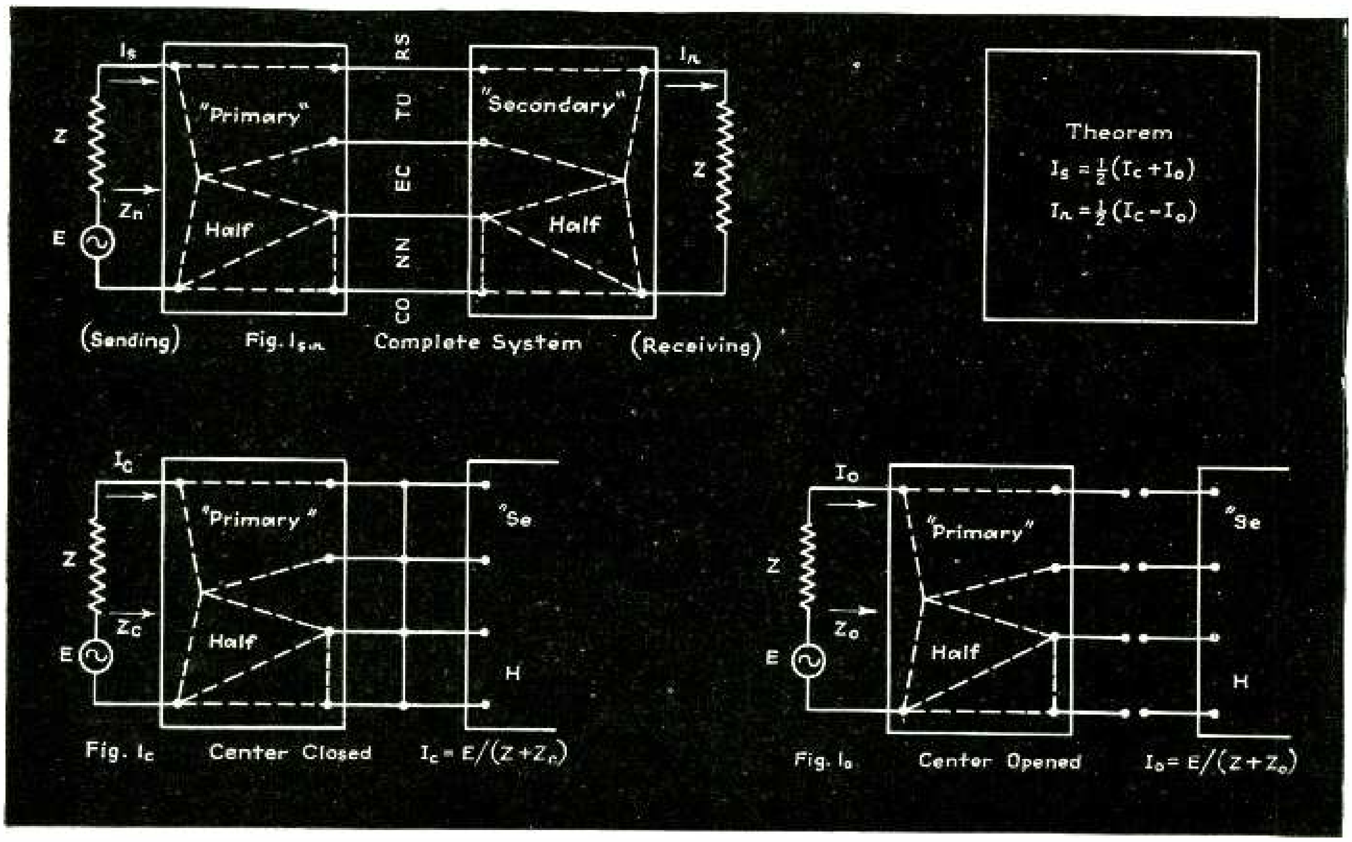
Fig. 1—To determine the characteristics of a symmetrical electrical four-terminal network, the sending and receiving currents are determined by shorting and then opening the connections between sending and receiving halves of the network



Symmetrical Electrical Systems

Part I—Basic Theory with Application to the Wien Bridge

By E. S. PURINGTON

Gloucester, Mass

TWO methods of evaluating the transmission performance of four-terminal networks are well recognized. Firstly and fundamentally, mesh equations may be set up and solved to determine the terminal currents. Secondly and more abstrusely, the performance of the network may be first determined on the basis of image impedance terminations, and then reflection and interaction factors applied to determine the performance with the actual terminations.

If the network possesses electrical symmetry (this is not unusual), and especially when the network together with its terminations possesses structural symmetry, a special method of treatment is available. It possesses the advantage of the mesh equation method of yielding explicit instead of tabular performance information, and the advantage of the image impedance termination method of dealing with assemblies of impedance elements instead of with currents and voltages at and between network junction points.

While nothing can be determined by the special purpose method which cannot also be determined by the other procedures, it has the important advantage of usually yielding the required information with the smallest effort. It can be advantageously applied in studies of resistor-capacitor and resistor-inductor networks, wave filter units, composite wave filters made up of a chain of related filter units, and transmission line phenomena.

This special purpose method is based upon a theorem recorded in Fig. 1. The symmetrical electrical system of Fig. $1_{s,r}$ involves a structurally symmetrical network separated into two mirrored half portions analagous to a primary and a secondary circuit. These two portions are joined by electrical connectors, through which power can pass from the primary to secondary portion. No mutual inductance exists between any inductor of the first portion and a corresponding inductor of the second portion. Power transfer is therefore measurable by the currents through and the voltages between the connectors. Major interest is in the received current I_r in the receiving termination Z due to a sinusoidal driving voltage E in the

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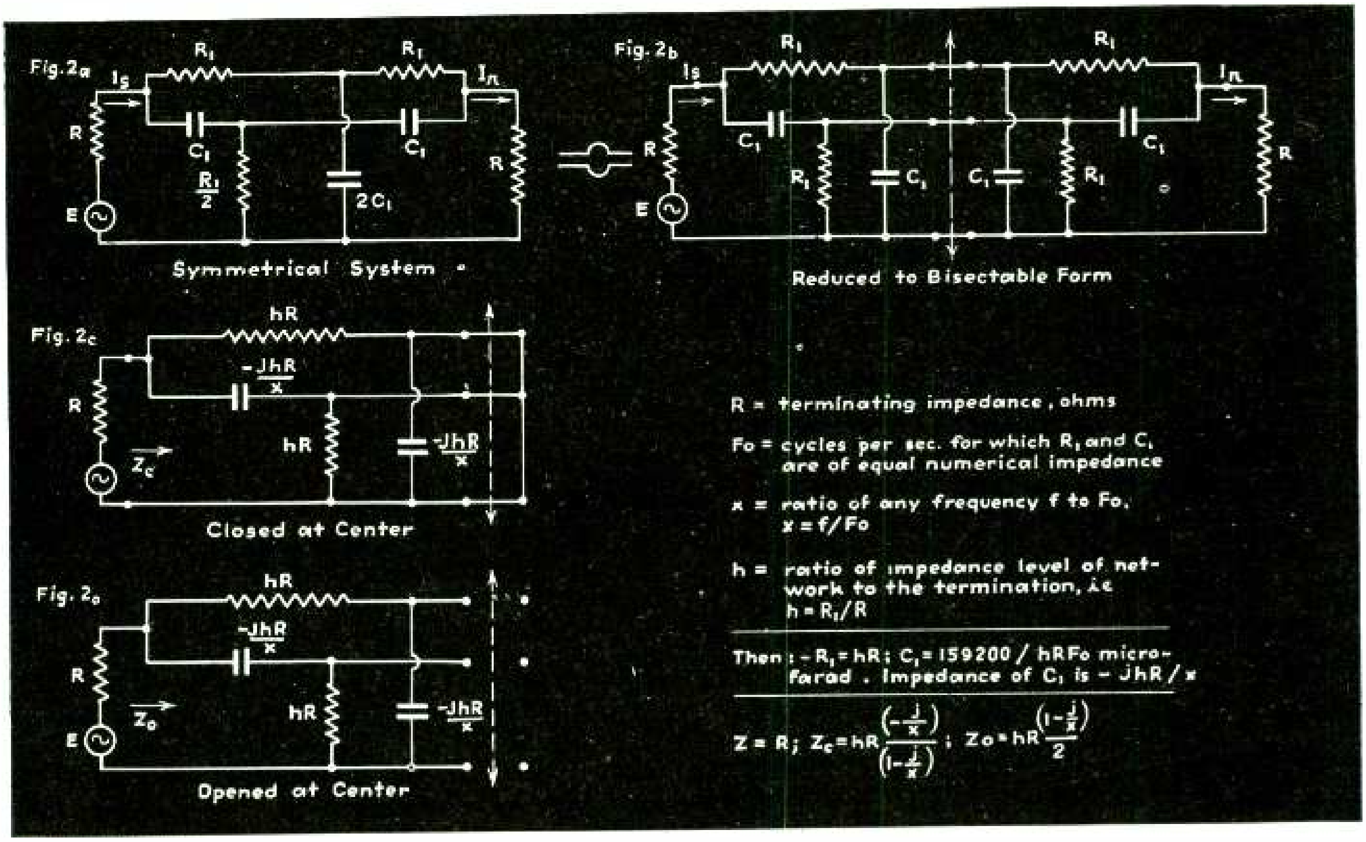
Fig. 2—Typical problem, that of the Wien bridge, solved by the method of closing and opening the structure at its center of symmetry



$$Z = R;\ Z_c = hR\frac{\left(-\frac{j}{x}\right)}{\left(1-\frac{j}{x}\right)};\ Z_o = hR\frac{\left(1-\frac{j}{x}\right)}{2}$$

A special method of evaluating the transmission characteristics of four-terminal networks which possess electrical and structural symmetry. This method saves considerable labor and time compared to conventional solutions

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sending arm which is also of impedance Z. Of minor interest may be the sending current I_s or the impedance Z_n looking into the network from the sending arm during the circuit operation.

The currents I_r and I_s can be most readily determined by evaluating the currents in the sending arm when the secondary is isolated from the primary, in one case by making the connectors voltageless by closing them together as in Fig. 1_c, and in another case by making them currentless by opening them as in Fig. 1_o. In these figures, the impedances Z_c and Z_o looking into the network from the sending arm are not dependent upon elements beyond the connectors, but depend upon the structural makeup of the first half portion only. In terms of the currents I_c and I_o, which are readily evaluated from E, Z, Z_c and Z_o, the currents of interest in Fig. $1_{s,r}$ are known and can be shown to be

$$I_s = \frac{1}{2}(I_c + I_o); \quad I_r = \frac{1}{2}(I_c - I_o) \quad (1)\ (2)$$

This simple theorem relating the terminal currents of the network as a whole to the sending currents under the conditions of the network being closed and opened at the center of symmetry is a generalization from information on symmetrical electrical coupled circuits previously published.* Its value is merely to provide a short cut in solving problems of the type to which it applies. If the difficulty of solving network problems for an explicit solution is roughly as the square or the third power of the number of elements, then there will be a time saving of 50 to 75 percent by evaluating first I_c and I_o, then I_s and I_r.

It is usually preferable to express the circuit performance on a comparative rather than an absolute basis, so that the expressed performance is not dependent upon the magnitude of the driving force E. A convenient reference condition is the system with the network absent, that is, with E and the sending and receiving impedances Z in a series arrangement. Then the current in the receiving arm would be $I_r' = E/2Z$. Performance may be expressed by an *insertion ratio*, defined as the ratio of the reference current I_r' in the receiving termination with the network absent to the actual current I_r in the receiving termination with the network present. In general this is a vector function, say $(M + jN)$ of the three impedances Z, Z_c and Z_o, which are readily found to be

* *Proc. I.R.E.*, June 1930, pages 996-998.

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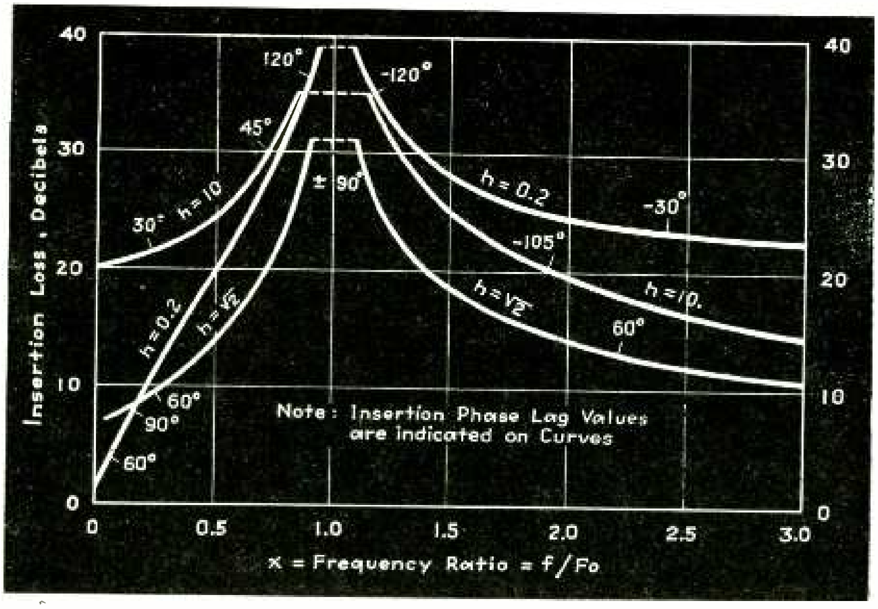

Fig. 3—Insertion loss curves of Wien bridge for three values of impedance level. $h\ R_1/R$

Insertion Ratio =

$$\frac{E/2Z}{I_r} = (M + jN) = \frac{(Z + Z_o)(Z + Z_c)}{Z\,(Z_o - Z_c)} \quad (3)$$

The insertion ratio is set up in this manner to make it numerically equal to or greater than unity for the important case of the terminations being equal pure resistors, for which no inserted network can possibly increase the received current.

In place of the vector insertion ratio, the performance may be more conveniently expressed by the insertion loss, db, in combination with the insertion phase lag due to the presence of the circuit. These are derivable from the vector insertion ratio $(M + jN)$ by

$$\text{Ins. loss db} = 10 \log_{10} (M^2 + N^2) \quad (4)$$

$$\text{Ins. phase lag} = \tan^{-1} (N/M) \quad (5)$$

Inspection of the insertion ratio equation yields only the general information that the insertion loss is infinite for any frequency making $Z_o = Z_c$. This is equivalent to saying that I_r is zero provided $I_c = I_o = I_s$.

The insertion ratio expresses the effect of insertion of the network upon the output circuit of the system. For the input branch, the performance, if of interest, may be expressed in terms of the relative loading on the sending arm, given by the ratio of the load impedance Z_n upon the source to the load Z which would exist with the network absent:

$$\text{Loading effect} = \frac{Z_n}{Z} = \frac{\frac{Z_o Z_c}{Z^2} + \frac{(Z_o + Z_c)}{2Z}}{1 + \frac{(Z_o + Z_c)}{2Z}} \quad (6)$$

From Eq. (6) can be deduced that the loading and therefore the sending current is unchanged for any frequency making $Z_o Z_c = Z^2$, or for any frequency making one of Z_o and Z_c infinite and the other zero, with a finite product. At such frequencies, the source delivers the same amount of power regardless of whether the network is absent or present. Zero insertion loss can exist for such a frequency only if the inserted network contains no current carrying dissipative impedance.

Therefore the complete performance of the system of Fig. 1 may be determined, relative to the performance with the network absent, by equations 3 to 6, involving the impedance Z representing the terminations, and the impedances Z_c and Z_o looking into the network closed and opened at the center of symmetry as representing the complete inserted network.

Application of Method to Wien Bridge

As a specific example, consider the parallel T equivalent of the Wien Bridge, made up of resistor and capacitor elements, and terminated by equal resistors, as in Fig. 2a. The entire system involves eight arms, with three independently choosable elements, R, R_1 and C_1, and has the known property of not transmitting at the frequency for which C_1 and R_1 are of equal numerical impedance. The system rearranged for evaluation of Z_c and Z_o is shown in Fig. 2b.

Now if the transconductance (I_n/E) of the system were plotted as a function of frequency, there would be a threefold infinitude of curve shapes, since the magnitudes of R, R_1 and C_1 independently influence the performance so expressed. But in putting the performance on a relative basis, the insertion ratio would not be changed if the impedances of each of the three independently chooseable elements were all modified by the same factor. Therefore the insertion performance as a function of frequency would require a twofold infinitude of curve shapes. But further, the abscissa representing frequency as well as the ordinate representing power transfer can be put on a relative basis by establishing a reference frequency, as for example F_o, the frequency of infinite loss for which R_1 and C_1 are of equal numerical impedance. The actual abscissa, then, will be $x = f/F_o$, the ratio of any frequency f to the reference frequency, F_o. Under these conditions a single infinitude of curves will relate an insertion effect to the frequency ratio. That is, the insertion loss and the insertion phase lag will be a function of the frequency ratio x, and of a single other independent variable or parameter which will be the same for all points on representative curves. This is most conveniently an "impedance level" parameter relating to the ratio of the numerical impedance of R_1, and therefore of C_1 at F_o, to the terminating resistance of R. These relations are fully summarized in Fig. 2, together with the evaluation of Z, Z_c and Z_o in terms of R, h and x.

The balance of the problem involves a routine algebraic process of substituting Z, Z_c and Z_o in Eq. 3, to determine M and N in terms of x and h, with R dropping out because all impedances are on a relative basis. Thereupon the insertion loss and insertion phase lag, also functions solely of x and h, are determined by Eq. 4 and 5. In dealing with resistor-capacitor systems, the routine will be found less tedious upon making a change of variable $y = -1/x$, for the duration of the main algebraic manipulation. In any event, the routine algebraic work for the particular problem of Fig. 2 yields:

Ins. loss db =

$$10 \log_{10} \left\{ \frac{[x^2 + (1 + h)^2]\,[(1 + 2h^{-1})^2 x^2 + 1]}{(x^2 - 1)^2} \right\} \quad (7)$$

Ins. phase lag =

$$\tan^{-1} \left\{ \left[\frac{2 + 4h + h^2}{h + h^2} \right] \left[\frac{x}{1 - \left(\frac{2+h}{h+h^2} \right) x^2} \right] \right\} \quad (8)$$

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In Fig. 3 is shown the insertion loss as a function of x for three values of impedance level h, namely 0.2, $\sqrt{2}$ and 10. For the value $h = \sqrt{2}$, the insertion loss is the same function of x as of $1/x$, and would be symmetrical if the abscissae were plotted logarithmically. For low values of h, the structure has low-pass properties, with infinite loss at $x = 1$; and for high values of h has similar high-pass properties.

In addition to the usual use of the circuit as a frequency metering device, it may be also used for filtering purposes. For example suppose the network is to be used to supply filtering for rectified power supply. If R, the load resistance, is to be 50,000 ohms, h is chosen 0.2, and F_o is desired to be 120 cps. Then application of the equations of Fig. 2 indicate the parts required for such a filter are:—1-5000 ohm, and 2-10000 ohm resistors, and 1-0.266 and 2-0.133 μf capacitors.

Uses of the Wien Bridge

In Fig. 3, values of the insertion phase lag are indicated at various points on the curves, and in each case at $x = 1$ corresponding to infinite insertion loss, there is a discontinuity of 180 deg. This is not predictable of Eq. 8 since any angle has the same tangent as the same angle plus or minus any integer times 180 deg. The location of the quadrant of the phase lag angle can be determined by knowing the algebraic senses of both M and N, or in simple cases physical checks are useful. This may be at zero frequency for which any capacitor becomes an open circuit of infinite impedance, and at infinite frequency for which any capacitor is a short circuit of zero impedance.

Figure 4 shows how Fig. 2 appears at zero and infinite frequencies, as pure resistance networks, with the network producing an insertion loss in both cases but with no phase shift. On the curves, 180 deg. must be subtracted in passing through $x = 1$ from the low side to the high, to make the insertion phase lag the same at $x = 0$ and $x = \infty$. It would be only for mathematical convenience to assert the lag as zero at zero frequency, and 360 deg. at infinite frequency, with the lag increasing continuously on the two legs of the curves, and increasing discontinuously between them. There is of course no physical discontinuity involved, because the phase lag discontinuity occurs simultaneously with infinite insertion loss value. Physically, the received current I_r is in one direction before becoming zero, and in the reverse direction after becoming zero. This suggests an impedance bridge at the condition of balance, with the received current in the detector arm of the bridge, and in fact such an interpretative arrangement is possible.

Application of Method to Impedance Bridge

The general equations for the currents in all six arms of a simple impedance bridge due to a driving force in the power arm are a matter of record. In Fig. 5a, the general type of structure under consideration is shown in block, with the network specified by Z_c and Z_o the impedances looking into the network closed and opened at the center of symmetry. With the network bisectable, Z_c and Z_o represent physically realizable combinations of reactor and resistor elements. If now an impedance bridge is made up as in Fig. 5b, using the same driving force and terminations as in Fig. 5a, and the bridge arms are made Z_c and Z_o derived from Fig. 5a and arranged as indicated, then it will be found that identical sending currents and identical received currents occur for the two figures. That is, except for internal arrangement, any bisectable four-terminal network may be replaced by a symmetrical but non-bisectable network in the form of an impedance bridge. When used for transmission purposes, any impedance bridge with opposite arms equal as in the present case is termed a symmetrical lattice network. Such networks are of especial importance because not all lattice networks are capable of being replaced by simple bisectable equivalents, since the two terminal impedances Z_c and Z_o in the bridge structure in general need not correspond to Z_c and Z_o obtained by bisection of a four terminal impedance.

Accordingly the basic treatment of structurally bisectable networks here presented automatically extends itself to cover one important type of network which although not bisectable is nevertheless electrically symmetrical.

Editors Note—A second part of Mr. Purington's article dealing with reactance type networks will be published in a succeeding issue.

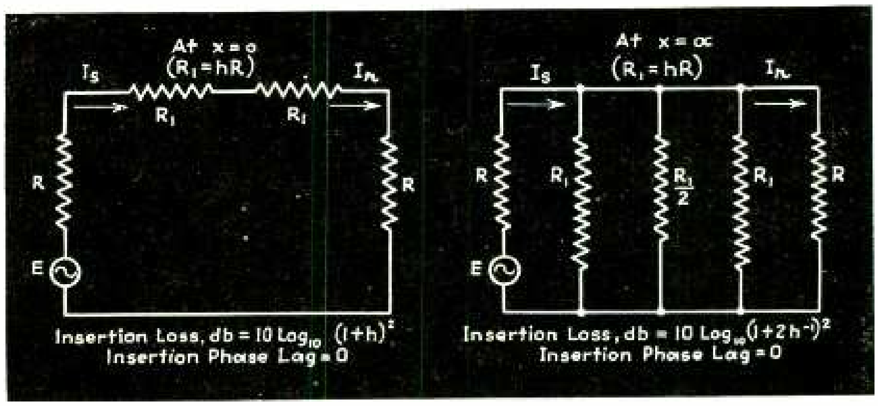

Fig. 4—Equivalent circuit of Wien bridge at zero and infinite frequencies

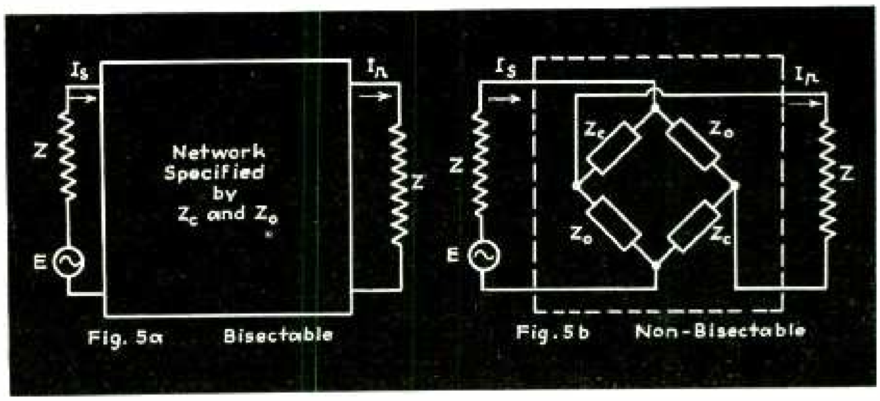

Fig. 5—Method of replacing a bisectable network by a non-bisectable bridge

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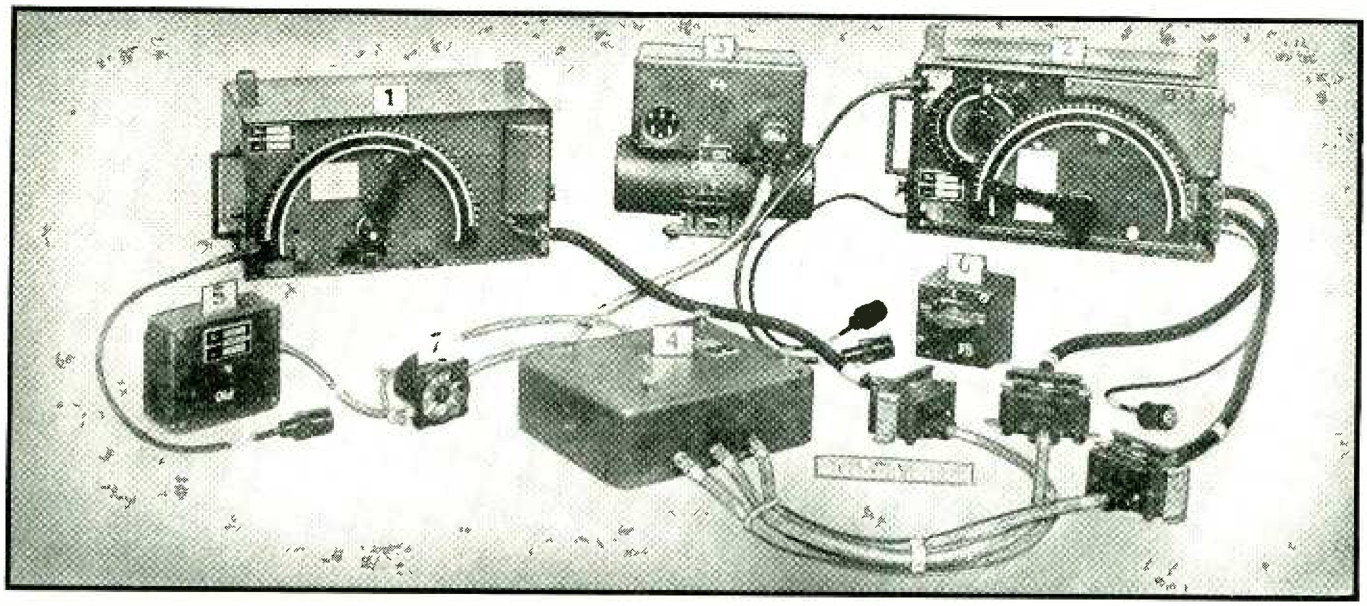
NAZI AIRCRAFT RADIO

By JOHN H. JUPE
Enfield, Middlesex, England



Radio telephone equipment of the Messerschmitt 109 fighter plane. The various units are indicated by the numbered cards. No. 1 receiver; 2, transmitter; 3, rotary transformer; 4, junction box; 5, resistance box; 6, switch; and 7, the antenna current meter

DETAILS of the radio equipment used in Nazi aircraft were recently released to the public by the British authorities. The information indicates that any rumors that our enemies are using inferior materials is unfounded and that the electrical performance of all Nazi aircraft radio is good but there are no features which place it ahead of equivalent apparatus used by the United Nations. Mechanical construction is of the highest order, neither material expense nor cheapness of production being allowed to interfere with a first class job being done. In one respect, however, German aircraft radio equipment is very inferior and that is its excessive weight. It would seem that the designers have been so anxious to make mechanically strong apparatus that the impression is given that it is for a ground installation rather than for aircraft.

Typical German radio apparatus as found on captured airplanes is described in the following paragraphs:

Junkers 88 (Bomber). The radio equipment in this airplane consists of a transmitter and receiver using voice and covering the band from 38.6 to 42.2 Mc. The tuning controls are not accessible during flight because no provision is made for remote control. Choice is made of one of four frequencies before the plane leaves the ground by means of a click stop mechanism fitted to the tuning dials. A conventional type of superheterodyne circuit is used in the receiver. Nine tubes, all of the same type, are used. The r-f amplifier, mixer, oscillator, and i-f amplifier tubes are all connected as pentodes. The detector and a-v-c tubes are diodes and the audio amplifier tube is connected as a triode.

Considerable trouble has been taken to produce r-f oscillations of high stability without resorting to crystal control and this has largely been achieved by the use of low temperature coefficient inductances constructed in the following manner. A spiral groove is cut on a ceramic former and the inside of the groove is coated with a thin film of copper or silver which had been fired on the ceramic. Afterwards the winding is built up to the required thickness by electroplating the film.

Second channel interference is effectively suppressed over the entire tuning range. The coupling of the antenna to the r-f stage is very loose and consists of the capacitance between a coil and a short wire. Coupling between i-f stages is by means of transformers, with powdered iron cores, and fixed condensers. The intermediate frequency is 3.15 Mc.

The transmitter uses two pentode tubes, one in a Colpitts oscillator circuit combined with a frequency doubler and the other as a power amplifier. Signal grid modulation is employed, the modulator tube being the standard receiving type pentode. The oscillator operates at half the carrier frequency and high performance inductances are used. Careful filtering is used to isolate the heater-capacity from the oscillator. A special means is provided for accurately tuning the transmitter and receiver to the same frequency.

Power is obtained from a dynamotor fitted with three commutators, one for the 24-volt d-c supply to the motor, one for the anode supplies and one for the grid bias to the transmitter. Maximum power demand is 10.5 amperes at 24 volts, 210 ma at

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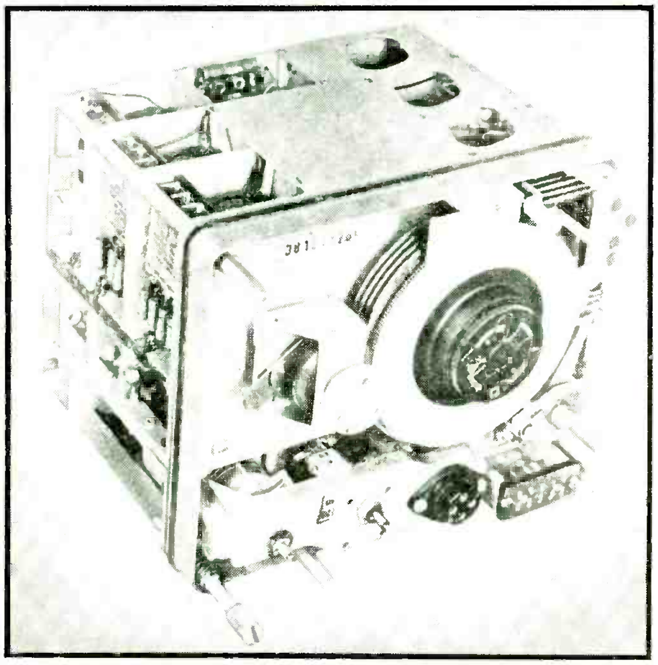
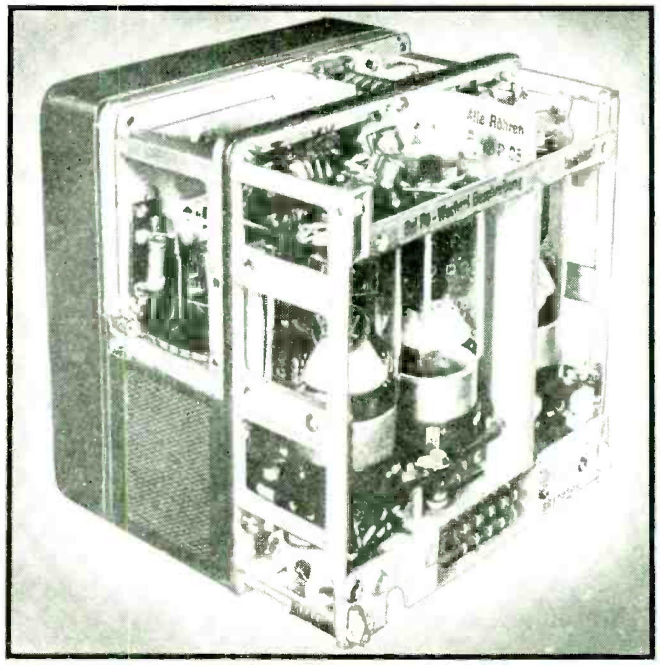




Receiver (left) and transmitter of the Heinkel 111H reconnaissance plane showing some of the construction and arrangement of components. The electrical and mechanical designs are good, but the equipment is very heavy for aircraft installation

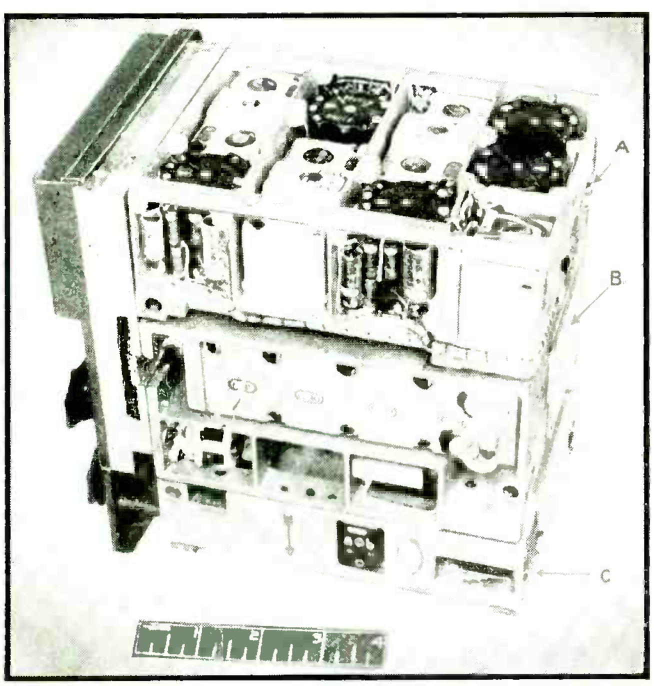
400 volts for the transmitter anode circuits, and 85 ma at 440 volts for the receiver.

The antenna is a single wire 6 feet 11 inches long suspended from a deck type insulator to a point on the tail of the craft and it is matched to a concentric feeder by means of a T network. Bombers of the Junkers 88 class also carry a small radio telephone set for inter-aircraft communication.

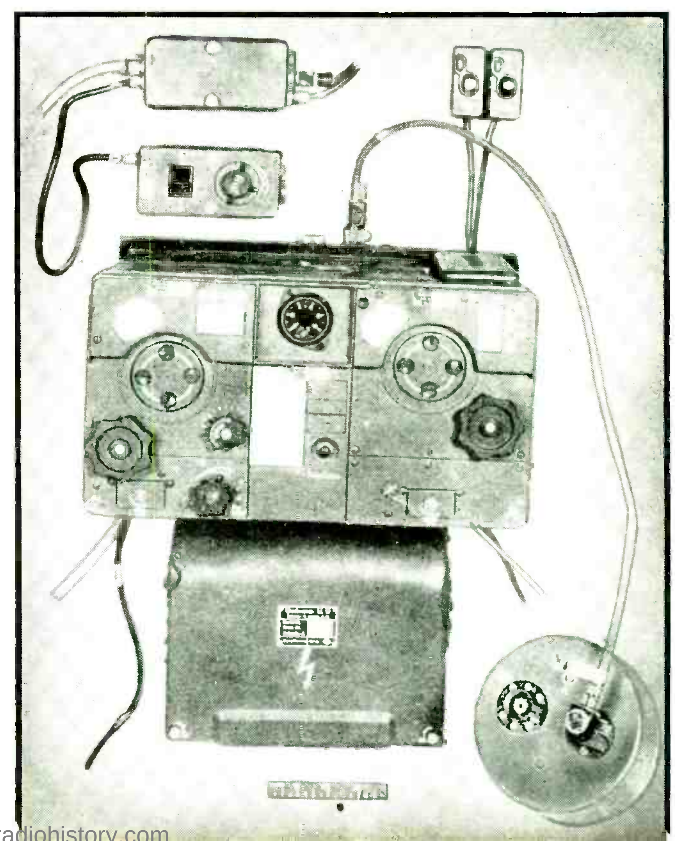
Heinkel 111H (Reconnaissance). The radio equipment on this craft is the latest standardized type and is installed on all later bombers and reconnaissance machines of the Luftwaffe. It comprises long and shortwave radio on four fixed frequencies, blind landing approach, direction finding equipment and there is an internal intercommunication circuit for conference facilities between pilot, navigator, radio operator and rear gunner. Navigation is aided by a separate direction finder receiver under the control of the navigator and combined with a compass repeater. Aural signals are provided

(*Continued on page* 167)

Receiver of the Junkers 88 bomber. The r-f and converter circuits are contained in section B; the i-f amplifiers, detector and a-v-c are in section A; and the a-f amplifier and a neon stabilizer for the oscillator are in section C



General layout of the front panel of the Junkers 88 radio apparatus. The receiver is at the left, the transmitter at the right, and the modulation amplifier, antenna current meter and a-f output transformer are in the center



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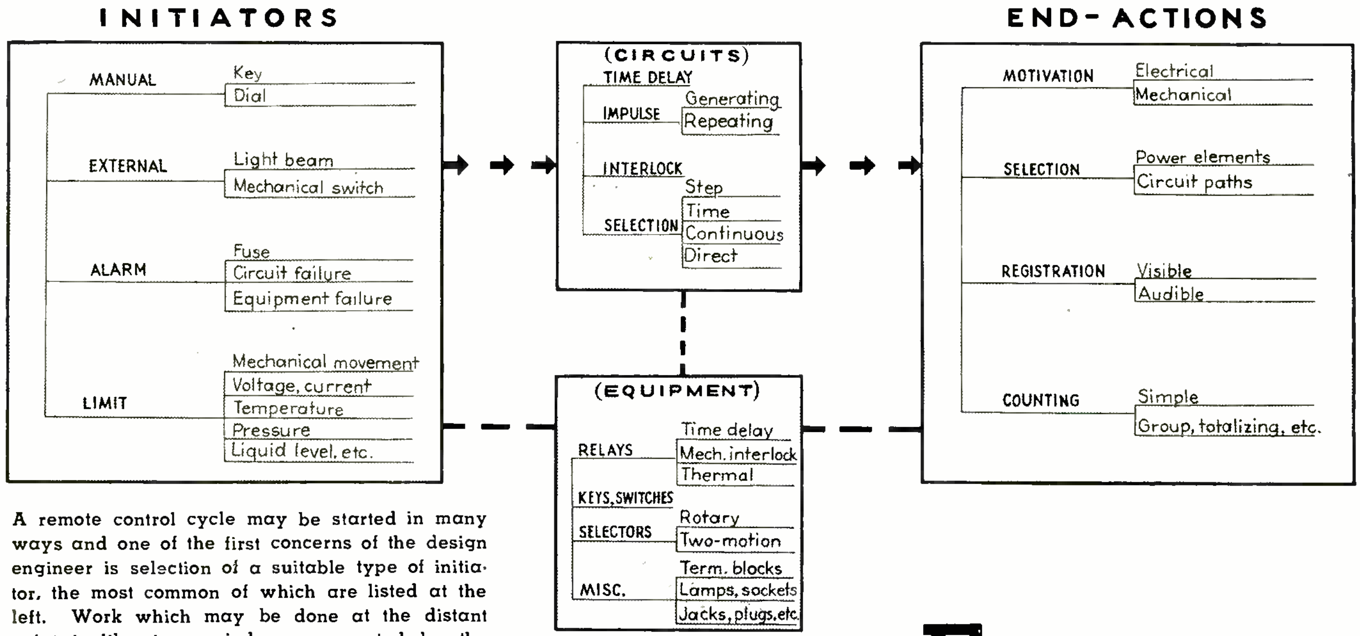

A remote control cycle may be started in many ways and one of the first concerns of the design engineer is selection of a suitable type of initiator, the most common of which are listed at the left. Work which may be done at the distant point is likewise varied, as suggested by the tabulation at the right, so the most desirable end-action must simultaneously be chosen

Electrical

ELECTRICAL REMOTE CONTROL is used to solve innumerable problems in factory operations; to count and inspect materials, route them on conveyors and guard against accidents in machine operation. Equally important are its applications in other fields. In the electric power field, for example, it is used to remotely control substations, provide protective relaying and facilitate communications. In broadcasting it controls radio transmitters, monitors programs. In aviation, it controls airport lighting and radio beacons.

Actually, it is difficult to find a business in which electrical remote control is not doing some job or other and laboratories are crowded with new applications which, after the war, will greatly affect America's every day way of life.

Definition

Just what is electrical remote control? A simple definition is this: Remote control is a term applied to any system which by electrical means accomplishes, with little initial effort, many actions near at hand or far away. While many men think of electrical remote control as the performance of control functions at great distances over telephone or telegraph circuits, the field is much broader since the same circuit elements and equipment may be employed to accomplish jobs near at hand, even on a single machine.

To get a clear picture of electrical remote control, let us break it down into its major elements. As the accompanying chart shows, there are three: (1) Initiating devices whose operation either manually or automatically serves to originate the remote control cycle; (2) circuits and equipment (the real tools) which, properly combined, translate the originating force into (3) desired end-actions.

It is the purpose of this article to consider broadly typical initiating methods available, end-actions which can be accomplished, equipment elements and their possibilities and limitations, and the vocabulary used by electrical remote control engineers. In a succeeding article we will discuss electrical remote control circuits and how they are utilized.

> **ALLIED ARTS**
>
> **REMOTE CONTROL may or may not involve electronics in the strict sense of the word but the electrical devices commonly employed are so frequently associated with tubes that engineers will find them a profitable study**

Initiators

One of the first concerns of the engineer who is attempting to use a remote control system for the solution of a specific problem is to determine what initiator he will use.

Broadly, four general types are available. *Manual* initiations, most direct of all, may be accomplished by use of a "key" such as a snap switch. Similarly, there are pushbuttons, toggle switches, telegraph keys and electric typewriter keyboards. Manual initiation may also be accomplished with a dial such as is used in automatic telephony, in broadcast circuit monitoring and remote radio transmitter control. A governor-controlled device to transmit impulses (circuit closures) over a line, the dial is conventionally arranged to transmit up to ten impulses in a group and several series of groups, can be utilized on a decimal basis to provide an almost unlimited number of combinations.

External initiators start a control function under some external influence. The cutting of a light-beam to open doors or count manufactured articles is an example. Mechanical switches may be utilized in a similar manner.

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Electrical remote control solves innumerable industrial and communications problems. Typical applications, circuit initiating methods and end-actions are broadly discussed in this introductory article. Factors governing choice of equipment are outlined. Part 2, to follow, deals with basic circuit design details

By C. J. DORR and L. N. GALTON

American Automatic Electric Sales Co.

REMOTE CONTROL...Part 1

Alarm initiators start control functions as a result of some non-standard condition. For instance, a fuse alarm "initiates" when a fuse blows. A circuit failure alarm may function when a normally closed electric circuit becomes grounded or opens. An equipment failure alarm may be one which indicates the burning out of a vacuum tube filament, the abnormal rise in temperature of a machine bearing or the presence of fire in a supervised area. The latter two instances overlap somewhat with limit initiators.

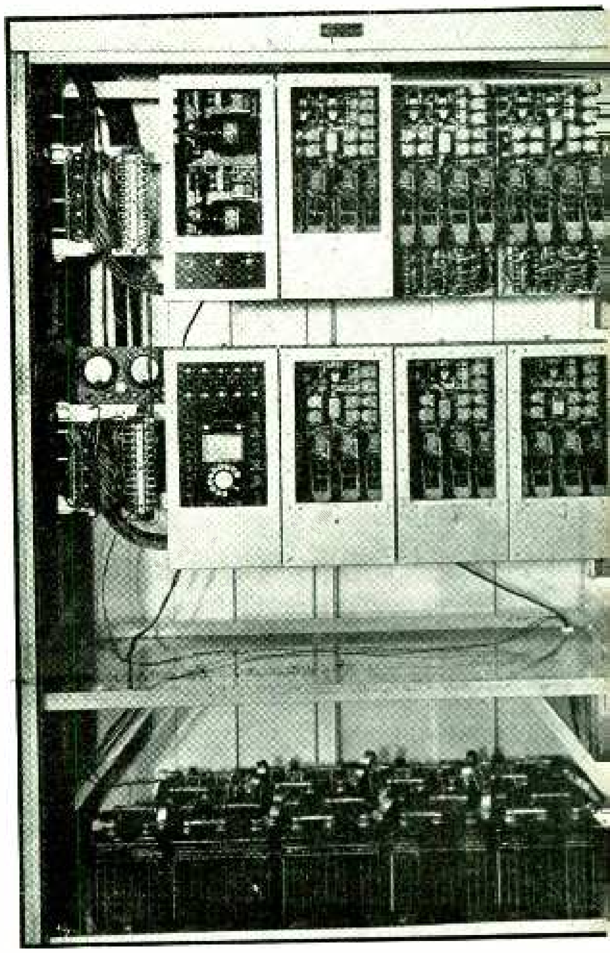
Limit initiators start a control function as the result of some predetermined limit being exceeded. There are many types. The mechanical movement limit initiator is exemplified by the switch at the top of an elevator shaft which causes controls to function to prohibit the elevator from going beyond the top floor. Similarly, an automatic milling machine may have a switch which operates at the limit of travel to reverse the miller. An example of a voltage limit device is the high-low voltage relay which controls the charging of a storage battery, stopping the charger when the battery reaches the full-charge voltage condition and restarting it when the low-voltage discharge condition is reached. The thermostat in a heat-treating oven, which functions to maintain constant temperature between narrow limits, is a temperature limit initiator. The pressure-actuated mechanical switch in the air tank of the automobile service station, which serves to start and stop the pump motor, is a pressure limit initiator. Liquid level limit problems are commonly encountered in fuel oil storage tanks and here initiation may be the result of actuation of a float switch or of electrical contact with the liquid itself.

There are many other initiators of specialized varieties which can be fitted into one or more of the foregoing four classifications. For example, the light-beam and phototube employed to obtain smoke density readings and control combustion in a boiler would be classed as an external initiator.

End-Actions

Initiating actions, individually or in combination, may be utilized to accompliish many end-actions over wire circuits, carrier-current, radio or light-beam transmission paths. End-actions break down into four general classifications, with some overlapping.

The simplest is *motivation*, in which a small amount of electric power is used to control some larger electric power flow or mechanical force. The starting of a huge electric motor by remote control is an example of the first. Mechanical motiva-



American Teletimer Corporation equipment measures and records the time for the leading horse at various points around a racetrack. Modulated light-beams are cut as the animal passes, stopping a rotary switch and relay mechanism in the equipment room

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Western Union "varioplex" printing telegraph equipment permits as many as 49 subscribers in one city to receive typed messages from a remote point over a single circuit. A teleprinter and one of the many racks in a main operating room are shown

tion is typified by the solenoid-operated valve which controls a bubbler drinking fountain when a light-beam is cut by the user.

However, when the problem becomes more complex and one or more of a group of possible events must be chosen, then the end-action becomes one of *selection*. For example, in a typical airport installation the border lights, beacon light or any one of several radio transmitters may be turned on by use of an initiator dial. In the case of the transmitters, the selection operation might choose any one of several different radio frequencies and thereafter pick either phone or code transmission. Beyond that, in the case of phone transmission, a specific circuit path for audio frequency input might also be selected.

Registrations are end-actions in which some visible or audible registration is produced. Examples are the simple annunciator systems in factories or business offices and the complex moving electric signs which post the news of the day under control of an electric typewriter keyboard. The community fire alarm siren employs audible registration.

Counting end-action is often of great use to the production engineer. Simple counting is exemplified by the counter on a telephone line which totalizes completed local calls. There are also group or totalizing counters to combine the individual counts from several sources. Such counters were used at the New York World's Fair, where impulses from each entrance gate were totalled to show complete attendance on an indicator atop the National Cash Register display. Other specialized counters may provide for performance of a power function when a predetermined count is reached.

It will be obvious that the foregoing end-actions can be combined. In fact, it is often the case that one end-action, such as counting, becomes the initiator for a succeeding end-action, such as registration. For example, in a folding machine used in printing plants a preset counter operated from a phototube is arranged to stop the machine momentarily when the preset count is reached and then to reset and start the folder over again. This momentary stop spaces stacks of finished work on a continuously moving conveyor so they can be readily removed by the operator in precounted and readily handled groups. In this case, the actual initiator for the repeat function, rather than being a mechanical switch or phototube, is the contacts of a relay actuated by the previous end-action.

Relays, Switches

What equipment is available to the engineer for accomplishing electrical remote control? Relays, rotary switches, keys, lamps, jacks, plugs, and other needed components are available from many manufacturers and every engineer working with remote control will find it valuable to have at his finger tips a library of catalogs, which usually offer complete information as to operating characteristics, sizes, limitations and special features.

Before consulting such catalogs it is essential to have a general understanding of relays and their capabilities, since they are the primary equipment tool.

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The simplest d-c relay consists of an electromagnet, an armature and a set of contacts. Commercial telephone-type relays are available, however, having characteristics that make them ideally suitable for a wide variety of applications. For example, there are simple quick-acting relays with operate times (interval from circuit closure to contact actuations) of 2 to 25 milliseconds and release times (interval from circuit opening to restoration of contact to normal) of 5 to 50 milliseconds. Since this operate time depends upon the interval required for the magnetic flux to rise to a point capable of moving the relay armature, plus the time needed for the relay armature to actuate the contacts, maximum speed for any particular type of relay will be realized when the coil inductance is at a minimum, thus permitting the flux to rise at a maximum rate. Minimizing coil inductance is useful when there is no limitation upon the amount of current. Where current limitation exists, then maximum speed is often obtained by providing a winding which will develop approximately twice the number of ampere turns needed to just operate the relay.

Under other conditions, it may be desirable to slow up relay contact closure and this can be accomplished by increasing coil core air gaps, spring tension and the inductance of the relay coil. In addition, a short-circuited winding, slug or sleeve can be placed on the relay coil to obtain total closure delays up to approximately 100 milliseconds. The delay will vary in inverse ratio to the resistance of the slug or sleeve.

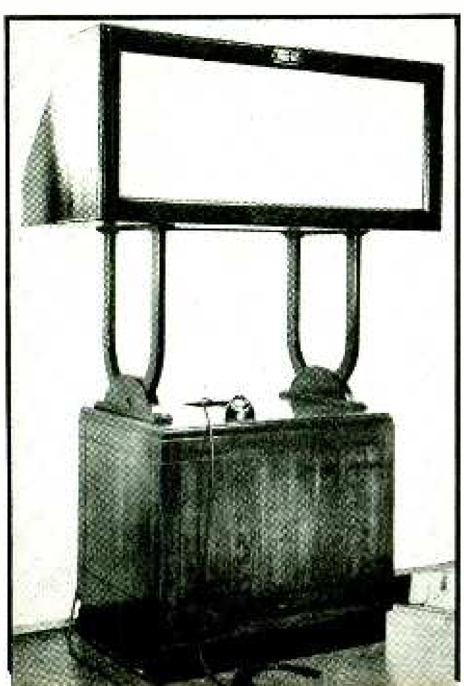
To slow up release, core gaps and spring tension can be set at a minimum. The addition of a slug or sleeve will provide a further delay up to a total of approximately one-half second.

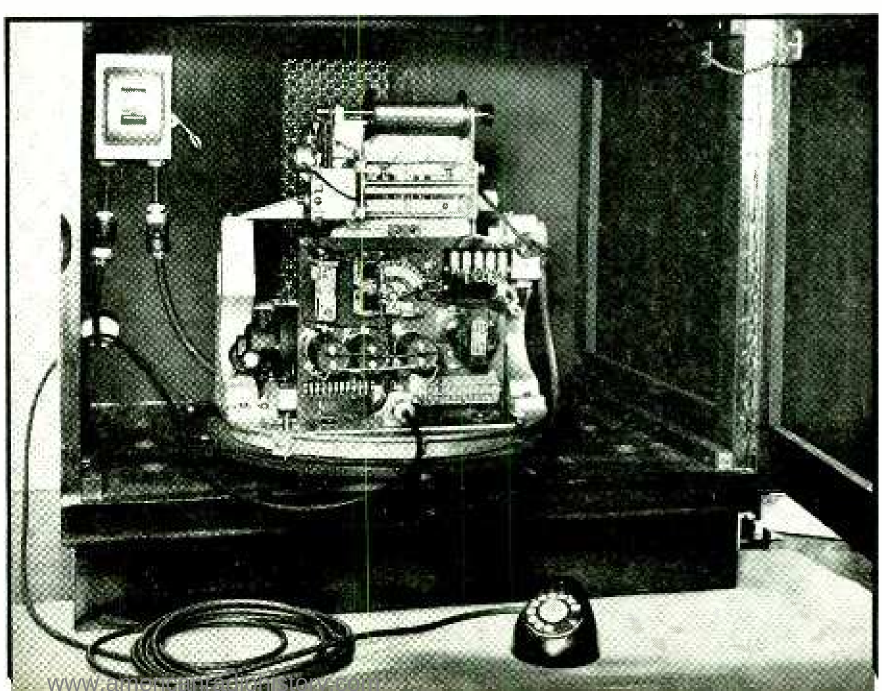
Considerable design leeway can also be provided by judicious use of capacitors. For instance, a large capacitor in parallel with the relay winding will so rob the relay of current during the early stages of circuit closure that the relay will be delayed in its operation. Delay time can be controlled to some extent by placing a variable resistance in the circuit. On release, such a capacitor acts like a small storage battery in parallel with the relay after the initiating circuit is opened and thus holds the relay in the operated position until energy in the capacitor is dissipated. A simple relay with a large shunt capacitor provides release delays up to as much as 30 seconds. Some release delay can also be obtained by the use of a parallel non-inductive resistance. When the coil circuit is opened, the induced voltage will cause a current to circulate through the non-inductive resistor and the coil and thus delay release.

So far no mention has been made of a-c relays. There is a reason. The a-c relay is not as versatile as the d-c relay. There is no comparably simple means of varying the operate or release time. Additionally, an a-c relay ordinarily starts to pick up on approximately 75 percent of the current needed to completely operate it and to hold the armature against the core without "chatter" or vibration. This makes it difficult to use an a-c relay in circuits where the current rises from zero to a maximum over a relatively long period of time and where the relay is intended to pick up when the current or voltage reaches a predetermined intermediate point. Further, a-c relay coil resistance at 60 cps is about ten times the d-c resistance in telephone type relays and the large number of turns commonly employed on a d-c relay is not possible. Power, therefore, must be obtained by an increase in current. This introduces more heating and attendant ills. There are many applications, however, where it is desired merely to have a relay operate on a closed circuit and release on an open circuit and d-c current is at a premium. Under such conditions, the use of an a-c relay is well justified.

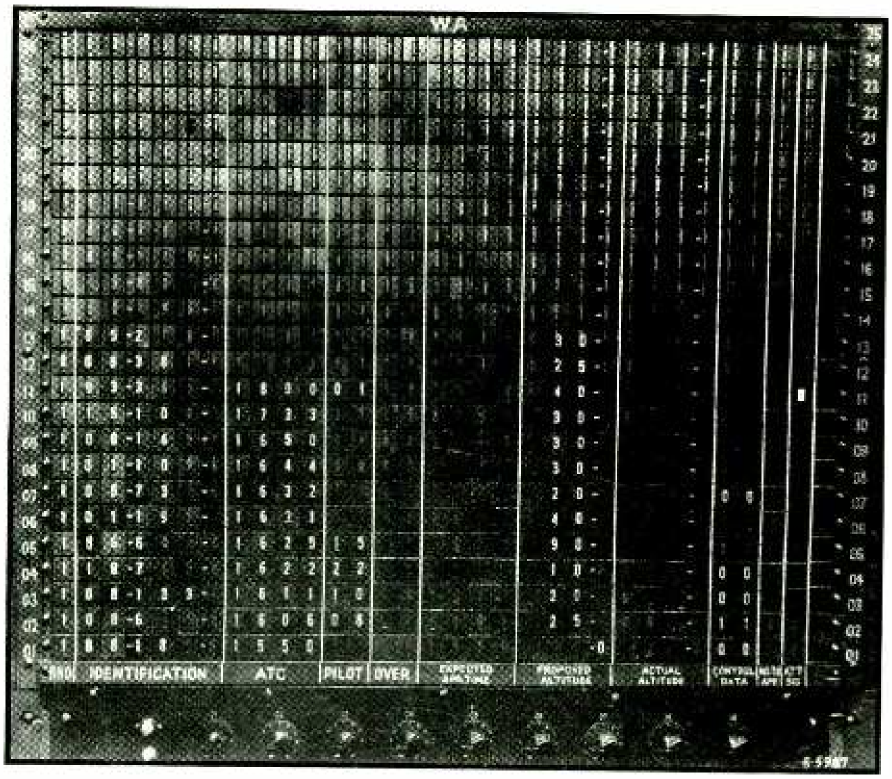
A selection switch is an electrically operated mechanical device arranged so that a wiper or contact arm may be caused to contact any one of many bank contacts, under control of a solenoid or magnet which is operated from an initiating device such as a pushbutton or dial or the contacts of a relay. Among those most commonly known are "Strowger" switches. These fall into three classifications. The first consists of single motion switches which transmit only rotary motion to the wipers and

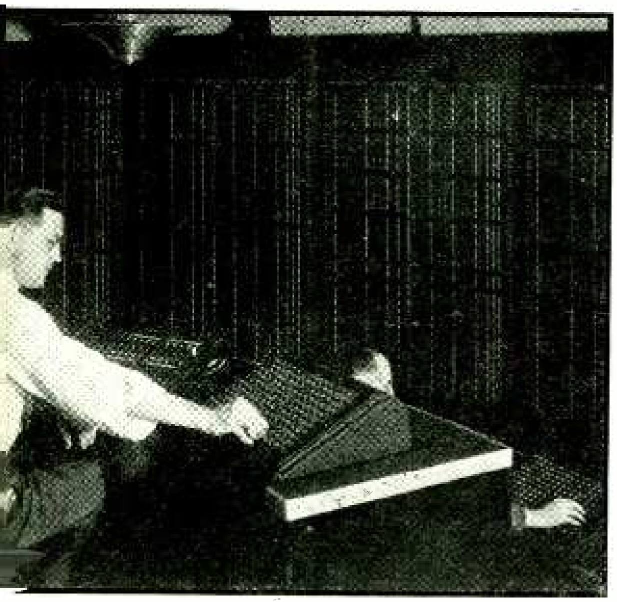
Text material typed, handwritten, drawn, painted or stamped on a transparent cellophane web is projected to the screen of the Trans-Lux Visualizer for educational purposes. The speed at which the material moves on its reel may be varied from a remote point by manipulation of the dial shown in the foreground of the picture at the right





Flight data typed out in distant offices is automatically registered on a board in the administration building at one of the nation's busiest airports. Operators in the administration building may also register pertinent data by using their own local keyboards. A close-up of a section of the board, designed by the Teleregister Corporation, is shown





make use of this rotary motion both for selection of contacts and restoration of the wipers to normal. A common switch of this type has 25 contacts in a row associated with each wiper or level and from 1 to 6 levels. Switches of this type are indirect stepping varieties since energizing the magnet "cocks" the spring, which in turn advances the wipers one step when the magnet is de-energized. Homing, or restoration of the wiper to its original position, is accomplished by interrupter contacts on the magnet which generate impulses to advance the switch around the circle.

A second class of switch has single-action selection, with a special release action which returns the wipers to normal, or home, through the same arc traversed in the original action. A rotary magnet advances the wipers and at the same time stretches an attached coil spring which restores the wipers when the positioning detent or latch is disengaged by the operation of the release magnet. This switch is commonly called a minor switch.

The third class of switch has two-motion selection and a separate release action. A shaft carrying one or more wipers is stepped vertically by one set of magnets and rotated horizontally by another set of magnets. As in minor switches, springs return the wipers to normal, or home, position when the positioning detent is removed by operation of a release magnet. Usually up to 10 rows of contacts with 10 contacts per row are associated with each wiper to provide for a maximum of 100 selections. Minor and two-motion switches are of the direct stepping variety since the wipers are advanced as the switch magnet is energized.

In general, the amount of current required by selection switches of the type described (½ to 1 amp at 50 volts dc) prohibits their use directly over wire of any appreciable length. Consequently, a more sensitive relay is frequently operated over the line and the switch is operated from contacts on this relay.

Choosing Equipment

There are six major factors to be considered whenever relays or selection switches are to be used for any application. They are:

1. *Voltage available*
2. *Operating temperature range*
3. *Environmental conditions such as humidity, salt air, vibration*
4. *Reliability required*
5. *Speed at which equipment must operate*
6. *Life cycle of the equipment (number of operations)*

1. *Voltage.* The most common telephone circuit control voltage is 50 volts dc. However, telephone type equipment can usually be obtained to operate on direct voltages from 6 to 110. When using low voltages, consideration must be given to the increased wire size necessary to handle the associated higher current, increased contact erosion problems, and the probabilities of increased dirty contact troubles (which may be partially overcome by heavier contact pressures). At the other end of the scale, higher voltages may create a contact arcing problem because of the ability of higher voltages to break down larger air gaps. They also produce higher induced voltages, which increase the electrical shock hazard. Then, too, more insulation is required, especially where underwriters' requirements must be met in the form of high voltage insulation tests of twice normal plus one thousand. It is also desirable, if not actually required, that wires carrying the higher voltages and extending outside the control equipment housing case be enclosed in conduit.

2. *Operating temperature* range is not ordinarily as much of a limiting factor with telephone-type ap-

(*Continued on page* 173)

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Timers for WELDING CONTROL . . . Part 4

Tubes are widely used to control the power required for resistance welding. Many power tube circuits inherently provide a certain measure of control unobtainable by electrical or mechanical means. Electronic timers discussed in detail in the text complete the job

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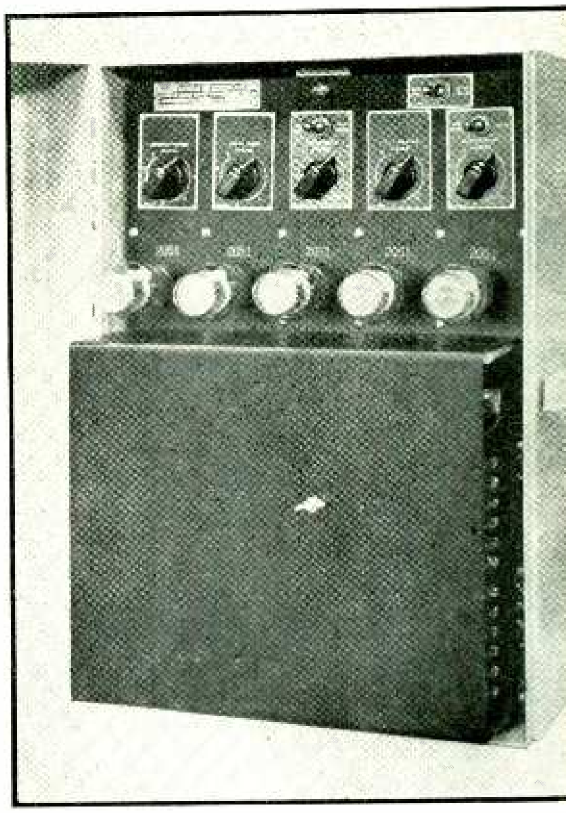

Typical electronic sequence timer of the 9B type, designed for use with welding power control units of the synchronous variety

PREVIOUS ARTICLES in this series have described various kinds of electronic control systems used in resistance welding, with particular emphasis upon power circuits. This article concentrates upon the requirements, types and operation of electronic timers associated with such circuits.

In making a resistance weld, there are several operations that have to be controlled or timed in proper order. That is, the mechanical operation of the welder has to be co-ordinated with the application of welding current. The nature of the resistance welding process is such that controlling the elapsed time is a natural and logical means for controlling most of the operations. The time unit is the cycle, or 1/60 sec. for a 60-cps power supply. This time unit is used since most of the operations that take place during a single weld require only a fraction of a second of time. That is, a single weld requiring from three to five operations may require less than a total elapsed time of 30 cycles or ½ sec.

Welding Operations

When making a resistance weld the principal operations that take place and require timing are:

(1) The electrodes close, applying pressure to the work piece. This operation is timed so that weld current is started at the end of this operation; this is called the "squeeze time." Electronic timing for this operation is not usually required as a pressure switch may be used on the welder.

(2) Current flows to make the weld. For spot welding, the number of cycles that current is allowed to flow must be timed. This is called the "weld time." For pulsation welding, which is similar to spot welding except that weld current is started and stopped a predetermined number of times per individual weld, three time periods must be provided: heat time, cool time, and weld interval. The total time that weld current is allowed to flow is called the "heat time." The total time that the current is stopped between pulsations is called the "cool time." The "weld interval" is the total time during which heat and cool pulsations per individual weld take place.

(3) Pressure is maintained on the work piece after the current stops, while the weld cools. This time period is called the "hold time." and at the end of the period the electrodes open, completing the welding operation.

(4) An additional time period, called the "off time," is necessary where repeat operation is required. This timing starts at the end of the hold time, when the electrodes open, and allows the operator time to shift the work piece to a new position before the electrodes reclose to start another weld.

Some resistance welding processes require additional timing periods to control, for example: the application of increasing electrode pressure during the weld, extra heating and cooling periods for heat treating purposes, etc.

Timer Types

Timers for controlling the operations described above are divided into three main classes; semi-automatic weld timers, automatic weld timers and sequence timers.

To time a welder having a *non-syn-*

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chronous electronic contractor type of power control, semi-automatic and automatic weld timers are used. The semi-automatic weld timer determines the weld time only, whereas, the automatic weld timer determines the weld time and also times and controls other electrical and mechanical functions required for a complete welding operation.

The sequence timer is used with *synchronous* electronic welding power controls, for automatic timing of the overall sequence of operations. The timing of the weld is usually included as part of the synchronous control unit, rather than as part of the sequence timer.

These classes are further sub-divided into types to provide the various combination of operations required. There are two types of semi-automatic weld timers, eight types of automatic weld timers, and eight types of sequence timers. The National Electrical Manufacturer's Association has assigned numbers to these types, as follows:

SEMI-AUTOMATIC WELD TIMERS

- **1A** NON-REPEAT without non-beat feature, providing weld time only; for use on manual, air, or motor-operated welders having maintained contact type initiating switch.
- **1B** PULSATION, NON-REPEAT without non-beat feature, providing weld interval, heat and cool times; for use on manual, air, or motor-operated welders having maintained contact-type initiating switch.

AUTOMATIC WELD TIMERS

(For use on air-operated welders operated from electric valves)

- **2A** NON-REPEAT, providing weld and hold time.
- **2B** NON-REPEAT, NON-BEAT, providing squeeze, weld, and hold time.
- **3A** REPEAT, NON-BEAT, providing weld, hold, and off time only.
- **3B** REPEAT, NON-BEAT, providing squeeze, weld, hold and off time.
- **4A** PULSATION, NON-REPEAT, NON-BEAT, providing weld interval, heat and cool times, and hold time.
- **4B** PULSATION, NON-REPEAT, NON-BEAT, providing squeeze time, weld interval, heat and cool times, and hold time.
- **5A** PULSATION, REPEAT, NON-BEAT, providing weld interval, heat and cool times, hold time and off time.
- **5B** PULSATION, REPEAT, NON-BEAT, providing squeeze time, weld interval, heat and cool times, hold time, and off time.

SEQUENCE TIMERS

(For use on air-operated welders operated from electric valves)

- **6A** NON-REPEAT, NON-BEAT, providing hold time only.
- **6B** NON-REPEAT, NON-BEAT, providing squeeze and hold time.
- **7A** REPEAT, NON-BEAT, providing hold and off time.
- **7B** REPEAT, NON-BEAT, providing squeeze, hold, and off time.
- **8A** PULSATION, NON-REPEAT, NON-BEAT, providing weld interval, cool time, and hold time.
- **8B** PULSATION, NON-REPEAT, NON-BEAT, providing squeeze time, weld interval, cool time, and hold time.
- **9A** PULSATION, REPEAT, NON-BEAT, providing weld interval, cool time, hold time, and off time.
- **9B** PULSATION, REPEAT, NON-BEAT, providing squeeze time, weld interval, cool time, hold time, and off time.

The non-beat feature provides that once the welding cycle has been initiated from the pilot switch the welding cycle will then be carried through to completion, regardless of whether the pilot switch remains closed or not.

The timers are self-contained units consisting essentially of one or more electronic timer circuits (with adjustable time range) using small thyratron tubes and fast acting relays. The usual time ranges, adjustable in one cycle steps, are: 30 cycles for the weld heat and cool timers, 60 cycles for the squeeze, hold, and off timers and a combination 180/360 cycle time range for the weld interval timers.

Fig. 1 shows a typical arrangement of welder controls. Fig. 2 is an elementary circuit diagram of an automatic weld timer, type 5A, for use with an electronic contactor type of resistance welding control. By-pass capacitors, etc., have been omitted for the sake of simplicity. Spot or pulsation welding with repeat, non-beat operation is provided by this type of device, which has individual electronic timers for weld interval, heat time, cool time, hold time, and off time. The operation of the individual timer circuits will be considered first and then the operation of the complete weld timer will be discussed.

Timing Tube Circuit Operation

Figure 3 shows the thyratron timing tube circuit for the weld interval timer. It is typical, however, of all of the timing tube circuits enclosed by dashed lines in Fig. 2 with the exception of the cool timer.

The timing tube circuit consists principally of a telephone-type relay marked TD_4, controlled by a thyratron tube marked tube 4, the time delay action being obtained by the

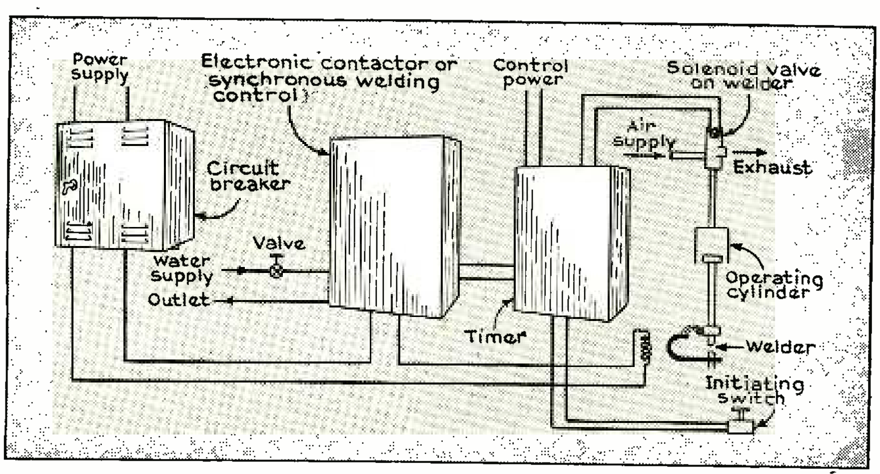

Fig. 1—Complete setup for resistance welding, illustrating a typical arrangement of electrical and mechanical as well as electronic controls

PUBLISHED

Spot Welding Controls

(August, page 36)

Seam and Pulsation Welding

(September, page 55)

Special Welding Controls

(October, page 62)

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Energy Storage Controls
Checking Welding Controls

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manner in which the tube is controlled. The tube can be considered as a fast-acting, circuit closing or opening device in series with the coil of the relay.

An a-c potential of 115 v is impressed across the circuit from point 1 to point 3. A voltage divider consisting of resistors R_{44}, P_4, and R_{40} provides means for controlling the voltage on the control grid of the tube. Because of grid rectification, direct current flows in the control grid circuit of the tube and charges the timing capacitor C_{41} when switch S_1 is in the closed position and relay contact 1–46 is open, as illustrated. The charging current is undirectional and flows from point 1 through resistor R_{44}, potentiometer P_4, timing capacitor C_{41}, resistor R_{43}, through the tube from grid to cathode (during the half cycles when point 1 and the grid are positive with respect to point 3 and the cathode) and then through resistor R_{47} to point 3. The charge on C_{41} will be maintained as long as the relay contact 1–46 is open. Furthermore, when the relay contact is open in the cathode circuit of the tube, anode current cannot flow through the tube to operate the TD_4 relay as the tube's anode and cathode are connected to the same side of the line and are at the same approximate potential.

When the relay contact 1–46 is closed, the voltage from 1 to 3 is applied across the anode-cathode circuit of the tube. The grid voltage is then made up of two voltages, the d-c voltage stored up in timing capacitor C_{41} and the a-c voltage from point 1 to point 41. The a-c grid voltage tends to make the grid positive at the same time that the anode is positive but the negative d-c voltage across the timing capacitor C_{41} is sufficient to momentarily hold the grid negative and the tube does not immediately pass current through its anode circuit. The charge in timing capacitor C_{41} slowly discharges through resistor R_{41} (with switch S_4 closed) and, after a time interval depending upon the values of timing capacitor C_{41}, timing resistor R_{41} and the setting of potentiometer P_4, the grid voltage becomes equal to or more positive than the critical grid voltage and the tube passes current during the half cycles in which the anode is positive, energizing relay TD_4. The relationship of the a-c and d-c grid voltages, plotted against

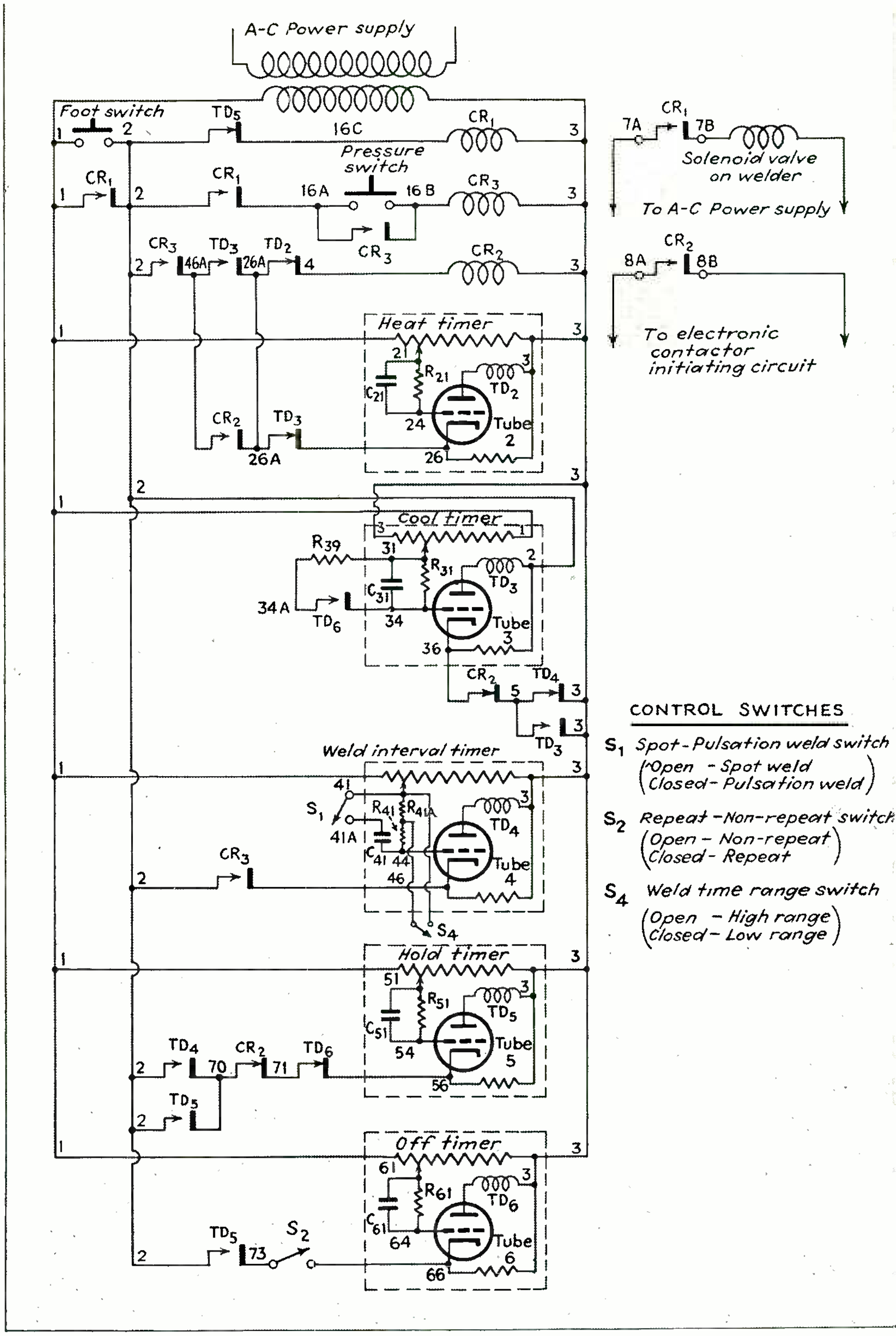

Fig. 2—Elementary diagram of a 5A type automatic electronic weld timer designed for use with welding power control units of the non-synchronous electronic contactor variety. Circuits inclosed by the dashed lines are shown in simplified form

time, is shown graphically in Fig. 4.

Referring to Fig. 4, A is the d-c voltage charge on capacitor C_4 that is maintained until the relay contact 1-46 in the cathode circuit is closed. A_1 is the d-c voltage on capacitor C_{41} at some time after the relay contact 1-46 is closed. E is the actual voltage on the grid at some particular time after the relay contact is closed, E being the sum of the capacitor C_{41} voltage and the a-c voltage at that given instant.

The d-c voltage continues to leak off through timing resistor R_{41} until such time as the sum of the a-c and the d-c voltage is approximately zero, at which time the anode will pass current and pick up relay TD_4. The time delay in Fig. 4 is seen to be 5 cycles. If potentiometer P_4 is moved toward point 40 the d-c voltage of timing capacitor C_{41} will increase and the a-c voltage from point 1 to 41

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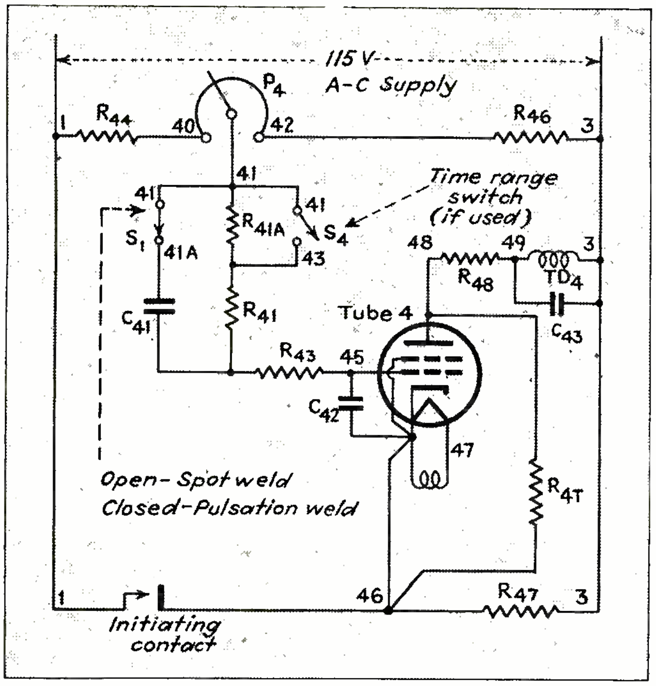

Fig. 3—Simplified diagram of a typical thyratron tube timer circuit. It is the basis of design for all the individual timing units shown within the dashed lines of Fig. 2 except the cool timer

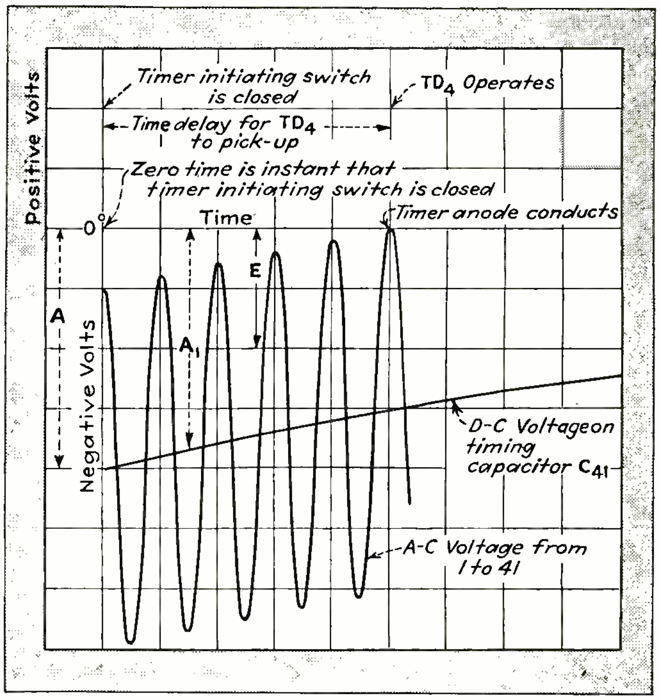

Fig. 4—Grid voltage characteristic of typical timer circuit. When the sum of the d-c voltage and the instantaneous a-c voltage equals zero the thyratron timing tube will fire

will decrease, therefore a longer period of time will elapse before relay TD_4 picks up.

Opening the relay contact 1-46 will drop out relay TD_4 and re-establish the first or zero time condition and allow timing capacitor C_{41} to be recharged. The time required to charge C_{41} to its maximum value is referred to as the reset time.

For given values of capacity C_{41} and resistance R_{41}, the time range is established by the relative values of resistor R_{44}, potentiometer P_4 and resistor R_{46}. That is, point 40 determines the maximum peak voltage to which capacitor C_{41} may be charged when resetting, determines the minimum positive a-c grid bias during the timing action and, consequently, establishes the maximum operating time. Conversely, point 42 determines the minimum peak voltage to which capacitor C_{41} may be charged when fully reset, determines the maximum positive a-c grid voltage during the timing action and, consequently, establishes the minimum operating time delay.

The timing range can be extended by increasing the value of capacitor C_{41} or resistor R_{41}. In cases where an extended timing range is provided it is generally accomplished by inserting an additional resistor, R_{41A}, in series with resistor R_{41}.

Disconnecting the timing capacitor C_{41} by means of the switch S_1 renders the timer substantially instantaneous in operation. Instantaneous operation is required in a weld interval timer when the controls on the timer panel are set for spot welding.

Cool Timer Circuit Operation

The circuit of a typical cool timer is similar to the circuit described above but certain connections are reversed. The anode, cathode, and voltage divider circuits are connected to the a-c voltage supply with opposite polarity. This is done so that the cool timer relay TD_3 will be energized when the foot switch is closed.

Figure 5 shows the connections of a cool timer circuit. When the foot switch is closed, relay TD_3 will be energized since the control grid of the thyratron tube is at cathode potential and anode current flows through the relay coil. Circuit 3 to 36 is closed and the negative voltage on the grid from the charge in capacitor C_{31} is equal and opposite in sign to the positive peak of the a-c voltage from point 31 to point 3. CR_2 relay contact 5-36 then opens, at the start of the heat time when a weld is being made, and drops out relay TD_3. When CR_2 opens, capacitor C_{31} is charged to a value near the peak of the a-c voltage from point 31 to point 1, during the half cycles when point 31 is positive and point 1 is negative. CR_2 relay contact 5-36 then closes at the end of the heat time but there is a time delay before relay TD_3 again closes.

The cool timer circuit is obviously set up with circuit voltages equivalent to the other timer circuits and performs its particular function in much the same manner.

Automatic Weld Timer Operation

The operation chart Fig. 6 shows graphically the operation of the automatic weld timer circuit of Fig. 2. The operation of each individual timer and relay circuit is shown with reference to time. The timing action of each timer is indicated by a dashed line prior to the closing of the relay that it controls.

The detailed operation of the circuit of Fig. 2, considering switch S_1 in the closed position for pulsation welding and switch S_2 in the open position for non-repeat operation, is as follows:

Momentarily closing the pilot or foot switch energizes relay CR_1, which seals closed by establishing a circuit around the foot switch. At the same time, relay TD_4 in the cool timer circuit closes without time delay. Contacts 7A-7B on relay CR_1 energize the solenoid valve circuit on the welder, which in turn cause the welder electrodes to close on the work piece. Contacts 2-16A of relay

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CR_1 close, preparing the circuit of relay CR_3.

After the electrodes of the welder close, contacts 16A-16B on the pressure switch (mounted on the welder) close and energize relay CR_3. Relay CR_3 seals closed through its own normally open contacts 16A-16B. At the same time, CR_3 relay contacts 2-46A close to energize relay CR_2 since TD_3 relay contacts 46A-26A are already closed. Furthermore, CR_3 relay contacts 2-46 close to initiate the weld interval timer, which starts timing. CR_2 contacts 8A-8B close the control circuit to the electronic contactor and start the weld current flowing. CR_2 relay contacts 5-36 open as soon as relay CR_2 closes, opening the cathode circuit to the cool timer and dropping out relay TD_3. TD_3 relay contacts 26-26A then close in the cathode circuit of the heat timer, which starts timing since CR_2 contacts 46A-26A are already closed. The latter contacts also seal around TD_3 contacts 46A-26A, which have just opened, and thus maintain relay CR_2 energized.

Summarizing to this point, the weld current has started to flow and the heat and weld interval timers have started timing. As soon as the heat timer times out, ending the heat time, relay TD_2 in the anode circuit of the heat timer closes and its contacts 4-26A open to de-energized relay CR_2. Weld current stops flowing since CR_2 relay contacts 8A-8B open the control circuit to the electronic contactor. Furthermore, CR_2 relay contacts 26A-46A open to drop out relay TD_2 and the heat timer resets. Also, CR_2 relay contacts 5-36 close the cathode circuit to the cool timer, which starts timing.

As soon as the cool timer times out, ending the cool time, relay TD_3 is energized and its contacts 26A-46A close to energize relay CR_2. The closing of relay CR_2 starts another heat time, which in turn is followed by a cool time (the operations chart of Fig. 6 shows only one cool time interval, for simplicity of illustration) and this series of operations repeats continuously until the weld interval timer times out. Assuming that the weld interval timer times out energizing relay TD_4 during a heat time, contacts 3-5 on relay TD_4 open the cathode circuit to the cool timer, stopping the repeating action of the heat and cool timers. Also, TD_4 relay contacts 2-70 close in the cathode circuit of the hold timer. The hold timer cannot be initiated, however, until the end of the heat time, when the CR_2 relay drops out and its contacts 70-71 close, completing the initiating circuit to the cathode of the hold timer, which starts timing. Contacts 70-71 of CR_2, in the cathode initiating circuit of the hold timer, prevents a hold timer with a short time setting being initiated and timing out during a heat time, which would cause the opening of the welder electrodes during a weld.

When the hold timer times out, ending the hold time, relay TD_5 is energized and its contacts 2-16C open, dropping out relay CR_1. Relay CR_1 contacts 7A-7B open the circuit to the solenoid valve on the welder, resulting in the opening of the welder electrodes, and contacts 1-2 open the sealing circuit around the foot switch, dropping out relays CR_3, TD_4 and TD_5 to complete the welding cycle. If the foot switch has been kept closed, relay TD_5 will remain closed, holding open the circuit to relay CR_1 since TD_5 relay contact 2-70 seals around TD_4 relay contact 2-70 to maintain relay TD_5 energized. Relay TD_5 will then drop out as soon as the foot switch is opened.

For repeat operation, switch S_2 in the cathode circuit of the off timer

(Continued on page 170)

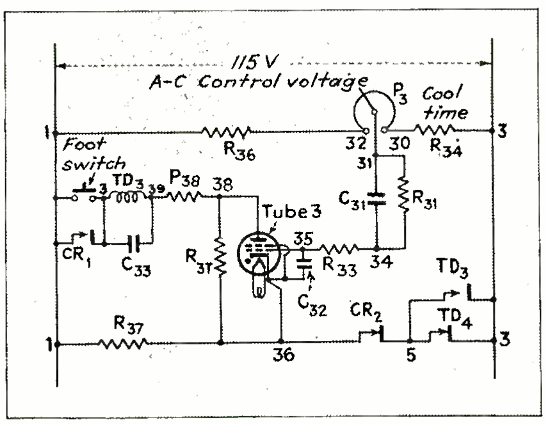

Fig. 5—Elementary diagram of cool timer circuit. It resembles the circuit of Fig. 3 but a-c supply leads are reversed to secure required polarity conditions

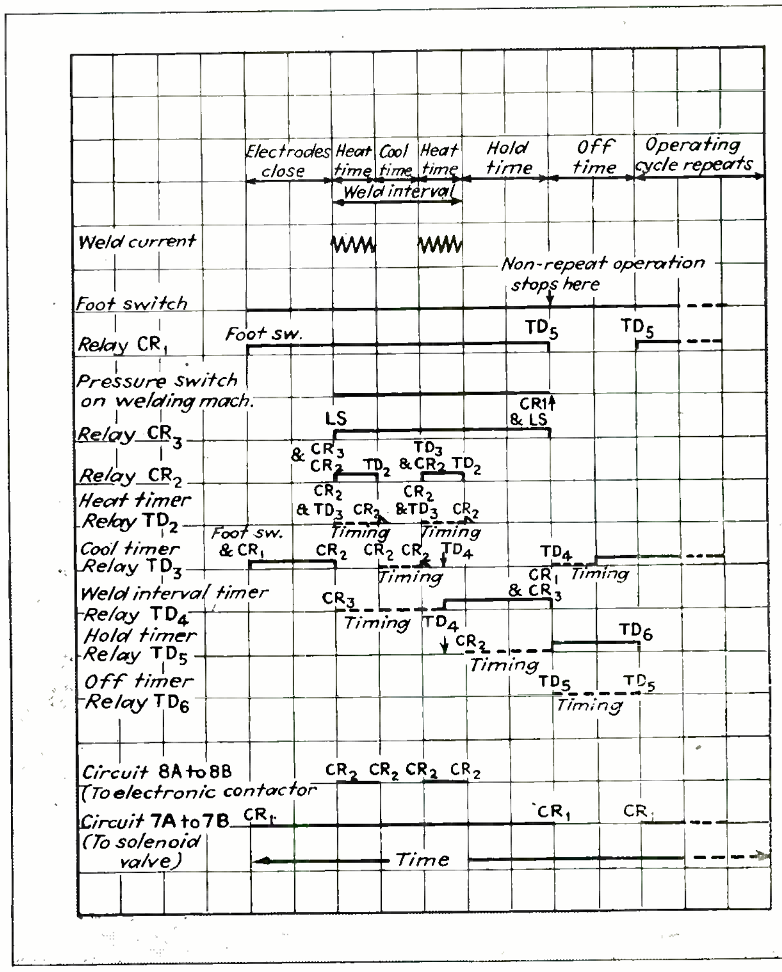

Fig. 6—Chart graphically illustrating the operation of automatic weld timer type 5A, shown schematically in Fig. 2. The notation at the beginning and at the end of a circuit or relay operation indicates the relay or device that closed or opened the circuit

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An Instrument for Measuring

An application of electron tubes to analyze not only the degree of roughness of a surface but the character of the surface; utilizes a Rochelle salt piezoelectric crystal, an amplifier and an oscillograph. Direct reading graph immediately available after test

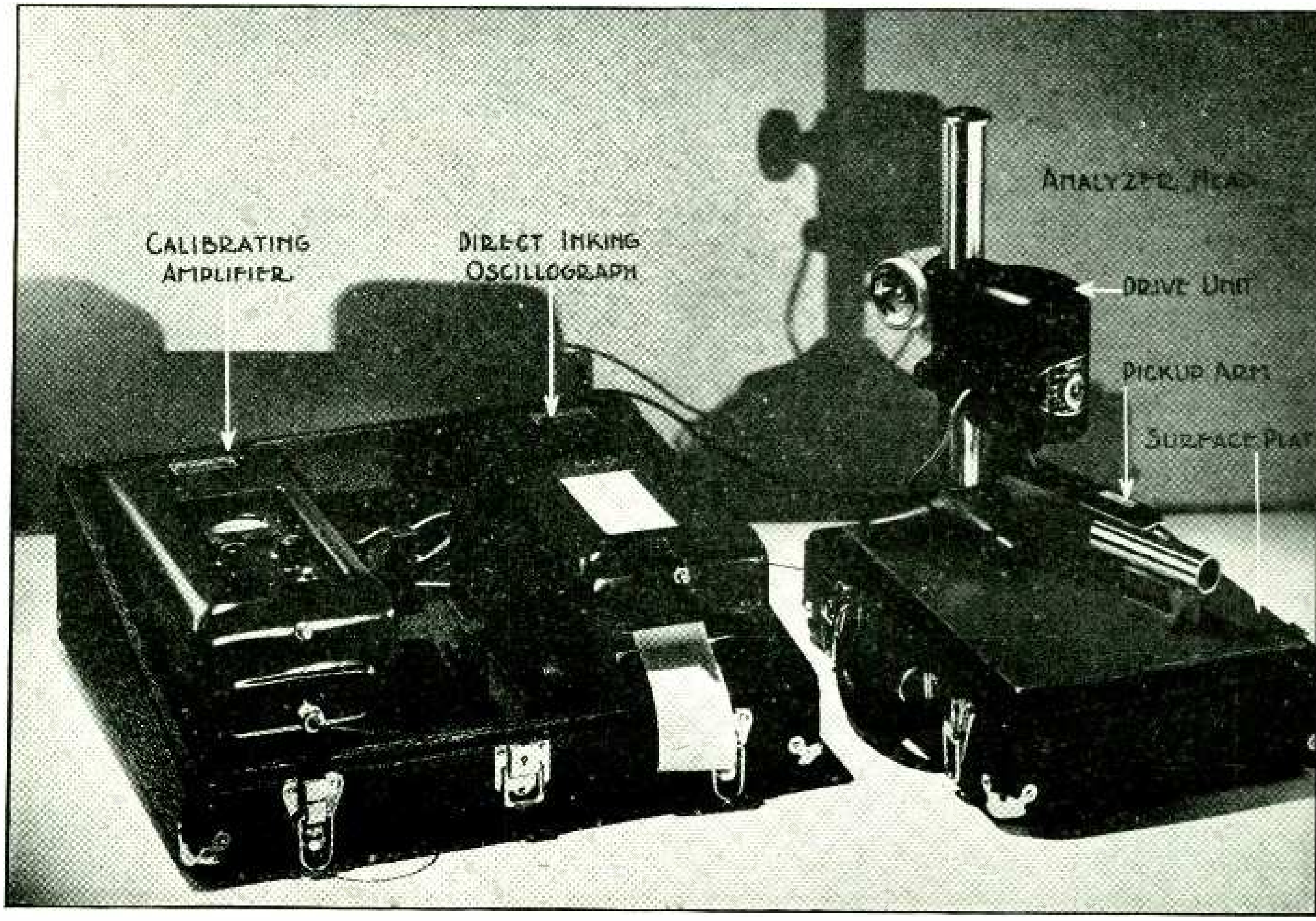

Fig. 1—A complete setup for measuring surface roughness composed of a hill-and-dale pickup, a means for moving the pickup over the surface and amplifier with oscillograph

SURFACE roughness, as defined by the American Standards Association Committee B46, applies to recurrent or random irregularities in a surface having the form of small waves or bumps. It is generally considered that on smooth machined, or other industrially important surfaces, these irregularities have wavelengths that are shorter than $\frac{1}{32}$ inch, and have peak-to-valley amplitudes in excess of one millionth of an inch (1 micro-inch). It is also fairly well established that most metal finishing methods produce surface irregularities with wavelengths much longer than their peak-to-valley amplitudes, and that a sharp exploring point having a spherical radius as large as 500 micro-inches can be used to measure the amplitudes of the principle irregularities.

The various methods used for evaluating surface roughness are visual inspection, with or without optical aids, feel and fingernail tests, miscroscopic examination of cross-sectioned specimens, and by using tracer instruments. The latter two are the only ones that give quantitative data and of these the tracer method is most sensitive.

The tracer method of measuring surface roughness is the currently accepted practical method and consists primarily of a means for moving a sharp tracer point over the surface and recording or indicating its motions as a departure from a geometrically perfect surface.

One of the early tracer instruments designed and built at the University of Michigan by Dr. E. J. Abbott employs optical methods of magnifying angular motions im-

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Surface Roughness

By CHARLES K. GRAVLEY

Brush Development Company, Cleveland, Ohio

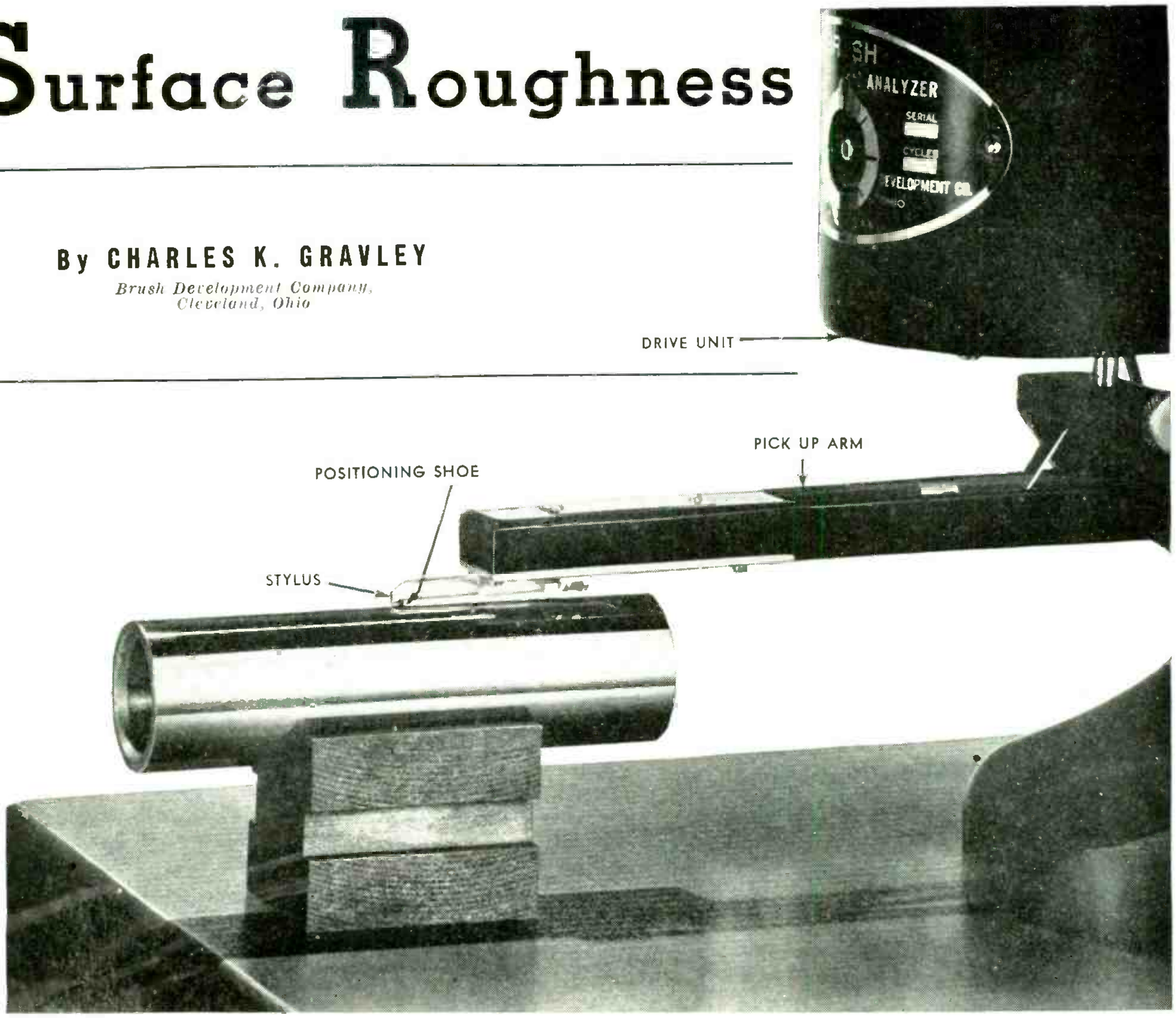

Fig. 2—Closeup of the pickup arm with positioning shoe and tracer point

parted to a mirror by a tracer point that is moved across the surface being measured.

A tracer instrument of the oscillographic type should be able to magnify the tracer motions at least 50,000 times and preferably 100,000 times if it is used to measure all industrially important surfaces. An electronic amplifier is the logical method of obtaining magnifications as large as this, and by its use, and a proper choice of electromechanical transducers, an efficient and practical instrument can be designed.

The Brush surface analyzer pictured in Figs. 1 and 2, and shown in block diagram form in Fig. 3, is an instrument that is being successfully applied to the measurement of surface roughness. This instrument consists of an amplifier, a direct inking oscillograph, and a specially designed hill-and-dale pickup with a means for moving it over the surface to be studied.

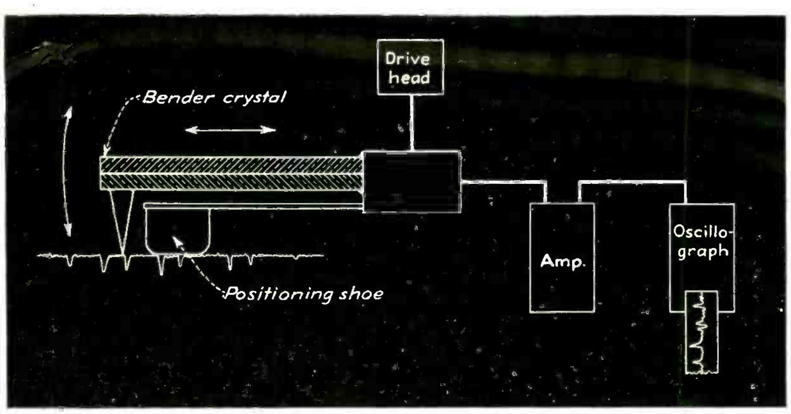

Fig. 3—Block diagram of the surface analyzer showing method by which tracer point follows indentations in surface to be measured

Pickup and Galvanometer

The pickup and oscillograph galvanometer merit special attention, since they are used as electromechanical transducers. Piezoelectric crystals provide special advantages for this application.

The utility of any surface roughness measuring instrument is dependent on such factors as portability, simplicity and speed of operation, the amount of information obtained, and more especially, its ability to measure all sizes, shapes, and

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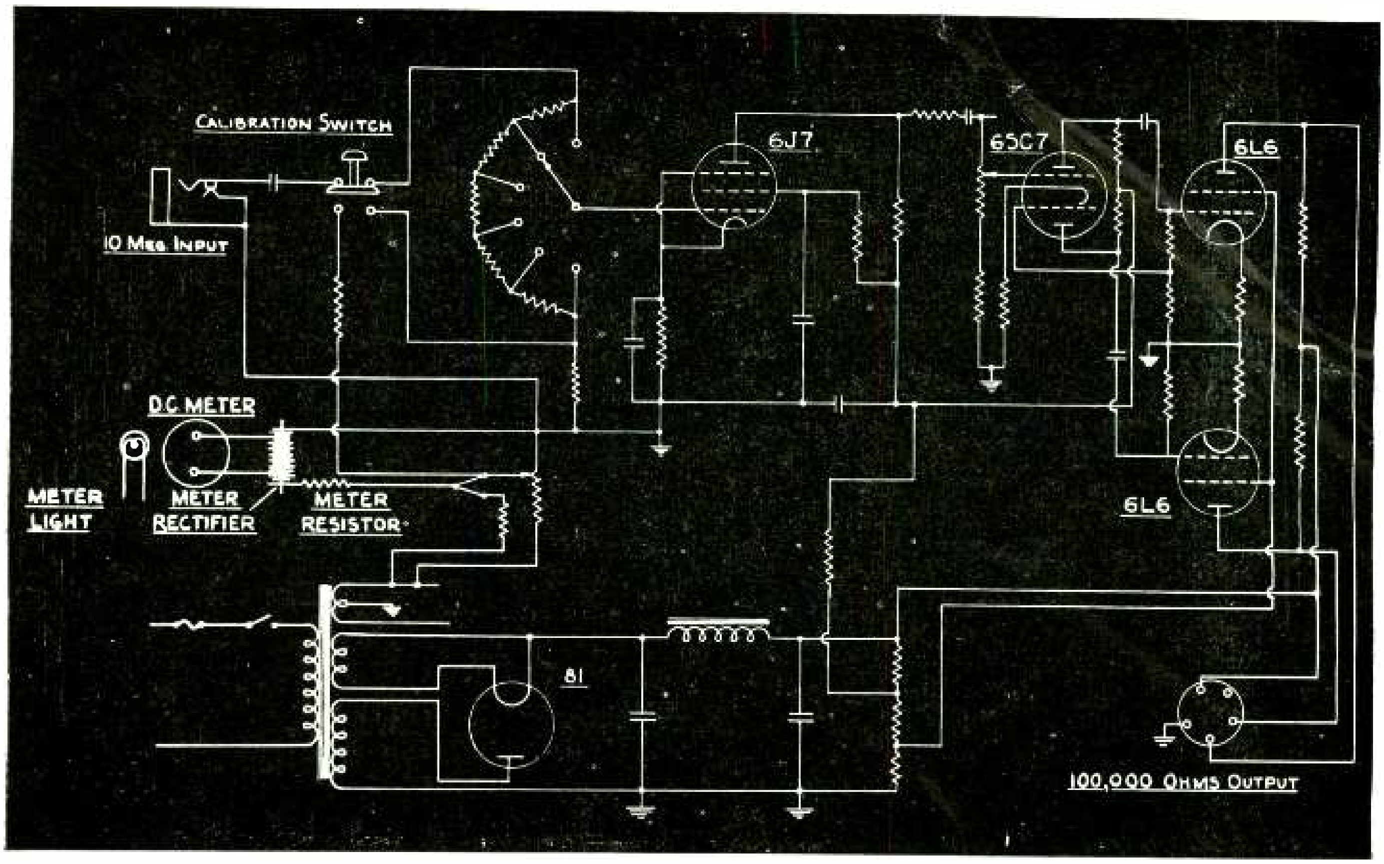

Fig. 4—Resistance-capacity, three-stage amplifier for use between Rochelle salt crystal and oscillograph. Amplifier gain is approximately 100,000

kinds of specimens. Nearly all of these factors involve the design of the pickup and its actuating mechanism.

The ideal pickup assembly might consist of a very small low-pressure tracer point, coupled by some dimensionless means to a suitable transducer, and a means for moving it over all surface contours. All of this is not to be realized in these instruments at present; however, by the choice of a suitable transducer unit, such as a "bimorph" element of piezoelectric Rochelle salt, the size, weight, and shape of the pickup permit a favorable approach to the ideal.

The crystal used in the surface analyzer pickup is of small size 1½ x ⅜ x 0.030 inch, requires a small actuating force (less than 0.1 gm), has a high order of sensitivity (1.2 millivolts per micro-inch), and a relatively high electrical capacity (0.02 μf). It is housed in an arm that carries a positioning shoe and tracer point, Fig. 2., and has a form that permits the measurement of internal bores as small as 7/32 inch, external cylindrical surfaces larger than 1/32 inch, and all flat surfaces. When the pickup is coupled to the oscillograph amplifier which has an input resistance of 10 megohms, it develops a voltage that is proportional to tracer point amplitude, independent of frequencies from 3 to approximately 500 cps and temperatures below 45 to 50 deg. C. The conductivity of the crystal at higher temperatures causes a loss in low frequency sensitivity.

The pen galvanometer, used to record the roughness pattern on a moving chart, has an amplitude response that is proportional to voltage, and essentially independent of frequency below 60 cps. It has a sensitivity of 0.02 mm per volt, and an effective impedance of 100,000 ohms, which permits coupling directly to the output of radio receiver types of vacuum tubes. A high order of efficiency is realized for this type of device since only 2.5 volt-amperes are required to obtain the full amplitude of ⅜ inch each side of zero.

Amplifier for Oscillograph

The galvanometer unit is approximately 2 inches wide, 4 inches high and 4 inches deep, and weighs about 2 lbs. Its size and weight, plus the weight saving design it permits in a driving amplifier, provides good portability for this type of instrument.

The amplifier shown schematically in Fig. 4 is a resistance-capacity coupled three-stage unit having an overall voltage gain of approximately 100,000. It is designed to drive the direct inking oscillograph and is required to deliver 500 volts rms from 1 to 60 cps. The plate supply of the first two stages has additional filtering to minimize disturbances resulting from line-voltage fluctuation. The use of un-bypassed separate bias resistors in the final stage provides some inverse feedback, which reduces distortion and d-c unbalance to a point where it is not necessary to carefully match the output tubes.

Oscillograph and Drive Head

The input of the amplifier is equipped with a stepped attenuator having an impedance of 10 megohms. A calibration circuit is provided so that input voltage can be compared with a measured alternating voltage. The gain control between the first and second stage provides limited adjustment of the gain and overlaps the 10 to 1 change in sensitivity obtained with the input attenuator in the grid circuit of the 6J7.

The oscillograph as a unit consists

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of the direct inking pen galvanometer attached to a chart drive mechanism which is powered by a synchronous motor, providing readily selected chart speeds of 0.5 to 2.5 and 12.5 cm per second, or approximately ½ to 1 and 5 inches per second.

The drive head, powered by a synchronous motor, applies a constant velocity reciprocating, straight line motion 1/16 inch in length to the pickup. The pickup can be set at almost any angle to the drive head in the plane of motion and its height can be adjusted by means of a hand wheel on the pickup head.

By setting the pickup at right angles to the direction of motion it is possible to measure narrow surfaces, slots, and the circumferential roughness of small diameter parts.

A rubber cushioned surface plate is provided to support the drive head and the test specimen, however, the drive head can be placed on or clamped to any stable support that rigidly couples the unit to the surface being measured.

Pickup Calibration

The amplitude calibration of the pickup has been established and checked by several methods, and the results have agreed to within 10 percent. A d-c calibration was obtained by applying a known deflection to the tracer point and measuring the open circuit voltage with a vacuum tube electrometer. This result was checked by allowing the tracer to ride over a shim of known thickness, and measuring the voltage with the oscillograph.

An a-c calibration at amplitudes of 1 to 10 micro-inches was obtained by actuating the pickup tracer point with a 45 deg. B-cut crystal of Rochelle salt. The physical and electrical constants for this crystal are accurately known, so that small known amplitudes are obtained by applying measured voltages to the crystal.

Though the pickup amplitude calibration is known, the equipment may still be in error if the tracer point is damaged in any way. In use, an overall check on the amplitude calibration, and the condition of the tracer point is obtained by measuring two ruled lines of known depth. A piece of polished glass is ruled with two lines, one approximately 100 micro-inches deep and the other 10 micro-inches deep. The 100-micro-inch line is not very dependent on the condition of the tracer point and is used to check the overall calibration. The small line is then used to check the condition of the tracer point.

Operation of the instrument consists first of checking the chart calibration, either by applying an a-c calibrating voltage, corresponding to the pickup sensitivity, or by measuring the ruled glass calibrating block. The part to be measured is then set up by placing it in a V block, if cylindrical, and lining it up with the direction of pickup travel and adjusting the height of the drive lead until the pickup is approximately horizontal when resting on the surface. If the stepped attenuator is set for the right sensitivity the chart drive is started and allowed to run for approximately 20 seconds. The chart should then be two cycles in length, and the respective cycles should be identical if the test specimen has been properly cleaned and set up.

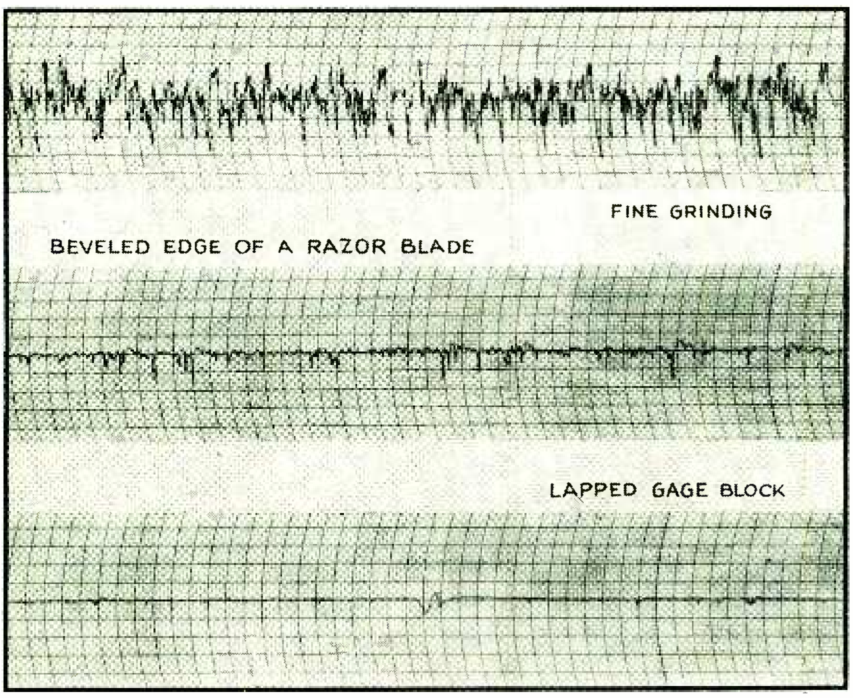

Fig. 5—Typical roughness charts. Vertical scale—2 micro-inches per small division; horizontal scale—500 micro-inches per small division

Operation of the Analyzer

It should be noted that the critical operation of moving the tracer over the surface is performed automatically and is, therefore, independent of the operator's skill, that the chart provides a means of checking the accuracy of the measurement, and is a measurement of surface character as well as roughness.

The charts shown in Fig. 5 are of surfaces that are being produced by mass production methods. The ground surface is usually considered adequate for most journal bearings, and the gauge block represents the degree of finish that can be attained. Gauge block finishes are obtained by lapping, which is a method that produces very smooth surfaces with major irregularities below the nominal surface. In examining the razor blade chart it can be seen that one of the final honing operations has not removed all of the deep scratches from a previous grinding operation.

These charts show finishes that have been developed for specific applications, and it should be noted that the character as well as the degree of roughness is different for each case. Most investigators of surface roughness have for the most part neglected surface character, and have only considered roughness measured as an average value; it should be significant that there is considerable disagreement in their results. It is expected that with improved instruments and the proper control of all surface qualities, the true importance of surface roughness will be established in the near future.

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Superheterodyne Tracking SIMPLIFIED

By P. C. GARDINER *Radio Transmitter Engineering Department General Electric Company, Schenectady*

IN superheterodyne receiver engineering, the oscillator condenser tracking design is now considered as one of the more or less cut and dried problems. However, the calculations usually involved have been a nuisance to the engineer inasmuch as one value of capacitance per band or less is all he needs to know, and to get this he must wade through one or more rather long formulas.

The writer presents here the results of his efforts to simplify the general solution of the problem, together with a chart laid out for rapid design.

In Fig. 1 we have r-f and oscillator circuits whose frequencies are separated by the intermediate frequency. With C_v the same value of tracked variable capacity in both circuits we desire to choose C_2 and C_1 to be such values as to cause the oscillator frequency to more nearly track the r-f circuit than if C_2 were shorted out and C_1 were given the entire tracking responsibility.

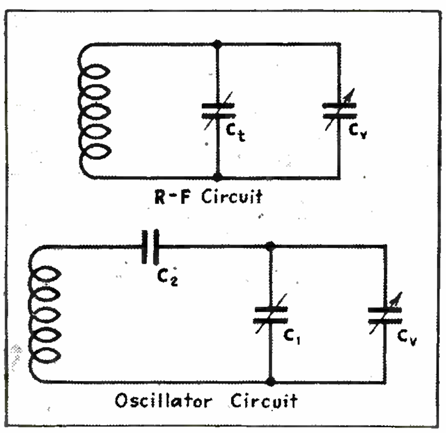

Fig. 1—Radio-frequency amplifier and oscillator circuits in which are the trimmer and padder condensers whose relations are outlined in this short-cut to the tracking problem

The value of inductance of the oscillator circuit must be adjusted to place the circuit in the correct frequency region (e.g. 1 to 1.5 Mc or 10 to 15 Mc, etc.), but this value can easily be found after the capacitances are known.

The inductance need not clutter up our straightforward reasoning. The capacitances and frequencies are all we need to obtain an equation containing C_1, C_2, C_v, F_1, and F_2, where F_1 and F_2 are respectively the low and high frequency limits of the r-f band. Furthermore, a direct solution for any one of these five quantities need not be made, since for normal given conditions enough values are usually known to produce a quick solution from the following equations, or from the chart.

In this material it is not attempted to cover the case where C_2 lies between C_1 and C_v. However, even where C_2 is in the same order of magnitude as C_v the solutions given are sufficiently accurate for use with this circuit position of C_2.

Other special cases, such as that of a coil of high distributed capacity, are not covered for the simple reason that in practically all cases the results fall very close to those given.

In the r-f circuit let:

F_1 = lowest r-f frequency
F_2 = highest r-f frequency
C_v = ΔC of variable condenser
C_t = r-f parallel capacitance
X = multiplier of C_v necessary to give "midtrack" point

Then:

$$\frac{F_2^2}{F_1^2} = \frac{C_t + C_v}{C_t} \text{ or } \frac{C_t}{C_v} = \frac{F_1^2}{F_2^2 - F_1^2} \qquad (1)$$

Now assume r-f midtrack frequency, F_m, to be geometric mean of extreme frequencies. (Calculations show that the arithmetic mean or other approximate center frequencies give practically no error from the following.) Thus,

$$F_m = \sqrt{F_1 F_2} = F_2 \sqrt{\frac{C_t}{C_t + XC_v}}$$

$$\text{or } \frac{C_t}{C_v} = X \frac{F_1}{F_2 - F_1} \qquad (2)$$

Combining Eqs. 1 and 2 $X = \dfrac{F_1}{F_1 + F_2}$

In the oscillator circuit let:

f_1 = lowest oscillator frequency = F_1 + I F
f_m = oscillator "midtrack" frequency = F_m + I F
f_2 = highest oscillator frequency = F_2 + I F
C_1 = fixed capacitance including trimmer and all minimum capacitance in parallel with C_v
C_2 = series capacitance

Then:

$$\frac{f_2^2}{f_1^2} = \frac{\dfrac{C_2 (C_1 + C_v)}{C_1 + C_2 + C_v}}{\dfrac{C_1 C_2}{C_1 + C_2}}$$

$$\text{or } \left[\frac{f_2^2}{f_1^2} - 1\right] = A = \frac{C_2 C_v}{C_1} \left[\frac{1}{C_1 + C_2 + C_v}\right] \qquad (3)$$

$$\frac{f_1^2}{f_m^2} = \frac{\dfrac{C_2 (C_1 + X C_v)}{C_1 + C_2 + X C_v}}{\dfrac{C_1 C_2}{C_1 + C_2}}$$

$$\text{or } \left[\frac{f_2^2}{f_m^2} - 1\right] \frac{1}{X} = B$$

$$= \frac{C_2 C_v}{C_1} \left[\frac{1}{C_1 + C_2 + X C_v}\right] \qquad (4)$$

From Eqs. 3 and 4

$$\frac{A}{B} = \frac{C_1 + C_2 + X C_v}{C_1 + C_2 + C_v} \qquad (5)$$

$$C_1 = C_v \left[\frac{A - X B}{B - A}\right] - C_2 \qquad (6)$$

Putting this into Eq. 3

$$\frac{C_2}{C_v} = \frac{(A - X B)}{\dfrac{(A - B)^2}{(1 - X) A B} - (A - B)} \qquad (7)$$

From Eq. 6 we have

$$\frac{C_1}{C_v} = \frac{A - X B}{B - A} - \frac{C_2}{C_v} \qquad (8)$$

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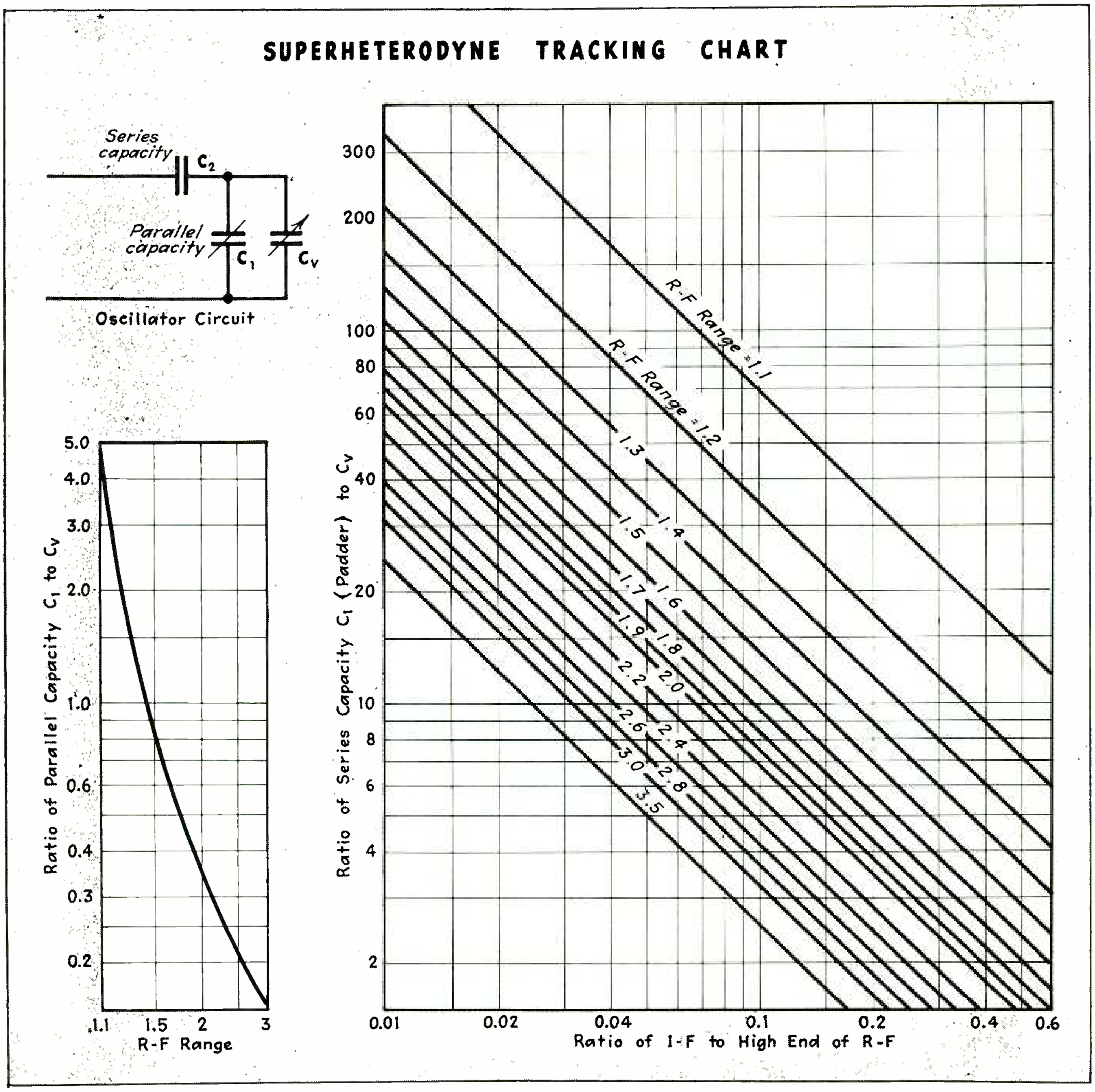

Fig. 2—Design chart for determining series and shunt capacities for tuned circuits in single control superheterodyne receivers

Equation 7 is plotted on the chart as a family of straight lines, and C_2 is called series capacity or padder. Equation 8 is plotted on the chart as a single curve, and C_1 is called parallel capacity.

Example of Design from Chart

The use of the superheterodyne tracking chart may be made more clear by means of an example involving a numerical result.

Let the upper and lower carrier frequencies be 15 Mc and 10 Mc respectively, and let the intermediate frequency be 3.0 Mc. Let the tuning condenser, C_v, have a capacitance of 50 $\mu\mu$f at 10 Mc. The problem is to determine C_1 and C_2, the shunt and series capacitance, respectively, and the tuning inductance, L.

The tuning ratio is the ratio of the limits of the r-f spectrum, or $15/10 = 1.5$. The ratio of the intermediate frequency to the higher carrier frequency is $3/15 = 0.20$. Using the first of these values, we determine for an r-f tuning range of 1.5 that the value of $(C_1/C_v) = 0.85$, from the smaller graph. At 10 Mc, $C_v = 50$ $\mu\mu$f and therefore $C_1 = 42\frac{1}{2}$ $\mu\mu$f.

Using the larger graph, we enter the chart at the bottom corresponding to a value of 0.2 and follow vertically until we reach the 45 degree line representing an r-f tuning range of 1.5. Then, projecting to the left, we find $(C_2/C_v) = 0.7$ and hence $C_2 = 35$ $\mu\mu$f at 10 Mc. The three capacitances are thus determined.

The condensers C_1 and C_v in parallel are equivalent to a single condenser, C, of $92\frac{1}{2}$ $\mu\mu$f. The series capacitance, C_2 in series with C gives a resultant capacitance of 26.8 $\mu\mu$f, so that the required inductance is 10.7 microhenries.

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Impedance Magnitude and Phase Shift Curves

For Some Common Two-Terminal Three-Element Linear Networks

By VITOLD LEOPOLD EDUTIS

Naval Research Laboratory

THIS Reference Sheet contains graphs showing the magnitude and phase shift of resonant circuit impedances composed of lumped L, R, and C constants connected in a two-terminal network. The curves represent a selection from a wide range of two terminal networks prepared and calculated by the author* as a result of a systematic examination of two-terminal networks. For the circuit networks shown in the table on each of the following pages, the curves show the magnitude of the impedance, and the phase shift for various values of the parameter K, which is defined in the table. The curves are plotted as normalized impedances, so that the true impedance in ohms may be determined from the graph for any value of resistance R. The curves are also generalized to apply for any frequency over a wide range in the vicinity of the natural resonant frequency by plotting the abscissa in terms of f/f_o, where f is the frequency at which the circuit is operated, and f_o is the resonant frequency of the circuit defined by $f_o = 1/2\pi\sqrt{LC}$. Because of the general manner in which the curves are plotted, the graphs are applicable to six types of three-element resonant circuits istead of only to two, as might be expected.

The table accompanying each graph shows the circuit of the appropriate network, indicates the correct set of axes to be used in determining the impedance magnitude and phase shift, indicates the value of the parameter K for the various curves of any family, and designates the inverse and reciprocal network of the selected circuit. Two networks are said to be inverse if their magnitude and phase angle characteristics vary with frequency in a mutually inverse manner and if definite ratios exist between corresponding elements in the two networks. Two networks are said to be reciprocal if the impedance of one is conjugate to the impedance of the other when the frequency of one is the reciprocal of the frequency of the other.

The graphs may be used to determine the magnitude and phase of the impedance of any of the six selected circuits, or, conversely, for the magnitude and phase curves selected, any of two or more networks may be selected to provide the desired impedance characteristic within the range of the graphs.

With the characteristic curves of magnitude and phase shift presented, it is possible to find the impedance magnitude and phase angle of a network graphically. This eliminates many long and tedious calculations. Although the method is not as accurate as the method of calculation, it is extremely useful because in most cases the accuracy is sufficient for engineering purposes. The impedance magnitude can be obtained to within approximately one percent of the exact value. The phase shift can be read to within one degree. The graphs are drawn to apply to values of R, L, and C, in ohms, henries, and farads, respectively, while f is of course determined in cycles per second.

Two examples will suffice to illustrate the method of using these graphs. Suppose we have a series L, R, C circuit consisting of an inductance of 100 microhenries, and a capacitance of 100 micromicrofarads so that the resonant frequency is 1.592 Mc. What resistance will be required if the circuit impedance is to be maintained to 3 db (ratio of 0.5) below its resonant impedance at 2.4 Mc? What will be the phase shift?

From the data above, $ZR = 0.5$ and $f/f_o = 1.5$ from which we find $K = 2$. From these data, and transposing the formula for K, we find the value of the required resistance to be

$$R = \frac{1}{K}\sqrt{\frac{L}{C}} = \frac{1}{2}\sqrt{\frac{100 \times 10^{-6}}{100 \times 10^{-12}}} = \frac{1}{2}\sqrt{\frac{1}{10^{-6}}} = \frac{1}{2}\sqrt{10^{6}} = \frac{1000}{2} = 500 \text{ ohms}$$

The phase angle will be 58 degrees.

The same problem may be applied to a circuit consisting of a capacitance in parallel with an inductance. (Circuit 3) Assume, for simplicity, that the same values and circuit constants are employed. What value of resistance of the coil is required?

For $f/f_o = 1.5$ and $ZR = 0.5$, we find $K = 0.62$, from which $R = 1620$ ohms.

The phase angle is -73 degrees.

* Taken from "Impedance Curves for Two-Terminal Networks," a thesis submitted in the Graduate School of the Illinois Institute of Technology in partial fulfillment for the requirements of degree of Master of Science in Electrical Engineering.

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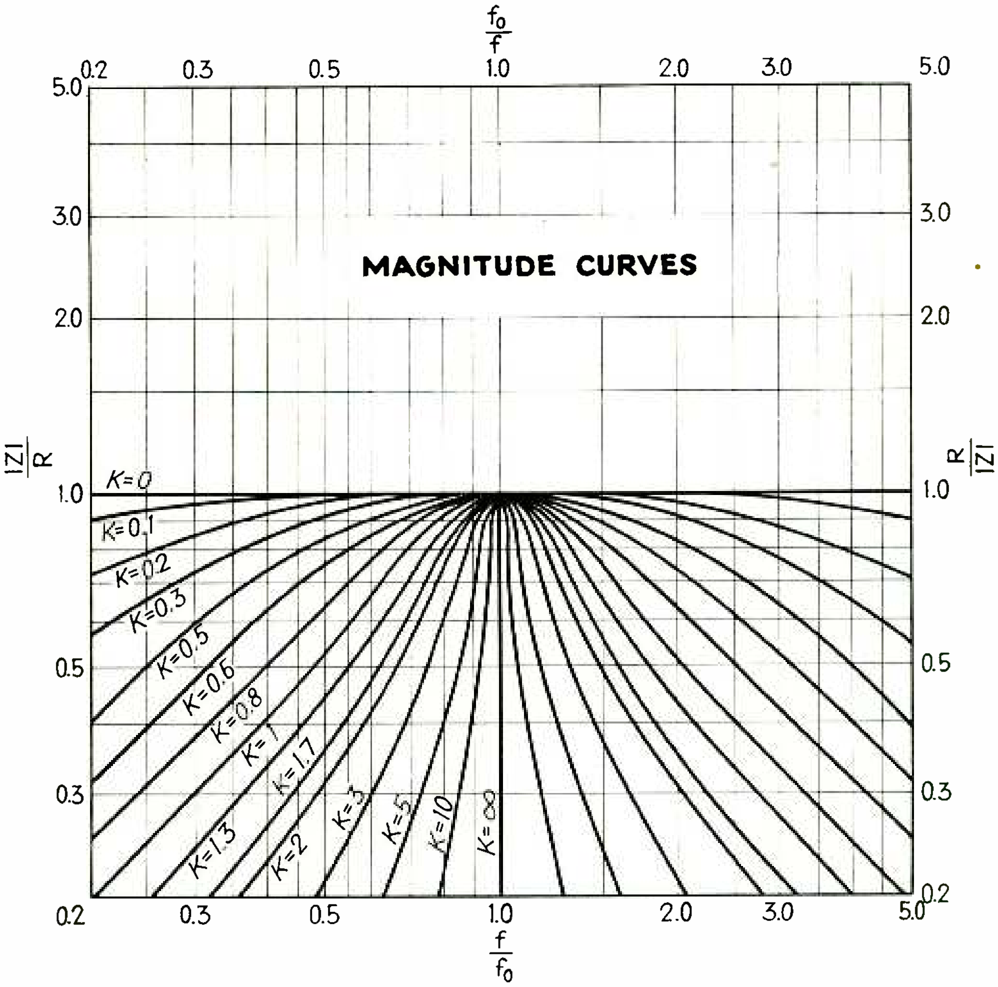
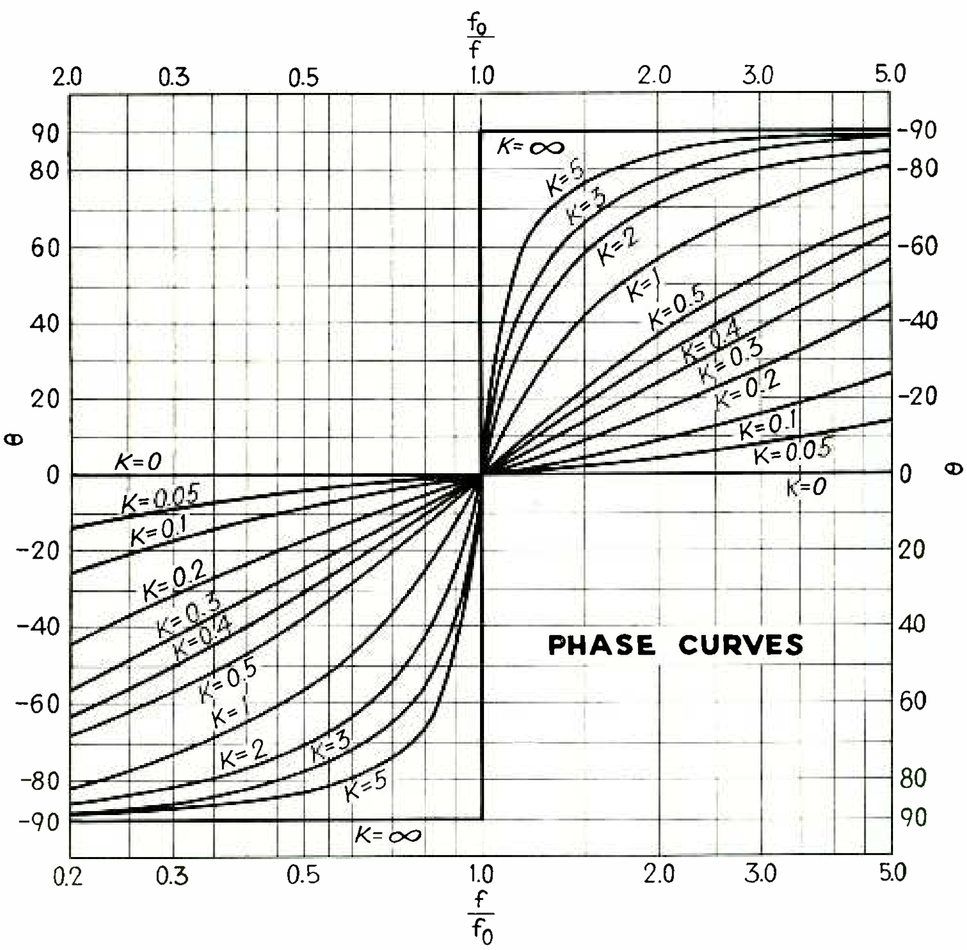
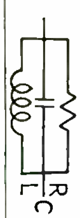
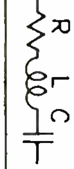
Magnitude and Phase Angle Curves for Networks 1 and 2





Network	No.	Inverse Network	Reciprocal Network	Resonant Frequency f_0	Parameter K	Magnitude Axes	Phase Axes
 R C L	1	2	1	$\frac{1}{2\pi\sqrt{LC}}$	$\sqrt{\frac{R^2C}{L}}$	$\frac{\lvert Z\rvert}{R}, \frac{f}{f_0}$	$\theta, \frac{f}{f_0}$
 R L C	2	1	2	$\frac{1}{2\pi\sqrt{LC}}$	$\sqrt{\frac{L}{R^2C}}$	$\frac{f}{f_0}, \frac{R}{\lvert Z\rvert}$	$\frac{f}{f_0}, \theta'$

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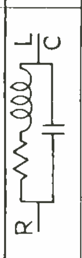
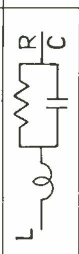
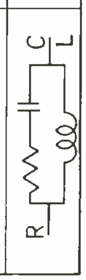
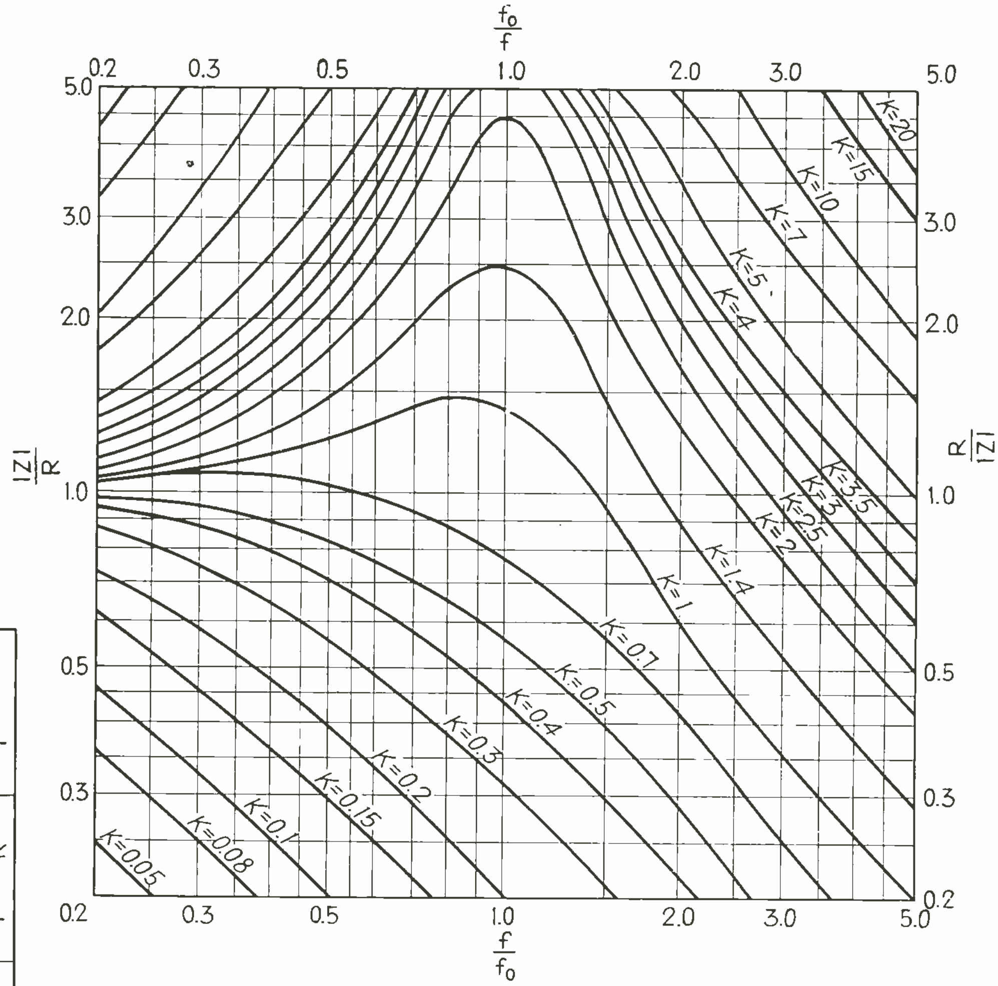
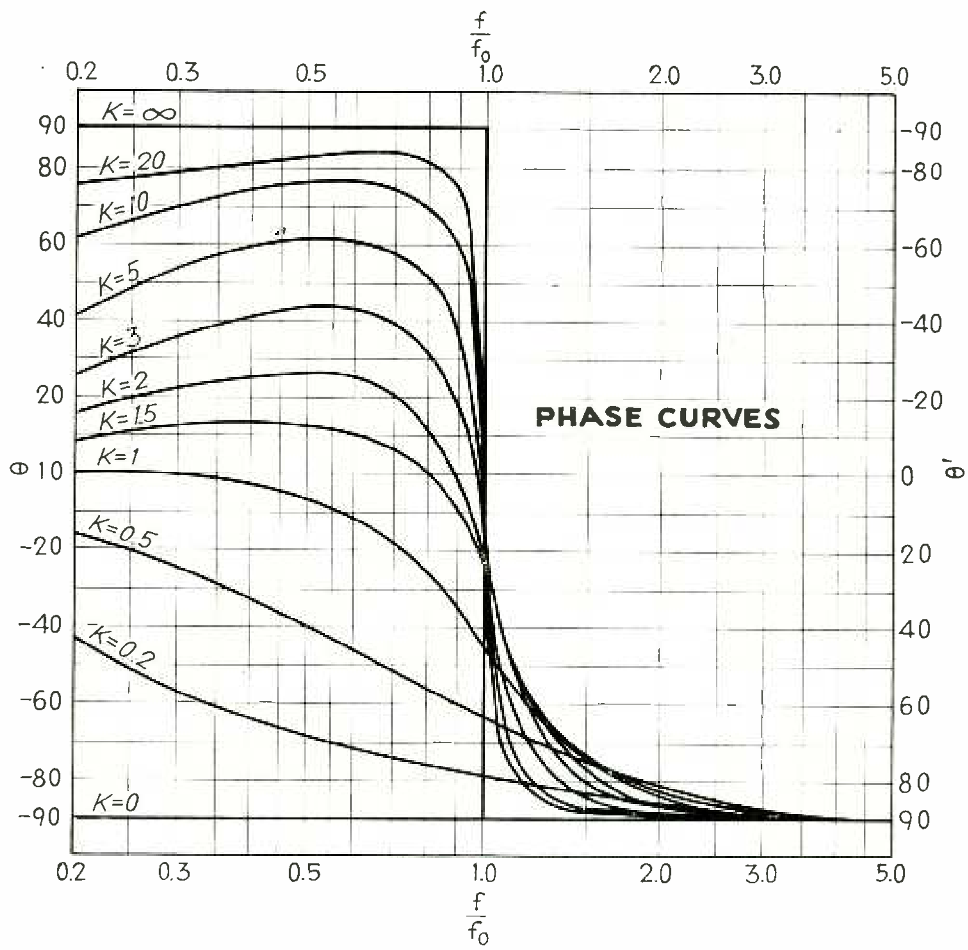
Magnitude and Phase Angle Curves for Networks 3, 4, 5, and 6

Network	No.	Inverse Network	Reciprocal Network	Resonant Frequency f_0	Parameter K	Magnitude Axes	Phase Axes
	3	4	6	$\frac{1}{2\pi\sqrt{LC}}$	$\sqrt{\frac{L}{R^2C}}$	$\frac{\lvert Z\rvert}{R}, \frac{f}{f_0}$	$\theta, \frac{f}{f_0}$
	4	3	5	$\frac{1}{2\pi\sqrt{LC}}$	$\sqrt{\frac{R^2C}{L}}$	$\frac{f}{f_0}, \frac{R}{\lvert Z\rvert}$	$\frac{f}{f_0}, \theta'$
	5	6	3	$\frac{1}{2\pi\sqrt{LC}}$	$\sqrt{\frac{R^2C}{L}}$	$\frac{R}{\lvert Z\rvert}, \frac{f_0}{f}$	$\theta', \frac{f_0}{f}$
	6	5	4	$\frac{1}{2\pi\sqrt{LC}}$	$\sqrt{\frac{L}{R^2C}}$	$\frac{f_0}{f}, \frac{\lvert Z\rvert}{R}$	$\frac{f_0}{f}, \theta$





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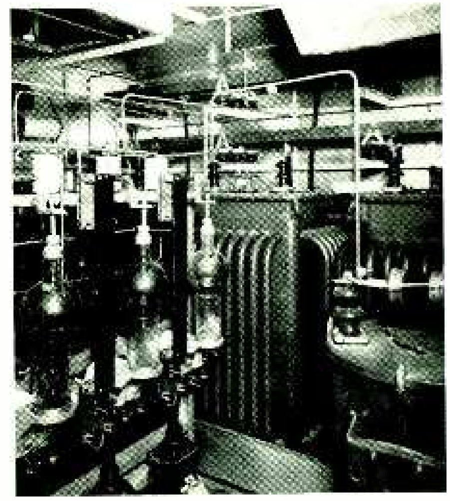
TUBES AT WORK



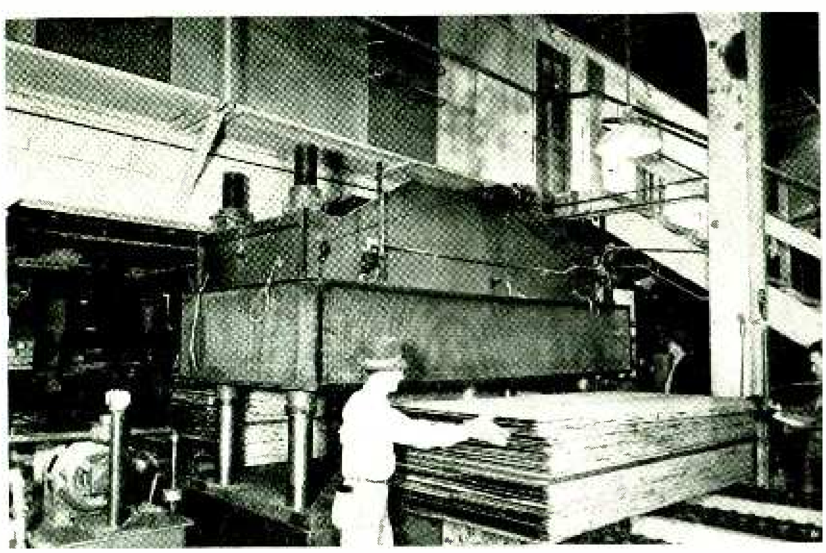
High-vacuum tubes and associated mercury-arc rectifiers comprising part of the equipment in the plywood manufacturing plant's balcony. The equipment turns out 400 kw of r-f at approximately 2000 kc

Radio Frequency Heating Speeds Plywood Bonding

WHEN MANUFACTURING plywood, individual sheets or laminations must be held together under pressure until the glue or plastic constituting the bond "sets." Where "cold" presses are used and nothing is done to hurry the process setting may require a day or more. During this period the press is tied up, limiting plant capacity. Setting is sometimes accomplished in a matter of hours by using "hot" presses that apply live steam to the outer surfaces of the metal jaws between which work is held. This speed-up scheme does not readily lend itself to the economical production of plywood more than about one-inch thick. (Heat applied to the outer surfaces of the work is not rapidly conducted to the inner laminations.)

By utilizing a well-known principle employed in modern diathermy, which uniformly heats "from the inside out" that part of a patient's anatomy included between the electrodes of a capacitor through which alternating current is flowing at a radio frequency, plywood up to 9-inches or so in thickness is now set in a matter of minutes. As in a diathermy machine, heat is generated within the body or dielectric (in this instance moist wood sheets and the glue or plastic bonding material) included between the capacitor electrodes by distortion or disturbance of the dielectric's molecular structure. Radio frequency power, in other words, is converted into heat within the plywood itself and, while with a given quantity of power the length of time required for setting is roughly proportional to the thickness and character of the stacked sheets of wood and the bonding material between them, heating is relatively uniform throughout panels so processed.

Two plywood presses in a western plant operated by the Albany Plylock Division of the M & M Wood Working Company utilize the radio frequency heating principle described. Designed by M & M's chief engineer Michael Pasquier and Paul D. Zottu of the Girdler Corporation of Louisville, Ky., these press employs a "twin" or two-section 8 ft. and 4 by 10 ft. in area. Each press employs "twin" or two-section capacitor having a common center electrode and two outside electrodes, permitting two thick plywood panels or a number of panels of equivalent thickness to be processed at the same time. Up to 9-inches of plywood thickness may be accommodated between the bottom and center electrode of each press and a similar thickness may be simultaneously processed between the center electrode and the top electrode. Thus a total of 18-inches of plywood thickness (40 panels of average thickness turned out by the plant) may be simultaneously set in each press.



One of two presses utilizing radio frequency power to speed up plywood bonding in Albany Plylock's western plant. Radio frequency generators and associated equipment are located in the balcony immediately above the press. The control panel just barely visible behind and to the right of the press permits both presses to be operated at maximum efficiency from a central point

Radio frequency power for both presses is delivered by a high-vacuum tube generator turning out a maximum of 400 kw. on approximately 2000 kc. Direct current required by the anode circuits of the tubes (15,000 v) is obtained from a bank of mercury-arc rectifiers to which a-c is delivered by the secondary of a step-up transformer. A rotating-machine driven by the mill's steam plant delivers 4,400 v of 60 cps power to the primary of the transformer. Balancing of r-f power fed to the two presses (where plywood stacks of different thickness and composition present different load conditions) is automatically assured by auxiliary electronic controls so that both presses may be used simultaneously.

Depending upon the amount of heat required for setting various kinds of bonding material and the amount of heat which stacks will stand without burning of wood or boiling of glue or plastic, the temperature of work in process in each press may be manually adjusted between 160 and 300 deg. F. Temperatures most frequently used are between 160 and 180 deg.

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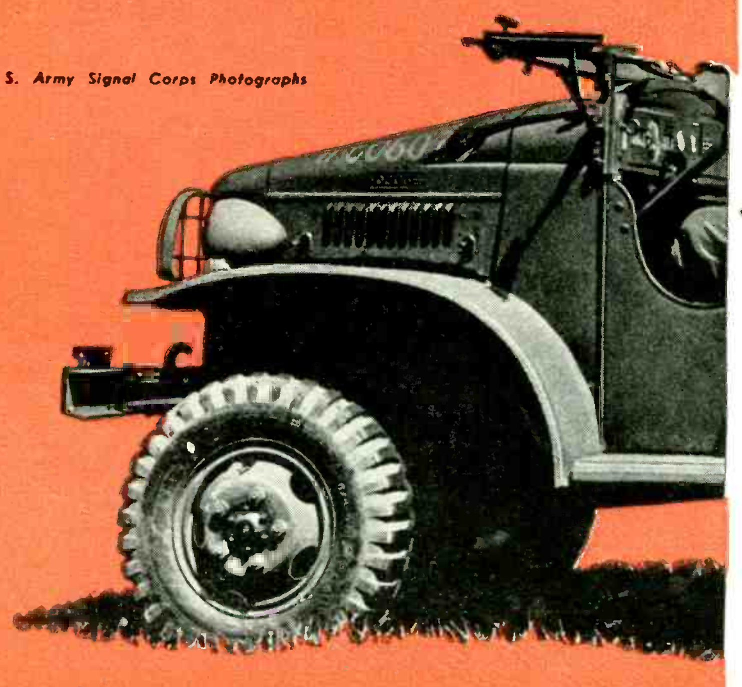
Men wanted for the Signal Corps of the U. S. Army

You can (1) serve your country, (2) learn the rapidly advancing science of electronics, (3) prepare yourself for a promising career after the war by joining "The Nerve Center of the Army" now.

Men are needed now to man America's electronic weapons.

This is a war of communications. "The message must get through!" Radio communication equipment and electronic devices known only to the men of the U. S. Signal Corps are fighting the war on world fronts.

U. S. Army Signal Corps Photographs



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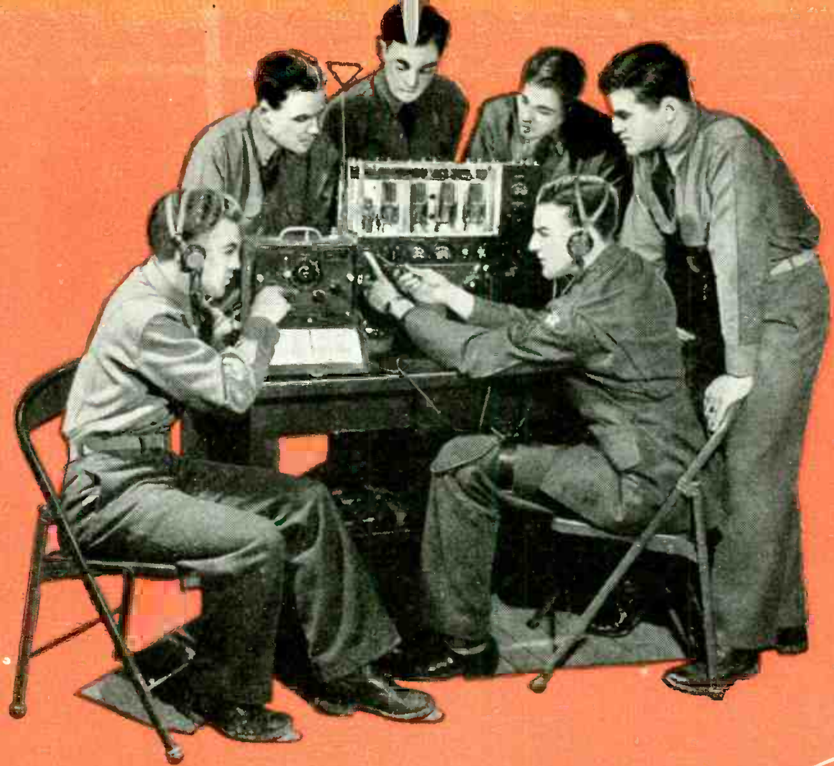


Here is an outstanding opportunity for radio and communications men to do their part, and at the same time get the finest possible training in one of the brightest after-the-war industries.

The electronics field is still in its infancy. Ten years ago there were comparatively few electronic devices. Today there are more than a thousand kinds of electronic devices at work in factory, hospital, office, cotton mill, steel mill, the home and on the fighting front!

General Electric is a leader in electronic research. We are definitely interested in having available, when victory comes, trained men for the sales and service of future electronic devices. This is a highly specialized field, and good men will be in demand.

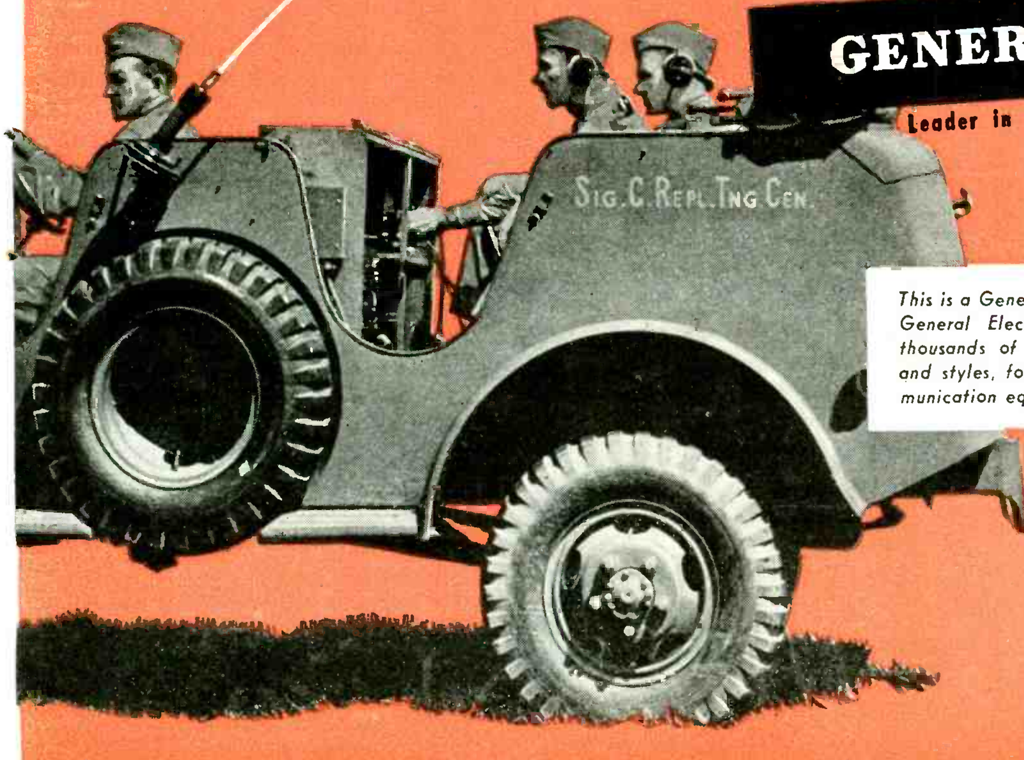
If you are now an expert in radio, or are ambitious and willing to learn at good pay, General Electric urges you to consider the Signal Corps now. The Signal Corps is also sponsoring courses in the fundamental theories of radio and electronics in many colleges and universities. . . . Get in on the ground floor today!

★ ★ ★

For further information regarding enlistment, call at the nearest Army Recruiting and Induction Station. Or write to "The Commanding General" of the Service Command nearest you. For Civilian Training information, call at any office of the U. S. Civil Service or U. S. Employment Bureau.

GENERAL ELECTRIC

Leader in radio, television, and electronic research



This is a General Electric electronic radio tube. General Electric is building thousands and thousands of electronic tubes, of many sizes and styles, for use in Uncle Sam's radio communication equipment and electronic weapons.

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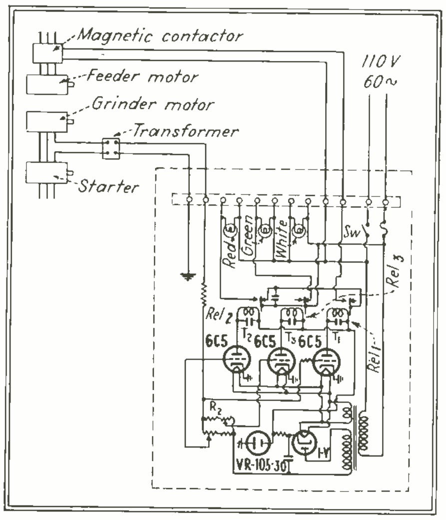
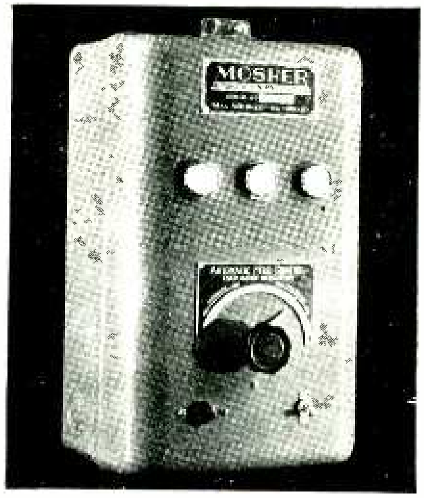
Automatic Control for Grinding Machine Feed Motors

WHEN GRINDING or pulverizing industrial materials the load upon the electric motor operating the grinder or pulverizer frequently depends upon variable factors beyond the control of the operator. For example, the grindability of material may vary widely with humidity changes. Mechanical and electrical arrangements for automatically controlling feed, decreasing the inflow of material to the grinder when the motor is overloaded, are commonly known but recent application of electronic technique to this problem considerably simplifies the apparatus required and increases its versatility.

The accompanying diagram shows the schematic of an automatic control manufactured by Max Mosher of New York. This control unit is so arranged that, when connected as shown, the feed motor will be stopped when the load on the grinder motor exceeds an amount for which a front-of-panel control is set while a green pilot will light, notifying the operator that the grinder motor is being under-worked, when the load on the grinder motor goes below an amount for which internal control R_2 is adjusted. Restoration of normal grinder load after the control unit cuts off the feed motor (on overload) automatically re-starts the feed motor without any switching by the operator. The unit may be adjusted to cut off the feed motor for grinder loads anywhere between 50 percent and 125 percent of full grinder motor capacity. The underload indicator is ordinarily adjusted by the installation man to function when the grinder motor load drops about 25 percent below the operating point selected as normal.



Circuit of automatic control for grinding machine feed motors



Front panel of the automatic feed control

The primary of a transformer is connected in series with one of the grinder motor power supply leads. An a-c voltage proportional to the load current of the grinder motor appears across the secondary of the transformer and is applied to the grids of control tubes T_1, T_2 and T_3. A d-c bias voltage is also applied to the tube grids by the power pack which incorporates a type 1-V halfwave rectifier tube and a VR-105-30 voltage regulator. Anode current, supplied by the same d-c power pack, flows or ceases to flow through the control tubes and their associated relay coils when the balance between a-c input voltage obtained from the external source and d-c grid voltage applied from the power pack is disturbed.

In operation, the white pilot lamp indicating that the control unit is properly energized from the a-c line lights when the switch S_w is closed. With the grinder motor operating and drawing any reasonable amount of current, relay REL_1 in the anode circuit of T_1 closes and stays closed as long as the grinder motor continues to operate, opening the magnetic contactor in the supply line to the feed motor only in the event that the grinder motor stops entirely and so constituting an interlock safety device. When grinder motor load current increases beyond the point for which the panel control is balanced the unit performs its primary function. Relay REL_2 in the anode circuit of T_2 pulls up and opens the magnetic contactor circuit to shut off the feed motor, simultaneously energizing a red warning lamp.

The under-load indicator, consisting of component parts R_2, T_3, REL_3 and the green pilot lamp, operates in a similar manner. In this instance, however, it is a decline in external a-c voltage which must actuate a pilot (feed motor operation continues undisturbed on underload conditions) so relay REL_3 connections are reversed and the green pilot lights when T_3 anode current declines below the critical adjustment point.

• • •

Conserving Station Equipment

By ALVIN H. SMITH

Chief Engineer, Radio Station KSCJ

IN ADDITION to his worries over the tires on the family car and other defense measures affecting all civilians, the broadcast engineer is confronted with the problem of keeping station equipment operating at the highest possible efficiency so that the public will be adequately served during these critical times. In so doing, he is faced with a shortage of essential items of equipment for maintenance. He must,

RADIO AND DEFENSE


With radio playing an increasingly important part in the war, increased efforts are being made to teach radio transmission methods. This group of army men are busily engaged in mastering the rudiments of electrical communication at a government school in Toronto, Canada

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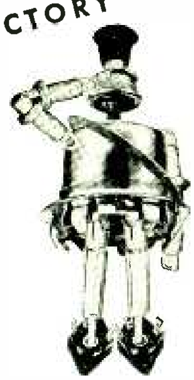
"IT'S IN THE AIR . . ." — VICTORY

Making every small part do its duty, its maximum, for in the big job it has a major part. Our contribution—sockets, terminal strips, lugs, connectors—are essential in the perfection of the transmitted message . . . A good reception in any set!

Photo by U. S. Army Signal Corps

BUY BONDS FOR VICTORY



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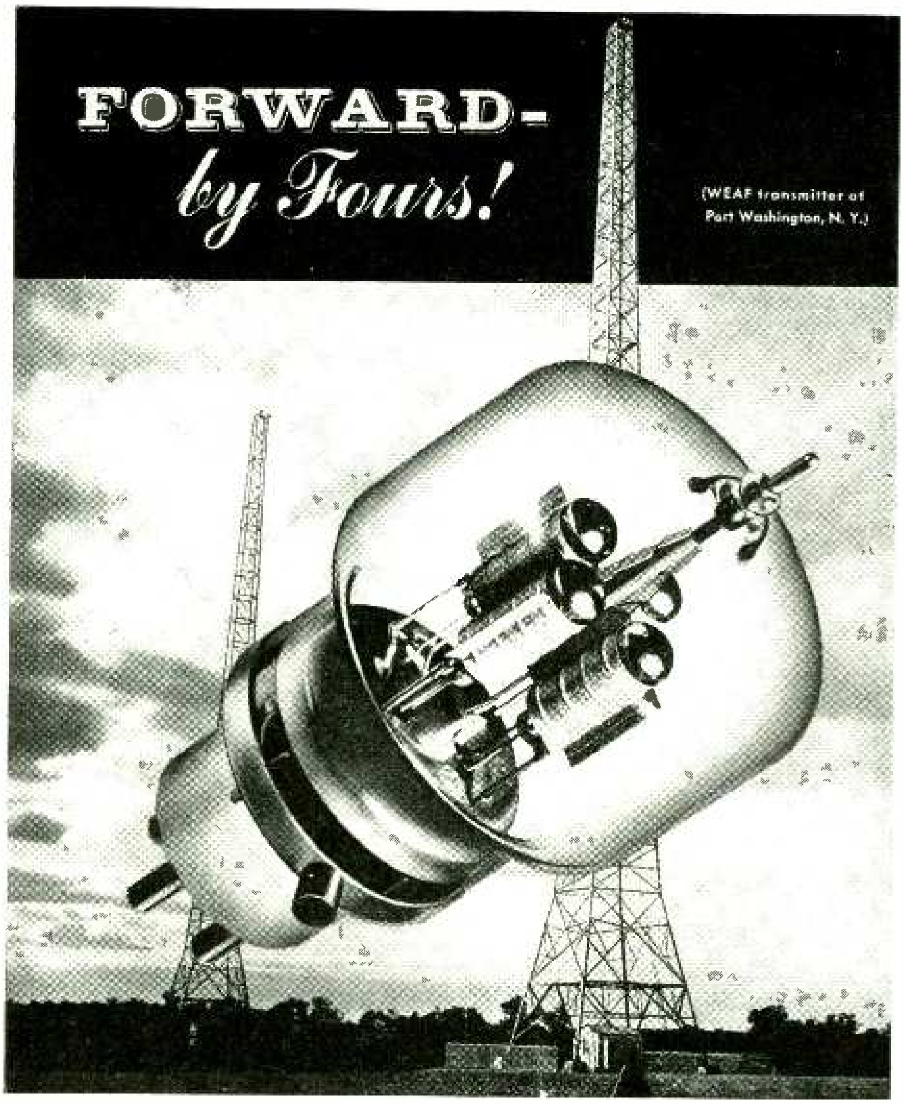

an **EIMAC** *achievement*
to which **CALLITE** *contributed*

IT was axiomatic that tube operating efficiency decreased as size was increased — until Eitel-McCullough revolutionized tube design by mounting four triodes within a single envelope.

Today the Eimac 304T tube, pictured above, is seeing service in the key sockets of the world's most important transmitters including new FM installations. Although essentially a low voltage tube the 304T is often used with as much as 20,000 volts on the plates, 10 times the rated voltage. Contributing to this stamina are grid and plate leads fashioned from Callite tungsten rods and Callite thoriated filament — eloquent evidence of Callite dependability.

There is a large group of Callite Tungsten products, each designed to do a particular job better. Callite research and resourcefulness have contributed to countless technical and scientific developments. If you have a special problem, why not consult Callite's engineering department today?

Specialists in the manufacture of electrical contacts of refractory and precious metals, bi-metals, lead-in wires, filaments and grids—formed parts and raw materials for all electronic applications.

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therefore, obtain maximum life from every part that goes to make up the station.

Here is what we, the technical staff of a typical midwest 5000 watt station are doing:

(1) We are operating our high voltage mercury vapor rectifier tubes with as low an a-c plate voltage as is practical, in order to extend their useful life. Mercury vapor rectifier tubes in which "arc backs" occur at normal operating voltages in many cases operate satisfactorily when the a-c voltage is reduced as little as 5 percent. Plate current is increased slightly to maintain required power output.

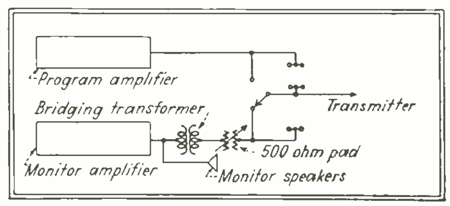
(2) In checking the exciter stages of our main transmitter we found that it was possible to appreciably reduce the excitation to a particular buffer and still obtain satisfactory operation. The life of the preceding buffer amplifier tube has been increased an estimated 50 percent by reducing its load.

(3) We limit all test programs to a bare minimum of time, to prolong tube life as far as regular operating hours are concerned.

(4) We ascertain that all equipment is receiving sufficient ventilation, to prolong the life of many parts and accessories.

(5) We store remote amplifying equipment not in immediate use at various locations throughout the organization to keep losses at a minimum in case of fire.

(6) KSCJ uses a four element directional antenna system, two towers and their coupling equipment being almost identical. One of these two towers is operated as a non-directional antenna during daylight hours. We have devised a procedure by which the second identical tower may be quickly placed in non-directional service in the event of a failure of the regular non-directional tower.

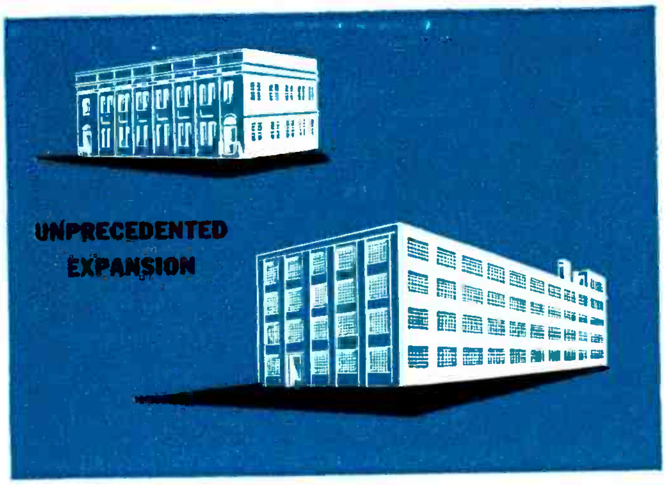


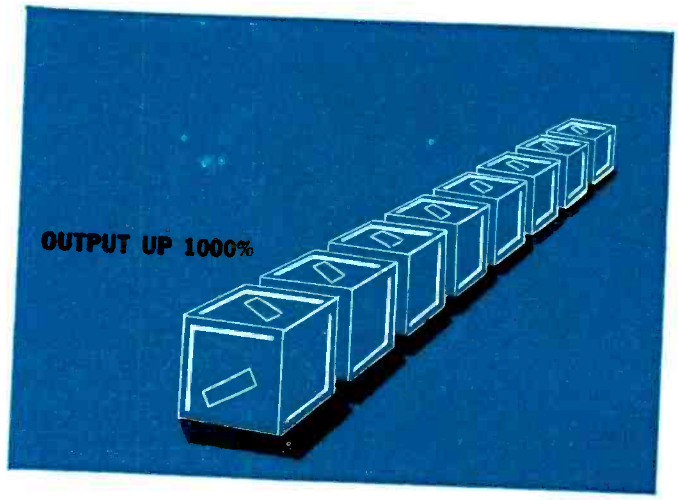
Scheme permitting rapid substitution of a monitor amplifier for a program amplifier in the event the latter fails

(7) There are many stations (particularly locals and some regionals) using speech input studio consoles that have no provision for transferring to a spare program amplifier in the event of a program amplifier failure. They are just off the air until a repair can be made. This point becomes more and more important as more and more technical men join the colors. We utilize the monitoring amplifier as a spare program amplifier, as shown in the accompanying diagram.

The gain of the program and monitoring amplifiers is equalized by means of the 500 ohm pad indicated in the diagram. The monitoring speakers are

What Isolantite is Doing To Supply the Materials that Help Keep Communications Open



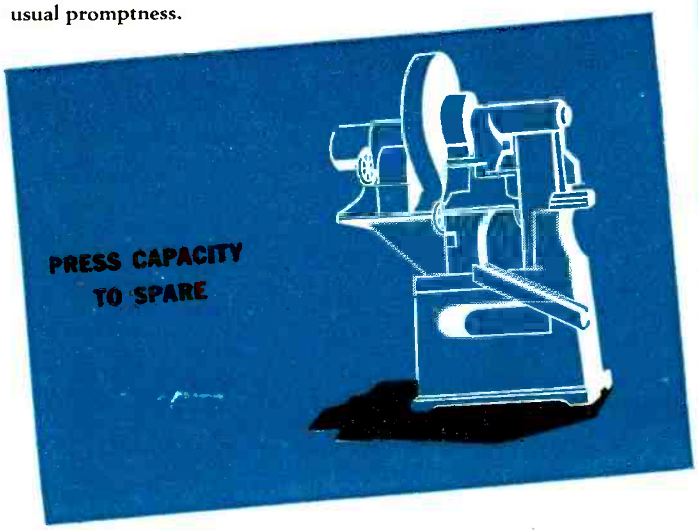


(*Above*) No one who hasn't been here to see it happen would recognize the great, humming plant that is Isolantite, Inc. today. Here at Isolantite the change has been extraordinary—even for these times. For the products of Isolantite help to keep vital war communication lines operating efficiently.

(*Above*) Isolantite has increased production of precision ceramic parts to ten times the level of two years ago. There is no pause in Isolantite's research for new and improved manufacturing methods, numerous and revolutionary as these have been.

(*Right*) Isolantite has not only met the most rigid Government specifications, but found ways to improve the quality of its products and service. Still newer bodies in process of development will increase the efficiency and reliability of communications equipment for wartime service, and promise finer performance in radio once the war is over.

(*Below*) In some fields of Isolantite activity, notably small pressed parts, there is output capacity to spare. When parts of this type are needed for war applications, Isolantite can make delivery with unusual promptness.



ISOLANTITE

CERAMIC INSULATORS

ISOLANTITE INC., BELLEVILLE, NEW JERSEY

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left connected as shown. In our case, this scheme worked out remarkably well. Distortion and frequency response characteristics are nearly as good with the monitor amplifier as with the program amplifier.

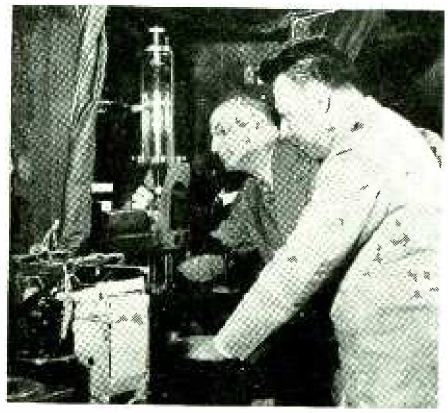
• • •

Electronic Robot Measures Creep of Metals

AN ELECTRONIC ROBOT now measures the rate at which metals flow when heated and stressed in the General Electric research laboratory. Not only does this release for other important work the attention of metallurgists who formerly watched the metal sample through a microscope; it also is more sensitive than the eye of any human observer and more reliable.

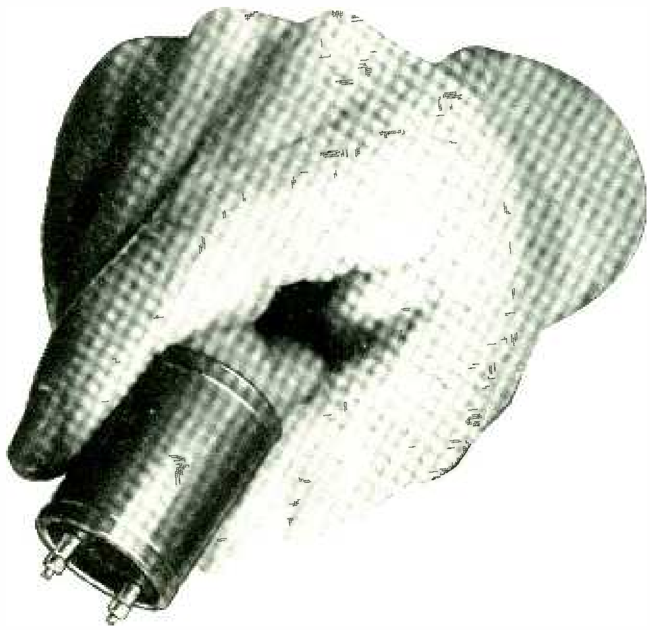
The usual tests employ a bar of sample metal, which is heated in a furnace to the range of operating temperatures between 800–1400 F. The method under discussion here uses a thin wire of the metal and passes an electric current through it to heat it to perhaps 2000 F. The wire is enclosed in a glass cylinder, which protects it from air currents and even permits the tests to be made in an atmosphere of nitrogen, thus preventing rusting caused by contact with oxygen. A weight is attached to the wire. The wire slowly stretches, as much as a half percent an hour.

A light shines through a lens and then through a rigidly positioned



GE's Dr. Saul Dushman adjusts a wire sample while J. T. Mireles Malpica, who substituted a phototube for an eye at a microscope as a means of measuring "creep" rate, looks on

glass "grid", which is ruled with opaque horizontal lines each 1/250th inch wide and the same distance apart, onto the light-sensitive surface of a phototube. Attached to the bottom of the test wire is another identical grid, nearly in contact with the first. When the test starts the lines of the second grid are adjusted so that they fill in the spaces between the lines on the first grid and the two-piece "shutter" so formed virtually cuts off all light to the phototube. As the test wire stretches more



UNIFORM ACCURACY VITAL IN TRANSFORMERS, TOO

Accuracy is more than a matter of design and construction—transformer accuracy and dependability of performance can only be assured when experience, specialized design engineering, modern manufacturing facilities, trained and skilled employees are combined in one organization.

From the earliest days of radio and communication systems, Jefferson Electric has specialized on transformers—working in the field, anticipating the requirements and new developments. Jefferson complete testing, experimental and engineering research laboratories leave nothing to chance. Modern manufacturing facilities with 250,000 square feet of space, and skilled craftsmen insure the uniform accuracy and dependability of performance that users associate with Jefferson Electric Transformers.

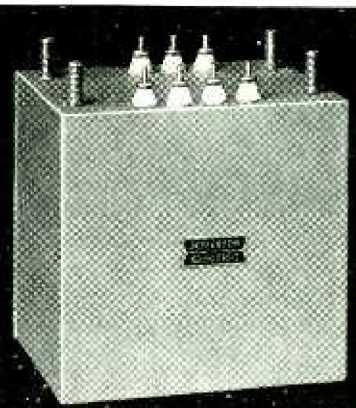
Jefferson Electric Line Includes Transformers for:

Radio Receivers, Televisors, Amplifiers;—Communication Systems; Power Circuits; Luminous Tube and Cold Cathode Lighting; Mercury and Fluorescent Lamps; Ignition; Signal Systems; Control Circuits.

The specialized experience of Jefferson Electric engineers can be put to work for you—to save your time and insure the correct selection of the transformers you need. JEFFERSON ELECTRIC COMPANY, Bellwood (Suburb of Chicago), Illinois. Canadian Factory: 60-64 Osler Ave., W. Toronto, Ont.

JEFFERSON ELECTRIC

TRANSFORMERS



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PREFERRED *for* PERFORMANCE

IRC

RESISTORS

WHY? . . . Results of a nation-wide survey conducted by a wholly independent research organization disclosed that Executives and Engineers in the electronic industries *overwhelmingly prefer* IRC resistors. In voting them "superior" by a plurality of more than two to one, these specific reasons were cited—

BECAUSE . . . ***IRC offers "best product" and "most complete line."***

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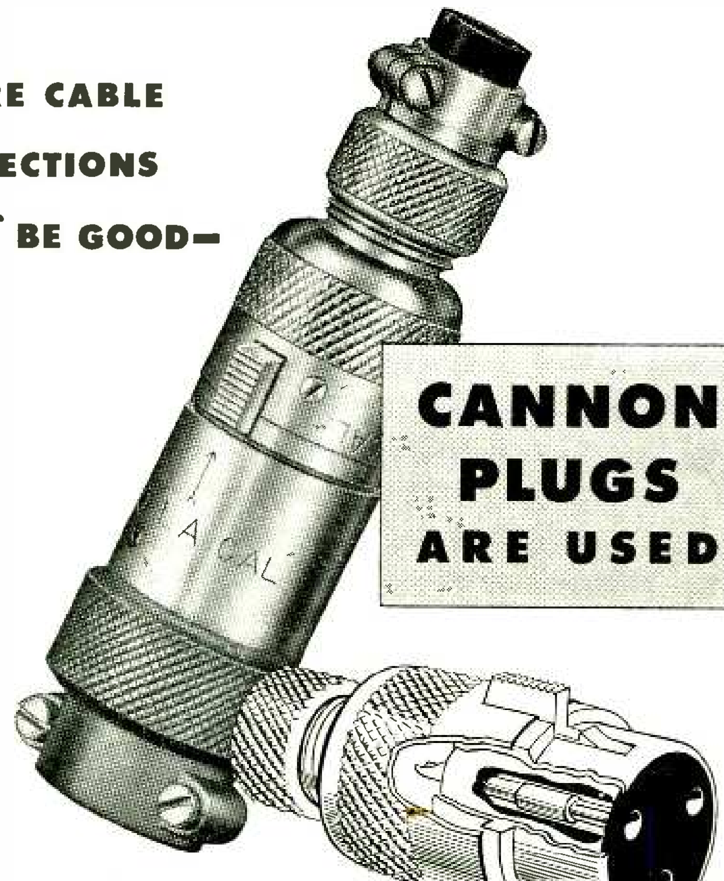
WHERE CABLE CONNECTIONS *MUST* BE GOOD—



The sturdy construction and many exclusive features of the Cannon Type P Cable Connectors and Panel Mounting Units make them ideal for a wide variety of uses in the radio field.

The design of pin and socket contacts assures a perfect connection under severe operating conditions. A thumb latch securely locks the fittings together, yet permits a quick, easy disconnect. Three types of cable entries are provided in the straight and 90° connectors. Six different contact arrangements are available in each of the thirty-eight different fittings comprising the Type P Line.

The coupled fittings shown here are Type P, having three contacts. The receptacle barrel containing the Bakelite insert on all Type P Connectors is 1" in diameter regardless of the number of contacts.

CANNON SERVES MANY INDUSTRIES

Radio engineers make use of many types of Cannon Connectors in addition to the Type P. The variety of Cannon precision-built Connectors runs into the thousands and includes specialized equipment for aircraft, television, radio, motion pictures, ships, railroad rolling stock and many other fields where electrical connections must be made quickly and securely.

CANNON ELECTRIC

Cannon Electric Development Company, Los Angeles, Calif.

Canadian Factory and Engineering Office: Cannon Electric Company, Limited, Toronto, Canada

light (or less if the shutter is started in the "open" position) reaches the phototube and the difference in phototube output is graphically inked in on a moving paper scale by an electronic recorder.

By means of the measurement method described it is readily possible to record an extension of wire length as small as 1/10,000 inch.

• • •

Hydrogen, But Not Freon

ON PAGE 100 of the August issue a device employing a special tube to determine the moisture content of hydrogen gas by a direct electronic method was described. An inquiry from a mechanical refrigerator manufacturer asks whether the test method is applicable to Freon 12.

From A. Allan Bates, manager of the Westinghouse Chemical & Metallurgical Department (this firm made the special tube), comes the following advice: "We cannot be encouraging concerning the use of the described device to determine the moisture content of Freon 12. I am quite sure that the tube we used in the hydrogen moisture meter would not stand up very long in the presence of Freon 12. The filament of the tube operates at a temperature so high that dissociation of the Freon would occur and the resulting free chlorine and fluorine would quickly bring about disintegration of the tube elements.

"Whether an acid resistant element could be devised for operation at lower temperatures is a question that we are not prepared to answer at this time and which, unfortunately, cannot be followed up because of pressure of war work."

• • •

Direct-Reading Impedance Comparator

WRITING IN THE *A.W.A. Technical Review*, Vol. 5, No. 6, 1941, F. M. Leyden and W. R. Baker describe a direct-reading radio-frequency bridge suitable for rapid production testing of inductances. The percentage deviation in inductance from a pre-set reference standard is read instantly on a calibrated scale on which tolerance limits may be marked. The bridge is said to be particularly effective in testing each section of tapped coils such as those used in multi-band receivers.

The main outlines of the circuit are shown schematically in Fig. 1. A voltage of rms value E, transformer-coupled from the oscillator, is impressed across the unknown inductance L_x and the standard inductance L_s connected in series. If we assume $L_x = L_s$, then an a-c voltage $E/2$ will be applied to each diode, the resulting positive d-c voltage of approximately $E\sqrt{2}/2$ or

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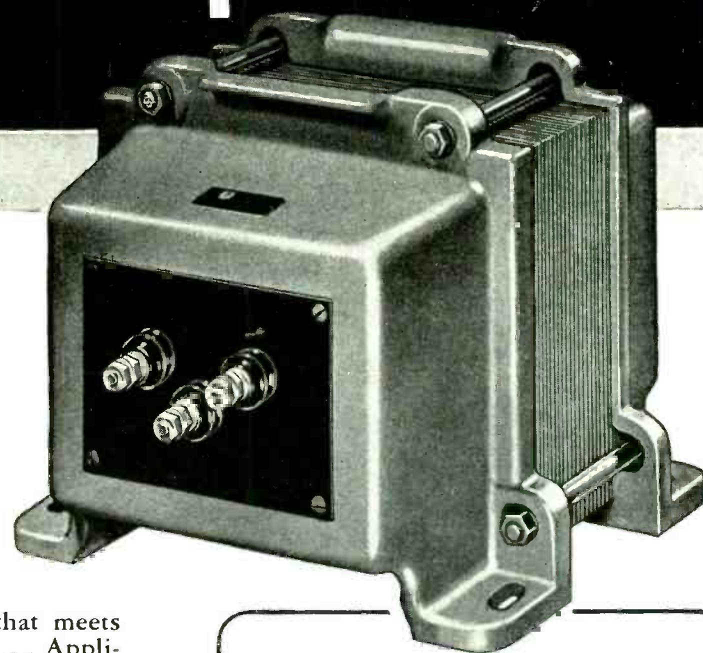

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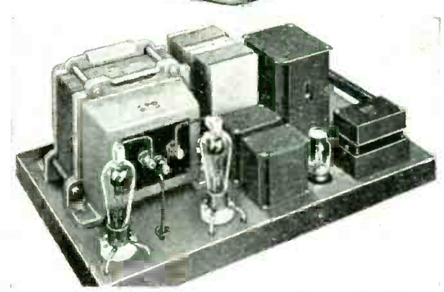
A TRULY fine Plate Transformer that meets stringent wartime requirements. . . . Applicable to a broad field including governmental agencies, broadcast engineers and many other electronic equipment designers and users.

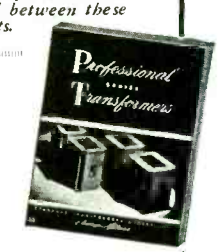
These rugged Plate Transformers represent long months of skillful planning in which the exacting needs of potential users were carefully considered and analyzed. It was STANCOR'S desire to make these transformers the finest obtainable. . . . This was achieved!

Many are now serving our country in locations where failure might prove disastrous. . . . They are *proved* units.



Here is a typical application of Stancor's Plate and other Professional Series Transformers Note the excellent harmony achieved between these transformers and allied components.

The new Stancor Professional Series Transformer Catalog No. 240—just out—lists not only the new Plate Transformers but includes Tiny-Trans, High Fidelity Units and a complete line of Professional Series Transformers. It also gives valuable charts to identify the correct unit to be used in various applications. Write for your copy-free!



NOTE THESE FEATURES:

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- New lamination sizes
- Rugged mounting feet
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- Balanced coil construction
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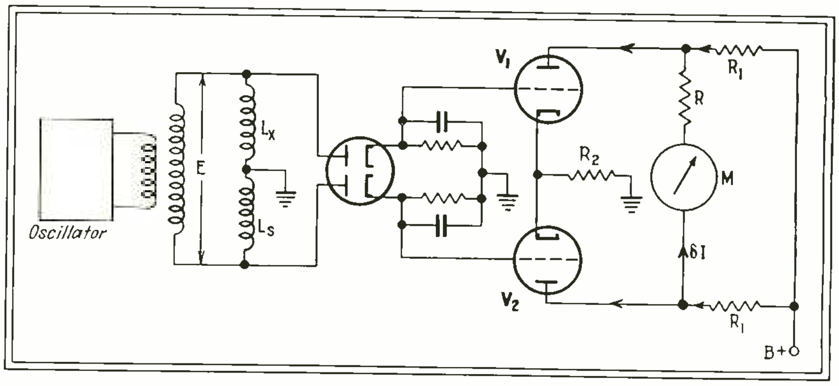

FIG. 1—Simplified circuit diagram of impedance testing bridge

$E/\sqrt{2}$ volts being applied to the grids of each of the similar tubes, V_1 and V_2. A negative bucking voltage is supplied by the common cathode resistor R_2 in such way as to keep V_1 and V_2 operating with any desired negative grid potential. The plate load resistances of each tube are made equal and high compared with the output resistance of the high voltage supply.

Now, if $L_x = L_s$, the grids of V_1 and V_2 will be at the same potential and the current passing through the meter will be zero. If, however, L_x differs by one percent from L_s, the difference between the rectified positive voltages applied to the grids of V_1 and V_2 will be one per cent of $E/\sqrt{2}$, that is to say, the rectified voltage applied to one grid will be 1.005 $E/\sqrt{2}$ and to the other 0.995 $E/\sqrt{2}$ and the current through the meter will change from zero. This current will be the same as if we regard one grid as remaining at a constant potential with a rectified voltage of $E/\sqrt{2}$, and the other (say V_1) having its positive rectified voltage increased to 1.01 $E/\sqrt{2}$. Hence we may regard a one percent change in inductance of L_x as increasing or decreasing the rectified d-c potential applied to V_1 by one per cent, the bias of the tube V_2 remaining constant.

Experimental Verification of Theory

It will have been observed that the section containing the tubes V_1 and V_2 and the meter is essentially a d-c Wheatstone bridge. Consequently this circuit will be amenable to d-c methods in experimentally establishing the relation between the meter current and the differential of the grid voltage. The arrangement adopted for this purpose is schematically outlined in Fig. 2. The incremental bias changes are supplied by the battery K, and calibrated resistance box indicated by HFE. The battery L supplies the ordinary bias to V_1, and the battery N and variable resistance R_3 supply a nearly equal value of bias to V_2, so that when F is connected to E, the meter reads zero. Thus inevitable small variations between the similar tubes are balanced out.

High voltage of sufficient stability is provided by including in the power supply a stabilizing tube and its associated resistance. The junction of the two plate load resistances has a relatively low resistance path to ground, since the internal resistance of the stabilizing tube used is less than 100 ohms. For any position of F, increment δe of the grid voltage of V_1 is given by EF/EH times the voltage of K, where EF and EH are in ohms. Readings may be plotted against δe for different tube types, provided the same type of tube is always used in the V_1 and V_2 positions. Triode connection of each tube type was used, the current and voltage conditions being those recommended for general service. The straight line obtained for each type plotted passed through the origin and had a slope equal to half the measured mutual conductance under the same conditions of anode and grid voltage.

Production Version and Calibration

In the design of a production testing instrument incorporating the principles set out, the desirability of a number of improvements became apparent. In order to protect the meter from excessive reverse current when the test coil L_x is removed, a diode tube was suitably connected in series with the meter, thus providing an open circuit in the reverse current direction and so causing the meter pointed to fall to zero on removal of the test coil. The advantages so gained in simplicity of operation more than offset the resultant lack of linearity of the meter scale for low current values (below 10 μa) and the reduction in sensitivity by about 30 percent.

Although the meter current stability in this system is quite good it may be further improved by the use of inverse feedback. This may be done by providing separate cathode bias resistors for the tubes V_1 and V_2, a part of the output voltage then appearing, in the reversed direction, in series with the input. This arrangement will also reduce the meter sensitivity. Using a pair of 6J7G tubes for V_1 and V_2 gave best performance. Using both reversed feedback. This may be done by procuit, it was found that with $E = 5$ volts and a steady bias of 5 volts per tube, a deflection of 20 microamps was obtained for a one percent change of L_x.

When L_x and L_s are equal and the anode currents of V_1 and V_2 are bal-

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HERR BRAUN HAD A BROTHER IN COLOGNE

When the Nazis ordered Herr Braun to report for farm work in the south of Germany, he made an arrangement with his brother, who worked in the railroad yards. He was to write him from Cologne every week, no matter what happened.

For a while the letters came. Written on cheap, thin paper, they always said the same thing: "Am as well as can be. Nothing new in Cologne."

But one week the letters stopped. No explanation. No reason . . . Of course, Herr Braun did see a little item in the local Nazi paper about an ineffective British raid on Cologne. But didn't the paper say the damage was small—mostly schools and hospitals? And wasn't the Luftwaffe invincible? It would never let the enemy reach Cologne in force.

. . . Still, the letters did not come. And besides, Herr Braun began to hear strange rumors . . . spread quietly behind the backs of the Nazis . . . disturbing rumors about a big raid on Cologne . . . the biggest air raid in history . . .

One night Herr Braun tuned his radio to a forbidden station—an American short-wave station. And there it was—the facts, the figures, the full grim story of the mighty German city blown to bits from the air . . . Yes, the railroad yards were destroyed.

And Herr Braun began to wonder . . . So the Nazi paper had lied. The Luftwaffe was *not* invincible. The British and Americans could come and bomb German cities despite Der Fuehrer's boast that it would never happen . . . And the faith of Herr Braun began to fade. The faith Goebbels and Goering and Hitler had been building up in Herr Braun for nine long years—began to crumble.

* * *

RCA equipment, used by short-wave stations WRCA and WNBI, is helping reach thousands of Herr Brauns with the truth . . . the truth to shake their faith in Fascism. But together with the destruction of that faith, these messengers from America are molding a *new* faith. A faith that out of the chaos and destruction, out of Nazi defeat, and out of the victory of the United Nations—will come a better and freer life . . . for Herr Braun and for all the world.

★ BUY U. S. WAR BONDS ★

RCA BROADCAST EQUIPMENT

RCA Manufacturing Co., Inc., Camden, New Jersey

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anced, the meter will read zero. The state of balance is then disturbed slightly by suitably adjusting the bias on one of the tubes, so that the meter reads exactly half scale. Positive and negative percentage inductance changes are then calibrated on the scale with respect to this new zero. A center-reading meter could be used but is not essential as the sensitivity is not impaired by the small initial degree of asymmetry.

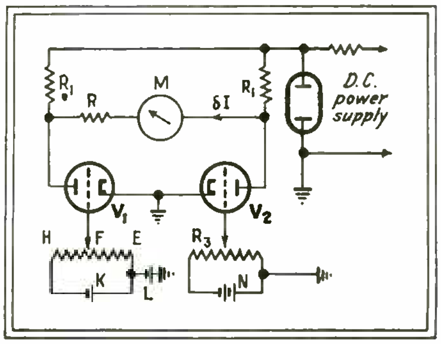
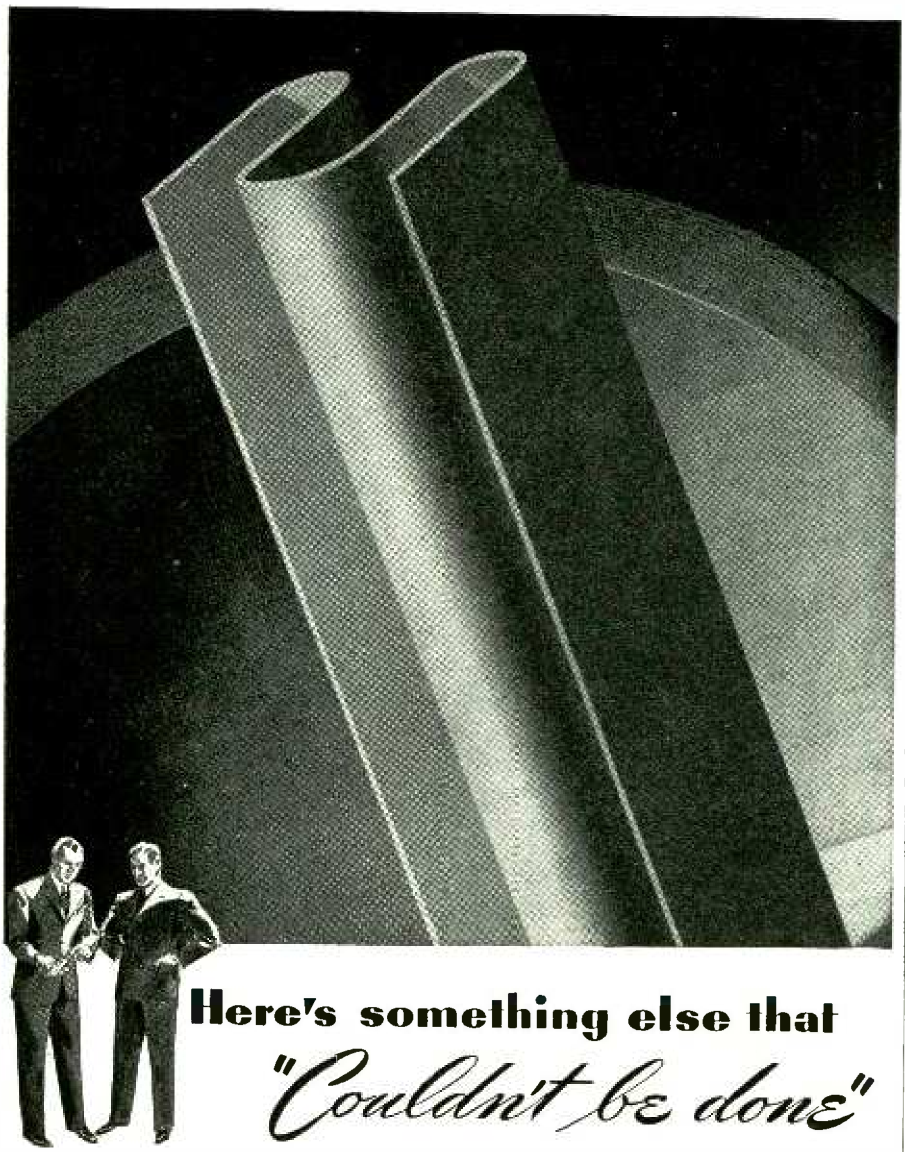


FIG. 2—Simplified circuit of equipment used for experimental verification of theoretical results and for calibrating the meter

Calibration of the instrument may be performed using the arrangement of Fig. 2, since a one percent change in L_x is still equivalent to a one percent change in rectified voltage at the grid of V_1. It is only necessary to re-plot the linear characteristic for 6J7G's under the same conditions of voltage, current and circuit resistances that are used in the final instrument. The steady grid voltage in the calibration set-up, for example, will be the algebraic sum of the rectified grid voltage, obtained for the value E chosen, and the steady grid voltage obtained from the voltage drop across R_2 in Fig. 1.

The meter used was a 0-100 μa d-c meter re-scaled with center zero, so as to read ±50 μa. A reading of ±20 μa then represented a one percent difference between L_x and L_s. A small change in the meter reading amounting to about 2μa is observed when a coil (e.g. L_x) is removed from and replaced in the circuit owing to the thermal changes produced by the resulting unbalance of the bridge. The meter returns to its initial reading, however, in about a quarter of a minute. When adjusting coils in quantity production, this period causes no loss of time, since it is concurrent with the time of adjusting the coil and it is usually found that when the coil has been adjusted the residual shift is negligible.

Although the frequency of the voltage E applied to the reactances to be compared does not affect the calibration of the instrument, it should be chosen in relation to the value of these reactances and the available oscillator power, so that the magnitude of this voltage will be sufficient for the satisfactory operation of the diodes. The oscillator frequency must also be kept well away from the natural resonant frequencies of the coils under test. The frequencies used for three instruments



WITHOUT fuss or fury, many limitations have been overcome in the manufacture and use of plastics. Molded INSUROK parts, for example, are being produced in large quantities for war uses so important that they cannot be mentioned. And now Laminated INSUROK is being formed into "accordion pleats" and other shapes to solve another category of production problems.

In addition to extending the ways in which INSUROK can serve the armed forces, *Richardson Plasticians* are helping designers take full advantage of this versatile material, are helping many manufacturers increase their output per machine-hour.

If you have a problem which molded or laminated plastics might solve, write us. We'll be glad to furnish the details and characteristics of INSUROK Precision Plastics—or give you the benefit of our experience.

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INSUROK *and the experience of Richardson Plasticians are helping war products producers by:*

1. Increasing output per machine-hour.
2. Shortening time from blueprint to production.
3. Facilitating sub-contracting.
4. Saving other critical materials for other important jobs.
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6. ✓ Doing things that "can't be done."
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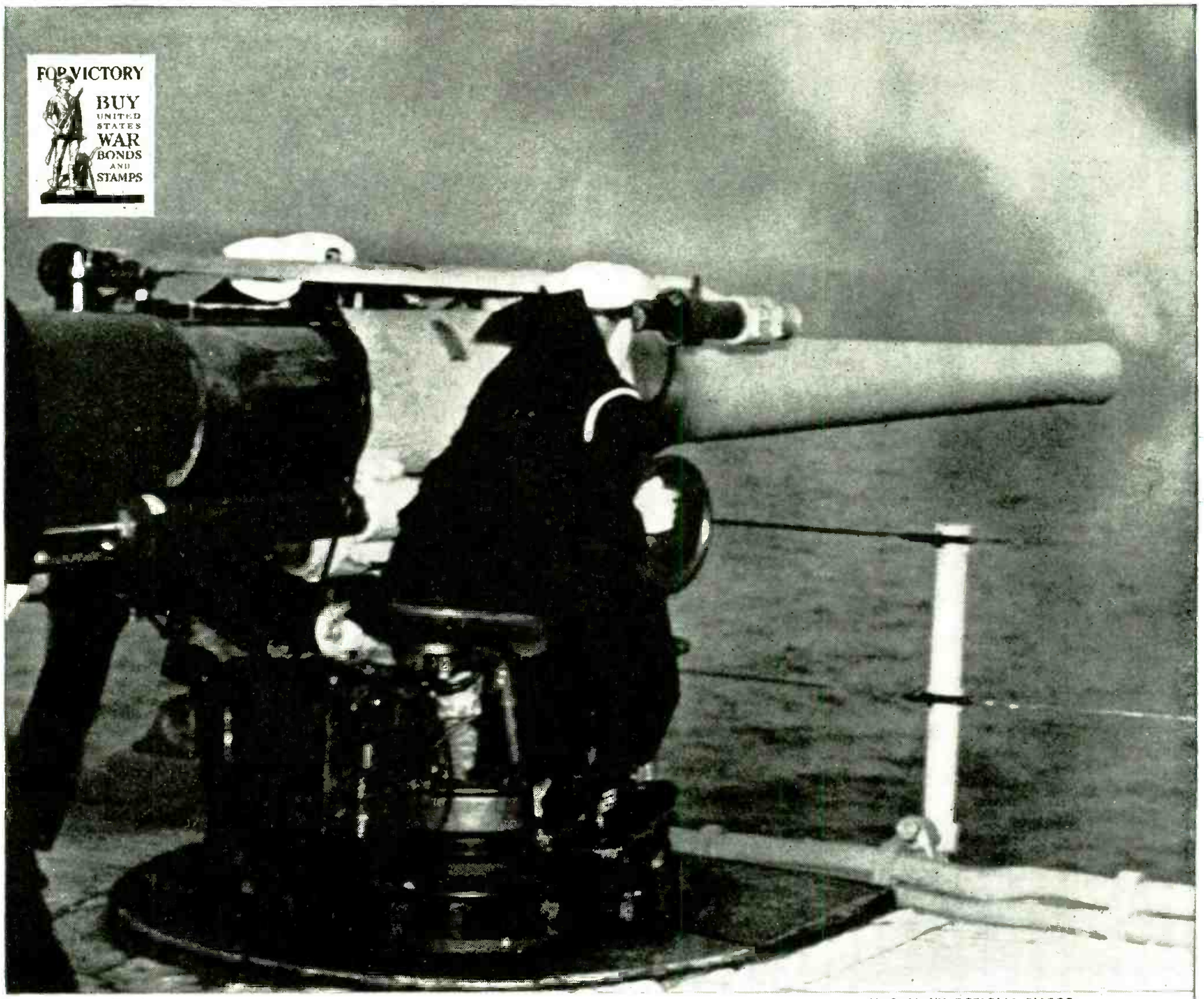

U. S. NAVY OFFICIAL PHOTO

A man talks into a microphone

And somewhere . . . a pilot gets set to meet a foe he can't see . . . a tank rumbles into action . . . Navy guns begin to thunder. Coordination of forces, that is just one of the functions of radio communication in this war.

Today, Jefferson-Travis is working 100% on the production of radio communication equipment for the armed forces of the United Nations. And our entire Organization is dedicated to all-out production until Victory is won.

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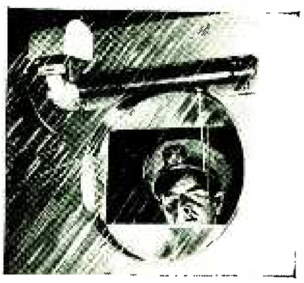
THAT AID THE VISION OF

OUR NAVY



PORTLIGHT TYPE WIPER
Removes Sleet, Ice and Salt Deposits
. . . and keeps going.

When rain and sleet are driven by wintry blasts . . . when sea spray thrown by plunging bows dashes against protective glass . . . these are the times when the mariner needs the clearest of vision.

Electrically driven windshield wipers, developed for our Navy, are so powerful that they literally scrape ice off glass yet can be reduced in action to wipe away gently the slightest sea mist. Ward Leonard Rheostats are used in many of these jobs to control exactly the motive power of the wipers.

This is just another of the many instances where Ward Leonard Controls developed for peace time service meet a vital need in war activity. If your war work requires any form of electric control, you probably will find exactly what you want in the Ward Leonard Line.

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Electric control (WL) *devices since 1892.*

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32 SOUTH STREET MOUNT VERNON, NEW YORK

designed to test coils ranging from 1 to 200 μh were respectively 10 Mc, 1 Mc and 100 kc.

It will be apparent that normal stray capacities in parallel with the coils have negligible effect with this arrangement, because only differences in the total reactance of the arms L_x and L_s are significant and because the frequency used is very much lower than the parallel resonant frequency of the coil and circuit capacities. The system thus gives a true indication of inductance and is relatively independent of variations in the distributed capacity of the test coils, a feature not attained in either the resonance or beat frequency methods of testing.

For use in production testing of coils the bridge is first set up with an external standard coil. This coil is inserted in the jig and the internal standard adjusted for equal voltage across each coil. After setting the meter to the center zero in the test position by means of a vernier bias control, the instrument is ready to test a batch of coils. The coils are merely inserted individually in the test jig and adjusted in inductance until the meter pointer comes within the plus and minus percent inductance tolerance, marked on the meter scale. No further adjustment to the instrument is required. The process becomes as simple as checking resistances with an ohmmeter.

The beat frequency system which was previously used gave an average testing rate for broadcast coils of two per minute for one instrument and one operator. With the bridge system, under similar conditions, a rate of three coils per minute is easily maintained.

• • •

NEWEST BRITISH ARMY CORPS

A new Army Corps has come into existence in England. It is known as the Royal Electrical and Mechanical Engineers (R.E.M.E.) which will be responsible for Army mechanical maintenance, including the recovery and repair of tanks in action. After administrative details are completed, the men allocated to this corps will be officially transferred. The R.E.M.E. will be made up of engineering and maintenance personnel except those serving in transport platoons and workshops platoons and part of the mechanical maintenance personnel of the Royal Engineers. Shown here are radio mechanics at work on a tank radio in an R.E.M.E. workshop

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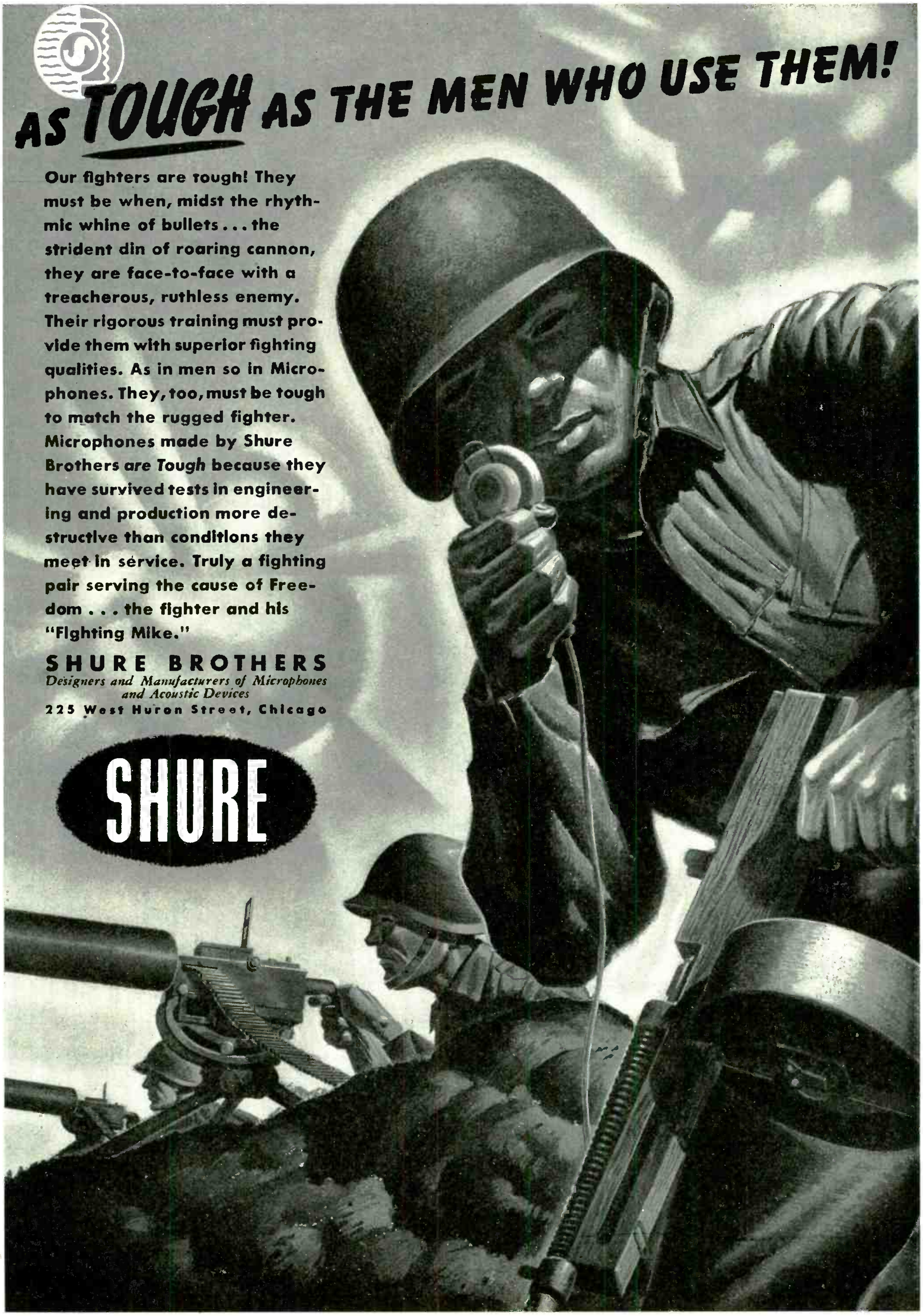

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THE ELECTRON ART

High Frequency Field Strength Measurements

WRITING UNDER THE title "An Instrument for Measuring Electrical Field Strength in Strong High Frequency Fields," in the August issue of the *Review of Scientific Instruments*, Kurt Lion describes an instrument which measures intensity of the high frequency electric fields, point by point, by means of an electrodeless discharge tube operated in conjunction with a phototube radiation indicator. Although the instrument described is largely intended for application to dosimetry and for local measurements in shortwave therapy, it is also applicable to the investigation of insulators or other parts exposed to high voltage, and to the measurement of field strength distribution in high-frequency alternating fields in general.

After a discussion of some of the previous methods of measuring field intensity, particularly at high frequencies, it is concluded that the utilization of the phenomena of electrodeless gas discharge best fulfills the requirement of a suitable field strength measuring instrument. It is shown that by putting a tube containing gas under low pressure into an electric field a gas discharge arises, the intensity of which depends on the field strength as well as upon the direction of the field. A tubular or similar container is most suitable if the direction of the electric field must be determined although if only its magnitude is required, it is more convenient to employ a spherical discharge vessel.

A schematic diagram of the completed instrument is shown in Fig. 1. Essentially the device consists of the spherical discharge vessel which is inserted in the field at the appropriate point, a phototube radiation indicator with its associated electron tube amplifier, and the necessary power supply, adjustable resistances and indicating meter. The spherical discharge vessel is contained at the end of a thin wall insulated tube whose inner surface has been made highly reflecting. Light from the discharge vessel falls upon the sensitive surface of the phototube which in turn varies the grid voltage on the amplifier tube. A milliammeter in the plate circuit of the amplifier tube is used to provide an indication of the brightness of the discharge, and this in turn may be calibrated in terms of the field intensity.

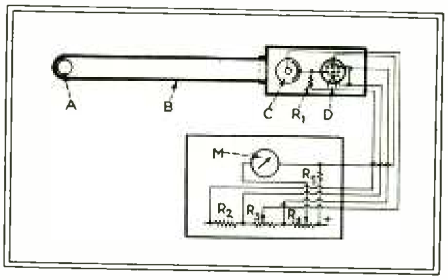


Fig. 1 — Diagram of field strength meter. (*A*) Discharge vessel, (*B*) Insulating tube, 1 in. in diameter, 2 ft. in length; (*C*) Phototube; (*D*) Amplifier tube; (*M*) Meter 0.25 milliamperes, (R_1) 10 megohm resistor, (R_2) 10,000 ohm resistor; (R_3) 10,000 ohm resistor; (R_4) 10,000 ohm resistor; (R_5) 2,000 ohm resistor

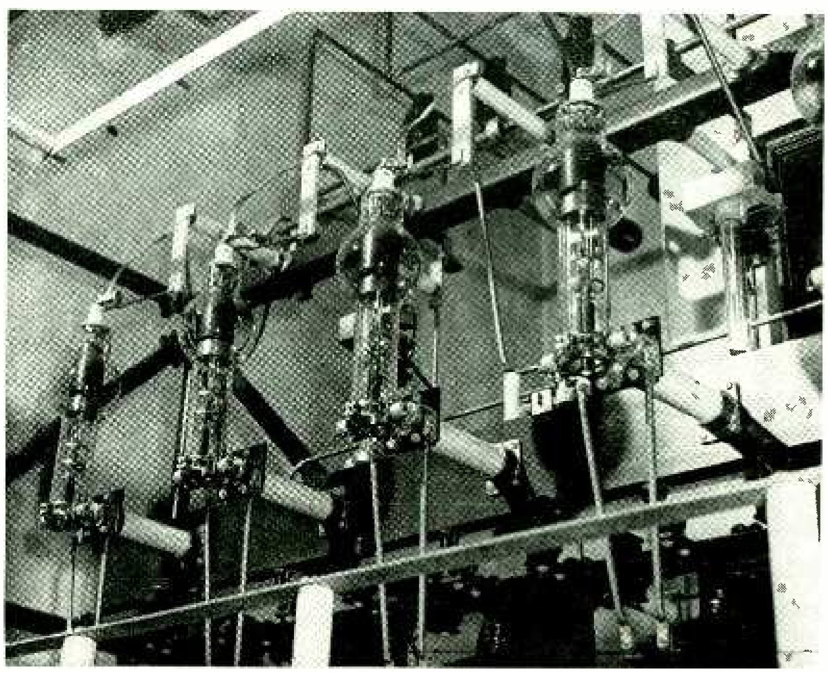
It is stated that the method is such as to provide measurements accurate within 2 percent providing the discharge vessel is given suitable pretreatment and provided further that the fields are homogeneous over the region of the discharge tube. It is further shown that the brightness of the discharge is proportional to the field strength but that the slope of the curve relating field strength with relative light intensity varies with the frequency of the field. The slope is greater as the frequency is increased and a calibration curve is shown for wavelengths between 3 and 14 meters. The inconvenience of providing a calibration for each new frequency has been overcome by providing an adjustment, R_3 which appropriately alters the sensitivity of the phototube to compensate for variation in sensitivity as a function of frequency.

• • •

Measurement with an Electronic Phase Bridge

METHODS FOR MAKING convenient and sensitive measurements of impedance, reactance, frequency, and phase relationships by means of an electronic phase bridge which is composed of a phase sensitive detector and an unbalanced bridge circuit are described by R. H. Brown in the July issue of the *Review of Scientific Instruments*. The title of this paper is "Sensitive Measurements of Impedance, Reactance, Frequency and Phase Relationships with an Electronic Phase Bridge." The

RECTIFIERS AT WHN



These rectifier tubes supply d-c power at 18,000 volts to operate the 50-kw transmitter of station WHN at East Rutherford, N. J. This station serves the New York City metropolitan area

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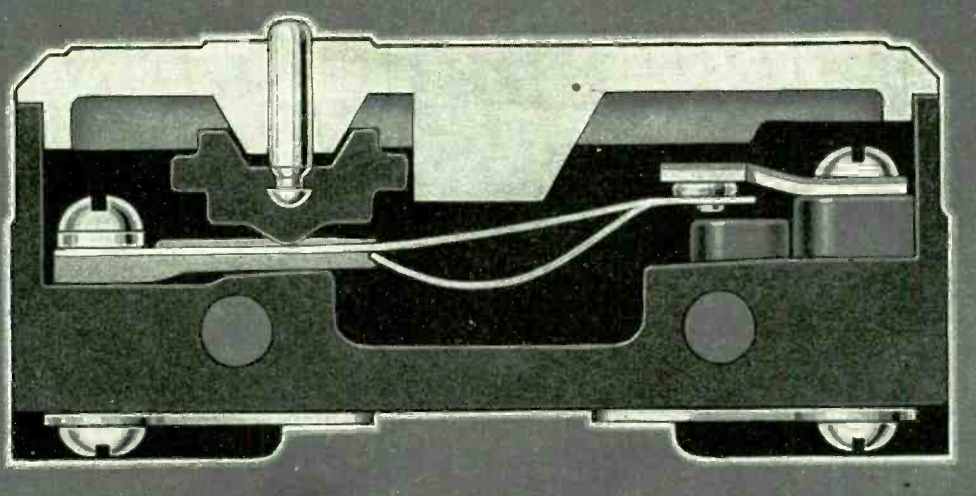
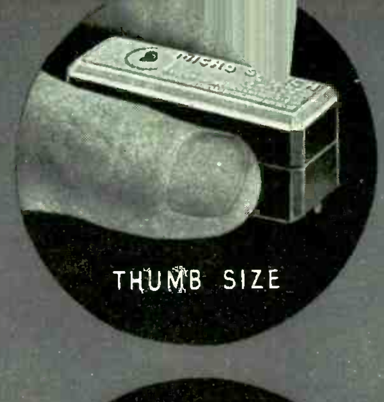
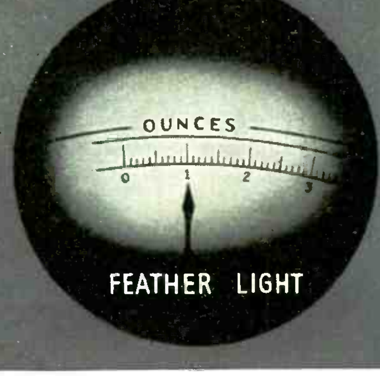






This sectional view of the Micro Switch shows assembly of features described below

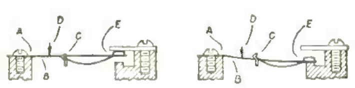
Why these basic principles of Micro Switch design assure you

...Longer Switch life than you will ever need
...Absolutely precise and accurate repeat operation
...40 grams contact pressure...lightning-fast contact action

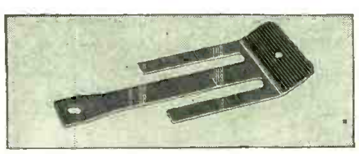
The Micro Switch design incorporates features that provide desirable performance characteristics not generally found in snap-action switches.

The operating principle is different in that the spring bends in the same direction as the operating plunger. There are no reverse bends—no "oilcan" action. Therefore, the Micro Switch provides you with longer switch life than you will ever need . . . accurate repeat action at a precise point . . . 40 grams contact pressure and positive, lightning-fast action.

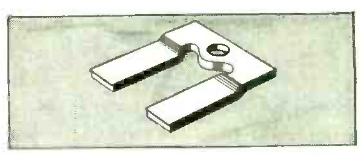
Its small size, its ability to operate satisfactorily for millions of operations on minute movement and force differentials, and its availability in various types of housings and a wide range of actuators—have made it the choice of design engineers in every form of equipment from heavy machinery to sensitive instruments.



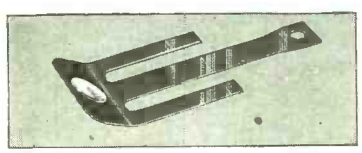
The operating principle as illustrated here, is simple and fundamentally correct. The long member of the one piece spring "B" is supported in a cantilever at "A". The two short members are compression members supported in V's at "C". Finish of the ends of the two short members of the spring and the exact shape of the V's (patented) produces a bearing of such low friction that when the plunger at "D" deforms the long tension member, the cantilever force overcomes the vertical force supplied by the two compression members and the free or contact end of the spring "E" snaps from one stop to the other with lightning-fast speed. Reverse action occurs when the deformation of the tension members of the spring by plunger "D" is removed. The cantilever force then becomes less than the vertical force supplied by the compression members.



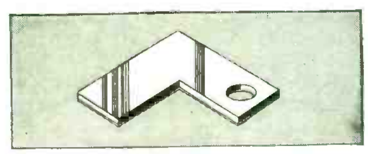
The Micro Switch spring is made in one piece from beryllium-copper strip. It is stamped before gauging and only those stampings which conform to an accurate .0085" thickness are used. The spring is heat-treated to provide high resistance to fatigue. Every lot is tested by an accelerated life-test for 10,000,000 mechanical operations to full overtravel. The ends of the two compression members of the springs are specially finished to provide an extremely low friction bearing.



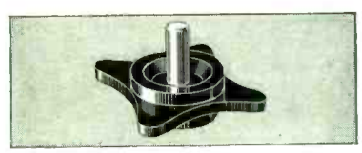
The short compression members of the spring pivot in the patented V-grooves of the sturdy brass anchor illustrated here and located directly under the plunger as shown in cutaway view of switch. Note the special shape of these grooves. This shape, plus the specially finished edge of the compression members of the spring reduce friction to a minimum.



The contact end of the spring is fitted with a riveted radius type contact of 99.95% fine silver. As the plunger is actuated, this contact moves from one position to the other at a speed of from 3/1000th's to 5/1000th's of a second with a rolling action and high pressure that minimizes welding and assures positive contact.



The stationary contact is a flat inlay of 99.95% fine silver. This construction assures ample over-load capacity and maximum heat dissipation.



The operating plunger consists of a highly polished stainless steel pin moulded into an accurately moulded star-shaped Bakelite head. Its size and form provide a long over-surface path to live parts, thus insuring freedom from electrical leakage. The star-shaped plunger head cannot rotate within the housing, insuring against any variation in point of operation. The Bakelite head comes to rest against the anchor within .020" after actuation occurs, thus preventing excessive overtravel, and insuring maximum spring life.

If you would like to know more about the Micro Switch, send for the two Handbook-Catalogs illustrated here—No. 60, which covers Micro Switches in general; and No. 70 which deals with specific Micro Switches for use in aircraft.

Micro Switch is a trade name indicating manufacture by Micro Switch Corporation

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paper discusses the theory of the phase sensitive detector, the use of the phase bridge in measurement and sensitivity and sources of errors in measurements with this bridge.

The essential elements of the electronic phase bridge are shown in Fig. 1.

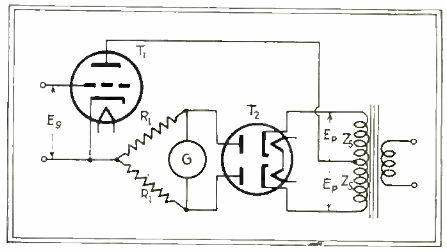

Fig. 1—Schematic wiring diagram of the essential elements of the electronic phase bridge

The device consists of an input vacuum tube, a Wheatstone bridge having two resistive arms, whereas the remaining arms are formed by the sections of a double diode and a transformer supplying power to the bridge.

With the arrangement shown in Fig. 1, and after a mathematical derivation of the circuit behavior, it is shown that for a true sine wave voltage applied to the grid of the measuring tube, a plate current will flow whose magnitude is given by

$$I_p = AE_g \sin \alpha + BE_g \cos \alpha + C$$

where α is the phase difference between E_g and the fictitious plate voltage E_p. When the bridge is balanced so that the galvanometer current is zero, the phase angle α will have some definite value. The circuit of Fig. 1 is used only for obtaining an appropriate null or balanced condition. In order that suitable phase measurements may be made, the device of Fig. 1 can be used in connection with an additional impedance bridge. The circuit of the complete instrument is shown in Fig. 2 in which the unknown impedance is connected to the terminal marked Z. In use, the switch S_2 is thrown to one position and the resistance R is varied until a balance is obtained in the phase bridge as indicated by a zero deflection of the galvanometer. The bridge connections to the source are then reversed by throwing the switch S_2 to the reverse position, in which case the galvanometer will no longer show the zero deflection. Accordingly, the new value of R will be required to bring the bridge to the condition of balance. If R and R' are the values of the resistances which are required to produce a balanced condition when the switch S_2 is thrown to the two possible positions, then it may be shown that the magnitude of the impedance is given by the relation

$$Z = (RR')^{1/2}$$

This affords a convenient method of determining an impedance by making two settings of a known resistance.

Using this arrangement, frequencies may be measured by using for Z a known impedance. A particularly useful arrangement is to use a perfect

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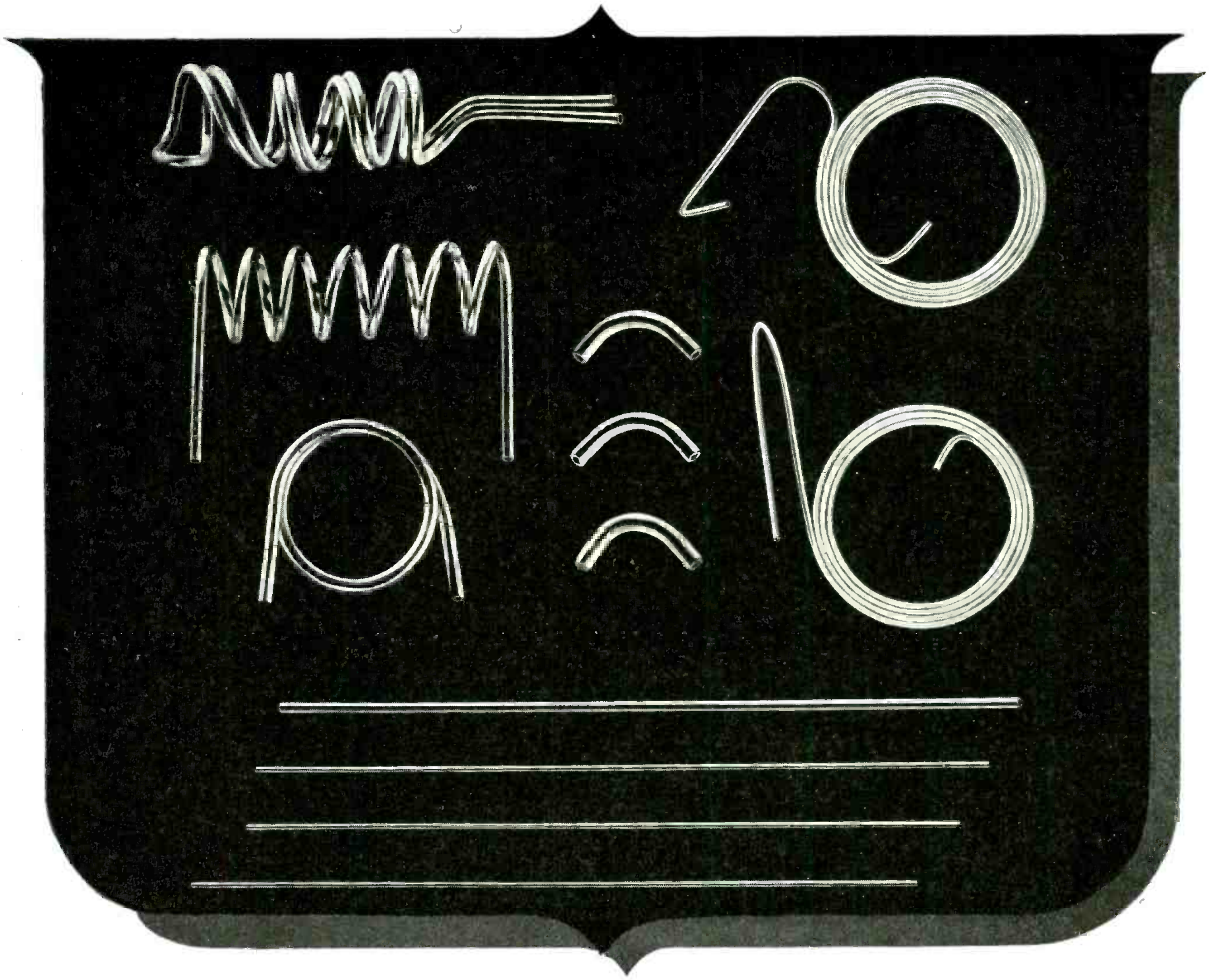

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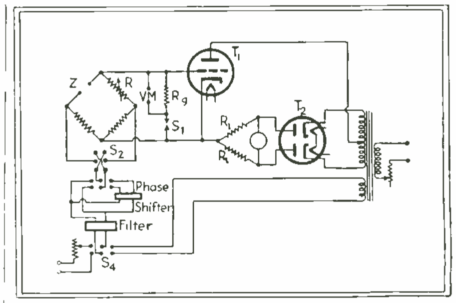

Fig. 2—Schematic wiring diagram of the complete phase bridge showing the electronic detector and supplementary impedance bridge required in making the measurement

condenser for R in which case the frequency is given by the expression

$$f = \frac{1}{2\pi \sqrt{RR' C^2}}$$

The author shows that in using the electronic phase bridge as described, three sources of errors not encountered in ordinary bridge work may arise. These are: (1) Errors due to current taken from the bridge by the detector, (2) errors due to a gain in the values of the coefficients A, B, and C in the equation for galvanometer current, caused by differences in the peak value of E_g for the two different balance adjustments, and (3) errors due to the effect of harmonics in the grid voltage E_g.

The first source of error may be removed by making the input impedance of the detector very high compared with that of the bridge. The second source of error is not likely to be large but can be removed by adjusting the voltage to the plate of the twin diode provided this does not change the phase relationship. The third source of error, harmonics of the detector input, are likely to prove a troublesome source of error. These errors may be minimized or eliminated by applying only a sine wave to the detector tube through the use of the filter shown in Fig. 2.

• • •

Electrical Safety

THE THIRD BIBLIOGRAPHY of technical literature entitled "Bibliography on Electrical Safety, 1930-1941" has just been published by the American Institute of Electrical Engineers, 33 W. 39th Street, New York City. This publication is designed to make available a fund of information on electrical safety which should be of special interest at a time when accident prevention is of national importance. Items in this 16-page pamphlet are divided into four groups as follows: (1) Electrical Accidents and Their Causes; (2) Accident Prevention Methods; (3) Safety Codes and Standards; (4) Effects of Electric Shock and (5) Resuscitation. Copies are available at 25 cents to Institute members or 50 cents to non-members.

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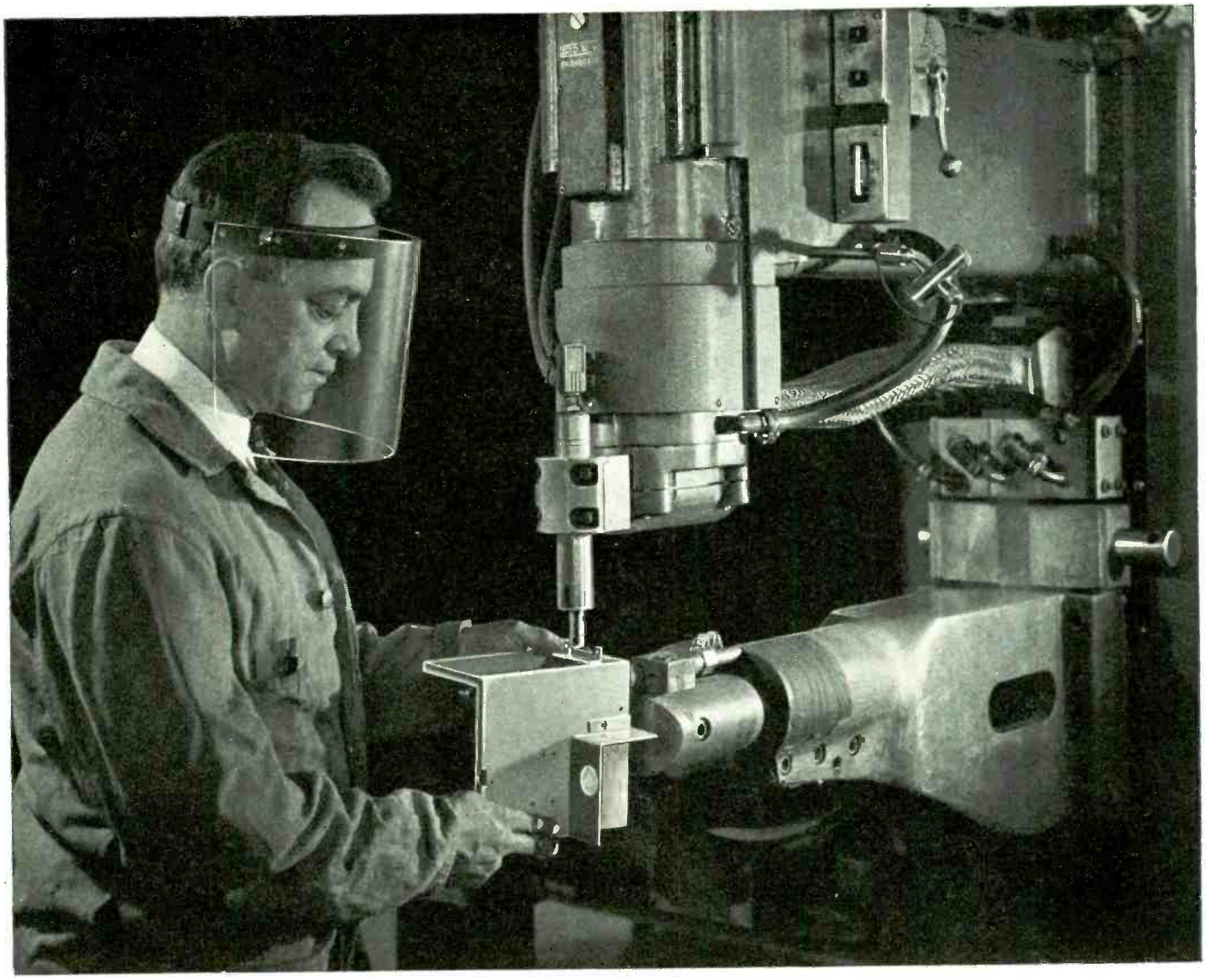

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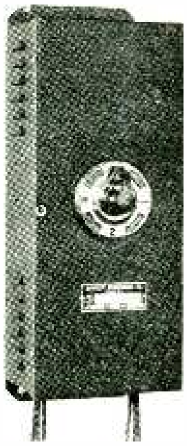

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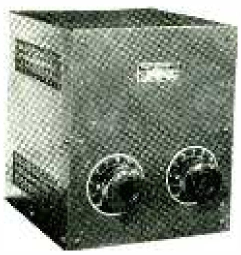

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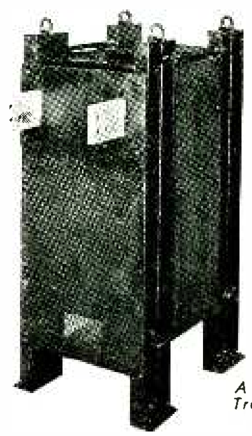

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Sensitive Tube Relay

AN INTERESTING VOLTAGE regulating device is described by S. S. Orlov and A. A. Pirogov under the title "A Sensitive Valve Voltmeter Relay" in the August 1942 issue of *The Wireless Engineer*. This article is an abbreviated translation from the Russian article which appeared in *Elektroscyaz*, 1942, No. 4, pp. 16 to 22.

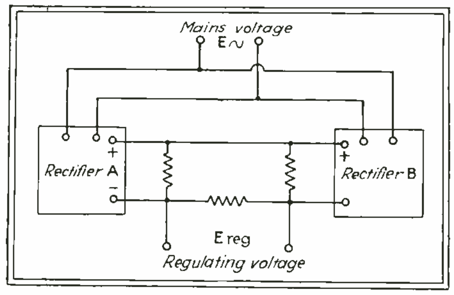


Fig. 1—Block diagram of voltage regulator consisting of two rectifiers operated in opposition

The essential modes of operation are shown in the diagram of Fig. 1 and Fig. 2. Two rectifiers are connected in parallel across the line voltage. The outputs of the rectifiers are connected in voltage opposition and the circuits are so adjusted that for the desired output voltage, the regulated voltage is zero. The characteristics of the two rectifiers are such that they have different slopes of rectified voltage versus applied alternating voltage. Suitable rectifier characteristics are shown in Fig. 2, whereas the essential connections of the system are shown in Fig. 1. From Fig. 2 it may be seen that if the alternating voltage changes from E_o to E_1, a regulated voltage will be obtained whose value is $E_{reg} = ab = (E_1 - E_o)$ $(\tan \alpha - \tan \beta)$. If the applied alternating voltage decreases below E_o, the polarity of the indicating voltage will be in the opposite direction. With this arrangement, the regulated voltage is determined not only by the rectifier characteristics but also by the deviation from the desired voltage. Since the regulated voltage is likely to be small, and was intended to operate

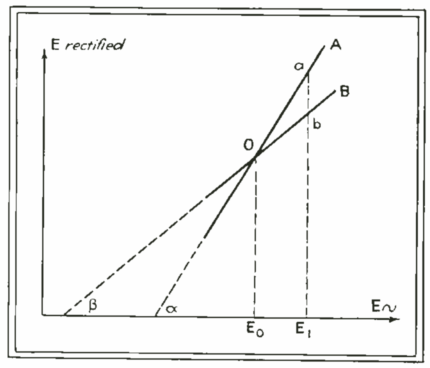
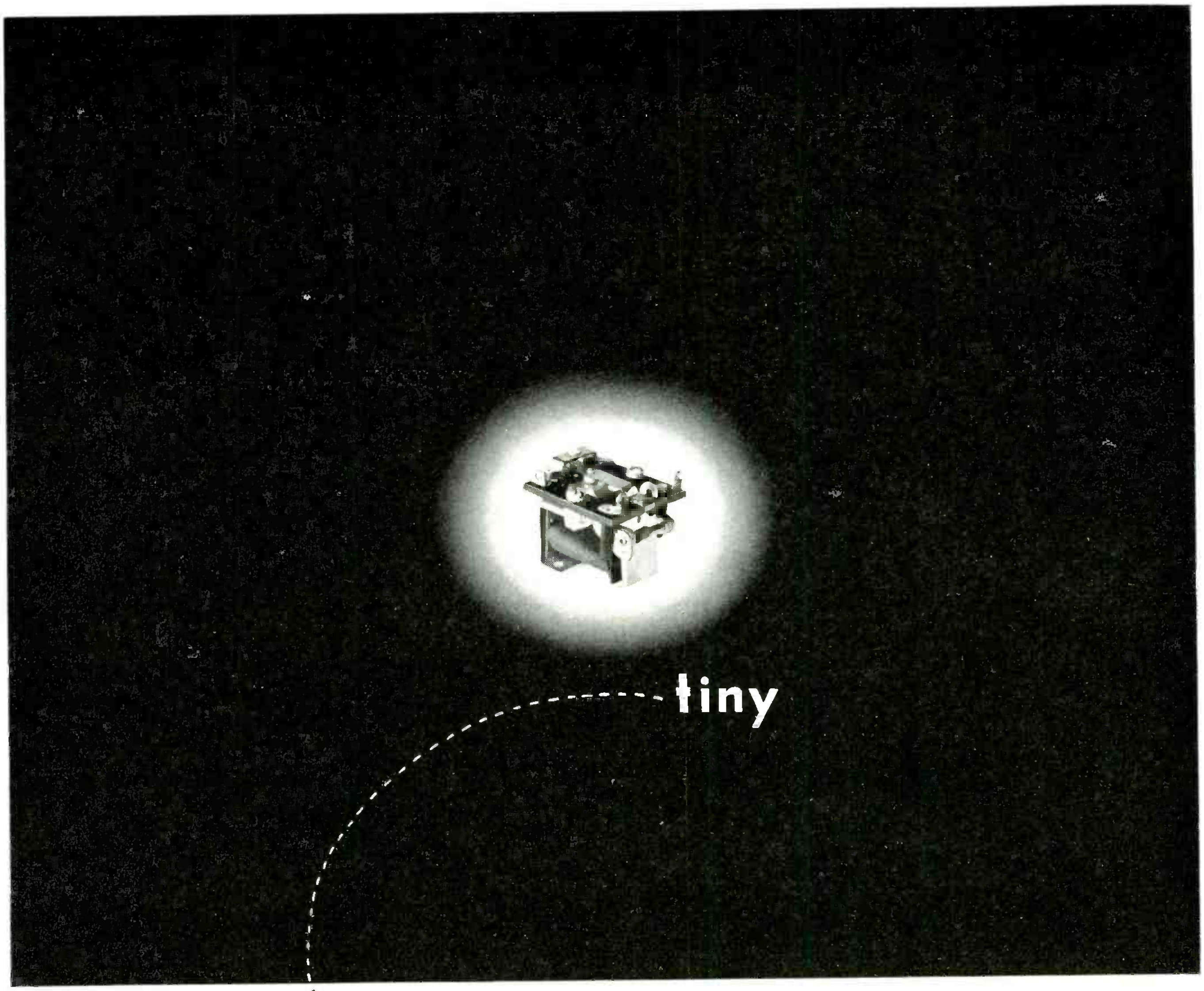


Fig. 2—The voltage output from the regulator is proportional to the difference of slopes of the two rectifiers and to the deviation from standard voltage, and can be used as a corrective means



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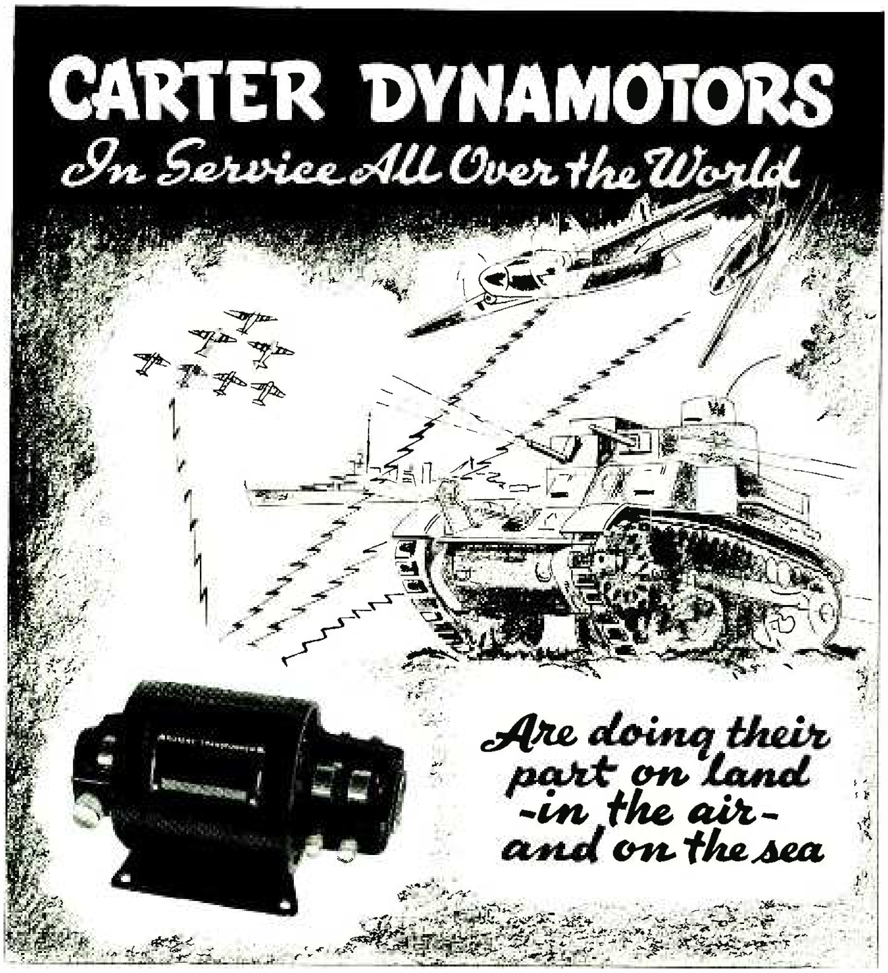

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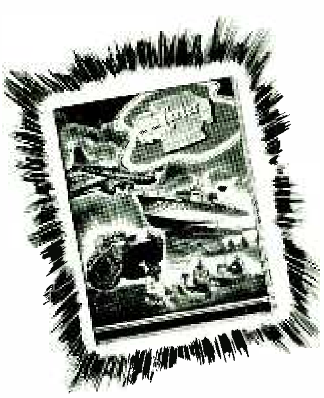

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a servo motor, the output of the device was inadequate without additional amplification.

The article in *Wireless Engineer* contains a complete schematic wiring diagram of the various rectifiers and amplifiers.

It is desirable to increase the slope of the characteristic *A* and to decrease the slope of characteristic *B*. Experience has shown that this can best be achieved by using a tungsten filament tube for rectifier *A*, and a tube with activated filament for rectifier *B*. Rectifier *A* should be operated so that the rectifier voltage will be determined in general by the filament saturation current. On the other hand, rectifier *B* should have a large reserve of electron emission so as to insure space charge limited operation.

It is stated that the voltage stability of this system has proven to be better than 0.5 percent and that in more than 4,000 hours of operation, no inspection or adjustment of the equipment was required other than to replace one tube.

• • •

Grid Controlled X-Ray Tube

DESCRIBED IN THE May, 1942, issue of the *Review of Scientific Instruments* is "A Grid Controlled X-Ray Diffraction Tube" by A. Eisenstein. It is pointed out that the use of grid control in a tube used for x-ray diffraction is of

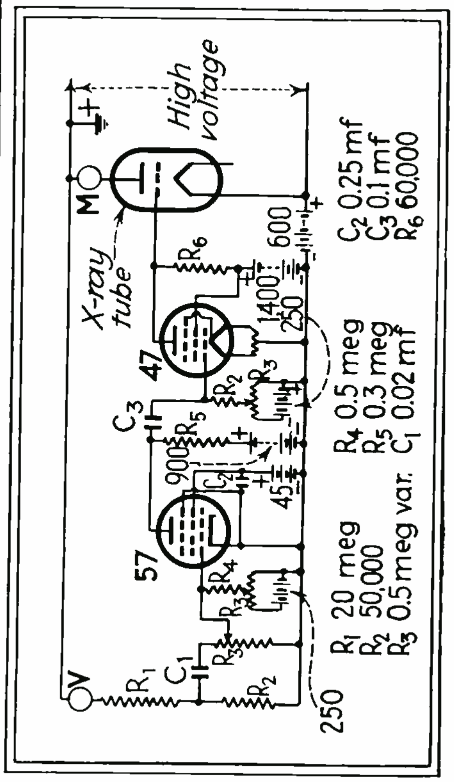

Fig. 1—Wiring diagram of square wave generator applying square wave voltage to grid of x-ray tube

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value because it makes possible a greater output of characteristic radiation for a given target dissipation of energy. In the research reported, a grid imposed between the filament and target of a demountable high vacuum type x-ray tube is modulated in synchronism with the full wave rectified voltage impressed upon the tube, through the use of a square wave generator. The grid potential varies in such a manner that the electron current flows only when the voltage is sufficiently high to excite the K series.

The grid of the demountable x-ray tube consists of a set of six parallel molybdenum wires 10 mils in diameter, mounted on a nickel frame and spaced $\frac{1}{16}$ in. apart except for the two center wires which are $\frac{1}{8}$ in. apart and spaced $\frac{1}{8}$ in. from the filament.

Since it was desirable to restrict the target current to those portions of the cycle during which the applied voltage was greater than 20,000 volts, the grid was modulated with a square wave voltage. The schematic wiring diagram of the square wave generator is shown in Fig. 1. To insure that the modulation of the current will be accurately in step with the voltage, the input to the square wave generator was obtained by means of the voltage divider consisting of R_1 and R_2, capable of passing a current of 2 milliamperes. A portion of this voltage is applied to the control grid of the type 57 tube. The circuit is adjusted so that with no signal input to the 57 tube, this becomes non-conducting while the type 47 tube becomes conducting, thus biassing the x-ray tube negatively by approximately 300 volts. When the signal voltage becomes sufficiently large so that the 57 suddenly conducts, a pulse is impressed on the grid of the 47 tube, making it non-conductive and biassing the x-ray tube positively by approximately 600 volts. The fraction of the half cycle over which the x-ray tube becomes conductive could be varied by controlling the signal intensity and bias of the 57 tube.

The power supply for the square wave generator is of the conventional full wave rectifier type with a variable autotransformer in the supply line to provide the desired voltage variation.

A number of photographs showing the wave forms obtained on an oscillograph with the diffraction tube operated under various conditions are included in the article.

• • •

Improved Amplifier for F-M Transmitters

AN ARTICLE BY A. A. Skene in the July issue of the *Bell Laboratories Record* describes "A Grounded Plate Amplifier for the F-M Transmitter" which contains a number of advantages over the usual arrangement. Customarily the radio frequency amplifier in f-m transmitters takes the form shown in Fig. 1, in which the filament is grounded and

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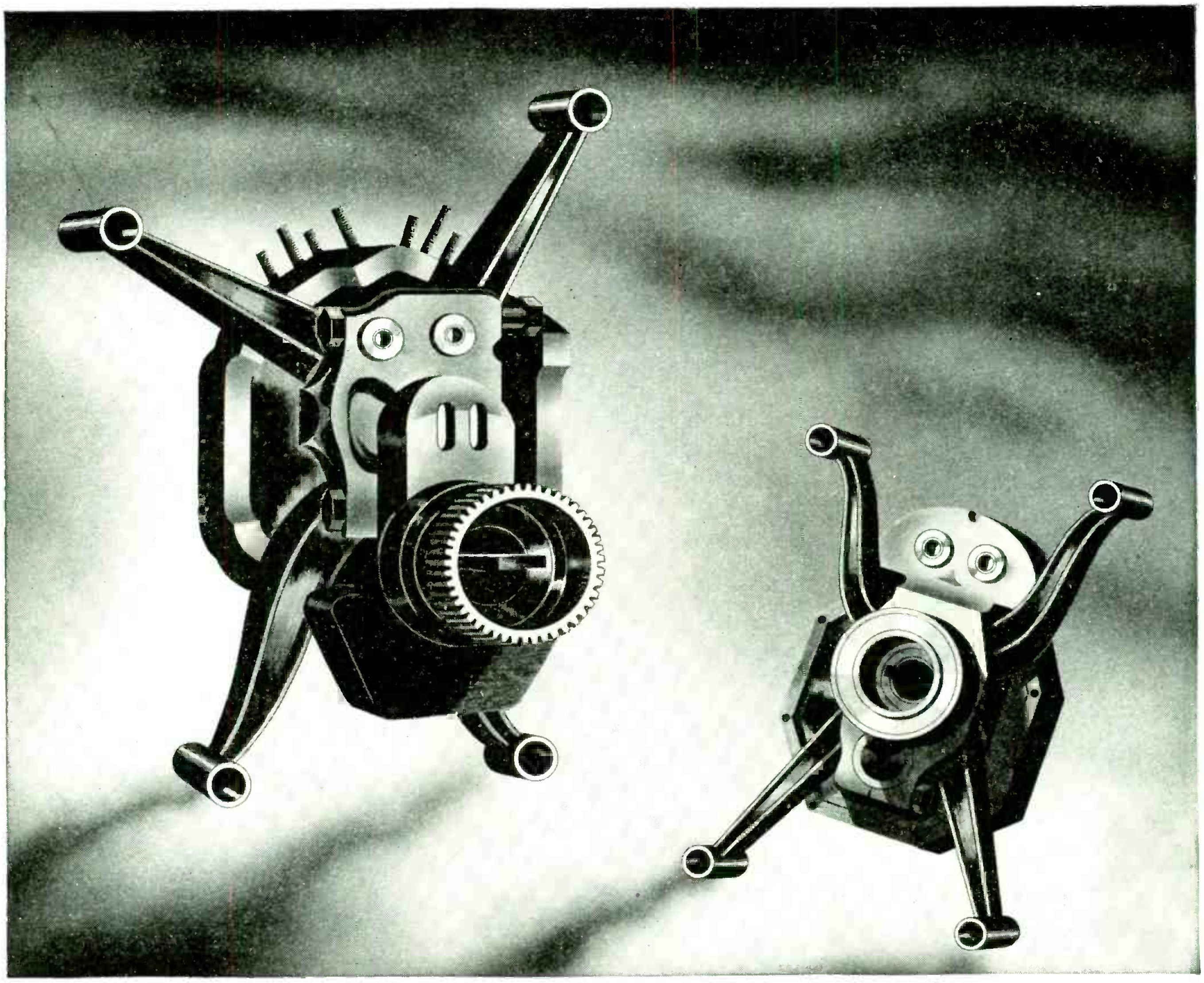

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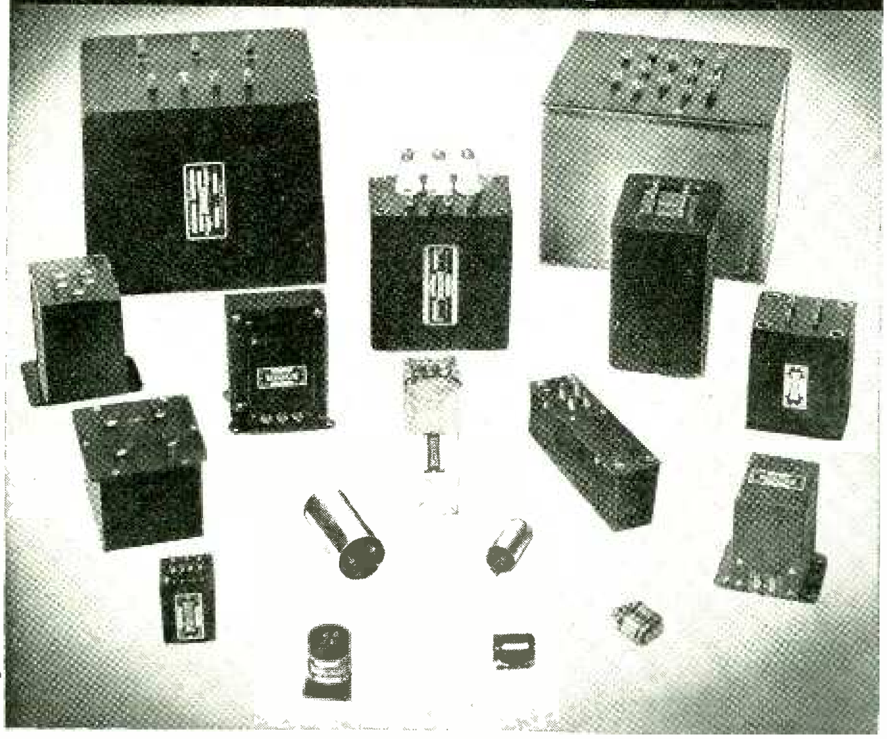

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the plate is at a high radio frequency potential. With this type of circuit the stray capacitance from plate to ground produces undesirably sharp tuning of the transmitter and results in relatively large loss in the plate tuning coil.

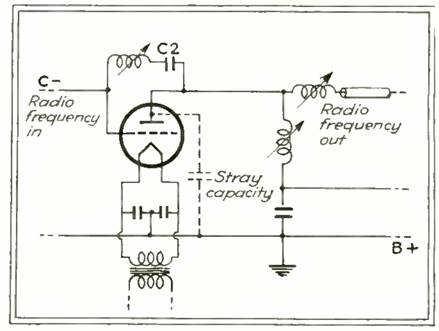


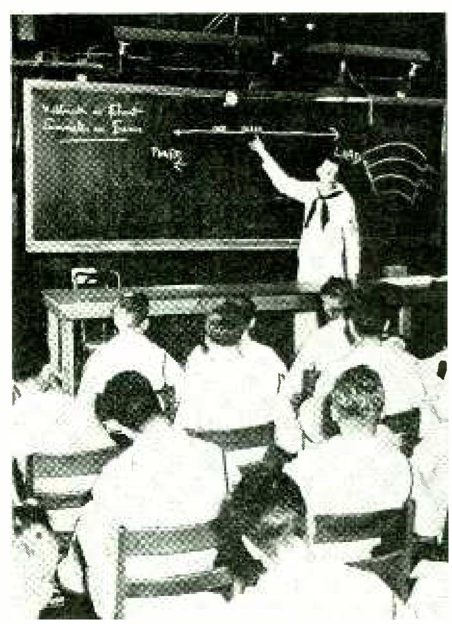
Fig. 1—Usual type of circuit employed in radio frequency power amplifiers

Both of these obstacles are overcome by the use of a grounded plate amplifier plus a number of additional and novel features used with it. The grounded plate circuit, indicated in simplified form in Fig. 2, results in an arrangement in which the stray capacitance from plates to ground is in parallel with the plate blocking condenser and consequently has no effect upon operation. The capacitance of the filament to ground is all that need be considered with this arrangement and this is much smaller than that between the plate and the ground.

Since the filament operates at a

• • •

NAVY INSTRUCTION



The students in the Materiel Laboratory of the Navy receive a lecture on electricity. The instructors find that the students gain first hand knowledge by working directly with equipment

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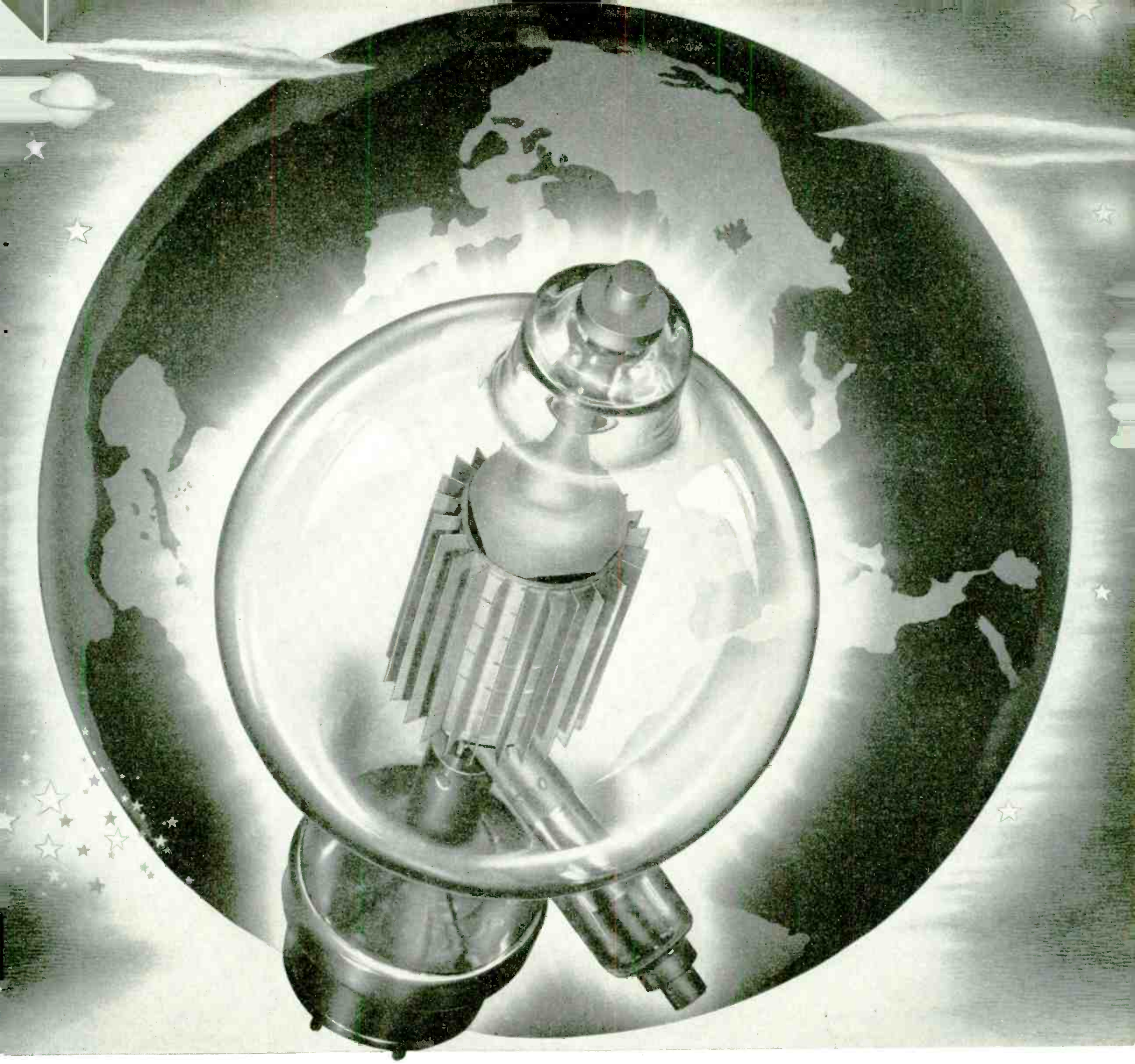

This is a "GLOBAL" war...

A man-made globe—the electronic tube—is today one of the key weapons of battle. Eimac tubes have assumed a rank of "high command" in this "global" war. Again they are "first choice in the important new developments in radio"

ARMY E NAVY

THE JOINT ARMY-NAVY "E" awarded September 4, 1942... first award of this kind to a manufacturer of electronic tubes.

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

Export Agents: Frazar & Company, Ltd., 301 Clay St., San Francisco, Calif.

Eimac TUBES

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MYCALEX CORPORATION OF AMERICA

announces

GREAT NEWS!

BOTTLENECK IS BROKEN!

Genuine MYCALEX THE INSULATOR INSULATING MATERIAL

Trade Mark Reg. U. S. Pat. Off.

(*Leadless* Grade)

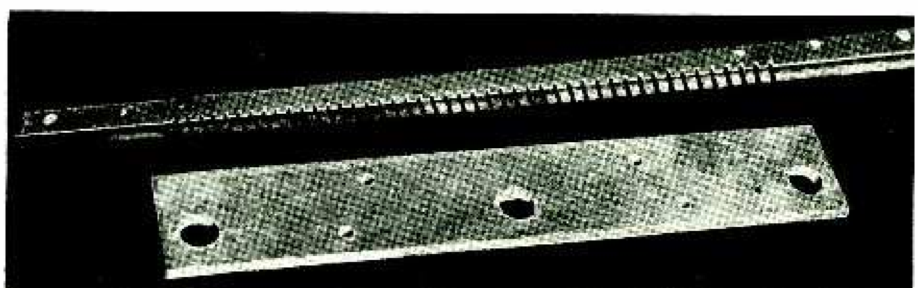
IS READY, ON HAND, FOR IMMEDIATE DELIVERIES

in sheet form

● **MANY** companies waited . . . patiently (for which we thank them) . . . because there just wasn't any way at that time to supply the quantities of MYCALEX Insulating Material (Leadless Grade) that our war work demanded.

● **NOW THINGS ARE DIFFERENT.** Our stepped-up production is clicking. The works are humming. The material is ready. Gentlemen: What are your requirements? PRIORITIES will, of course, continue to play a part in our own allocation of material until we are sure that defense needs will not be hampered. But we anticipate little difficulty in supplying *all* needs.

● **MYCALEX** Insulating Material is a ceramic, of great mechanical strength, made in 14"x18" sheets of 9 thicknesses ($\frac{1}{8}$" to 1"). Used with great success in electronics, mining, railroading, aviation, utilities, many other fields where low-loss characteristics are vitally necessary.



MACHINEABLE: Your own mechanics can machine parts to accurate dimensions. Or, send us specifications for quotation of cost and delivery schedule of parts fabricated in our large, modern machine shop.

FREE BOOKLET yours on request. Describes uses, instructs in machining technique, shows examples of intricate parts made of genuine Leadless MYCALEX Insulating Material. Write to

Exclusive American Licensee under all British patents:

MYCALEX CORPORATION OF AMERICA

60 Clifton Blvd. (Dept. 2L) Clifton, N. J.

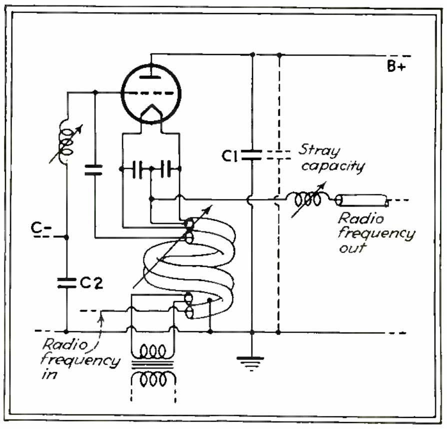


Fig. 2—Improved form of power amplifier circuit developed for use in frequency modulated transmitters

relatively high radio frequency potential, and since it is desirable for the filament heating transformer to operate at ground r-f potential, the plate tuning coil of Fig. 1 is replaced in this new circuit by a coil between the filament and ground. If this coil is formed by a pair of copper tubes in parallel as indicated, the filament leads may be threaded through the bore of one of the tubes and the grid driving potential supplied through the inner conductor of the other. At the filament end of this coil, the copper tubes are connected to the filament through condensers as shown, and the other end of the coil is grounded. Thus the filament current and grid driving voltage are delivered at the required circuit location with the sources (driver and filament transformer) maintained at ground potential.

The reactance of this coil is adjusted by the use of a coaxial transmission line less than a quarter wave in length, and short circuited by an adjustable bridging connector at the far end. In practice this results in the use of two concentric systems of the transmission line type.

• • •

SPECIAL TESTING STATION

Radio transmitters and receivers are being reconstructed and perfected at a testing station in Berne, Switzerland. Much of this test equipment is made in the United States

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WHERE IT'S SO COLD THAT VOICES FREEZE

• This favorite reminiscence of gifted liars is no tall tale in the development of military equipment. Army engineers set out to design field telephone sets which will give perfect service in lands where 'forty below' is a commonplace. In such cold the finest phones of standard design won't work, but today's army telephones operate as efficiently in arctic wastes as in the tropics.

• *Connecticut* was privileged to assist in this development, and put its precision manufacturing facilities to work producing instruments by the thousand.

• For the second time in its history, *Connecticut* has "joined up for the duration." Until final and complete victory is achieved, our entire facilities are placed at our government's disposal. We are sure our good peacetime customers would not have us do otherwise.

★ GET THE MESSAGE THROUGH! U.S. ARMY SIGNAL CORPS ★

CONNECTICUT TELEPHONE & ELECTRIC CORPORATION

RESEARCH • ENGINEERING • PRECISION MANUFACTURING ★★ MERIDEN, CONNECTICUT

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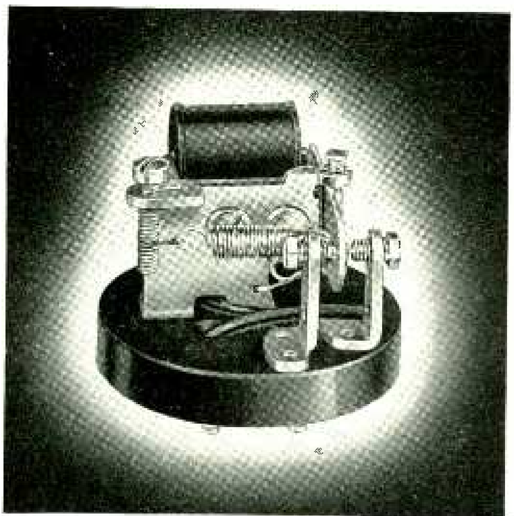

TYPE G
Operating Wattage 0.05

TYPE B
Operating Wattage 0.012

Sensitive
RELAYS

Sensitive in their ability to operate with minimum wattage.

Ruggedly constructed to withstand the vibration and shock of Army and Navy equipment.

Meet all Army, Navy and CAA specifications.

ALLIED CONTROL COMPANY, INC. ★ 227 FULTON ST., NEW YORK
Factories
NEW YORK CITY • LONG ISLAND CITY
CHICAGO • PLANTSVILLE, CONN.

Rochester Fall Meeting

War Radio Conference
November 9, 1942
Sagamore Hotel
Rochester, N. Y.

MONDAY, NOVEMBER 9

9:30 A. M.—12:30 P. M.

Symposium on Radio Production and the War Effort

Opening Address:

Dr. W. R. G. Baker, Director, Engineering Department, Radio Manufacturers Association

Addresses by:

Lieut. Commander A. B. Chamberlain, Radio Branch, Bureau of Ships, Navy Department

Capt. Billings MacArthur, U.S.A., Army-Navy Communications Production Expediting Agency

German Aircraft Radio Equipment: Of F. S. Barton, British Air Commission

Informal conferences

2:00 P. M.—6:00 P. M.

Technical Session on Radio Equipment Production

"Flexibility in Communications Equipment Production", by J. J. Farrell, General Electric Co., Schenectady, N. Y.

"Radio Production Test Methods", by Harry Rice, Sperry Gyroscope Co., Garden City, N. Y.

"Photographic Templates", by E. C. Jewett and C. D. Tate, Eastman Kodak Co., Rochester, N. Y.

Committee Meetings and Informal Conferences

7:00 P. M.—10:00 P. M.

Rochester Fall Meeting Dinner
Speaker—To be announced

• • •

RADIO INSTRUCTOR

Major Emily Saltonstall, member of Massachusetts Women's Defense Corps, is aiding the defense effort and is now instructing other members of the Corps in radio service. The classes are held three days a week in the Defense Corps headquarters

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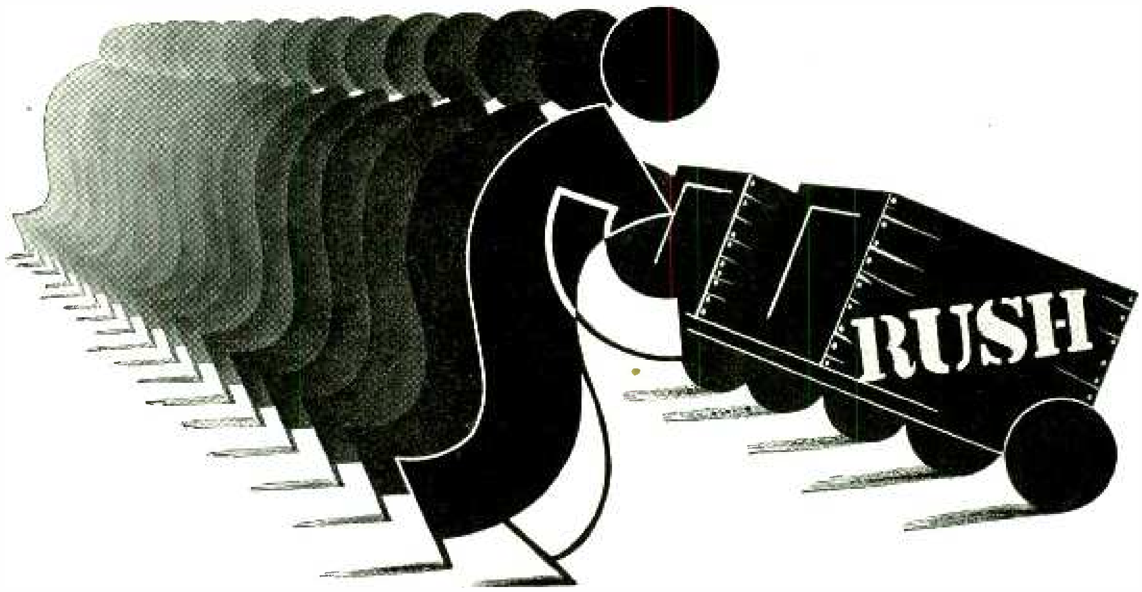


HOW TO GET MORE RESISTORS *faster*

In general—and based on the experience of other manufacturers as well as our own—carbon composition resistors can be made *more than twice as fast* to a tolerance of ±20%, as they can to a tolerance of ±10%.

They can be produced four times as fast, if the tolerance is ±20% instead of ±5%—and the resulting scrap or wastage is reduced by a similar figure!

Obviously, close tolerances are essential on many applications and Stackpole is producing such resistors in tremendous quantities. In other cases, however, ±20% resistors will prove entirely satisfactory, just as they did in approximately 95% of all civilian radio manufacture.

This is especially true in applications calling for resistors of .25 megohms and over. In these higher ranges, resistor tolerances often lose their relative importance—whereas resistor manufacturing difficulties actually increase, even beyond the percentages previously mentioned.

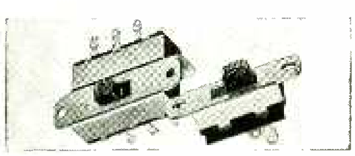
On higher value resistors, it is also well to consider the use of lower wattage units which are just as satisfactory and, at present, are more readily obtainable.

As the largest manufacturer of carbon resistors, Stackpole will cooperate to the hilt in meeting any war demands. It will help us to help you, however, if care is taken when ordering resistors to avoid specifying any closer tolerance or higher wattage rating than is actually required.

STACKPOLE CARBON COMPANY, ST. MARYS, PA.

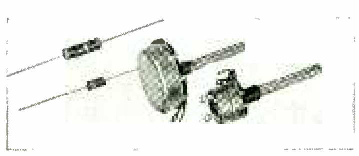
Sold to manufacturers only— Catalog and samples on request.

STACKPOLE



SWITCHES

Slide operated (either indexed or momentary contact type)— Rotary Index and Toggle types.



RESISTORS

(Fixed or Variable)

Carbon composition resistors, fixed types up to 4 watts—Variables in 4 different types.

IRON CORES

Molded from metallic powders in a wide variety of grades and sizes for use at frequencies as high as 150-175 meg.

STACKPOLE FOR CARBON — BRUSHES (all types for all rotating machines) — CONTACTS (all carbon, graphite, metal and composition types — also molded rare metal contacts) — ANODES — ELECTRODES — BRAZING BLOCKS — BEARINGS — WELDING RODS, ELECTRODES AND PLATES — PIPE — PACKING, PISTON AND SEAL RINGS — RHEOSTAT PLATES AND DISCS — BRAKE LINING, etc.

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NEWS OF THE INDUSTRY

Electronic flight recorder developed by Brown Instrument Co., E Awards to members of electronic industry, Army-Navy Preferred List of tubes, General Electric trains women as electrical engineers, FM news

Electronic Temperature Recorder Contributes to Aviation Developments

AT A LECTURE AND DEMONSTRATION in Philadelphia on October 1, a new electronic instrument, capable of recording temperature and pressure changes at the rate of 144 readings every three to four minutes was shown by the Brown Instrument Company, subsidiary of the Minneapolis-Honeywell Regulator Company. This portable instrument, used primarily as a flight recorder in the testing and development of America's newest airplanes, is now in regular use by the Army, Navy and leading airplane manufacturers. The instrument records as many as 144 different readings throughout various parts of the plane and automatically prints a record on graph paper at the rate of about one reading approximately every second. As applied to the test flight of airplanes, most of the measurements are those of temperature, although the instrument is capable of recording any physical phenomena which can be transformed into a change of voltage or current.

In the development of aircraft, the device is of importance in so far as it relieves the pilot of making test readings while he is engaged simultaneously in the operation of the plane. Accordingly, with an instrument of this type installed in the plane, readings will be made regularly and automatically and the pilot may devote his entire attention to the proper manipulation of the airplane controls. Another advantage of the flight recorder is that many more readings may be obtained in a given time interval so that much more complete and detailed information of the flight is available than has heretofore been the case where readings were recorded manually.

The basic recorder, which is the result of several years of research, was in the process of development for use in industrial plants when the need arose for some new type of instrument capable of compiling test data on the Douglas B-19, the world's largest plane. To meet this emergency, a corps of electronic and mechanical design engineers went to work in the Brown laboratories and adapted the experimental recorder in the process of development for the test run of the huge plane.

The requirements of the successful flight recorder have been met by the adaptation of a new type of self-balancing electronic potentiometer which completely eliminates the mechanical galvanometers which have been used extensively in industrial equipment for the measurement of temperature. As applied to the measurement of temperature, the relative temperature of any designated point on the plane is determined by means of thermocouples located at the strategic points. The difference in temperature between the two ends of the thermocouple produces an electromotive force across its terminals. The voltage across a potentiometer equal to the thermocouple voltage is then selected by motor-driven mechanical means. Ordinarily, equality of voltages in the two cases is indicated by 0 current which in turn is measured by a galvanometer. In the electronic flight recorder, the galvanometer is replaced by a multi-stage amplifier which drives a motor to restore the tap on the potentiometer to the appropriate position. When the appropriate null indication is obtained, the correct relative temperature is automatically recorded on a continuous chart. This is the essential method of operation for making one temperature reading.

For making additional temperature readings, a switching arrangement is used to introduce any of the remaining thermocouples into the electrical system. The switching arrangement for selecting the appropriate thermocouple is synchronized with the recording mechanism so that when a null or balanced condition obtains for each thermocouple in the test, its appropriate temperature is automatically printed on the chart paper.

Features of particular interest to readers of ELECTRONICS in the new device are the replacement of the usual type of galvanometer by an electronic amplifier, null indicator, and motor driving system which makes it possible to use the instrument in the severe conditions of temperature, humidity, and vibration which is encountered in airplane flying. The stability of the electronic system also gives the instrument its big advantage of making the many recorded readings. If all 144 thermocouples are employed, it is possible to get a reading of each individual thermocouple at an interval of approximately three minutes. If fewer thermocouples are used, it is of course possible to obtain readings of any one of the group in a smaller time interval. An additional feature which results from the improved design is that the instrument can measure to better than one degree Fahrenheit, whereas temperature meters formerly used and visually

Lieut. William C. Clay, U. S. N. and E. B. Evleth, vice president and general manager of the Brown Instrument Co. inspect the newly developed Flight Recorder. This instrument automatically records as many as 144 different readings every three to four minutes and provides a complete and accurate record of an airplane's performance while permitting the test pilot to concentrate on flying the plane

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This AMCOIL Test Chamber Assures Accurate Results Under Low or High Temperatures

Here is a completely automatic test chamber for makers of precision instruments. Here is a way to give delicate mechanisms scientifically-created "previews" of performance conditions. The Amcoil Model RTC-1 is an all-steel test chamber combining mechanical refrigeration and electric heating.

Entire operation is accurately controlled from front panel board. Five thicknesses of glass permit observation of instruments under test. Interior content is 28.7 cubic feet.

The temperature range extends from minus 55 degrees C. to plus 70 degrees C. Thermostatic control assures accuracy, helps maintain uniformity of temperature. This cabinet without production load should reach minus 50 degrees C. in approximately one hour.

Put your precision instrument testing problems up to Amcoil engineers. Ask for further information and technical data regarding the RTC-1, as well as additional models for refrigeration-, dry ice- and altitude-testing.

Many precision instruments must serve equally well today in substratosphere temperatures or desert heat.

For prompt attention, please direct your inquiries to Engineering Department:

TRADE MARK REGISTERED

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AMERICAN COILS INC.

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observed could not be depended upon to temperatures closer than about 10 degrees Fahrenheit.

The flight recorder consists of two portable cases in addition to the individual thermocouples which are distributed as the test data requires throughout the plane. The two instruments contained in boxes about the size of a small suitcase hold the electronic amplifier and recorder in one case and the synchronized switching arrangement for the 144 thermocouples in a bakelite housing. The complete installation weighs 128 pounds of which 53 pounds are assigned to the recorder mechanism itself. The recorder uses 15 feet of chart paper per hour, which is enough for a flight lasting eight hours.

General Electric Trains Women as Electrical Engineers

ON THE STRENGTH OF RESULTS achieved by a test group of 40 women hired for electrical engineering work, the General Electric Co. will hire more than a hundred more. The girls have had training in physics and mathematics, and are given additional laboratory and classroom instruction by GE to help bridge the gap between their college education and the work of electrical engineers.

FM News

IN LINE WITH THE POLICY of conservation of equipment by radio broadcasters, the management of station W47NY investigated the possibilities of changing the morning sign-on time from 7:30 to noon. Fifteen announcements were broadcast asking the station's audience what it thought about the proposal. In a short time more than 200 telephone calls, letters, and postcards were received protesting the change in hours. Considering that the response from the audience was from about 5 percent of the total, W47NY therefore has about 4000 morning listeners. This reaction was considered sufficient to justify the full day program and the station is still heard from 7:30 a.m. to 11:00 p.m.

FM listeners in Boston and Pittsburgh will soon be getting better service from stations W67B and W75P, respectively, when the heights of the antennas for these stations are increased by several times. The radiator for W67B is to be located atop the 500-foot antenna tower of station WBZ and that of W75P will be placed at the top of KDKA's 718-foot tower. At present the two FM antennas are mounted on 90-foot wooden poles.

New York City will have its eighth FM station in operation on or about November 1. It will be W75NY to be operated by Metropolitan Television, Inc. It will probably be the last new FM station in New York until after the war.

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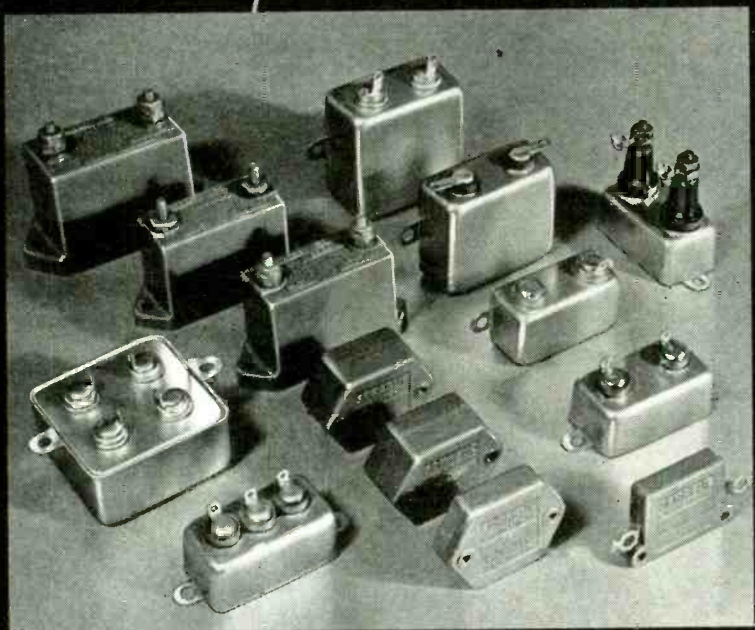


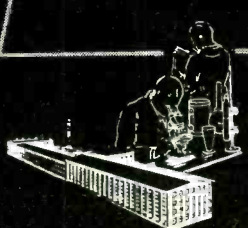
Honestly superior condensers tell their own story of quality.

SPRAGUE

CONDENSERS—KOOLOHM RESISTORS

Quality Components • Expertly Engineered • Competently Produced

SPRAGUE SPECIALTIES COMPANY, NORTH ADAMS, MASS.



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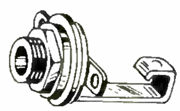
A Lot of Jack for the Job on Hand!


Utah Long Jack

● The success of many an operation may depend upon a jack. With Utah Jacks you can be sure of dependable performance. Utah-Carter Short Jacks, for instance, are small and compact, but do a full size job. Utah-Carter Long Jacks take minimum panel mounting space.

Short and long jacks fit all plugs in two and three conductor types. All contacts between springs are fine silver, giving minimum contact resistance.

Utah-Carter Imp Short Jacks are popular because they combine compact size, highest quality and economical price. Unique patented design makes them the smallest jack fitting standard plugs. Write today for full information — there is a Utah Jack to meet your requirements.


Utah Open Circuit Jack

UTAH VITREOUS ENAMELED RESISTORS—From 5 to 200 watts, they are available either as fixed—tapped or adjustable. Also non-inductive types.

UTAH JACK SWITCHES—Long and Short Frame and Imp Type Switches to meet the circuit and space requirements you need.

UTAH PHONE PLUGS—Two or three conductor types—for practically every type of application.

UTAH TRANSFORMERS are fully guaranteed. Able to meet the requirements in choke, input, output and smaller capacity power transformers.

WRITE FOR FULL DETAILS

UTAH RADIO PRODUCTS COMPANY
General Offices and Factory
837 ORLEANS STREET • CHICAGO, ILLINOIS

E Awards

THE RADIO AND ELECTRONIC industries and their suppliers are well represented in the group of companies which have won the Army-Navy E Award for high achievement in the production of war equipment. The following list of these organizations is reasonably complete as of press time and as additional companies receive the award they will be mentioned in these columns.

AMERICAN BRAKE SHOE & FOUNDRY CO.
Chicago, Ill.

AMERICAN LAVA CORP.
Chattanooga, Tenn.

BELL TELEPHONE LABORATORIES
New York, N. Y.

BENDIX AVIATION CORP.
(Bendix Radio Division)
Baltimore, Md.

BENDIX AVIATION CORP.
(Eclipse Machine Division)
Elmira Heights, N. Y.

BLAW-KNOX CO.
Pittsburgh, Pa.

COLLINS RADIO CO.
Cedar Rapids, Iowa

CORBIN SCREW CORP.
New Britain, Conn.

E. I. DU PONT DE NEMOURS
(Neoprene Plant)
Deepwater, N. J.

EITEL-MCCULLOGH, INC.
San Bruno, Calif.

GALVIN MANUFACTURING CO.
Chicago, Ill.

HALLICRAFTERS CO.
Chicago, Ill.

HANDY & HARMAN
Fairfield, Conn.

INTERNATIONAL RESISTANCE CO.
Philadelphia, Pa.

LEEDS & NORTHRUP CO.
Philadelphia, Pa.

LINDE AIR PRODUCTS CO.
East Chicago, Ill.

NATIONAL CARBON CO.
Clarksburg, W. Va.

PHILCO CORP.
Philadelphia, Pa.

RCA MANUFACTURING CO.
(Radiotron Division)
Harrison, N. J.

SIMPLEX WIRE & CABLE CO.
Cambridge, Mass.

SPERRY GYROSCOPE CO., INC.
(Five Plants)

VEEDER-ROOT, INC.
Hartford, Conn.

WARD LEONARD ELECTRIC CO.
Mount Vernon, N. Y.

WESTERN ELECTRIC CO.
(Hawthorne Works)
Chicago, Ill.

WESTERN ELECTRIC CO.
New York, N. Y.

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2 strong, tough alloys
non-magnetic down to 150° F. below...

Unusual characteristics of these two Alloys increase their range of usefulness

Well-known properties of age-hardenable "K"* and "KR"* Monel are strength and hardness equal to that of some heat-treated alloy steels. Lesser known but also important are two other characteristics exhibited by these metals:

1. "K" and "KR" Monel remain non-magnetic in all conditions, at temperatures far below those encountered in actual service.
2. "K" and "KR" Monel retain room temperature ductility and toughness at sub-zero temperatures.

For these reasons, in addition to their usual applications, "K" and "KR" Monel are used where magnetic disturbances must be avoided or eddy currents minimized . . . as in magnetic surveying equipment and important applications in aircraft structures and instruments.

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

MAGNETIC PERMEABILITY AND CURIE POINT OF "K" MONEL AND "KR" MONEL

Condition	Permeability at room temperature H = 200 oersteds (air = 1.02 max.)	Magnetic Transformation Temperature (permeability of 1.02° F.)
Soft (quenched)	1.001	–200
Quench and age-hardened	1.002	–150
Cold-drawn	1.001	–200
Cold-drawn and age-hardened	1.002	–150

MONEL

"Monel" and other trade-marks which have an asterisk associated with them are trade-marks of The International Nickel Co., Inc.

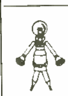
MECHANICAL PROPERTIES AT LOW TEMPERATURES

MATERIAL	Condition	Temperature °F.	Yield Strength (0.20% offset) psi.	Tensile Strength psi.	Elongation in 2 in. per cent	Reduction of Area per cent	Hardness Rockwell C	Charpy Impact Strength ft.-lb.
"K" MONEL	Cold-drawn age-hardened.....	Room	125,900	157,300	15.5	37.4	33	27
	Cold-drawn age-hardened.....	–110	134,600	171,550	17.3	41.1	36	27

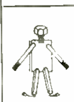
INCO NICKEL ALLOYS IN THE WAR EFFORT

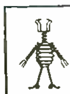
With the Nation at war, every pound of Nickel, Monel and Inconel that expanded facilities can produce is urgently needed for vessels of the Navy, mechanical and chemical equipment for the Army, vital parts of Aircraft, and for Chemical, Petroleum, Steel and other essential industries. As part of the all-out war effort the International Nickel Company will continue to report for the benefit of such users information concerning the selection, fabrication and use of Nickel and Nickel Alloys.


"K" MONEL — **EXTRA STRENGTH AND HARDNESS . . .** comparable to heat-treated alloy steel; age-hardenable, non-magnetic—

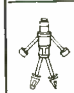

"KR" MONEL — **EXTRA STRENGTH AND HARDNESS PLUS MACHINABILITY** . . . free cutting, age-hardenable, non-magnetic—


INCONEL — **HEAT RESISTANCE . . .** with retention of high degree of strength. Resists oxidation, high corrosion resistance—


MONEL — **CORROSION RESISTANCE . . .** together with strength, hardness, toughness—


"Z" NICKEL — **RESILIENCE . . .** age-hardenable, for exceptional spring properties, magnetic, good electrical conductivity—


"R" MONEL — **MACHINABILITY . . .** for high speed production in automatic screw machines—

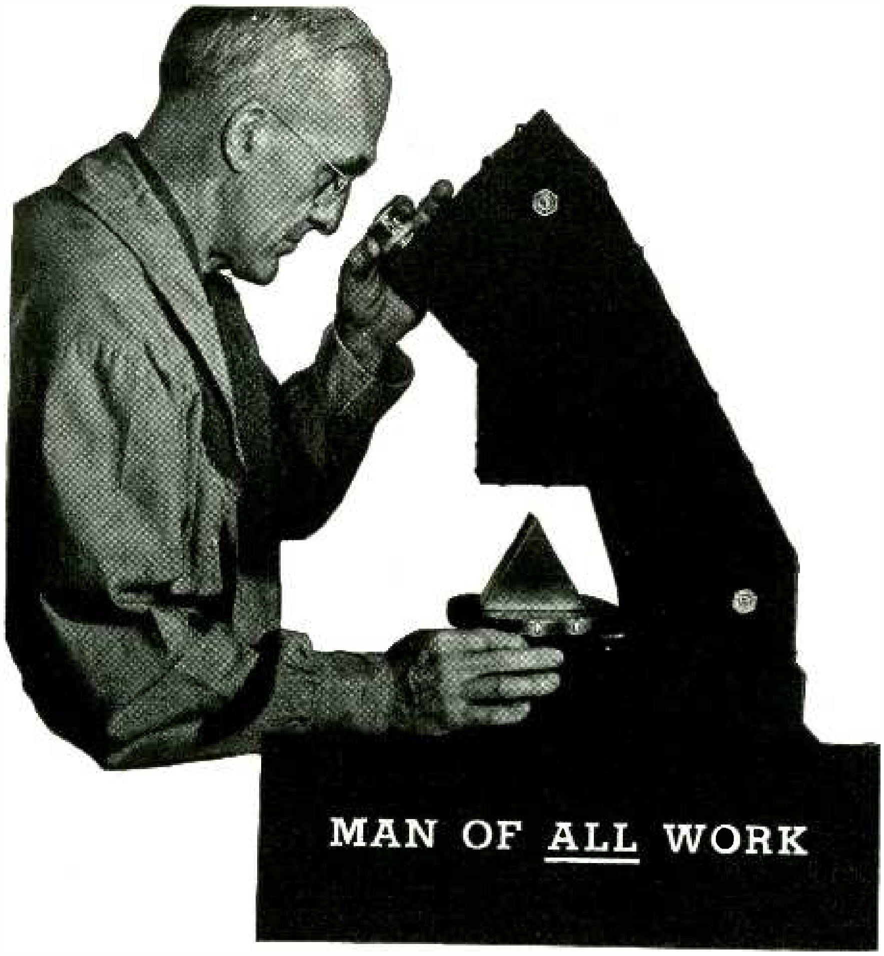

"S" MONEL — **HARDNESS IN CASTINGS . . .** anti-seizing and non-galling—


NICKEL — **CORROSION RESISTANCE . . .** protects product purity; offers adequate electrical conductivity—

★ ★ ★ ★ ★ **INCO NICKEL ALLOYS** ★ ★ ★ ★ ★

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • NICKEL • "Z" NICKEL

Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings



THE field of the optical engineer knows few boundaries. Naturally he is part and parcel of such sciences as astronomy and photography, but would you expect him to play an important role in a textile plant, a paint factory, the building of houses, or the discovery of defects in boiler tubes? These are but a few of the hundreds of assignments which Perkin-Elmer engineers have brought to a successful conclusion.

Today we are doing our bit for Uncle Sam. Precision manufacture of optical instruments and systems for Army and Navy needs has our whole attention. When Victory is won, the development and manufacture of new measuring devices, new control of industrial processes, new tools for research scientists, all will become of even greater importance than ever before. Then The Perkin-Elmer Corporation will stand ready to serve science and industry again, through the science of optics.

If you are already thinking ahead to post war necessities, you may want to know more about how optical engineers could be of service in your business. If so, we shall welcome your letter.

THE PERKIN-ELMER CORPORATION

GLENBROOK, CONNECTICUT

MANUFACTURERS OF PRECISION LENSES • PRISMS and MIRRORS

OPTICAL DESIGN AND CONSULTATION

WESTINGHOUSE ELECTRIC & MANUFACTURING CO.
(Five Plants)
WESTON ELECTRICAL INSTRUMENT
Newark, N. J.

Jolliffe Named Vice President of RCA

DR. CHARLES B. JOLLIFFE, assistant to the president of the Radio Corporation of America and chief engineer of the RCA Laboratories, has been appointed vice president and chief engineer of the RCA Manufacturing Co.

Army-Navy Preferred Tubes

THE ACCOMPANYING Army-Navy Preferred List of Vacuum Tubes sets up a group of unclassified general purpose tubes selected jointly by the Signal Corps and the Bureau of Ships. The purpose of this list is to effect an eventual reduction in the variety of tubes used in Service equipment. It is mandatory that all unclassified tubes to be used in all future designs of new equipment under the jurisdiction of the Signal Corps Laboratories or the Radio and Sound Branch of the Bureau of Ships be chosen from this list. Certain exceptions to this ruling may be made upon application and approval.

RECEIVING TYPES

Filament Voltage—1.4 v

Diode—1A3
Diode-Triode—1LH4
Triodes—1G4GT, 957, 958A
Twin Triodes—1291, 3A5
Pentodes
Remote Cutoff—1T4
Sharp Cutoff—1S5, 959, 1LN5, 1L4
Converters—1LC6, 1R5
Power Amplifiers—3A4, 1299, 3Q4, 3Q5GT
Indicator—991

Filament Voltage—5.0 v

Rectifiers—5U4G, 5Y3GT

Filament Voltage—6.3 v

Diodes—6H6*, 9004
Diode-Triodes—6SQ7*, 6SR7*
Triodes—6J5*, 1201, 955, 7193, 9002
Twin Triodes—6SL7GT, 6SN7GT
Pentodes
Remote Cutoff—6SG7*, 6SK7*, 956, 9003
Sharp Cutoff—6AC7*, 6AG7*, 6SH7*, 6SJ7*, 717A, 954, 9001
Rectifiers—6X5GT, 1005
Converter—6SA7*
Power Amplifiers—6L6G, 6V6GT, 6N7GT, 6B4G, 6G6G, 6Y6G
Indicator—6E5

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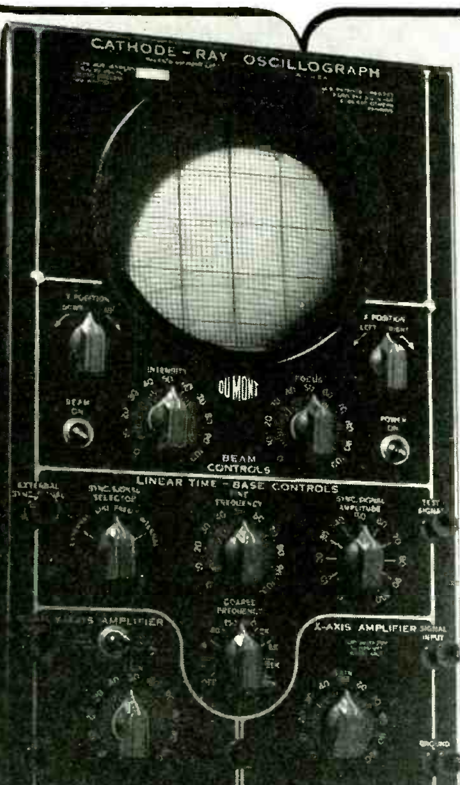
Now serving on *all fronts*

★ In aircraft plants, engine shops, powder works, ballistic laboratories, radio, electrical and other plants; in research laboratories and engineering departments shaping the weapons and tools of today and tomorrow; on the fighting fronts afloat and ashore—yes, in every phase of this great Battle for Democracy, DuMont Cathode-Ray Oscillographs are in the service.

For the most part, standard type DuMont Oscillographs are employed. An adequate selection of standard types meets the wide range of requirements. But for the highly specialized needs arising out of the drastic industrial and military demands of the war, special models are constantly being developed and built. Regardless of the need, a DuMont Cathode-Ray Oscillograph or related instrument, is available.

★ ★ ★ ★ ★

Write for Literature . . .



Wide selection of DuMont Oscillograph models—3" to 20".

DuMont Electronic Switch for placing two simultaneous signals on single tube screen.

DuMont Low-Frequency Linear-Time-Base Generator, providing sweeps as low as 1 cycle every few seconds.

Type 224 Oscillograph, with frequency response up to 2,000,000 cycles per second.

DuMont Cathode-Ray Tubes from 3" to 20". Choice of persistence screens.

★ ★ ★

DU MONT Type 208 OSCILLOGRAPH

DUMONT

ALLEN B. DU MONT LABORATORIES, Inc.
Passaic • New Jersey
Cable Address: Wespexlin, New York

Filament Voltage—12.6 v

Diode—12H6*
Diode-Triodes—12SQ7*, 12SR7*
Triode—12J5GT
Twin Triodes—12SL7GT, 12SN7GT
Pentodes
  Remote Cutoff—12SG7*, 12SK7*
  Sharp Cutoff—12SH7*, 12SJ7*
Converter—12SA7*
Power Amplifier—12A6
Indicator—1629

TRANSMITTING TYPES

Triodes—801A, 811, 826, 833A, 838, 1626, 8005, 8025, 304TH
Tetrodes—807, 813, 814, 1625
Twin Tetrodes—815, 829, 832
Pentodes—803, 837, 2E22
Rectifiers
  Vacuum-2X2, 836, 1616, 8020 (451), 705A, 371A
  Gas—83, 866A, 872A, 4B25

MISCELLANEOUS TYPES

Grid Controlled Gas Rectifiers—2050, 884, 394A, C1B, C5B
Voltage Regulators—VR-90-30, VR-105-30 (38205), VR-150-30 (38250)
Phototubes—918, 927

*Where interchangeability is assured GT counterparts of the preferred metal tubes may be used.

Plastic Manufacturers Pool Facilities

A NUMBER OF PLASTICS companies in the New York area have formed the Plastic War Production Association to pool the engineering, research, and manufacturing facilities for the benefit of the various government branches placing war contracts. The new organizations has been certified by the WPB "as a war production association appropriate in form and character to the fulfillment of the objectives of the War Production Board." The certification has been formally approved by the Attorney-General. Mr. Murray Frankl is the authorized contacting officer of PWPA and has his office at 122 East 42nd St., New York.

Charles E. Wilson, GE President, Joins WPB

CHARLES E. WILSON, president of the General Electric Co., has been made a vice chairman of the War Production Board. He also serves as Chairman of the Production Executive Committee and will exercise the powers of the Chairman of the War Production Board in seeing to it that all production programs are met. The Production Executive Committee has been formed to bring together top officials in the WPB, the Army, the Army Air Corps, the Navy, and the Maritime Commission to maintain a constant check and control on the production program. This committee will meet twice weekly. Serving with Mr. Wilson on this committee are Lieut. Gen. Brehon B. Somervell, Com-

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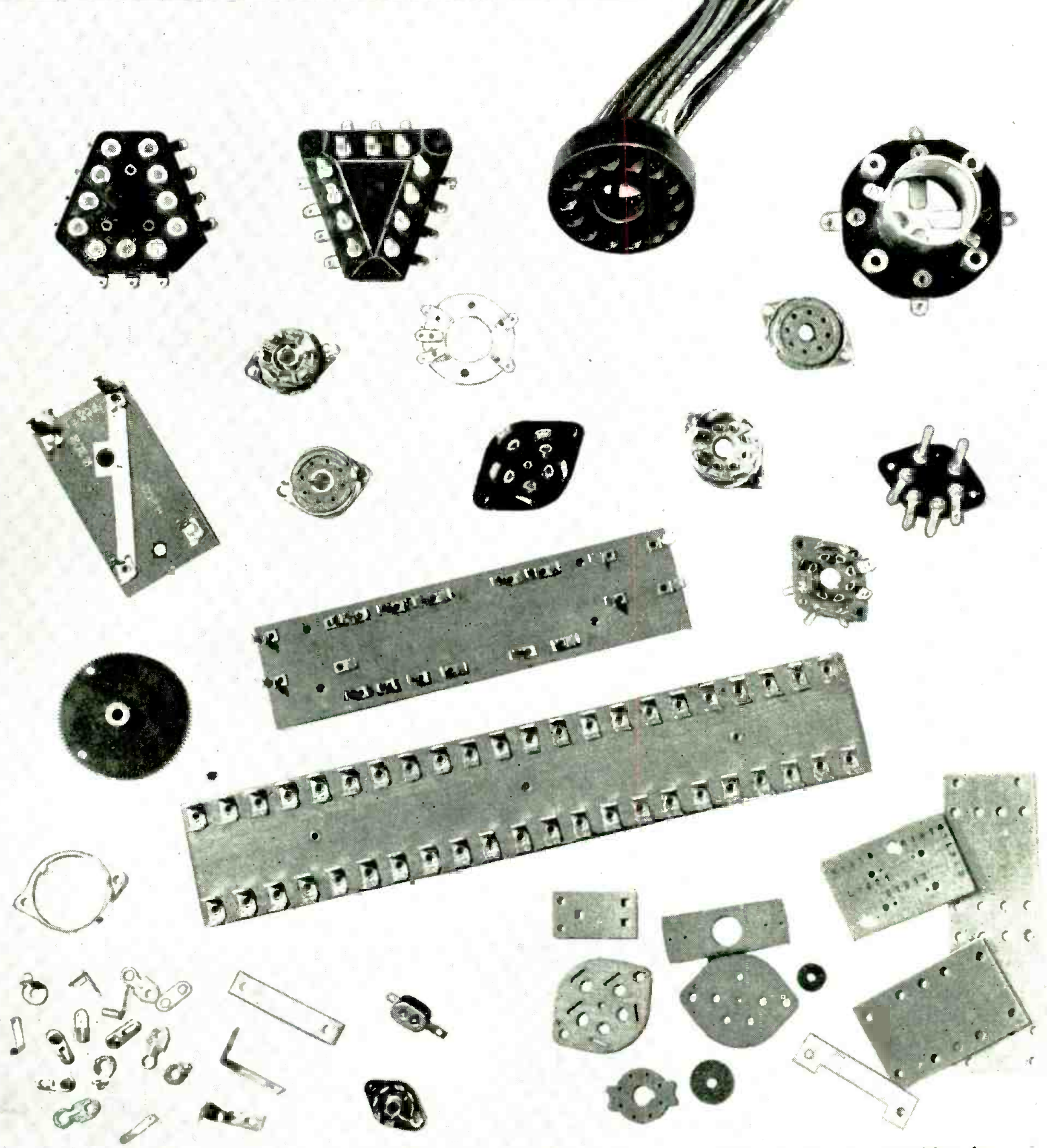
FRANKLIN ELECTRONIC COMPONENTS



● Illustrated are a few of the parts which we are now making in large quantities for many leading manufacturers of radio, electrical, aircraft and electronic equipment and instruments. Our complete tool room and manufacturing facilities assure you prompt service on deliveries. Our skilled engineers—who understand Army, Navy and Signal Corps specifications—are available to discuss your design problems. Quotations made promptly from your blueprints. Check your requirements with us. We may be already tooled up to make the components you need.

A. W. FRANKLIN MFG. CORP.

175 VARICK STREET . . . . . NEW YORK, N.Y.

Sockets • Terminal Strips • Plugs • Switches • Plastics Fabrication • Metal Stampings • Assemblies

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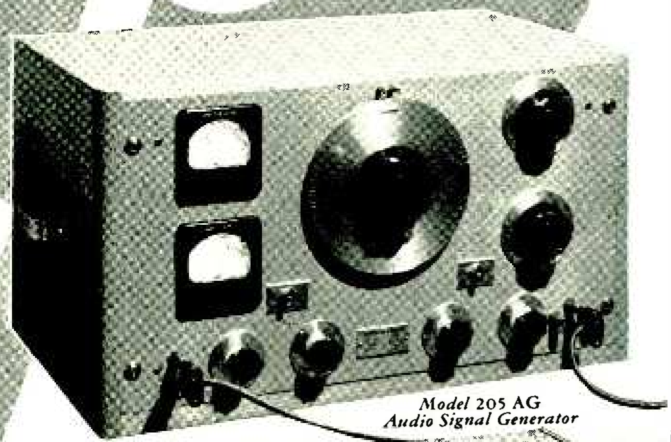
This trade mark is your guarantee of

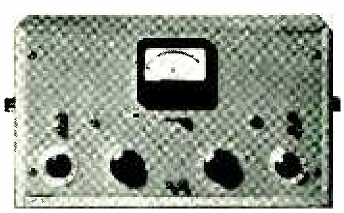
ACCURACY · SPEED · ECONOMY

in laboratory and production measurements

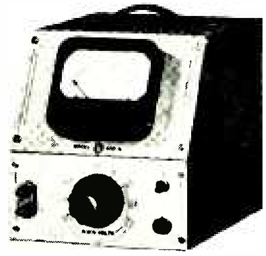


Model 205 AG
Audio Signal Generator

Model 200 B
Resistance Tuned Audio Oscillator



Model 325 B
Noise and Distortion Analyzer



Model 400 A
Vacuum Tube Voltmeter

hp INSTRUMENTS are as revolutionary as the one dial radio. They are designed to operate with the minimum of adjustments. Thus greater speed without sacrifice of accuracy is obtained.

SIMPLICITY IS THE KEYNOTE

Variable frequency, audio frequency oscillators require no zero setting. Vacuum tube voltmeter as simple to operate as a multi-range d-c instrument. Many types of instruments available separately or combinations in a single unit to fit your requirements such as the Model 205 AG which combines a resistance tuned audio oscillator, input meter, attenuator and impedence matching system. Illustrated are four -*hp*- instruments.

GET COMPLETE INFORMATION NOW!

Write today for technical data sheets. Give details of your problem so that our engineers can be of help. There is no cost or obligation.

HEWLETT-PACKARD COMPANY

Box 135K, Station A · Palo Alto, California

manding General, Services of Supply, U. S. Army; Major Gen. Oliver P. Echols, Commanding General, Material Command, Headquarters, Army Air Force; Vice Admiral Samuel M. Robinson, Director of Material and Procurement, U. S. Navy; and Rear Admiral Howard L. Vickery, Vice Chairman, U. S. Maritime Commission.

Priority Assistance for Radio Repair Shops

PRIORITY ASSISTANCE in the purchase of repair-shop materials for the maintenance of home radios may be applied for on Form PD-1X by distributers and dealers who buy directly from manufacturers according to Linford D. White, chief of the WPB's Distribution Branch. These preference ratings will be assigned only to items necessary to the functioning of receivers. No fancy, non-essential radio gadgets and no phonograph parts will be rated on Form PD-1X.

FCC Ceases to Issue Licenses to Amateurs

ORDER No. 87-B of the Federal Communications Commission orders that no renewed, or modified amateur licenses shall be issued until further order of the Commission. It is provided, however, that all presently outstanding amateur station licenses shall remain valid until expiration of the term thereof, unless revoked by specific order.

Electron Microscope and Cyclotron to be Featured at the National Chemical Exposition

THE FIRST SYMPOSIUM on the Electron Microscope, in which the users of all instruments in commercial use (estimated at more than 40) have been invited to participate, will be held at the National Chemical Exposition and Industrial Chemical Conference at the Hotel Sherman in Chicago on November 24 to 29. The Symposium committee is headed by Prof. G. L. Clark of the University of Illinois. The meeting is set for Friday morning, November 27, with arrangements for continuing the session on Saturday and Sunday if necessary.

Preceding the Symposium there will be a talk on Thursday evening by Dr. V. K. Zworykin, associate director of the RCA Laboratories, on "The Electron Microscope in Relation to Chemical Research." Also, there will be a gallery of some of the best micrographs obtained with the electron microscope.

Also on the program for Friday evening is a paper by P. Gerald Kruger, Department of Physics, University of Illinois, on "The Cyclotron and Its Uses in Research."

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vital radio instructions "in the air"!

THE thunder of fighting machines makes a battlefield the noisiest place on earth. Yet there's *one* noise that must be excluded — the noise of Man Made Static!

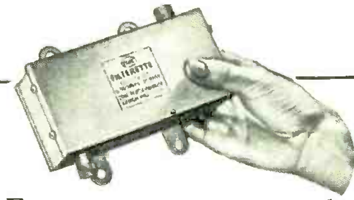
You've often heard Man Made Static in your own radio. Then it's merely a nuisance. But in *battle*, when urgent radio instructions are being short-waved to mechanized forces, think of the havoc radio interference could play in distorting headquarter commands!

It Was a Problem — Now It's Solved

TOBE engineers beat this radio interference problem just as they have conquered thousands of similar ones during the last 15 years. As unquestioned leaders in the field, they designed a compact TOBE FILTERETTE that blots out virtually all the noise that balked our radio-equipped Army vehicles. For example, TOBE FILTERETTES are now found on the powerful new "half-tracks" as well as Tanks, Jeeps, Command Cars, Weapons Carriers, etc. They're integrated as part of the ignition system, so they suppress static interference *at its source.*

When Peace Returns

After the war, widespread use of high frequencies in improved radio and television reception will make Man Made Static a greater problem than ever. But Tobe has already written the formula for your enjoyment of *noise-free* radio operation in your home and auto, aboard your boat. To radio interference caused by virtually any electrical device, you can say, *"No Noise Please! Thanks to Tobe Filterettes!"*



Fifteen years of research by Tobe has perfected the modern Tobe Filterette — a small, compact, inexpensive unit for static suppression. Its successful operation is assured by the famous Tobe Capacitor — the *capacitor of the future!*

TOBE DEUTSCHMANN CORP.
TOBE
CANTON · MASSACHUSETTS

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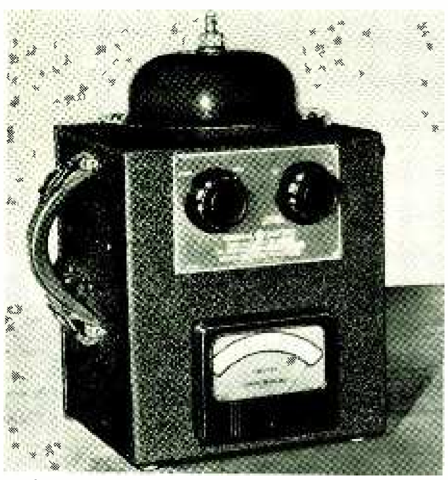
NEW PRODUCTS

Month after month, manufacturers develop new materials, new components, new measuring equipment; issue new technical bulletins, new catalogs. Each month descriptions of these new items will be found here

Electronic Crest Voltmeter

A PORTABLE, ELECTRONIC crest voltmeter which measures ignition voltages of internal combustion engines; surge voltages caused by corona and surface discharges in the insulation on such electric equipment as motors, generators, and cables; and other repeated-impulse voltages up to 30,000 volts is now available for both laboratory and production testing. The instrument is designated as Type A-3 and weighs 23 pounds. Other uses of the voltmeter are for field measurement such as trouble

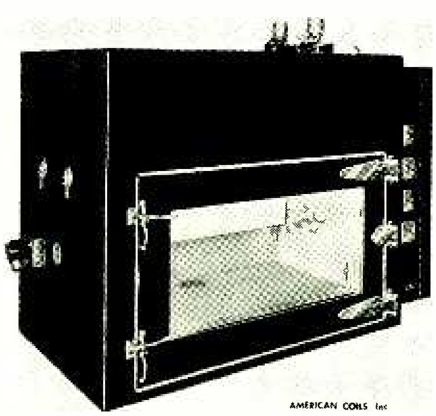


shooting; determinations of actual operating conditions; or testing of aircraft engines in flight. The instrument is equipped with an aircraft-instrument movement to provide resistance to vibration. It has a self-contained battery power supply. It is avaliable (marked and calibrated) for any of the following scale ranges: 0-10,000 volts; 0-20,000 volts; 0-30,000 volts.

Publication GEA-3619 gives more detailed information on this instrument which is manufactured by General Electric Co., Schenectady, N. Y.

Testing Chamber

ILLUSTRATED BELOW is Model RTC-1 which is a precision testing cabinet which tests instruments under extremes of cold and heat. It can produce whatever temperature is desired between minus 55 degrees C and plus 70 degrees C and can maintain the temperature at any level so that actual service conditions may be created. The instrument is completely automatic and the entire operation of the instrument is controlled from the front panel board.



Apparatus for mechanical refrigerating and electrical heating is included. Observation of instruments being tested is provided by an inner door with five glasses sealed and dehydrated against future passage of moisture. The inner glass is Tuf-flex tempered plated glass. The visible opening is 46 inches wide x 21½ inches high. The steel-framed door has a clear opening of 51½ x 26½ inches. The usable interior of the instrument is 59 inches long x 28 inches high, x 30 inches deep, with an interior content of 28.7 cubic feet.

American Coils Inc., 25 Lexington, Newark, N. J.

Contact-Making Clock

WHERE ALTERNATING CURRENT of commercial frequency is used, this Sauter contact-making clock (designated as Tvne CYC-4) when used in conjunction with maximum demand meters or time recorders can be used as an impulse timer for various time recording instruments. The unit will emit from one to twelve impulses per hour by momentarily closing a circuit at predetermined, fixed and unvarying time intervals. The motor of the clock is self-starting and consumes approximately 3 watts. It is of the hysteresis type and can be furnished for 110 or 220 volts and for any commercial frequency. Contacts are of pure silver and are rated at 1 amp at 110 volts alternating current. The duration of impulse is one-fifth of a second, but it can be adjusted if necessary.

The R. W. Cramer Co., Inc., Centerbrook, Conn.

Ionization Gauge Meter

TYPE HG-200, PORTABLE, ionization gauge meter is designed to operate in conjunction with the manufacturers ionization gauge meter, Type VG-1, to provide a method of measuring pressures from 10^{-3} to 10^{-9} mm of mercury. The ionization gauge meter circuit features a stabilized amplifier in a balanced vacuum tube of voltmeter design with negative feedback, and an integral amplifier recalibration for elimination of amplifier variation. Other variations in performance are prevented by gas tube voltage regulation and automatic grid current control.

To produce a complete cycle of operation, a switch is thrown to de-gas the grid of the ionization tube, while the amplification of the circuit is set to a standard value on the single meter, and the grid current is set to the correct value where the circuit will hold it constant. The plate current can then be read directly from the meter and converted to pressure readings with the factor of the ionization tube. The ionization gauge, Type VG-1, used in this arrangement, has a sensitivity of 200 microamperes per micron. The circuit which is already in use on many

production systems, including the exhaust of large transmitting tubes, is reliable and rugged.

The meter is simply designed and can be handled by nontechnically trained employees. The unit is furnished in a cabinet of gray-crackle finish, and comes complete with all necessary cords and plugs, and ionization tube ready to seal onto any Pyrex system. It operates on any 110-115 volt, 60 cps line. The price is approximately $200 f.o.b.

Distillation Products (subsidiary of Eastman Kodak Co.), Rochester, N. Y.

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A BETTERMENT . . .

Not a Substitute

The 1942 Scouting Plane is more than a substitute for the Observation Balloon of 1860.

The Scouting Plane is an advancement . . . a BETTERMENT!

And likewise . . . CONTINENTAL-DIAMOND NON-metallics are not substitute materials for corrosive, weighty, costly, and now hard-to-get materials. C-D NON-metallics possess unique characteristic combinations that make them ideally suited to meet many of the material problems of a war or peace economy.

Manufacturers who design to use C-D NON-metallics to the fullest measure of their capabilities will never go back to "Observation Balloon Days" . . . because they will have built into their products NON-metallic materials which are as modern as today's Scouting Plane.

A booklet describes all FIVE C-D NON-metallics. Ask for GF-13. Then, when you are ready to get down to brass tacks, write, wire or phone us about your problem . . . or ask us to send around one of our Research Engineers.

Continental-Diamond FIBRE COMPANY

Established 1895 . . Manufacturers of Laminated Plastics since 1911 — NEWARK • DELAWARE

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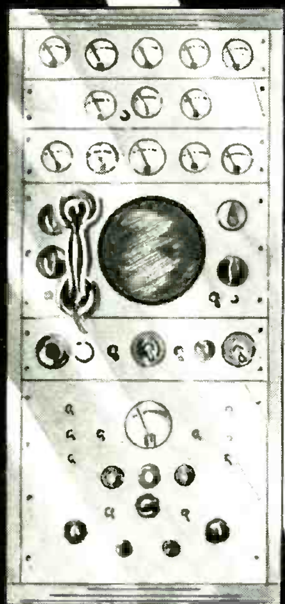
Pinch Hitting

Where Angels Fear To Tread



Oxford-Tartak Engineers are now running the gamut of war contracts. Almost overnight, production swings from one intricate device to another more complicated complete set. Our effort calls for versatility—we're giving it in Emergency Time. Here are a few typical assignments:

- ***Aviation Radio Range Filters***
- ***Transformers***
- ***Relay Coils***
- ***Transmitters***
- ***Electronic Equipments and Test Units***

Oxford-Tartak facilities are geared up full blast to take prime contracts and sub-contracts. And after the war is over, we will produce, from our greater experience, a finer line of popular priced equipment.

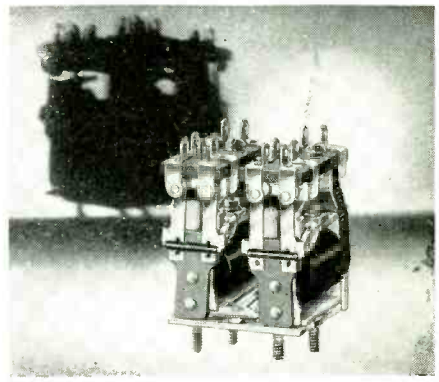
NOTE: For obvious reasons neither article illustrated is a new or military development.

OXFORD-TARTAK RADIO CORP.

3911 S. Michigan Ave., Chicago, Ill.

Latching Relay

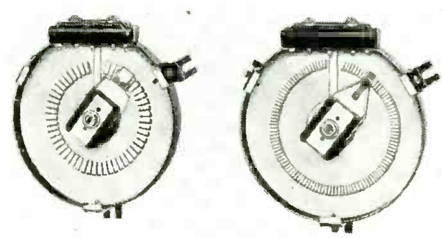
TYPE BJU AIRCRAFT RELAYS are available for either alternating or direct current. These relays lock mechanically in either position so that only momentary current needs to be applied to the coils. Other features include: 4 pole double throw contacts, maximum (non-inductive) rating of 5 amps per contact, weight 7 ounces, size 1 13/16 x 1 15/16 x 2 inches. They meet every Army, Navy or CAA specifications.



Allied Control Co., Inc., 227 Fulton St., New York, N. Y.

Pressed Steel Rheostats

THE MANUFACTURER HAS designed these pressed steel rheostats with solid rectangular contacts to provide a finer degree of control, smoother operation, and certain economies where interpolating rheostats would otherwise be required. Rectangular contacts are available in small and large sizes:—Small rectangular contacts can be furnished on 13 inch or smaller rheostats. Large rectangular contacts may be had on 8 inch or larger rheostats. Rheostats with rectangular contacts are available with complete enclosures, fittings for conduit connections, motor drives, and with accessories for floor, back-of-board and concentric mounting. Fixed and adjustable stops to protect control equipment can also be provided. The accompanying photo shows two Vitrohm field rheostats. The one on the left has large rectangular contacts while the one on the right has small rectangular contacts.



These and other rheostats are listed in a new 16-page Bulletin No. 60, available from Ward Leonard Electric Co., Mount Vernon, N. Y.

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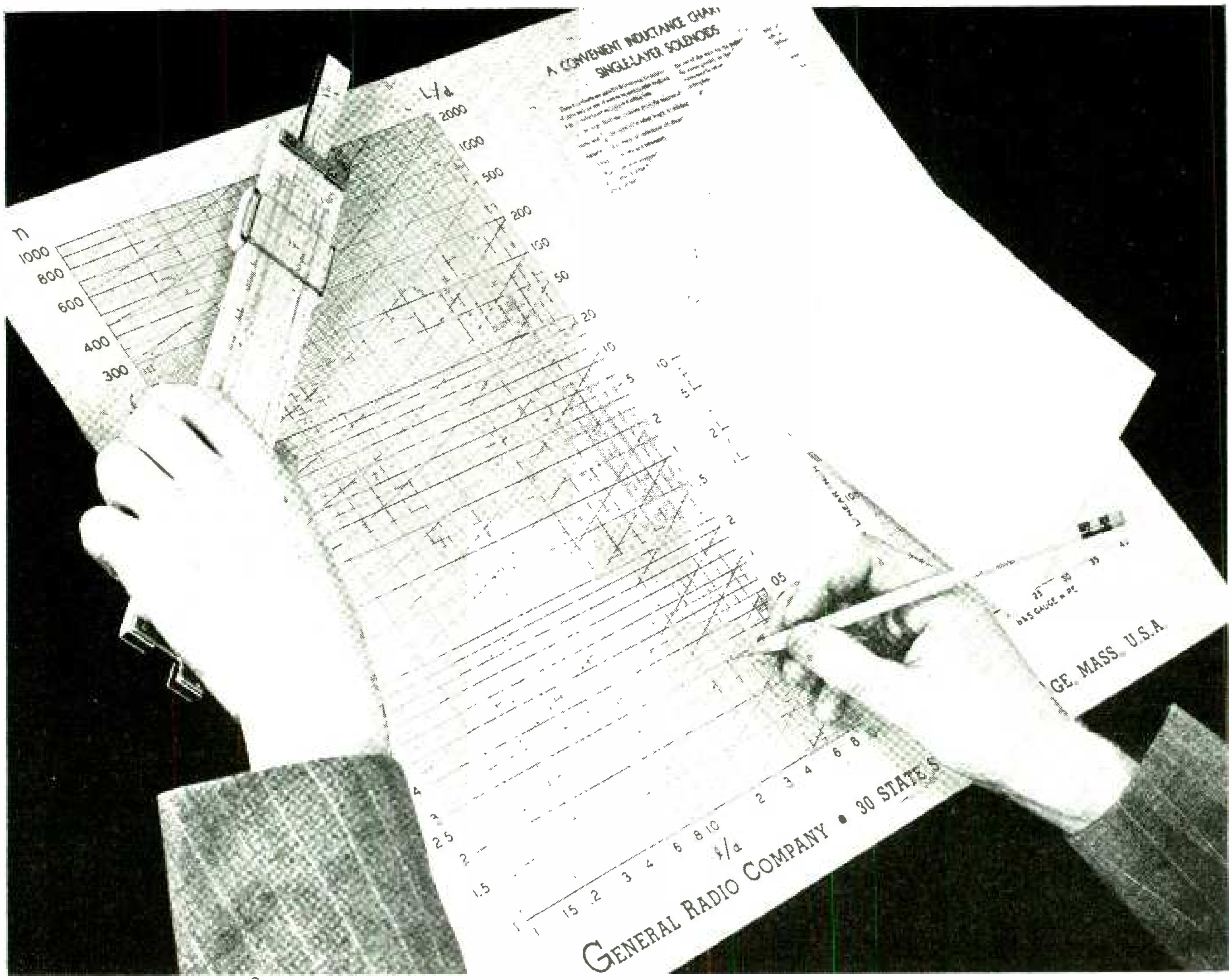


This Chart Saves Time . . .

Designing inductors for use at radio frequencies takes time. Even when accurate formulae are available, computing inductance may be tedious. Practically every radio engineer has to design inductors occasionally; many design them continually.

To save time in our own laboratories, we have devised a design chart for single layer coils which gives results to very good accuracy. It is entitled "A Convenient Inductance Chart for Single-Layer Solenoids," and is 18″ x 22″ overall, suitable for wall mounting. It is used for determining the number of turns and the size of wire to be used in order to obtain a given inductance on a given winding form. The explanation includes an example.

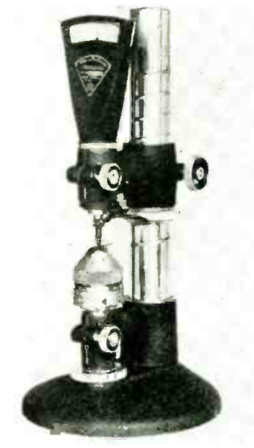
A number of these charts are available for our friends. If you can use a copy, we shall be glad to send it on request. Ask for Inductance Chart No. 799.

GENERAL RADIO COMPANY · Cambridge, Massachusetts

www.americanradiohistory.com

Measuring Device for Extremely Thin Pieces

A NEW BALL MEASURING anvil for use on the manufacturers "Comparitol" was designed to speed up, simplify and guarantee accuracy for the measurement of thin work such as quartz crystals, laminations, shims, extremely small gages, and other flat work. Accurate readings may be obtained in measurements such as 0.0001 inch or

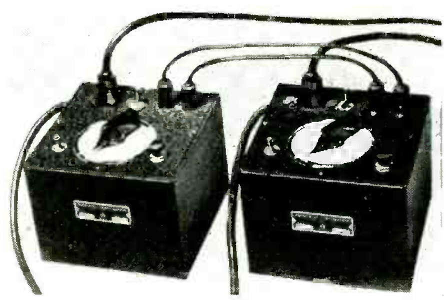


0.00005 inch. The piece to be measured is placed between the flat feeler point and the round ball surface and accurate measurements can be made regardless of which part of the thin piece under inspection is being measured. All danger of distorting or bending the shim or lamination out of size a few ten-thousandths of an inch due to measuring pressure of the instrument is eliminated. This measuring device may also be used to check the flatness or parallelism of long thin pieces in all positions and on all parts of the work.

George Scherr Co., Inc., 128 Lafayette St., New York, N. Y.

Electronic Timer

THIS IS AN ADJUSTABLE timing relay with immediate automatic resetting for timing periods from 1/20 second on. The function of the timer is to close or open an electrical circuit for a preset time interval. These timers are de-



signed for single actuation as well as for sequence timing and recycling in continuous operation and thus provide a wide range of operating combinations. When the timer is actuated, a

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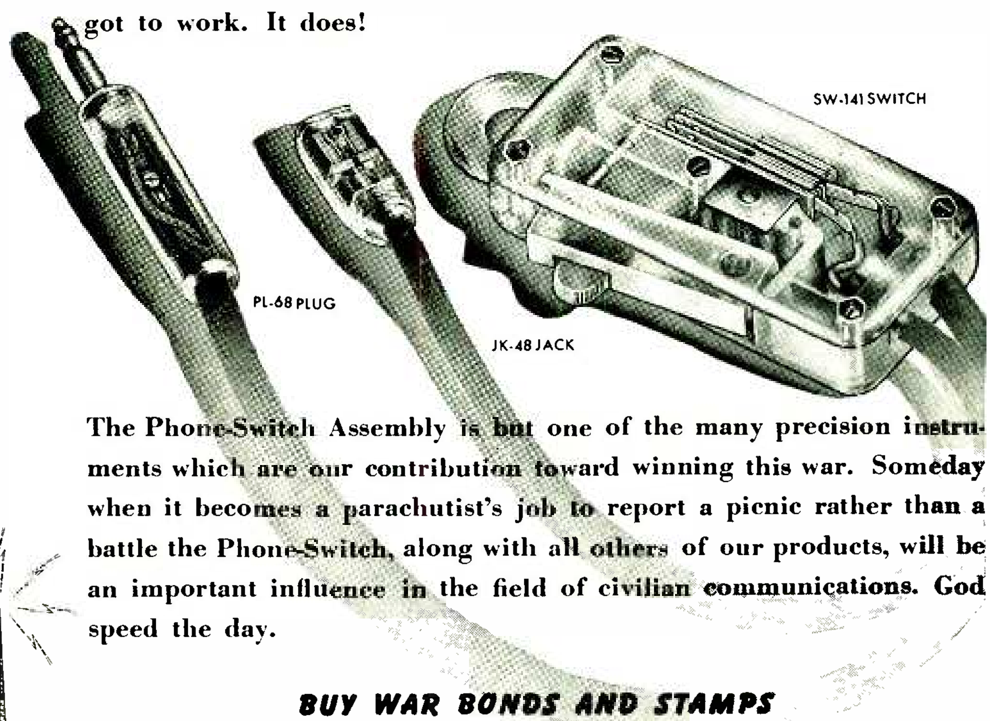
NO PLACE TO MONKEY AROUND WITH THE LAW OF GRAVITY!

Man going down . . . in a hurry. The geography of the territory must be surveyed and the movements of the enemy observed . . . and reported . . . on the way down.

The law of gravity still holds good . . . and the man at parachute's end must be keen-eyed and quick-minded. However, these important human qualities won't help him much without proper equipment.

An integral part of a parachutist's paraphernalia is the Phone-Switch unit made by American Radio Hardware Co. This is the vital connecting link between air and ground communications—and it has got to work. It does!



The Phone-Switch Assembly is but one of the many precision instruments which are our contribution toward winning this war. Someday when it becomes a parachutist's job to report a picnic rather than a battle the Phone-Switch, along with all others of our products, will be an important influence in the field of civilian communications. God speed the day.

BUY WAR BONDS AND STAMPS

ARHCO RADIO PRODUCTS

American Radio Hardware Co., Inc.

476 BROADWAY, NEW YORK, N. Y.

Write for Catalogue

MANUFACTURERS OF SHORT WAVE • TELEVISION • RADIO • SOUND EQUIPMENT

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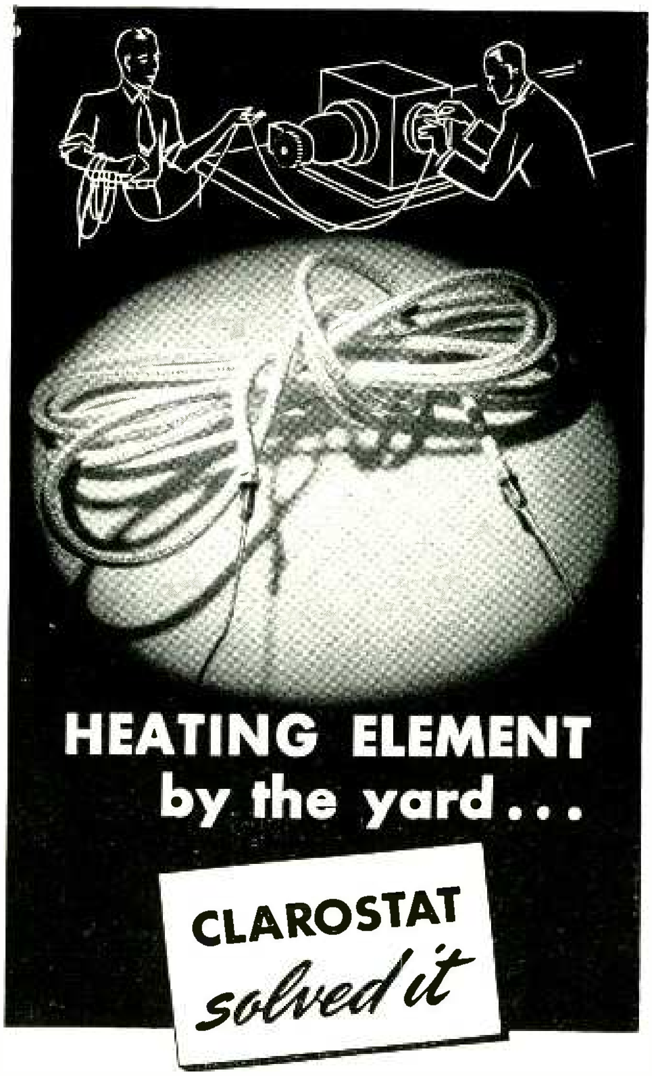

★ Flexible, compact, indestructible; an element that could be jammed into tight places, snugly fitting around parts to be heated, for maximum efficiency; any length by inches or feet. . . .

An outstanding manufacturer of precision navigational instruments submitted that problem to Clarostat. And Clarostat engineers soon had the solution in still another adaptation of their well-known Glasohms.

Produced in any length, Glasohms are the ideal low-wattage heating element or resistor. Fibreglass core and braided cover for the resistance-wire winding. Flexible. 1 to 2 watts per inch, depending upon application. Operating temperatures up to 750° F. Terminals—or without terminals.

Interested? Write for data. Let us quote on your requirements, whether usual or unusual.

CLAROSTAT *Manufacturing Co.* INC.
285-287 NORTH SIXTH STREET
BROOKLYN, NEW YORK, U.S.A.
• OFFICES IN PRINCIPAL CITIES •

charged condenser begins to discharge, the rate of discharge being controlled by adjustable resistors. Simultaneously with the actuation, amplifier tubes energize the relay. When the discharge of the condenser is completed, the amplifier tubes become inoperative and the relay is de-energized. The timer operates without clockwork or motor or any mechanically moving part except for the relay. To permit all possible switching operations which may occur in actual timing work such features as powered and unpowered load (which can be switched simultaneously), adjustments for "normally open" and "normally closed", and push-button and remote control have been incorporated in the instrument. The illustration shows two timers (Model 900) connected for recycling.

Photovolt Corp., 95 Madison Ave., New York, N. Y.

Phonograph Needle

THIS NEW PHONOGRAPH needle is called "Jensen Concert Needle" and utilizes a spring action construction. The needle is made rigid in a cross-wise plane so that all frequencies in the record are transmitted without loss to

the mechanism in the pick-up. A flattened cross-section, which causes less air to be agitated direct, reduces "needle-talk." Scratches and hisses which emanate directly from the needle are eliminated and cannot be heard even when the top on the phonograph is left open. The needle point itself is made from the manufacturers own formula of an alloy of precious metals. The point is made for greater wear-resisting qualities rather than extreme hardness.

Jensen Industries, Inc., 737 North Michigan Ave., Chicago, Ill.

D-C Power Supply

THIS POWER SUPPLY operates from alternating current lines to provide continuous direct current for the operation of direct current or battery-operated equipment. Units of this type are available in a variety of physical mounting

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REA

MAGNET WIRE HEADQUARTERS

ALL INSULATIONS

SILK GLASS
PAPER COTTON
NYLON FORMVAR
ENAMELED

REA MAGNET WIRE COMPANY
FORT WAYNE, INDIANA

WITH VICTORY AT STAKE THE BEST IS NONE TOO GOOD!

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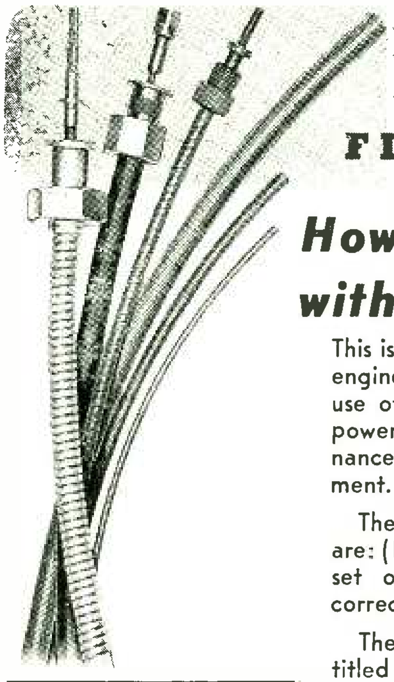

S·S·White for FLEXIBLE SHAFTS

How to get Best Results with Flexible Shafts

This is a subject of immediate interest to many engineers because of the wide and growing use of flexible shafts for remote control and power drive purposes in planes, tanks, ordnance, naval, signal corps and other war equipment.

The two basic points in getting best results are: (1) Selection of the right shaft for a given set of conditions; (2) Applying the shaft correctly.

These points are discussed in a bulletin titled "How to Make the Most of Flexible Shafts". We will be glad to mail you a copy on request.

CONSULT S. S. WHITE *when you need flexible shafts. Also for engineering aid in selecting and applying flexible shafts for any remote control or power drive application. At present, of course, our products and services are confined to work connected with war production.*

ASK FOR BULLETIN 641

S. S. WHITE

The S. S. White Dental Mfg. Co.

INDUSTRIAL DIVISION

Department E, 10 East 40th St., New York, N. Y.

Solve Voltage Variation PROBLEMS IN AIRCRAFT, TANKS, ETC. WITH

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Features:—

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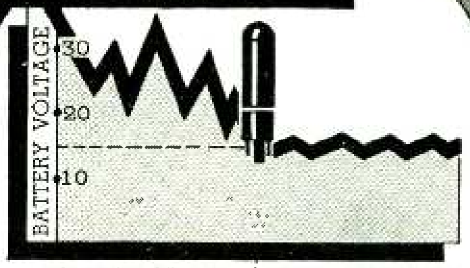

VOLTAGE OF 24V BATTERY & CHARGER VARIES APPROX. 50% | WITH AMPERITE VOLTAGE VARIES ONLY 2%

AMPERITE COMPANY • 561 Broadway, New York, N. Y.
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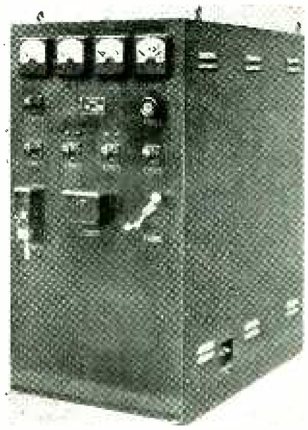
styles and can be made for operation on various line potentials and frequencies. This unit employs gaseous type rectifiers, has a two-section filter and a special built-in automatic voltage regulating device. It delivers 110 volts direct current up to 15 amps. The input circuit is designed to permit use on alternating current lines of various voltages.

Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.

Thyratron Rectifier

DIRECT-CURRENT CABLE-FAULT reduction and localization sets are available for locating faults on power-cable systems. The complete set consists of a thyratron rectifier, control, motor-driven interrupter, and current-limiting reactor, (completely enclosed in a metal housing), and a portable field set for



taking readings along the cable. The set first reduces the resistance of the fault to a satisfactory value and then transmits a tracer current which may be easily recognized by traversing the cable with the portable field set. Traversing the cable and observing indications at manholes requires less time than heretofore, and the method is positive. The instrument can be used up to its maximum-rated voltage for direct-current high-potential tests on cable systems and other apparatus. It is available in eight different ratings up to 20,000 volts and up to 20 amps.

General Electric Co., Schenectady, N. Y.

Insulating Varnishes

THREE TYPES OF "Bulls-Eye" insulating varnishes are available. The first of these is Type G which has high impregnating qualities and high elasticity over a maximum range of temperature. It is flexible and tough and has high dielectric strength. It can be used as a binding or coating tape for glass, paper or absestos fibres, or it can be used for binding cotton. The two other varnishes are Type BF and Type KR. Both of these come in black or yellow colors. Type BF is for use in impregnating

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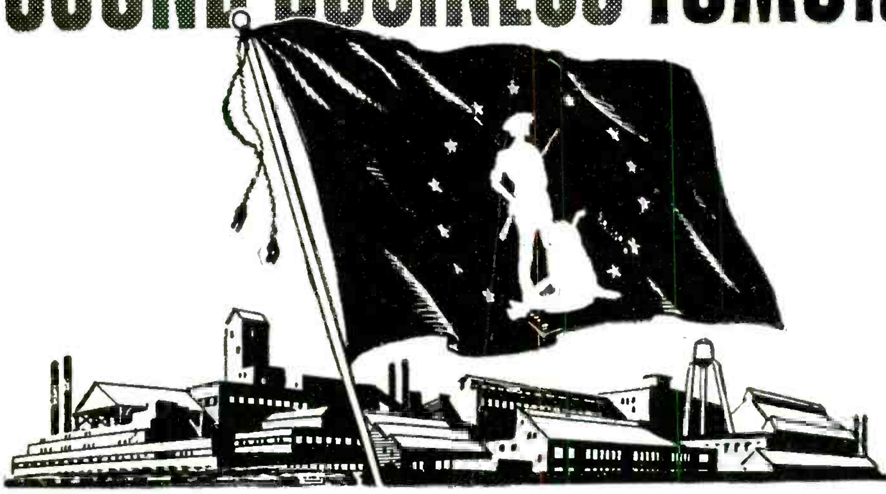
FOR VICTORY TODAY AND SOUND BUSINESS TOMORROW



Get This Flag Flying Now!

This War Savings Flag which flies today over companies, large and small, all across the land means *business.* It means, first, that 10% of the company's gross pay roll is being invested in War Bonds by the workers voluntarily.

It also means that the employees of all these companies are doing their part for Victory . . . by helping to buy the guns, tanks, and planes that America and her allies *must* have to win.

It means that billions of dollars are being diverted from "bidding" for the constantly shrinking stock of goods available, thus putting a brake on inflation. And it means that billions of dollars will be held in readiness for post-war readjustment.

Think what 10% of the national income, saved in War Bonds now, month after month, can buy when the war ends!

For Victory today . . . and prosperity *tomorrow,* keep the War Bond Pay-roll Savings Plan rolling in *your* firm. Get that flag flying now! Your State War Savings Staff Administrator will gladly explain how you may do so.

If your firm has not already installed the Payroll Savings Plan, *now is the time to do so.* For full details, plus samples of result-getting literature and promotional helps, write or wire: War Savings Staff, Section F, Treasury Department, 709 Twelfth Street NW., Washington, D. C.

EVERYBODY EVERY PAYDAY AT LEAST 10%

Save With
War Savings Bonds

This Space Is a Contribution to America's All-Out War Program by

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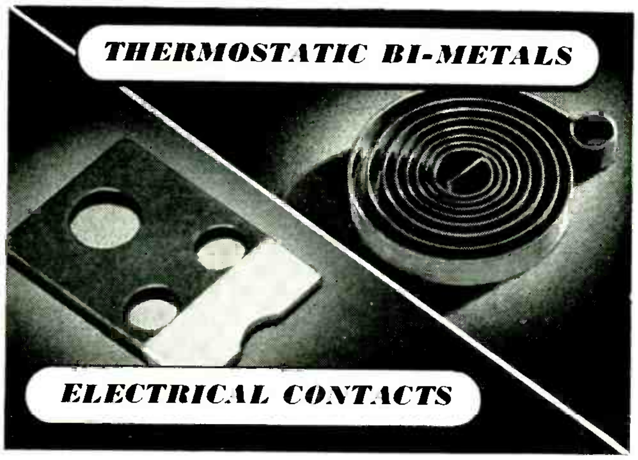

Fans or Flying Fortresses

★ The H. A. Wilson Company is playing a vital role in today's war production—just as it has for over 27 years in peace-time industry. Meeting the most exacting war requirements, Wilco offers a wide variety of specialized thermostatic bi-metals of the high and low temperature types. Also a series of resistance bi-metals, (from 24 to 440 ohms, per sq. mil, ft.). Wilco electrical contact alloys are available in Silver, Platinum, Gold, Tungsten, Special Alloys, Metal Powder Groups. Wilco Aeralloy is the outstanding aircraft magneto contact alloy. Wilco engineers welcome your problem.

The H. A. WILSON CO.
105 CHESTNUT ST., NEWARK, N. J.
Branches: Chicago and Detroit

coils, motors and transformers. Type KR can be used for impregnating cloth, or it can be used on laminated metal sheets which can be fabricated after the application of the varnish.

William Zinsser & Co., Inc., 516 West 58th St., New York, N. Y.

Balancer

"Dy-Namic Balancing" is the name of a new balancing machine which was designed to eliminate the noise and premature wear of shafts, production line machinery, motors, bearings, etc., resulting from the excessive vibrations of rotating parts. The instrument will indicate with accuracy the disturbing centrifugal force or force couple, and both the angular position and the value or amount of unbalance is shown at the same time. A variety of models ranging from bench models to large floor and pit-type models are available for balancing equipment weighing from 6 ounces to 1000 pounds. These machines are easy to operate and are economical.

Bear Mfg. Co., Industrial Div., Rock Island, Ill.

Literature

Measurement Instruments. Bulletin D-1 describes the No. 630 Wheatstone bridge. This is a basic electrical measuring instrument which can be used by laboratories and manufacturers for production testing. Also described and illustrated is No. 638-1 Kelvin Wheatstone bridge, an electrical resistance-measuring instrument and No. 621-A percent limit bridge for rapid testing of resistances. Bulletin D-1 from Shallcross Mfg. Co., Collingdale, Pa.

Guidance Manual. "Manual for Committees of Engineers Interested in Engineering Education and the Engineering Profession" an aid to engineers and committees acting in an advisory capacity to high school students considering engineering as a vocation. It includes a separately bound appendix addressed to the student as a prospective engineer. Copies of the manual with appendix may be obtained from Engineers' Council for Professional Development, 29 W. 39th St., New York City, at ten cents per copy, copies of the appendix at five cents per copy, discount on quantity orders.

Wavemeter. In the September 1942 issue of the *Experimenter* is a description of a general purpose wavemeter (Type 566-A). Among its uses may be mentioned its application for checking the frequency ranges of oscillator coils, setting and determining oscillator frequencies and finding the frequencies of

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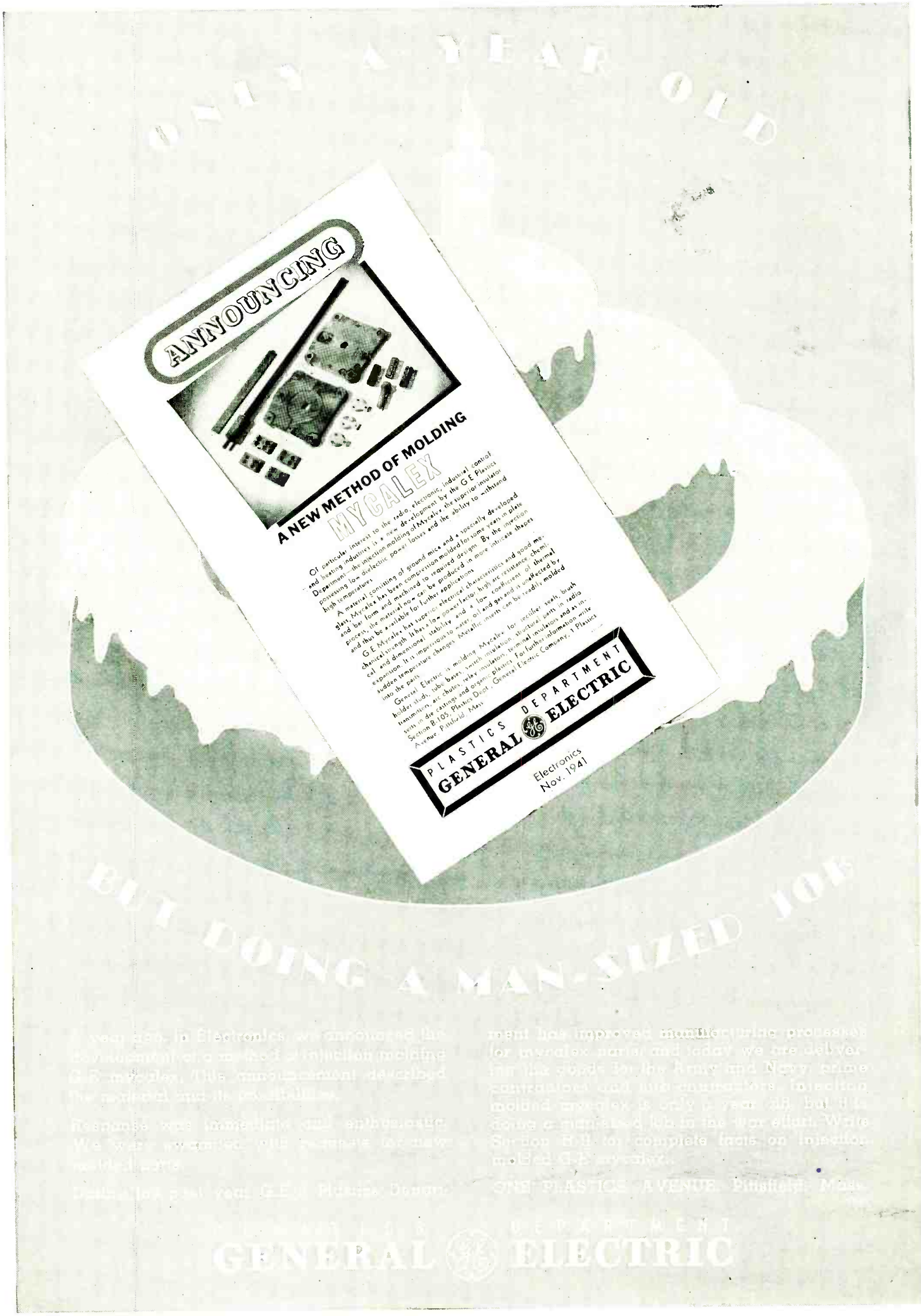
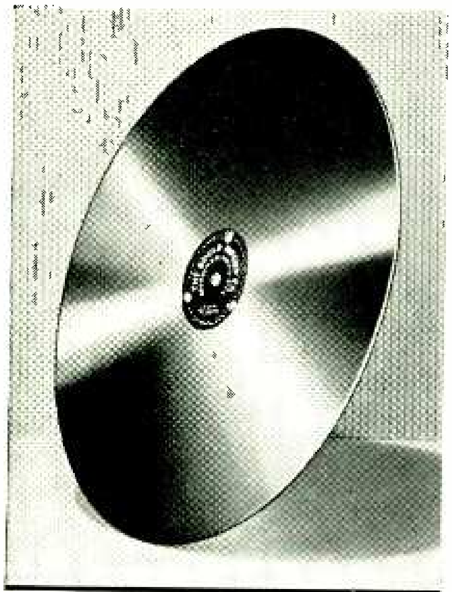
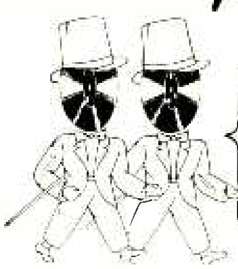

ONLY A YEAR OLD
ANNOUNCING
A NEW METHOD OF MOLDING
MYCALEX
PLASTICS DEPARTMENT
GENERAL ELECTRIC
Electronics
Nov. 1941
BUT DOING A MAN-SIZED JOB
GENERAL ELECTRIC



Try them at our expense!



- Choice: Medium weight or flexible glass.
- Both with two or four holes.
- All glass . . . no fibre or foreign material inserts to warp or fall out.
- No metal gromets to "wow"; holes precision machined in glass.
- Priced at less than other fine brands; immediate delivery.

HERE'S OUR GUARANTEE!

Send for a trial order. If you're not entirely satisfied, return the unused blanks, and keep the used ones with our compliments. We'll pay freight both ways. You've got nothing to lose.

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"BLACK SEAL"
GLASS BASE INSTANTANEOUS
RECORDING BLANKS

TURN IN YOUR SCRAP • UNCLE SAM NEEDS IT!

parasitic oscillation in r-f amplifiers. It has a frequency range of 0.5 to 150 Mc.

Also in this issue are several other articles: "Measuring Balanced Impedances with the R-F Bridge," "Taking the Pulse of Turbines," "Using a Polarizing Voltage with the Capacitance Test Bridge" and a list of discontinued instruments. General Radio Co., 30 State St., Cambridge A, Mass.

Tubes. A booklet "Thirteen Ways to Prolong Tube Life" contains hints on how to get the longest service from electronic tubes. It covers: plate dissipation, circuit tuning, saving watt hours, minimizing stray circuit losses in class C stages, adjustment of grid drive, maintainance of rated filament voltages, prevention of parasitic oscillations and other subjects. Heintz and Kaufman, Ltd., 1012 Tanforan Ave., S. San Francisco, Calif.

Screw Products. An up-to-date listing of aviation products, machine screws, cap screws, set screws, wood screws, sheet metal screws, Phillips head screws, bolts, studs, rods, nuts, stampings, rivets, eyelets, pins, bright wire goods, toggle bolts, anchors, shields and special screws made. Manufacturers Screw Products, 216–222 W. Hubbard St., Chicago, Ill.

Positioners. Bulletin WP 22 is an illustrated bulletin describing the practice of welding on positioners. It gives the functions, safety factors, features, and installation suggestions. Several welding positioners are described and illustrated and their adaptability is pointed out. Cullen—Friestedt Co., 1300 S. Kilbourn Ave., Chicago, Ill.

Breakdown Testers. Model IT-30-J insulation breakdown tester and Model IT-25 portable insulation breakdown test set, designed for accurate testing of apparatus at fixed voltages, is described and illustrated in a four page folder released by Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.

Fasteners. In an 11-page booklet "Camloc" is described. This fastener is used on airplanes for parts and panels requiring instant removal and replacement. It describes the construction, replacement and maintenance of the fasteners. Camloc Fastener Co., 420 Lexington Ave., New York, N. Y.

Plastics. In a folder entitled "Plastic Parts for War Production" several plastic parts are illustrated. The folder also tells how companies may send a blueprint or sample for immediate quotation. Creative Plastics Corp., 963 Kent Ave., Brooklyn, N. Y.

Tubing. In a 4-page folder standard shapes, special shapes and parts of seamless steel tubing are illustrated. The usefulness to which seamless tubing has been put recently is pointed out. Summerill Tubing Co., Bridgeport, Pa.

Induction Heating Equipment. Catalog E-10 contains data on the most recent developments of high frequency induction heating. The booklet explains how induction heating units save time and money, how to apply heat treating applications to irregularly shaped parts as well as symmetrical parts, how it is applied to metal joining and melting. The construction features of several units are explained. Catalog E-10 obtainable from Lepel High Frequency Labs, Inc., 39 West 60th St., New York, New York.

High Altitude Chambers. Described and illustrated in an 11-page booklet are high altitude chambers, constant temperature bath tables, temperature and humidity cabinets, all-weather units, and weathering cabinets. The installations described are standard units. The booklet also explains how to go about ordering special units built to specifications for exceptional purposes. Tenney Engineering, Inc., Dept. E, 8-A Elm St., Montclair, N. J.

Lathe Operation. A 16-page illustrated booklet "Keep Your Lathe Clean" explains how keeping lathes clean will help increase production, reduce scrap, and lengthen the life of the lathe. This Bulletin H-1 is the first of a series which are being issued to lathe users and operators to help them get the best service out of their lathes. Copies of Bulletin H-1 from South Bend Lathe Works, Dept. 4E, South Bend, Indiana.

Portable Tool Accessories. This is a new manual which shows types of mounted wheels and a wide variety of portable tool accessories. Included is a selection guide for mounted wheels, data on the grinding of all class material with mounted wheels and a section devoted to a newly developed polishing wheel. Chicago Wheel & Mfg. Co., 1101 W. Monroe St., Chicago, Ill.

Rheostats. Bulletin 60A contains general information on rheostats. Included in this bulletin are data on field rheostats, solid rectangular contacts, motor drive accessories, pressed steel plate type rheostats, manual drive accessories for individually mounted rheostats, field discharge resistors, and a listing of spare parts. Ward Leonard Electric Co., Mount Vernon, New York.

Circuit Breakers. 15,000-volt oil circuit breakers for indoor use, classes 150-TCR-3 and 250-TCR-3, are described in catalog No. 3350. These breakers are of the oil tight single round tank type, single throw, and are available in 2 and 3 pole designs. Class 150-TCR-3 breakers are available in 600 and 1200 ampere capacities and have an interrupting capacity of 150,000 kva. Class 250-TCR-3 breakers, which can be furnished in 600, 1200, and 2000 ampere ratings, have an interrupting capacity of 250,000 kva. Roller-Smith Co., Bethlehem, Pa.

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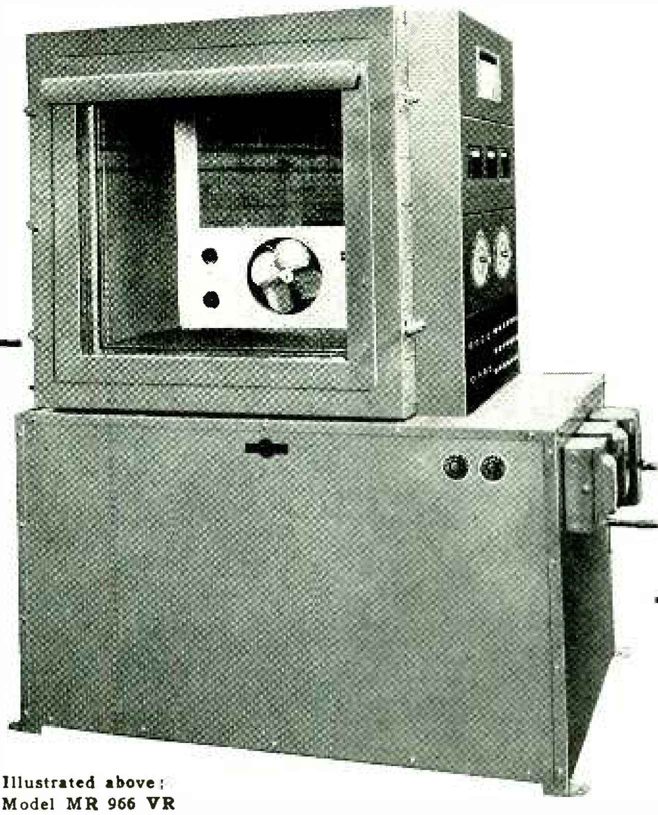
HIGH ALTITUDE . . . . .
TEST and CALIBRATION CHAMBERS
FOR AIRCRAFT AND ELECTRONIC INSTRUMENTS

POSITIVE AUTOMATIC MECHANICAL MEANS PROVIDE:



Illustrated above:
Model MR 966 VR

- LOW TEMPERATURES TO —100° F.
- HIGH TEMPERATURE +158° F.
- TEMPERATURES THERMOSTATICALLY HELD WITHIN ±2° F.
- ALTITUDE 60,000 feet. 2.13" Hg. abs.
- INTERNAL PRESSURES TO 30 lbs./SQUARE INCH
- RATE OF CLIMB TO 10,000 FEET/MINUTE
- HUMIDITIES
  AUTOMATIC OR MANUAL CONTROL

- Standard Models are available in two sizes of clear visible test space:

  MR 966 VR—24 in. high by 24 in. wide by 16" front to back.

  MR 965 VR—12 in. high by 12 in. wide by 12" front to back.

Temperature Ranges for standard models are from +158°Fahr. to -40°F, -76°F, or -100°F.

- Model illustrated includes standard four-panel relay rack. Bottom panel has separate controls and indicator lights for chamber functions as well as 20 direct electrical connections to the chamber interior. Next panel is equipped with 2 micrometer type dials and control shafts extending through the chamber wall. Top panels come blank for mounting your own instrumentation.

- Engineering department will gladly cooperate with you on any high altitude test or calibration problem or on special size or purpose chambers.

MOBILE REFRIGERATION INC.
630—5th AVENUE **NEW YORK, N. Y.**

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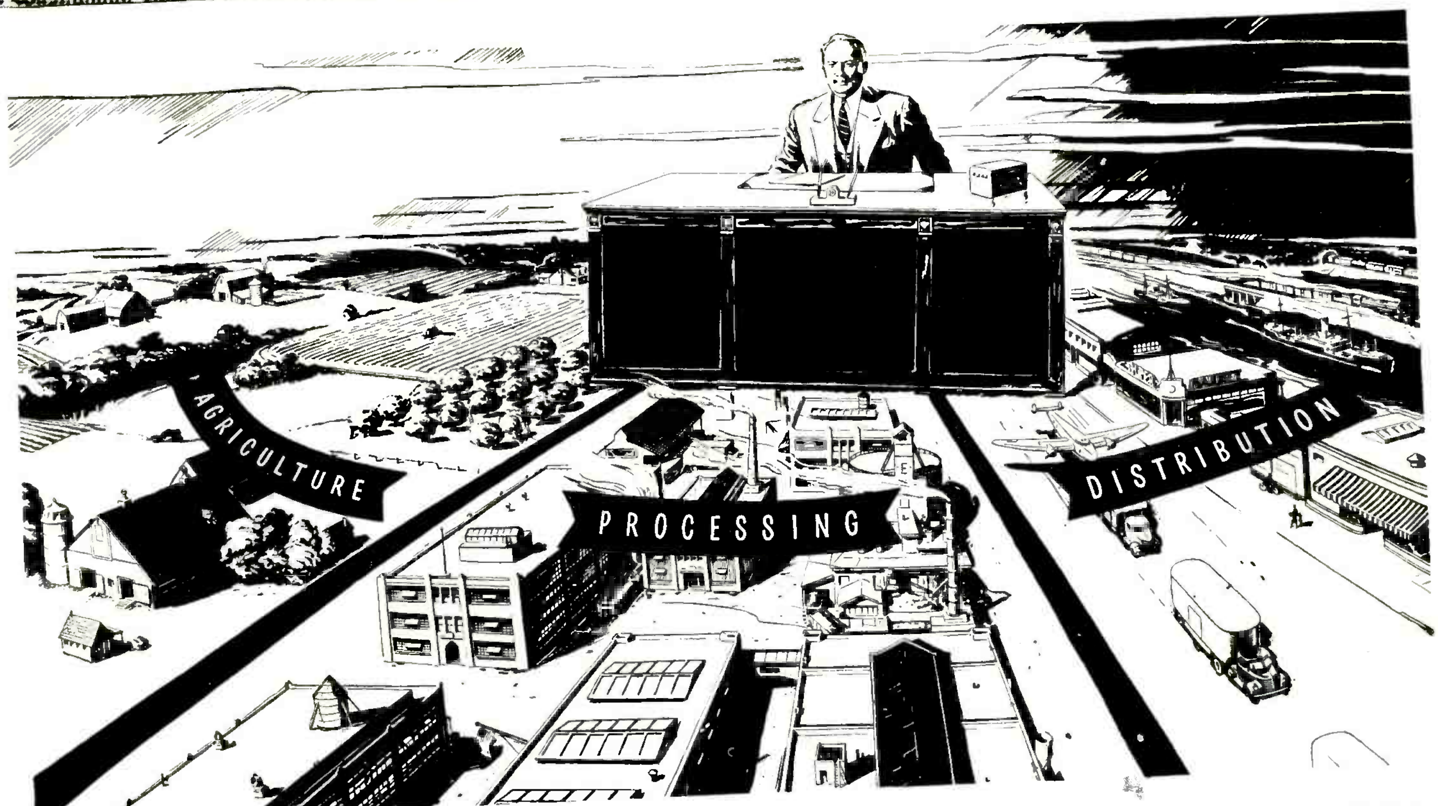

America needs a Food Administrator—NOW

IN war or in peace, you and your fellow Americans require 1,465 lbs. (raw weight) of food every year. Soldiers require even more.

In all, for ourselves and our allies, America must produce, process and transport 250 billion pounds of food per year, for the duration, and for many years thereafter.

► Don't try to remember that figure, but *do* remember that food processing is a huge industry, in a high state of technical development, but not yet fully coordinated into the war effort.

The food industry needs over-all coordination, comparable to long-last rubber coordination. America needs an administrator of food supply; to assure priorities in equipment and transportation and to end conflicting and overlapping committee jurisdiction.

If the food supply gets into a tangle, through lack of a comprehensive plan, the result will make the rubber shortage seem a picnic in comparison.

► In the impending pandemonium, the Food Production Engineer will be strictly in the middle. He is neither a grower nor a global strategist, but a production man who must needs wait for government to call its shots on growing, equipment production and distribution.

The Food Production Engineer must see that the food is grown in proper quantities, at proper distances from his plant, and delivered in perfect condition . . . From that moment, he has all the problems of ordinary manufacturing, plus the job of contriving to retain the fleeting qualities of color, aroma, taste, texture and nutritive value which nature intended only for a few brief hours of ripeness.

That was tough to do, even in the days of unlimited refrigeration and canning. But under the urge of saving cargo space for men and munitions, new miracles have been worked.

Fortunately for us, in the continuous battle between bulk and low cubic content, the latter is winning.

Food Production Engineers—by developing machines and processes for trimming and compressing—have reduced whole sides of beef to a carton the size of a suit box.

► They have replaced sunken refrigerator ships by lining the holds of ordinary cargo vessels with boxes of frozen lard. Preserved by this Yankee "ice house" trick, frozen meats arrive overseas in perfect condition—while the lard goes to allied explosives plants for making TNT.

Eggs, stripped of their shells, travel through a fabulous array of processing machines, leaving space-taking water in America, but sending every ounce of energy-giving food value to our far-flung armies and allies.

When the Food Processor gets through with a basket of ripe tomatoes, you can hold the resulting cellophaned package in the palm of your hand . . . and only replaceable water has been lost.

► The work these men are doing will easily be the equivalent of launching a ship a day, as the processes which have been perfected are applied in more and more food plants.

If, under the constant pressure of tire, tin, and freight-car shortages, you find yourself sitting down to meals of dehyrated meats, fruits and vegetables, you can thank the Food Production Engineer for the fact that the tomato dishes will be ripe—red and delicious in taste, that soups are full-flavored and nourishing. That nothing has been lost but the water you have replaced.

Reprints of this advertisement are available in handy booklet form.

McGRAW-HILL PUBLISHING COMPANY, Inc.

330 WEST 42ND STREET • • NEW YORK

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This advertisement appeared in a group of newspapers on Tuesday, October 13, 1942

How do you get the cube root of a cow?

READ the newspaper advertisement, reprinted opposite, and you'll see we are telling the public (and government) about the job engineers are doing in stuffing bigger food production into fewer ships.

When you get to that part of the ad that tells about Food Engineers reducing a cow's carcass to the size of a couple of suit boxes, you will have reached the point where McGraw-Hill really lives.

In Food Production, too, it's our job to collect the "how-to-do-it" news on each new advance in technology and equipment, and pass on this information to an entire industry.

The Industrial Press of America implements the exchange of ideas, which is a national characteristic and one of the secrets of our industrial development.

Through the interchange of ideas, made possible by the Industrial Press, the sum of American technical genius is greater than the sum of its parts.

If a food engineer in Illinois learns how to add and control Vitamin A in a food product, all food manufacturers learn how it was done, through a magazine like FOOD INDUSTRIES.*

If a manufacturer develops a new dehydrating machine, production men learn what it will do and how it operates, through the informative and helpful advertising that is characteristic of the Industrial Press.

No matter what your industry or your job, you can probably remember many instances where an industrial magazine has helped you find a solution to a production problem.

But valuable as they are, Industrial Magazines cost only a few dollars per year.

That's why the route slip is so puzzling. If a man needs to see a magazine at all, he should not be under pressure to pass it along.

For help in studying the proper distribution of technical magazines among the men in your organization, write to the Reading Counsellor, c/o McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York.

★ ★ ★

THE McGRAW-HILL NETWORK

23 publications, which gather "war-news" from the "war-production-front" through a staff of 153 editors and 725 engineer-correspondents . . . More than 1,000,000 executives, designers, production men and distributors use the editorial and advertising pages of these magazines to exchange ideas on war-production problems.

THE McGRAW-HILL BOOKS

Publishers of technical, engineering and business books for colleges, schools, and for business and industrial use.

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Electrical West
Electrical World
Electronics
Engineering & Mining Journal
E. & M. J. Metal and Mineral Markets
Engineering News-Record
Factory Management & Maintenance
*FOOD INDUSTRIES—Shows how to Manage Production, Retain Nutrition and Appetite Appeal.
Mill Supplies
Power
Product Engineering
Textile World
Transit Journal
Wholesaler's Salesman

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RECENT U.S. PATENTS

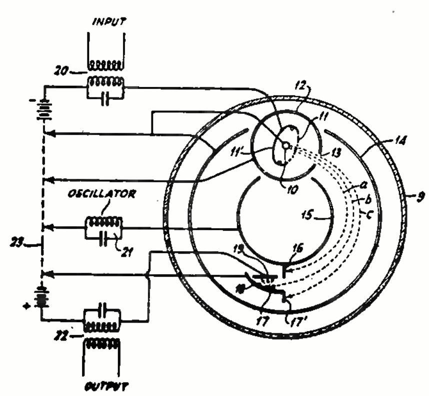
Each week the United States Patent Office issues grants to many hundreds of inventions that pass the acid test of that office. A few of those relating to electronics are reviewed here

High-Frequency Apparatus

Detector. A shield-grid type of velocity-modulation tube comprising means interposed in the electron stream to shield the collector and to accelerate electrons toward the collector independent of the potential of the collector. F. E. Terman, International Standard Electric. No. 2,293,180.

Amplifier. Tube containing a secondary-emission electrode and a circuit for using it as a high-frequency amplifier. M.J.O. Strutt, Eindhoven. No. 2,293,415.

Beam Tube. Secondary-emission type of tube in which a control means is used for making the electrons travel in

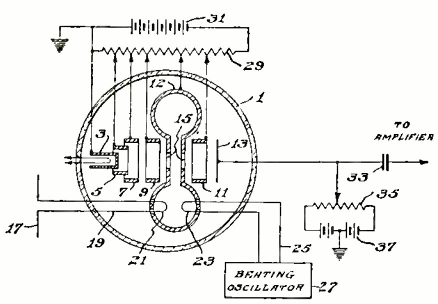


curved paths. H. C. Thompson, RCA No. 2,293,417 and No. 2,293,418 to R. M. Wagner, RCA.

Wave Absorber. In an ultrahigh frequency radio device, a container in which standing waves of ultrahigh r-f energy are formed and absorbing means comprising a mass of loosely packed fibrous conductors positioned within the container for minimizing the standing waves. E. G. Linder, RCA. No. 2,293,839.

UHF Modulator. Anode coupled to grid of triode; modulating voltages fed to tube through double-winding transformer, the windings being so poled and adjusted that frequency modulation occurs but so that the output energy of the oscillator remains constant. K. Christ, C. Lorenz. No. 2,294,073.

Cavity Device. Resonant cavity between source and collector of electrons, means for adjusting phase of electrons passing through the cavity so that velocity variations are produced, a hollow



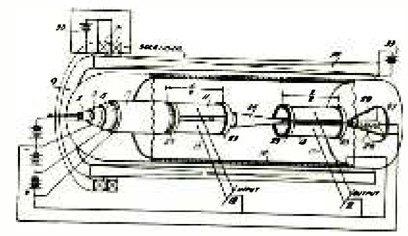
electrode between cavity and collector biased independently of the cavity and collector, the hollow electrode having the purpose of returning electrons to the cavity and for adjusting their phase so that the returning electrons produce uhf waves within cavity. E. G. Linder, RCA. No. 2,293,151.

UHF Device. In a radio device, a shielding container enclosing a source of uhf oscillations, a removable partition dividing said container into separate compartments, one of said compartments containing said source, the size of the other of compartments being adjusted to a condition of anti-resonance at the frequency of oscillations whereby the electric field strength in other compartment due to leakage around removable partition is minimized. E. G. Linder, RCA. No. 2,296,678.

Amplifier. Circuit utilizing a saturable core reactor between loud speaker and input of the system. J. G. Tovar, Mexico City. No. 2,293,480.

Relay Circuit. In a relay system, means in each repeater station responsive to a cessation of signals for a predetermined time in the output thereof for introducing a characteristic signal in its input, each repeater station having a different characteristic signal. C. W. Hansell, RCA. No. 2,296,-384.

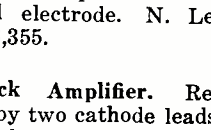
Microwave Device. A microwave device including in combination a source of electrons, controlling electrodes, a first and a second split anode electrode, means for forming electrons emitted from source into an advancing rotating substantially hollow cylinder of electrons, means for directing cylinder of electrons through split anode electrodes, means for applying alternating currents to one split anode electrode, means for adjusting the rotational rate of electrons within one split anode electrode to correspond to the period of



said alternating currents so that certain electrons are accelerated and others decelerated and thereby arranged in rotating variable charge density groups, means for directing the accelerated electrons of variable charge density electrons groups through the other split anode electrodes so that voltages are generated therein, and means for utilizing voltages. I. Wolff, RCA, No. 2,295,315.

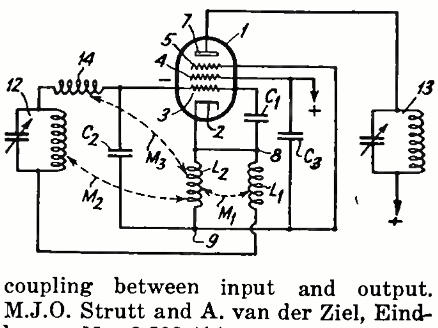
Frequency Control. In a uhf system, means using a buffer resonator for stabilizing the frequency of the generator section. R. H. Varian, W. W. Hansen, and E. L. Ginzton, Stanford Uni. No. 2,294,942.

Oscillator Tube. An electron tube having a cathode for supplying electrons and means adjacent the cathode for focusing the electrons into a well defined beam, a plane electrode spaced from said cathode and having a plurality of apertures therein, said electrode being positioned with one of said



apertures in alignment with said electron beam, and an electrode positioned in spaced relationship on each side of said apertured electrode, and means for inducing magnetic fields through said apertures and parallel to the plane apertured electrode. N. Levin, RCA. No. 2,296,355.

Feedback Amplifier. Regeneration provided by two cathode leads each containing inductances and each providing



coupling between input and output. M.J.O. Strutt and A. van der Ziel, Eindhoven. No. 2,293,414.

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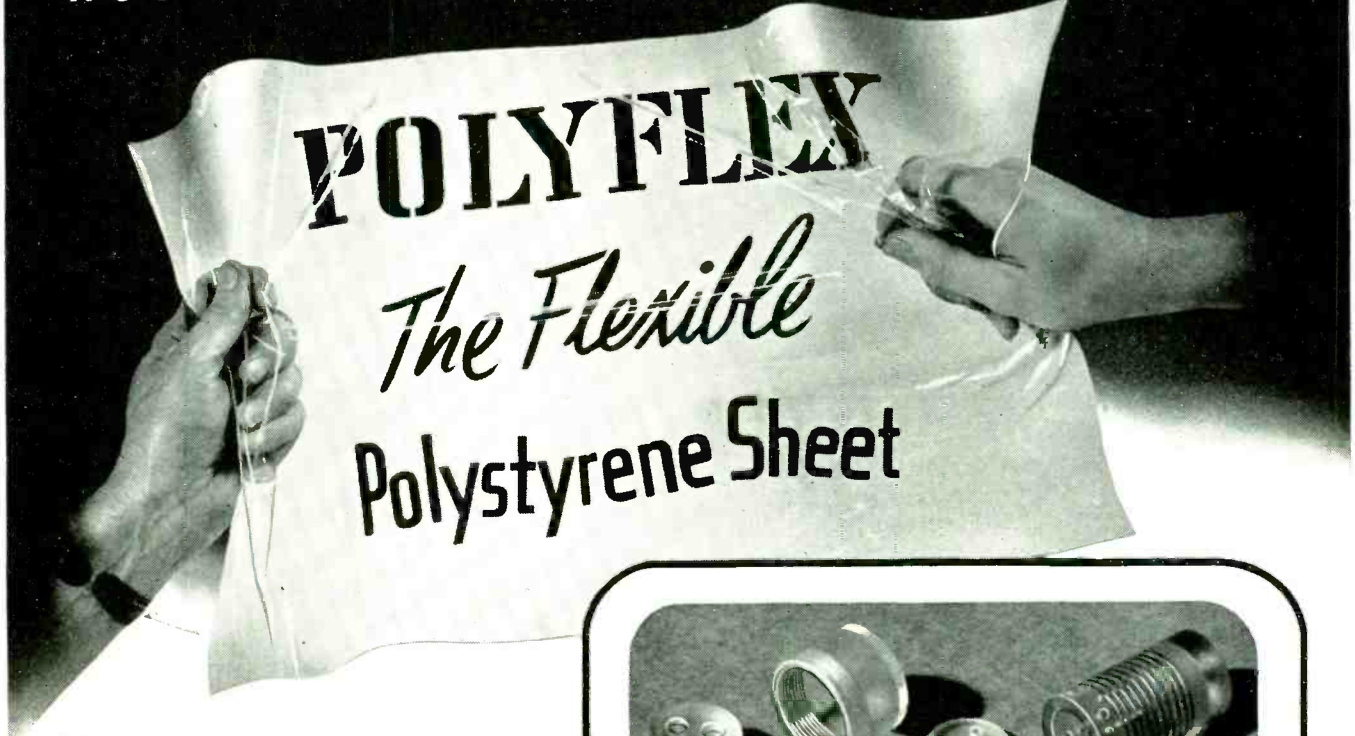

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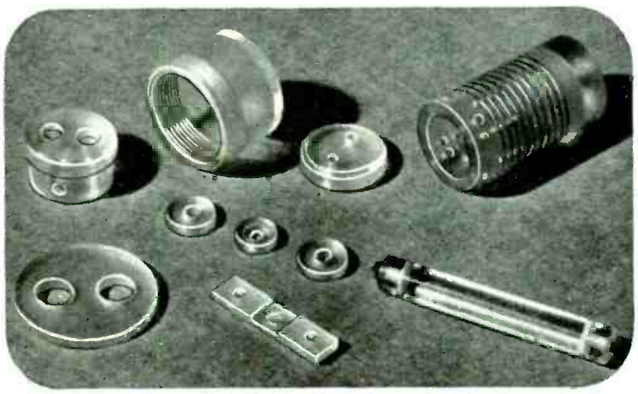

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1,000	2.5-2.6	.0001-.0002
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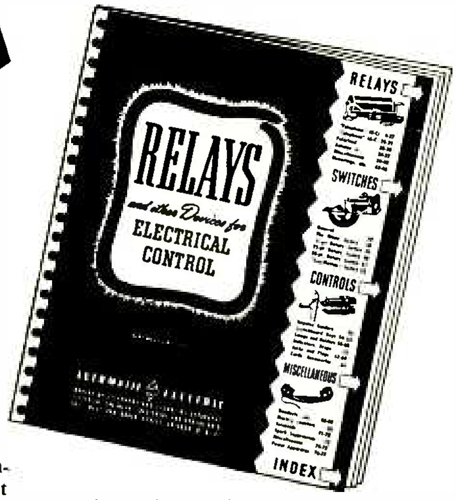

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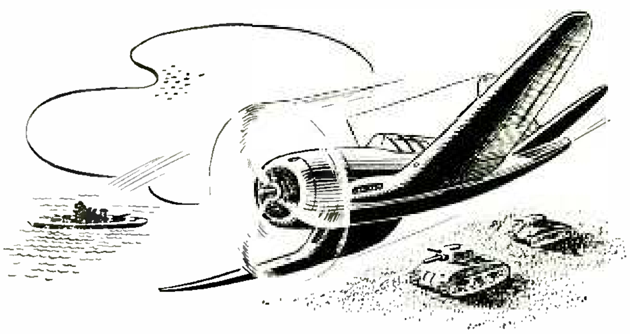

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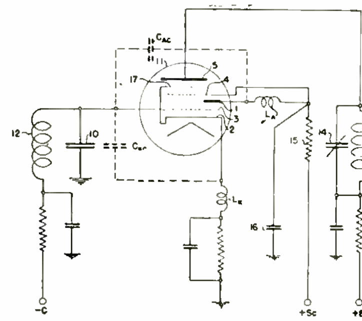
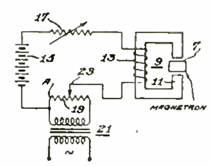


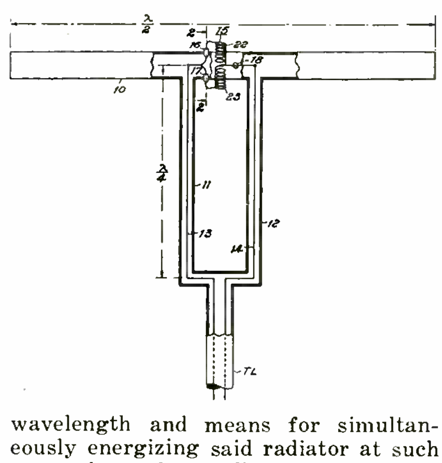
to neutralize a substantial part of this input conductance. W. H. Aldous, Hazeltine. No. 2,294,328.

Magnetron Circuit. The method of stabilizing a radio device including an electromagnet having a magnetizable metallic core the flux density of which determines the operating characteristics of the device which includes the steps of passing a direct energizing current through electromagnet, passing



an alternating current of a predetermined frequency through said electromagnet, and gradually reducing the amplitude of alternating current to condition said electronmagnet for operation at a predetermined point on its hysteresis loop characteristic. R. E. Braden, RCA. No. 2,296,764.

Antenna and Coupling. A wide band shortwave antenna for radiating horizontally polarized energy substantially uniformly in all directions in a horizontal plane comprising a horizontal ring radiator having a diameter substantially equal to 0.6 of the operating



wavelength and means for simultaneously energizing said radiator at such a number of equally spaced points around said ring that substantially uniform current distribution is obtained around said ring. N. E. Lindenblad, RCA. No. 2,296,356.

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Amplification, Modulation, etc.

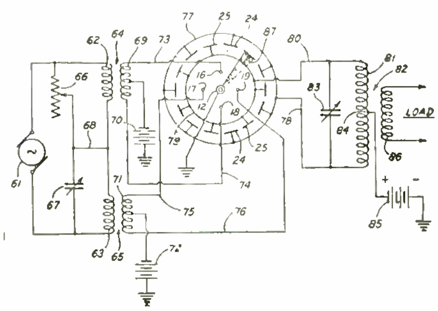
Limiter. Means for varying impedance of amplifier tubes in accordance with amplitude of signal voltage above a predetermined level, for simultaneously regulating feedback energy to two push-pull amplifier tubes. C. C. Van Cott, Collins Radio. Feb. 14, 1940. No. 2,283,241.

Feedback Circuits. Nos. 2,282,380 to 2,282,383 inc. to C. S. Root, GE, on degenerative feedback amplifiers.

Wide-band Amplifier. Means of compensating inductance of cathode lead by placing a low pass filter network in the cathode circuit. W. R. Koch, RCA. No. 2,293,262.

Modulating System. Constant impedance load made up of two fixed equal impedances and two variable impedances which are varied in accord with modulating signals, and means for maintaining square root of the product of the variable impedances constant and of such a value that the input impedance of device is constant. J. L. Pawsey and Eric L. C. White, AMI. 2,293,945.

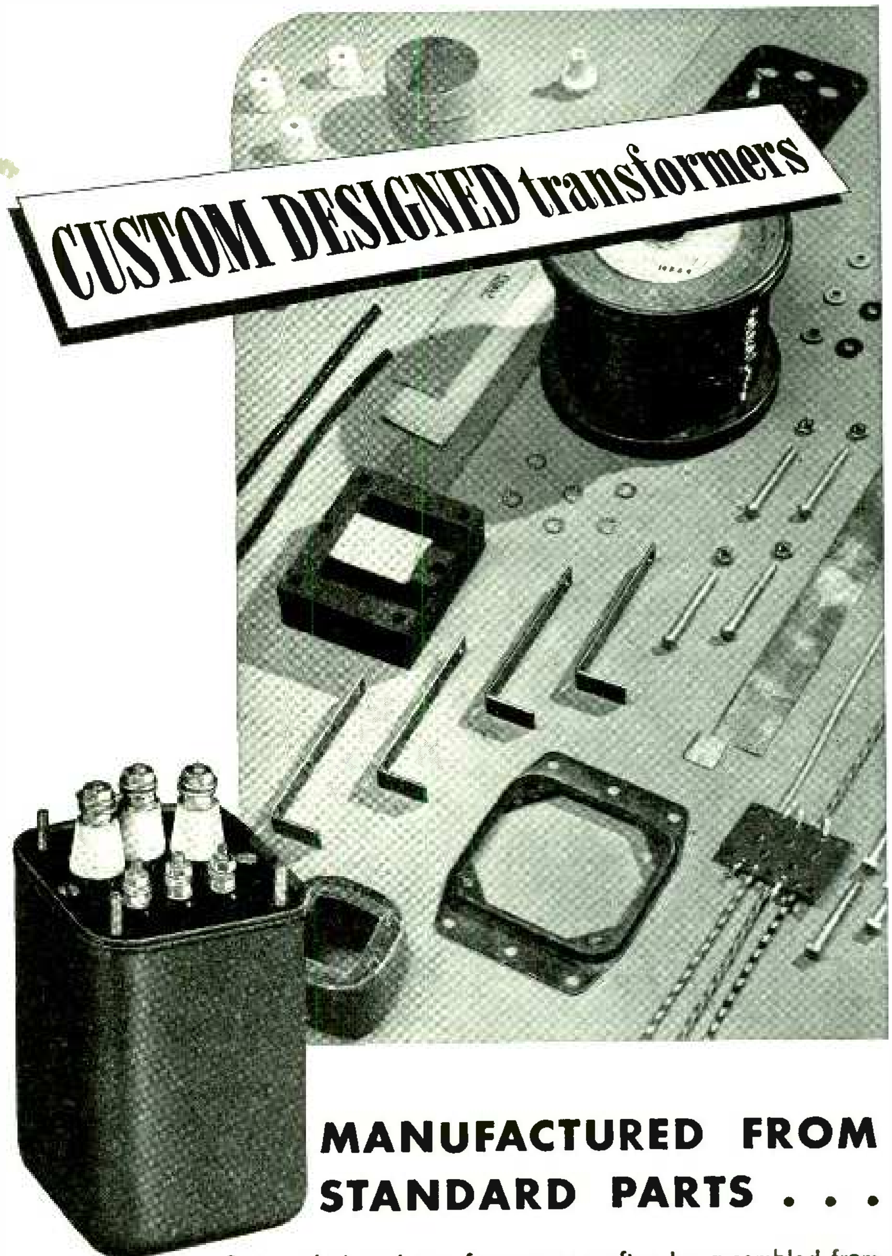
Converter. A frequency multiplying circuit including a source of polyphase current, the frequency of which is to be multiplied, an electronic tube having a cathode, several anodes, several grid members interposed between cathode and anodes, adjacent grids being equally spaced from one another and occupying separate angular positions, said grids being so connected to source of poly-



phase current as to produce a revolving electrostatic field and restrict the electrons emitted into a narrow beam, alternate anodes being connected together and to a source of high potential to form an output circuit, whereby, upon said beam rotating in sequence upon anodes, an alternating current of the frequency desired may be set up in output circuit. A. A. Stuart, Jr. Bendix Aviation. No. 2,293,368.

E-Award Correction

The Remler Co., Ltd., of San Francisco, Cal., should have appeared in the list of firms on page 118 who have received the Army-Navy E award.



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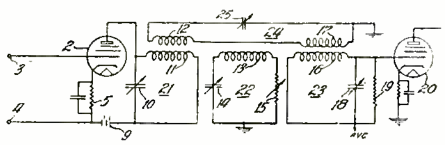
Secondary Emission Amplifier. Auxiliary cathode connected to a potential lower than anode through a voltage dropping resistor; to a point on this resistor is connected a condenser, the other terminal of which is connected to the grid for obtaining feedback. P. F. Eldik, RCA. No. 2,293,449.

Shorting Device. In a system for indicating electrical resonance characteristics, means for producing a baseline independent of a curve line on a CR tube and for adjusting position of curve with respect to base line. C. E. Hallmark, RCA. No. 2,293,135.

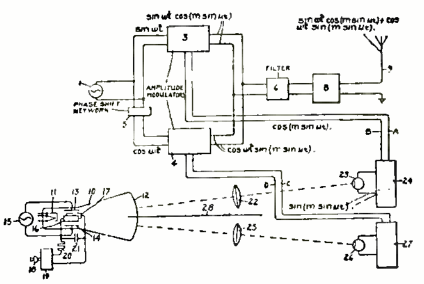
Band Pass Circuit. Three coupled circuits arranged so that frequencies within desired band are transmitted with uniform response, and so that at a frequency close above the desired band the current in the third circuit has a



lagging phase angle approaching 90 deg. and whereby currents in input and output differ in phase by approximately 180 deg. and the voltages induced in the output cancel. W. R. de Cola, Belmont Radio. No. 2,293,384.

Gastube Amplifier. Circuit made up of two gaseous tubes with means for using a portion of output voltages to oppose the initiation of current in sufficient amount to improve the linearity of the circuit. G. R. Stibitz, BTL. No. 2,293,570.

FM System. The method of modulation which includes the steps of generating a constant frequency carrier wave, producing signalling voltage of arbitrary waveform, utilizing said signalling voltage to generate an auxiliary



wave which is a simple sinusoidal function of the instantaneous value of the signalling voltage, and modulating the carrier wave in accordance with the auxiliary wave. Hans Roder, GE. No. 2,294,209.

Acoustic Device. Means of improving the directionality of a system composed of a ribbon velocity microphone and a moving coil pressure microphone by placing resistors across the moving coil mike for reducing its output; accessory transformers, etc. W. R. Harry, BTL Inc. No. 2,293,258.

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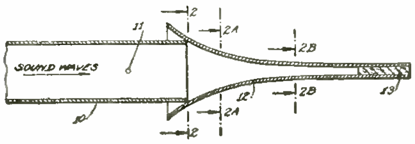
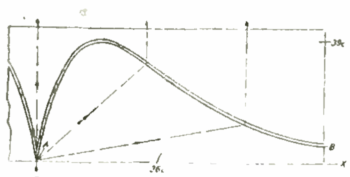
Sound Absorbing Apparatus. A sound absorbing system comprising a tapered horn with a relatively large input opening and a small throat portion, the taper of horn being such as to cause substantially no reflection and at least a portion of horn being tapered in accordance with an exponential law,



whereby sound waves applied at input opening are increased in particle velocity during progression through horn, and sound absorbing means at the throat of horn to absorb the energy of increased particle velocity waves. F. E. Terman, Int. Standard Electric. No. 2,293,181.

Discharge Apparatus. Electron discharge apparatus comprising a cathode, means for concentrating the electrons emanating from cathode into a thin beam of rectangular cross-section, an electron receiving element in alignment



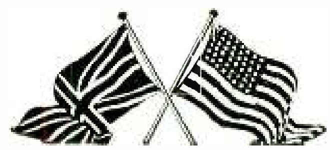
with cathode, means for producing a magnetic field having its lines of force parallel to the line of alignment of cathode and element, and means for deflecting beam normal to the longer cross-sectional dimension thereof including means for producing an electrostatic field having its lines of force crossing and normal to the lines of magnetic field and normal to the shorter cross-sectional dimension of electron beam. A. M. Skellett, BTL. No. 2,293,567.

Television Circuits

Picture Generator. Use of piezoelectric elements, styli and an image recording surface and means for moving the styli with respect to surface, means to impress image emfs to piezoelectric elements in succession so that styli produce images upon surfaces. R. A. Heising, BTL, No. 2,294,180.

Separating Circuit. Double-grid tube in a circuit for separating sync impulses from picture signals comprising means for shifting cut-off point of the tube in a direction to reduce signal in the separator tube. A. A. Barco, and C. N. Kimball, RCA. No. 2,293,528.

Deflection circuit. As a means of vertical deflection, a condenser and a discharging circuit with means of making the impedance of this circuit different for successive condenser discharges. R. D. Kell, RCA. No. 2,293,147.



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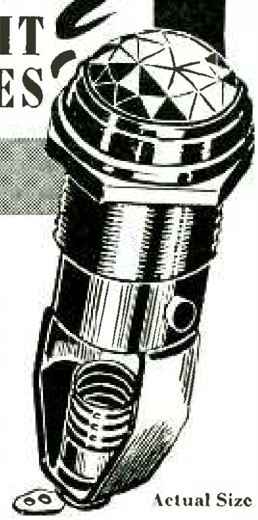

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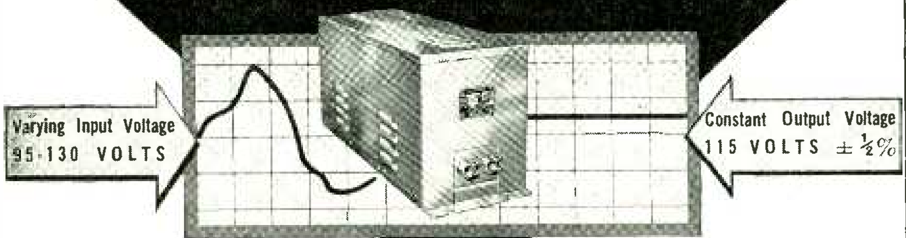

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Image production. An electro-optical image producing system comprising means to produce a video signal having frequency components extending from a very-low frequency to several hundred kilocycles, means to produce a control frequency lying within the range of frequencies constituting the video signal, means to produce two carrier frequencies which constitute adjacent odd harmonics of control frequency, means to modulate the lower of the carrier frequencies with the video signals, means to select and transmit only the lower side-band and vestigial upper side-band resulting from said modulation, means to modulate the higher carrier with the transmitted side-bands, means to select only the lower side-band resulting from the second modulation, and means to transmit the last selected side-band and produce a television image therefrom. C. L. Weis, Jr. BTL. No. 2,293,870.

Filter System. Television system operated with a remote pickup, and means at the main transmitter for balancing out certain undelayed synchronizing impulses which would otherwise become unavoidably mixed with the picture signal. R. D. Kell, RCA. No. 2,293,148.

Receiver. System for separately receiving two sets of sync signals comprising broadly selective circuits for one set of signals and a narrowly selective circuit for the other set of sync signals. H. A. Wheeler, Hazeltine. No. 2,293,233.

Scanning Systems. Three patents to R. E. Graham, BTL, on electrostatic scanning systems. Nos. 2,294, 114–116 inclusive.

Synchronizing Circuits. No. 2,294,341 to R. C. Moore, Philco, on a limiter circuit for reducing strength of unwanted extraneous signals.

Non-Communication Applications

Timing Device. In combination, electron tubes in which conduction between two electrodes is initiated by a control electrode, means for impressing alternating voltages between said two electrodes of each tube, means responsive to the stoppage of conduction in one tube for supplying a bias voltage between the control electrode and one of said two electrodes of another tube and means responsive to the restarting of conduction in the first for rendering said bias voltage effective to stop conduction in the second tube. W. P. Overbeck, Raytheon Mfg. Co. No. 2,295,601.

Inspection System. Means using light-sensitive cell, amplifier and thyratron for detection foreign body in fluid. G. P. Stout, Coco-Cola Co., Wilmington. No. 2,295,366.

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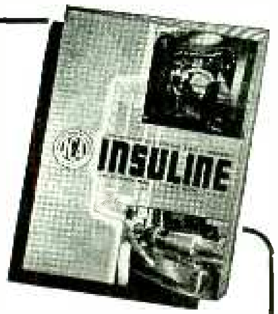

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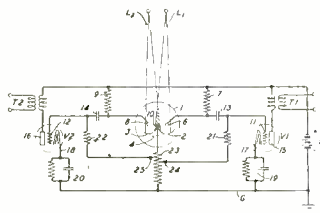
Light-sensitive Circuit. In a light-sensitive circuit including a phototube cell having dual anodes and a cathode common to said anodes, together with an amplifying tube individual to each of said anodes, the method of compensating crosstalk between the two



anode-cathode paths of said phototube by introducing into the grid circuit of each amplifying tube a controlled voltage derived from the currents generated in said phototubes opposite in phase but corresponding in magnitude to the crosstalk voltage normally present in said grid circuit. W. J. Albersheim, WECo. No. 2,295,536.

Registering Apparatus. Apparatus for detecting defective filaments projecting from an electrically non-conducting thread including means for imparting an electrical charge to the thread, means normally out of contact with said thread and engaged by said defective filaments for collecting said charge, and a device operated by the second mentioned means upon engagement therewith of said filaments. E. A. Keeler, Brown Instrument Co. No. 2,-295,795.

Magnetic Measurements. Use of the Hall effect in a relatively long and narrow magneto-sensitive element placed within the field of the specimen to be examined, a magnetic pickup between specimen and Hall effect element, oscilloscope and amplifier, means for rotating specimen and for examining the specimen in a point by point manner. No. 2,295,382. P. H. Brace, WEMCo.

Null Meter. Method of measuring an impedance by connecting the impedance to provide a transmission path between input and output circuits of a T network and balancing the output current of the T network against the current from the transmission path. W. N. Tuttle, General Radio Co. No. 2,294,941.

Illumination Control. Method of controlling illumination either by a time clock or by a phototube sensitive to changes in illumination. Leon Dewan, New York. No. 2,295,894.

AVC for Musical Instrument. Device for electrically reproducing and amplifying the sound of a keyboard instrument caused by depression of one of the keys in accordance with the amount that the key is depressed, a variable resistor associated with the keys for AVC. No. 2,296,125. J. L. Traub, Henning, Minn.

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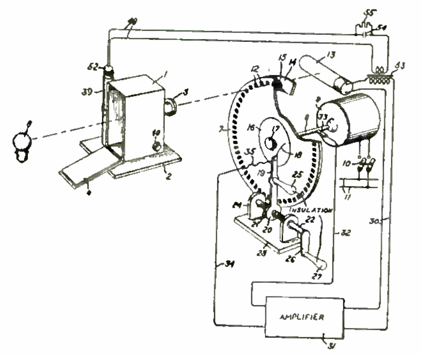
Shutter Tester. Shutter testing apparatus comprising a source of light, a photoelectric device arranged to receive a light beam therefrom controlled by a shutter to be tested, a conducting disk having means for rotating it at a fixed predetermined speed and having therein a predetermined number of equally spaced openings arranged in the path of said beam, said disk having

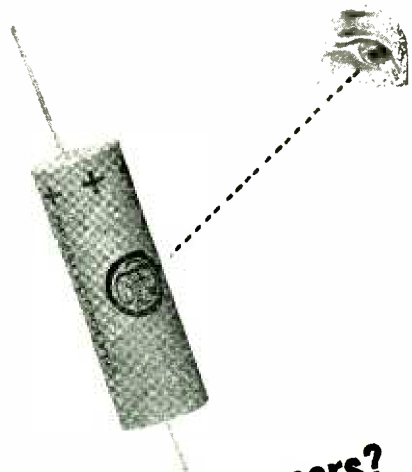


means whereby a record disk may be detachably mounted thereon, means for amplifying the output impulses of said device, a stylus arranged adjacent to said conducting disk, and means for applying said amplified impulses between said conducting disk and said stylus to mark said record disk. W. K. Kearsley, GECo. No. 2,296,676.

Automatic Meter Reading Apparatus. In apparatus for discriminating against voltages of certain amplitudes in favor of voltages of amplitudes slightly greater or lower, a voltage regulation tube circuit. W. Leathers, IBM. No. 2,295,534.

Photoelectric Cell. Annular casing, flange, etc. Surface is a metal plate coated successively with selenium, cadmium, and platinum. No. 2,296,670. C. W. Hewlett, GECo.

Luminescent Lamp. Use of luminescent screens and electrons oscillating between screens for producing illumination. H. W. Leverenz, RCA. No. 2,296,643.



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NEW BOOKS

Ultrahigh Frequency Technique

By J. G. Brainerd (*Editor*), Glenn H. Koehler, Herbert J. Reich, *and* L. F. Woodruff. (*534 pages. Price, $4.50. D. van Nostrand Co., New York.*)

The recent important developments in radio communication systems operating at frequencies well above 100 Mc. makes necessary a new evaluation of electrical phenomena and the new methods of analysis which are more general (but also more difficult) than the customary analytical procedures usually employed when dealing with linear circuit elements of lumped constants. As a result it may be expected that a more general theory of radio communication will be developed and that future generations of electrical engineering students will be much more thoroughly versed in field concepts and Maxwell's equations than is the case at present. From this general point of view, the treatment of usual circuits may be derived as a special case, just as all of the theory of direct currents may be derived from alternating current theory by the appropriate simplifications. Some texts are already appearing in which the more general point of view is developed, and to a certain extent the volume under discussion is one of them.

The present volume has been prepared by four well-known authors and educators in the field of electrical engineering, using as a basis, the material discussed at the Ultra-High-Frequency Conference held at the Massachusetts Institute of Technology in the Fall of 1941. Therefore, the material in the volume may be considered to represent a well-balanced cross-section of the information which will be required by those working in the field of u-h-f design and applications.

This is not to imply, as the title may indicate, that the present volume deals exclusively with ultrahigh-frequency phenomena. There are, in fact, quite a few chapters which are applicable to radio engineering at the broadcast or even lower frequencies. For example, the first three chapters dealing with Linear Circuit Analysis, Fundamentals of Tubes and Power Supplies, and Amplification, are treated in such a manner that little, if any, of the material is directly applicable to the ultrahigh-frequency spectrum. To a less extent, the same statement may be made about a number of the other chapters, but there are five chapters in which ultrahigh-frequency techniques are definitely emphasized. These are the chapters on: Ultra-High-Frequency Generators, Transmission Lines, Radiation, Propagation. and Hollow Wave Guides.

It is in these last chapters, which

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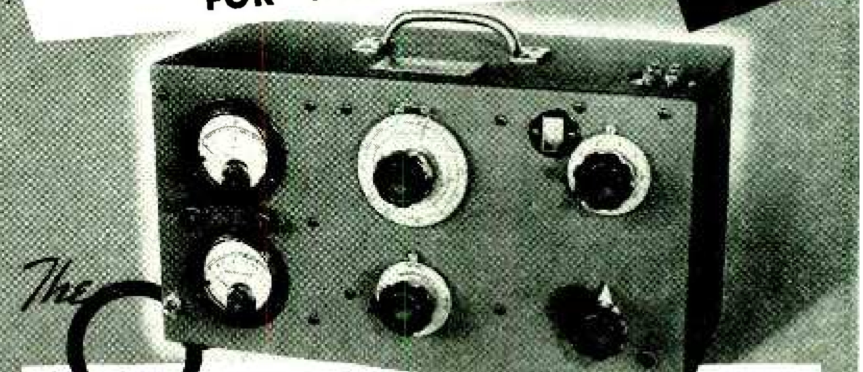

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specifically treat u-h-f circuits and equipment that the present volume makes its greatest contribution, and in which many of the more recent developments are treated for the first time as a unified whole. It is in this field that the reader, influenced by the title, would naturally expect the major contribution to be made.

In general, the text is definitely of advanced caliber and suitable for graduate engineers, or seniors or graduate students in electrical engineering at the better technical colleges. To some, the book may give the impression of being "theoretical" rather than "practical" but it appears to this reviewer that such a distinction is quite artificial (especially considering the close relation which now exists between breadboard laboratory models and production models) and could hardly be supported by those who could most profitably benefit from the text.

As might be expected, much of the material is of sufficiently mathematical character as to require a good background in differential equations and vector analysis, and one whose mathematical ability does not encompass these subjects cannot expect to reap the maximum benefits from this volume. At the same time the mathematics is used for engineering purposes, and wherever possible the physical interpretation is indicated. This is particularly true in the case of the chapter on radiation, where Maxwell's equations are given not only in the integral and derivative form, but the essential concepts are likewise stated in words. The final chapter on hollow wave guides presents an excellent summary of the

• • •

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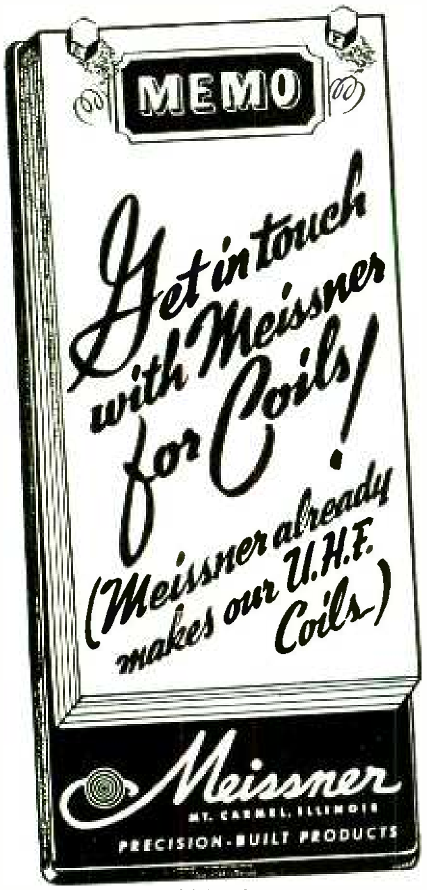

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outstanding researches of Southworth and Barrow. Incidentally, Dr. Barrow was largely responsible for initiating and conducting the M.I.T. Conference last year and has written the editorial preface of this volume.

The volume is up to date in so far as any textbook can be, and flatters this magazine by making reference several times to the material on Ultra High Frequency Technique originally appearing in the April 1942 issue.

A word should be said about the general printing and binding. The book is printed in an offset process, so that the pages resemble a typewritten manuscript and the diagrams are not always uniform. The general impression is that the book was produced as quickly as possible, but this is no disadvantage when one considers the rapidity with which developments are being made in the communications field and the importance of u-h-f developments. A work of this scope which has been produced in less than a year is no mean accomplishment, and all things considered, the book appears to be quite (although not completely) free from errors of commission. Certain errors of omission are more readily apparent, for there is little material on transit time effects or on the input admittance of the usual types of negative grid control tubes operated at high frequencies. The sections dealing with radio receivers are rather skimpy and the u-h-f receiver developments which have already appeared in the literature are largely conspicuous by their absence. There is no treatment of u-h-f measurements as such although the final chapter, entitled "Laboratory Manual" is partial compensation for this omission.

But the overall impression is the principal item of interest to the reader, and it can be truthfully said that "Ultra High Frequency Technique" is a definitely worthwhile contribution to the engineering literature on electrical communication. It is probably the first volume of serious nature which aims to present recent u-h-f developments as part of the stock of knowledge which the communications engineer should have at his finger tips. It undoubtedly is a landmark in communication literature and might well be on the book shelf (if not on the desk) of every communication engineer.—B. D.

Molecular Films, The Cyclotron, and the New Biology

By H. F. Taylor, E. O. Lawrence, and Irving Langmuir, *Rutgers University Press, New Brunswick, 110 pages. Price $1.25.*

Three essays, commemorating the 175th anniversary of Rutgers University, are included in this little volume published by the Rutgers University Press. The contents include "Fundamental Science from Phlogiston to Cyclotron" by Hugh Scott Taylor, "Molecular Films in Chemistry and Biology" by Irving

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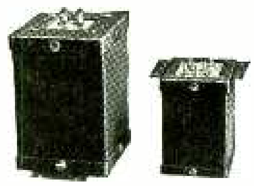

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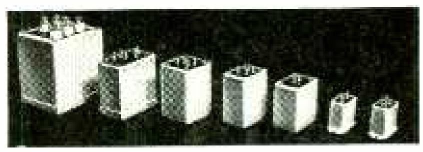

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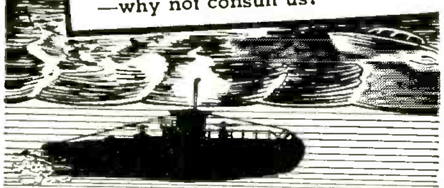

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Langmuir, "Nuclear Physics and Biology" by Ernest O. Lawrence, with commentaries by Leslie A. Chambers and J. R. Dunning.

Each of these essays is a brilliant and direct treatment of one particular branch of physical development. They are written in a manner which reminds one of the simple, direct writings of Michael Faraday, his essay on the candle, for example. These essays should prove useful to those who desire a brief, concise survey of some of the more important developments in physics, with an indication of their implications.—B.D.

Learning the Radio Telegraph Code

By JOHN HUNTOON, *Published by American Radio Relay League, West Hartford, Conn., 34 pp. of text. Price $0.25.*

THIS LITTLE BOOKLET is primarily designed to fill the need of those who find it necessary or desirable to master the ability to send and receive Morse code signals. The book is divided into six chapters entitled: Learning the Code, Learning to Send, High Speed Operation, Operating On the Air, Code Practice, and Class Instruction.

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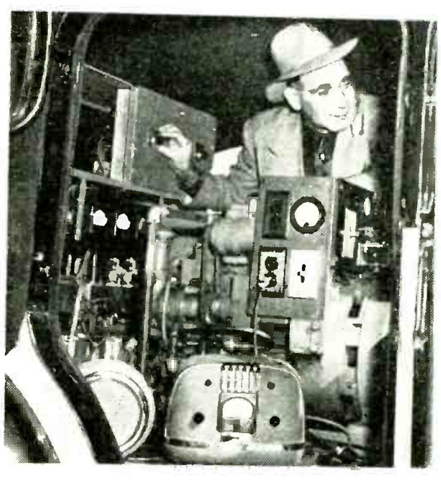

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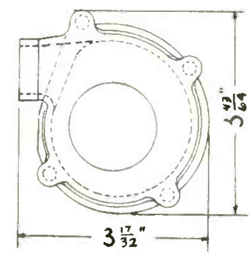

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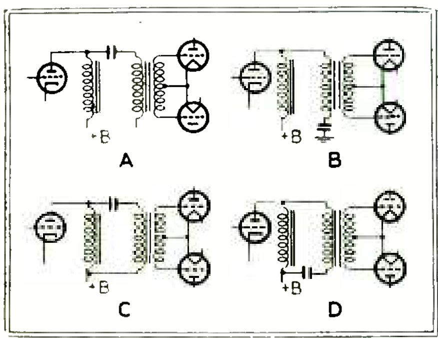
Question

I WOULD LIKE to see a question and answer section in ELECTRONICS.

MOZART JOHNSON,
Glendale, Calif.

• Nothing would suit ELECTRONICS better. To start the ball rolling we will ask the first question, one which was posed to us recently. The diagrams below represent a first stage audio amplifier feeding a push-pull stage. A choke



is used to feed d.c. to the first tube and a condenser is used to keep the d.c. out of the push-pull input transformer primary. Does it make any difference which of the four connections is used?

—*The Editors.*

RC Oscillators

CONSIDERABLE SPACE has been devoted recently in ELECTRONICS to an interesting one-tube oscillator circuit which uses a negative-transconductance tube to generate quasi-sinusoidal oscillations with R and C elements only[1, 2, 3]. All of the analyses have been applied to a relatively special form of circuit in which the unavoidable "stray" capacitance across the control grid resistor is neglected. The paucity of references given indicates unfamiliarity with the literature on the subject.

About seven years ago, I published the complete analysis of this oscillator[4], in which all capacitances were included and in which possible current flow to the control electrode (inverse transconductance) was also taken into

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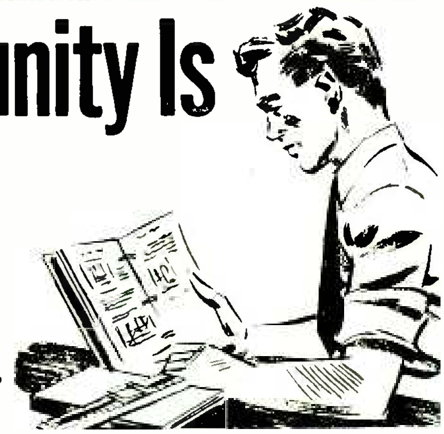

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Manufacturers are offering increased base pay to attract new additions to their staffs. The Civil Service Commission has revised its standards in many of its examinations, and the Army, Navy and Marine Corps are offering to properly qualified, technically trained radiomen ratings as high as staff sergeant and chief radioman as an inducement to enlist. All of this means that Opportunity . . . *is here, now!*

Hundreds of men have had new jobs at comparatively high pay literally thrust upon them. The Civil Service Commission in a letter addressed to, and requesting the aid of, Members of the Institute of Radio Engineers wrote: "Engineers—and today, particularly radio engineers—are needed in the government's drive for Victory. Publicity has been extensive, appeals to individuals have been numerous, to get qualified engineers on the employment rolls of the Civil Service Commission in order that jobs may be filled in vital war agencies on the shortest possible notice."

Every page in *Electronics* could be filled with more astounding facts concerning employment opportunities for trained radiomen . . . but this is not news to the majority of you who are now in radio. It may be evident in your own locality. The important thing is . . . *what are you going to do to obtain the greatest benefit from the present opportunities?*

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—Don W. Lowrey,
Senior Radio Electrician, CAA, 5/42

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—Oscar Carlson, RCA Corp. 2/42.

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account. In another connection and in a subsequent publication, the derivation was repeated with the inverse transconductance omitted, for simplicity[5]. By the use of the usual complex number a-c theory, the solution was derived almost by inspection, in three lines. Interested readers are referred to the last-mentioned publication. Because of the symmetry of the complete case the solution is as simple to visualize as the incomplete ones of De Laup, Nottingham, and Jordan. At the higher audio frequencies, the complete solution is necessary to obtain agreement with experiment.

The original analysis, which I made during 1933, predicted the sinusoidal nature of the oscillations generated by a negative transconductance tube with resistance and capacitance only. The predicted behavior caused me some surprise especially when I found that the circuit had been published by Van der Pol[6] many years ago as a relaxation oscillator, presumably non-sinusoidal. His findings were supported by Page and Curtis[7] and in these early papers, there is no mention of the sine-wave possibilities. As a result, during 1934 I made experimental checks in which the frequency and condition for oscillation were measured and found to be in close agreement with my aforementioned analysis for frequencies up to a hundred kilocycles or so. At still higher radio frequencies, obtainable with special tubes, the agreement was less accurate, presumably due to difficulty in properly measuring stray capacitances.

There is an important condition which is physically necessary before stable quasi-sinusoidal oscillations can be realized and which has not been mentioned in your columns. This condition requires that the tube used be biased close to a point of maximum negative transconductance so that the small-signal solution obtained by the analysis remains valid[8]. It was lack of appreciation of this condition that probably prevented prior workers from finding the effect. As applied to the pentode tube, the condition may be written

$$\frac{\delta^2 I_{c2}}{\delta E_{c3}^2} = 0$$

where I_{c2} is the No. 2 grid current and E_{c3} is the No. 3 grid voltage. The condition merely states that the introduction of an alternating grid voltage cannot give rise to an increase in average transconductance and, thus, lead to a large oscillation amplitude. The same restrictive condition was formulated for the sinusoidal oscillations of a two-tube multi-vibrator by Watanabe[9]. We may conclude that oscillators of this type must be operated "Class A" in order to give good voltage wavefrom. This requirement is in contrast with that of *L-C* type oscillators in which the tube may be operated "Class C" and still result in low harmonic content across the tuned circuit.

In connection with suggestion of Mr. Jordan[2] that the negative-transconductance tube be used for obtaining selectivity, the curves of my paper[5] show exactly this effect. Figures 2 and 3 of the paper are plots of the input impedance of a tube connected in the circuit under discussion. When the transconductance or the feedback capacitance is increased, the curves show increasing selectivity. The solution for this non-oscillatory case is also given in my paper and indicates what the results will be with an ideal tube when a given order of stability is required. Application of the equations given shows that, for commercially available tubes, the proposal of Mr. Jordan is only useful in the audio range of frequencies. Above 20 to 30 kc or so, a relatively small increase of tube transconductance will change the response curve from a flat one to that of infinite selectivity, i.e., self-oscillation. Even in the audio range, the effective selectivity is a rapidly varying function of transconductance and so does not possess the stability of inverse-feedback circuits for the same purpose.

E. W. HEROLD

Research Laboratories RCA Manufacturing Co., Harrison, N. J.

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Concentric Transmission Lines

WHILE GLANCING OVER the May, 1942 issue of ELECTRONICS I came across a short article by Raymond E. Snoddy on "Concentric Transmission Lines," wherein he calculates the electrical length of a section of the above type of line. In order to find the electrical wavelength in the manner suggested there it is necessary to know the capacity and inductance per unit length, the characteristic impedance, and the resistance and conductance per unit length. Armed with this information one must then calculate the wavelength constant and propagation constant before the electrical length can be found.

As a general rule the only information which one possesses about a particular type of line is the characteristic impedance. A very simple measurement or almost equally simple calculation will usually disclose the ca-

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pacity per unit length if it is not known. With these two constants only it is possible to calculate the wavelength in the following manner: Terman states the wavelength of a line is given with a high degree of accuracy by

$$\lambda = \frac{1}{f\sqrt{LC}}$$

where L and C are the series inductance and shunt capacity per unit length respectively. Since the characteristic impedance $Z_c = \sqrt{L/C}$ and the $\sqrt{LC} = C\sqrt{L/C}$ it is merely necessary to substitute this value in the above equation which then reads

$$\lambda = \frac{1}{fC\sqrt{\frac{L}{C}}} \quad \text{or} \quad \lambda = \frac{1}{fCZ_c}$$

This simplified formula should be of value to those who work with transmission lines particularly on the ultra-high frequencies where it often becomes necessary to know the electrical wavelength for such applications as phasing sections for directive antenna arrays.

Substituting the values given in the article by Mr. Snoddy and solving for the quarter wavelength section yields an answer of 311.5 as against 311.4 found by the author. This is close enough for all practical purposes as is evidenced by the difference of 0.4 feet between Mr. Snoddy's calculated and experimental values.

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• • •

MOLECULES GET TIRED

Dr. N. C. Beese, Westinghouse research engineer, is shown measuring the amount of fatigue of a piece of fluorescent glass when exposed to constant and continued ultraviolet radiations. Research on the fatigue phenomenon showed that the molecules responsible for fluorescence get "tired" and lose an appreciable amount of their activity when excited for long periods of time, but regain their strength after suitable rest periods in the dark

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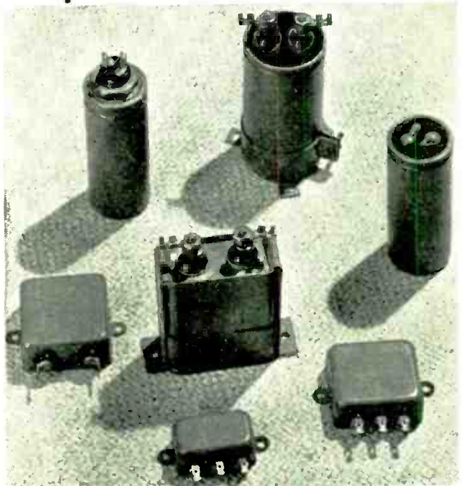

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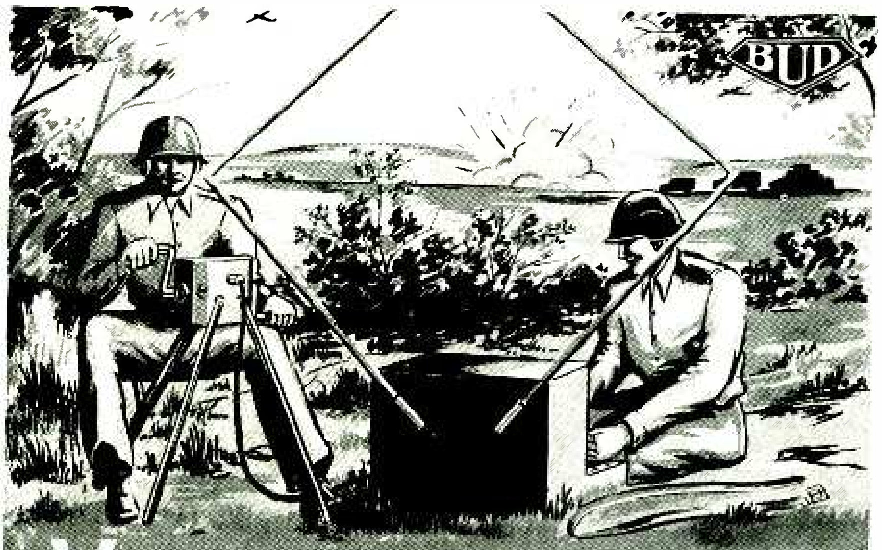

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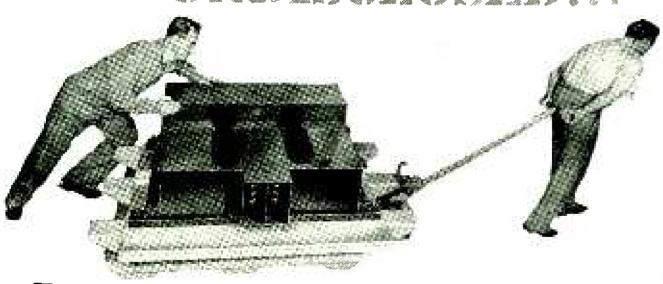

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Arnold's Aim . . .

(*Continued from page 43*)

"The procedure is easily understandable. You buy every conceivable patent that has a bearing on processes of manufacture of a particular commodity. You pool them, license, and cross-license so that you have a complete armory for infringement suits against weaker concerns, thus compelling them to keep out of your field or sell to you at your price so that you in turn can circumscribe production and dictate prices as you see fit. If there are big competitors that cannot be bought in or frozen out, you combine, to the same end.

"Thus from 1926 to the outbreak of the war" Mr. Arnold continues, "our great international and domestic cartels got a stranglehold on the production of basic materials and many consumers' necessities, for example, drugs, light metals such as magnesium and beryllium, synthetic rubber, gasoline both natural and synthetic, chemical products, glass and optical instruments. The building trade became a mass of cartel restrictions, suppressing experimentation by independent enterprises, preventing the mass production of houses, so that even an inadequate housing program required vast national subsidies.

"Wreck the patent system!" Mr. Arnold exclaimed. "What I want to do is to save it—save it for the good of our people and save it from foreign domination. We must not let ourselves be the dupe of Germany because of cartel agreements. Yet that is what happened!"

On July 31, 1942, the Assistant Attorney General submitted to senators a draft of legislation to curb "illegitimate" use of patents. Speaking before the senate patents committee, Mr. Arnold stated: "Briefly, the bill provides as follows: First, no infringement action can proceed without having a copy of pleadings served upon the Attorney General who has the right to intervene. Second, any use of a patent, including any unreasonable failure or refusal to grant licenses thereunder, which has the effect of unreasonably limiting the supply of any article moving in interstate commerce is de-

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clared to be illegal, and a judgment or conviction that a patent had been so used renders the patent null and void. Third, the criminal penalty for such misuse of a patent is made inapplicable where prior full disclosure has been made to the Attorney General. Fourth, all patent assignments and licenses must be in writing with a copy filed with the Attorney General."

With the cleaning up of patent abuses, one by one, and the reform of the patent law to meet present conditions, Mr. Arnold envisages a new era of economic expansion and higher living standards in the post-war period—an era featuring new chemical processes, light metals, and plastics. Magnesium, which is twenty times as abundant as the basic supply of copper, lead, zinc and nickel would be released from patent restrictions and flow freely into the channels of industry. And so with aluminum, the most abundant metal, and many others, the full exploitation of which has been severely thwarted through patent abuses. Plastics, based on chemicals whose supply is unlimited can take the place of glass, steel, and other metals.

"To bring in this new era, we must, once and for all, rid ourselves of our sluggish, non-competitive scarcity ideas," Mr. Arnold warns.

• • •

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Sodium light is being used in several important war plants for surface inspection by microscope, because of its efficiency in the detection of pits, cracks, and flaws in materials. The sodium lamp is essentially an arc lamp, and differs from the incandescent in that it requires a special socket and individual control for each lamp. The unusual perception of detail under sodium illumination is due to the monochromatic nature of the light

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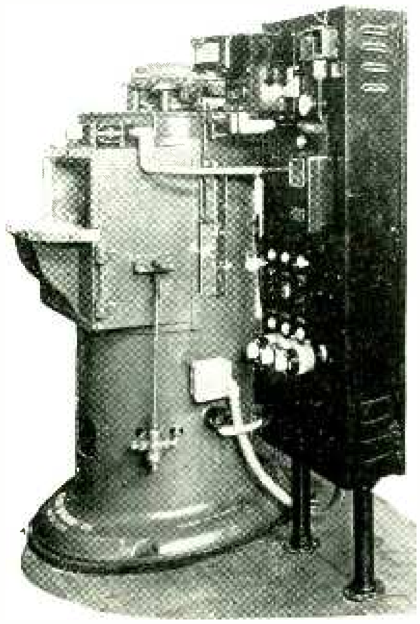

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Rebuttal to Arnold

(*Continued on page* 45)

Even more positive was the danger signal recently hoisted by S. Chesterfield Oppenheim, Professor of Law, George Washington University. "While abolition of the patent system is really not in issue," said Professor Oppenheim, "there is nevertheless danger that in the zeal for ridding the system of evils the rewards of the patent will be whittled away to the point of seriously impairing incentives to invent and causing a flight of capital from inventions inadequately protected by law in the initial stage of commercial development."

Subsidization of research by government, which Mr. Arnold favors, will never take the place of the large number of individual inventors, working on their own through years of experimentation in out of the way places—the Ketterings, the Edisons, the Bells and a host of other lesser knowns. Mr. Fenning contends: "There is no need of subsidized Government research facilities as long as the law continues to give patents strong enough protection to protect speculative money invested in patent inventions."

Mr. Fenning does not hold at all with the view so frequently expressed by Mr. Arnold to the effect that patents have been withheld from use, thereby curtailing the production and distribution of consumer goods and commodities. "Repeated elaborate investigations," said he, "have failed to reveal even a single unfair suppression of patented invention. Despite many allegations to the contrary, no one has ever been able to show a single instance. It is a most serious charge constantly recurring against patent owners, the idea being that an important invention is suppressed because it might adversely affect the profits of the current device or method. The myth of the alleged carburetor that would secure seventy-five miles per gallon of gas being suppressed by the automobile and gasoline companies is typical. The Oldfield hearings in

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1912, the Stanley hearings in 1922, the McFarlane hearings in 1938, and the Temporary National Economic Committee in 1939 pursued the subject with vigor without finding a single instance of such suppression. This alleged suppression of patents is a basic argument used by advocates of compulsory licensing of patents. The interest of the patent owner lies in the direction of using any invention that really accomplishes its purpose more satisfactorily than the existing art, and this is the obvious reason why suppression of patents cannot be found."

To Cure the Disease, Kill the Patient?

The bitterest opponents of Mr. Arnold's patent reform schemes freely admit that patents have from time to time been abused, for the most part in connection with commercial combinations in restraint of trade and in furtherance of monopoly violating the anti-trust laws. They point out, however, that this only happened when patent holders acted outside the rights conferred upon

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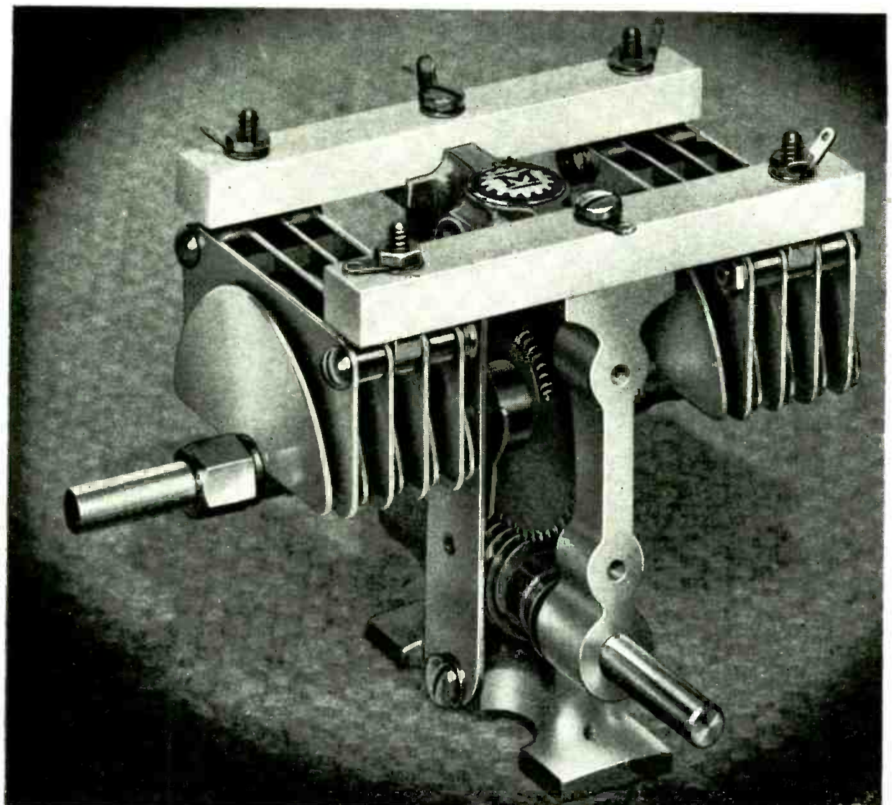

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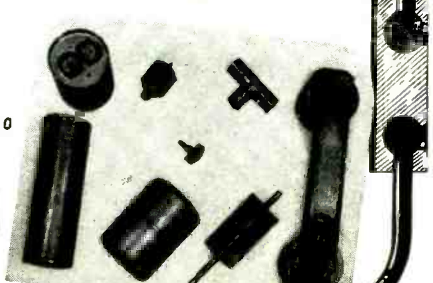

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them by the patent and that it is not in any sense a manifestation of an economic evil that inheres in the patent system or in the nature of the patent itself. They further contend that the reforms have made a "whipping boy" of patents before the bar of public opinion and distorted the picture out of all proportion to the number of cases of patent abuse on the basis of court decisions. Such abuses, they aver, have been and can be corrected through the established legal procedures under the anti-trust laws.† Senator Wallace White of Maine, a member of the Senate Patents Committee, made an extended speech recently in which he warned against meddling with the patent structure—at least until the President's Commission has reported. In the course of his address, Senator White dealt at length with the danger of confusing the patent with the occasional abuse of the patent. Such abuse, he contended in effect, does not any more invalidate a patent than it would invalidate rights in any form of property. He proceeded to quote from a decision of the late Chief Justice Taft as follows:

"It is only when he (the patent holder) adopts a combination with others by which he steps out of the scope of his patent rights and seeks to control and restrain those to

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Films are now being used to help in the training of British Naval personnel. These "WRENS" learn to project instructional films and to maintain and care for film machinery. The instructor, shown here, is explaining to the trainees the intricacies of an amplifier. A candidate must have a secondary education, a knowledge of mathematics and electricity and an interest in machinery before she is eligible to train for this category

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whom he has sold his patented articles in the subsequent distribution of what is theirs that he comes within the operation of the Anti-trust Act."

"It seems to be admitted" said Mr. Fenning, "that proper enforcement of the present Anti-trust laws would prevent what are called abuses of patents. Cartels are prohibited by the Sherman Act and the Clayton Act and the Department of Justice can bring suits to prevent improper uses of patents. Certainly cancellation of patents is not necessary since the courts now refuse to enforce patents which are used as bases for improper restraint of trade."

In building up for the public the picture of patents as so many wolves masquerading in sheep's clothing, much has been made by Mr. Arnold and his associates of the alleged handicaps resulting from the relations of American industries with foreign cartels. On this much exploited subject, Mr. Fenning has this to say, "We can get the information from patents issued in foreign countries, and foreign influence in our industries might be avoided by refusing patents to foreigners for inventions patented abroad. However, this would inevitably result in the refusal of foreign countries to grant patents to citizens of the United States. The tendency would be to promote secrecy rather than beneficial disclosure of patents. The inventive product being the creation of something that never before existed and that adds to the sum of human knowledge, it is again emphasized that a patent takes nothing from the public that was previously enjoyed and that the short period of exclusive use granted to the patentee is only a reasonable reward for the inventor's contribution."

* In a case recently decided in Toledo, the court upheld the contention of the Department of Justice that a conspiracy existed to effect a monopoly in the glass container industry. It was stated that "there has been a violation of the Anti-trust laws through an illegal aggregation of patents upon the part of the Hartford & Owens companies; there has been an illegal combination resulting in an unreasonable restraint of trade in the glass container industry through the control of machinery used in the manufacture of glass; and there has been a domination and control of the glass container industry that has resulted in an undue and unreasonable restraint of trade".

The judge ruled that the defendants will be enjoined from engaging in interstate commerce unless they comply with the orders of the court. As far as patents are concerned, it was ruled that they must license anyone, royalty free, on all present patents and pending applications for patents for the life of the patents; they must make available to anyone who desires them copies of drawings and patterns relating to suction devices, feeders, forming machines and lehrs.

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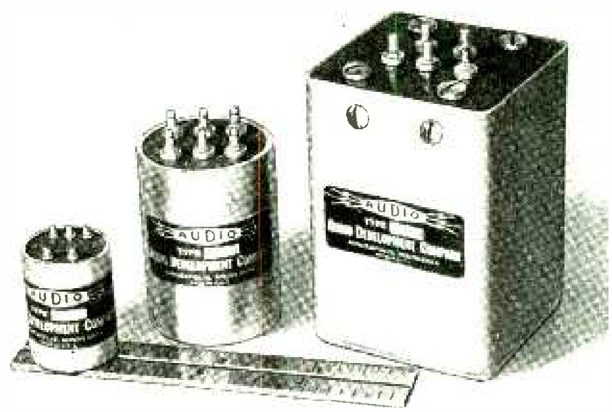

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Machinery Noise Characteristics

(*Continued from page* 51)

speed of the camera, film velocities ranging from about 1 in. per minute up to several feet per minute may be employed. An accurate frequency scale is more easily prepared than for a mechanical recorder. It is true that the films require development. On the other hand, if, as is generally the case, the investigation is to culminate in a published report, the original data can be used directly for illustration without any further processing.

Camera—The camera employed was of the shutterless revolving drum type, using standard 35 mm movie film. The motor mounted on its base and used normally for high speed work was disconnected and an auxiliary pinion attached by means of a small clamp to mesh with the gear on the film drum shaft. Various gear ratios were employed to give speeds ranging from 2 in. per minute up to 5 in. per minute.

The most satisfactory speed for the bulk of the work was found to be 3 in. per minute and the illustrations shown were made at that operating rate. The camera is driven by a shaft with a ball and pin at either end mating in slotted sockets to form small universal joints. The drive shaft is slipped out of its sockets when removing the camera for reloading.

Driving Motor—The motor assembly consists of a small 78 rpm phonograph motor of the direct drive type, to the shaft of which is fitted a worm driving an 80-tooth gear on a vertical shaft. The upper end of this shaft has a pair of miter gears to drive the camera shaft; the lower end contains a pin and socket member that mates with a receptacle attached to the dial of the sound analyzer.

The assembly was mounted on a base plate with a three-point support, of which the drive socket member formed the third point. The analyzer dial was also fitted with a cam arranged to close a pair of contacts when the dial reached the end of its scale. The contacts were connected to short circuit the output, preventing any deflection on the oscilloscope while the dial was traversing the blank space between scales. Switching from one frequency band to the next was done manually during the interval that the cam was in its short circuiting position.

The complete assembly as set up for operation is illustrated in the opening pages of this paper. A motor driven mechanism of this type is easily constructed.

Sound Analyzer—The sound analyzer employed was the General Radio type 760-A[9]. This instrument operates on the negative feedback principle with a range of from 25 to 7500 cps in five frequency bands. The output voltage of the analyzer is sufficient to drive the horizontal amplifier of the oscilloscope without intermediate amplification. The output jack of the analyzer delivers a half-wave rectified voltage and the overall response as taken at that point is semilogarithmic.

In some cases it might be desirable to provide a linear response characteristic. This is readily accomplished by installing an auxiliary output jack in the analyzer, connected to the grid of the last tube. It is advisable to insert a resistance of the order of one to two megohms in series with this jack as a precaution to avoid interfering with the calibration of the instrument. The linear characteristic is generally desirable where it is required to pick out individual frequencies from a spectrum that has a high unpitched noise level; the logarithmic response is most useful when the investigation is principally concerned with the distribution of energy in various frequency bands.

Scale—An accurate scale was prepared photographically as follows: The equipment was set up as for normal operation except that the motor shaft worm was disengaged so that the analyzer dial could be revolved by hand. The internal sweep circuit of the oscilloscope was set to provide a horizontal trace across the screen, focused to as fine a line as possible.

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The camera lens was capped. The analyzer dial was set at the first graduation on the scale and an exposure made by briefly uncapping the lens. The dial was then advanced to the second mark on the scale and the procedure repeated. The main numbered divisions on the dial were identified by exposing to the full width of the cathode trace, whereas exposures for the intermediate graduations were made half-length by masking off half the cathode-ray tube target during the exposures for these positions. The developed film consisted of a linear scale replica of the dial calibration and it was only necessary to letter the proper numerals on the divisions.

To facilitate making a large number of prints the original negatives of the scale were reprinted on a piece of cut film approximately 5x7 in. and the latter cemented to the glass of the printing frame to form a photographic mask or templet. The resulting prints form complete data sheets of suitable

• • •

TUBE REPLACEMENT

It is necessary to get every possible hour of efficient life from the giant transmitting tubes and other equipment at the 50,000 watt transmitter at KFI in Los Angeles. Frequent meter checks and constant surveillance of every circuit at the transmitter will help do the job. The co-chief engineers H. L. Blatterman, left, and Curtis Mason are shown replacing one of the big 849 vacuum tubes whose filament electron emission is no longer satisfactory

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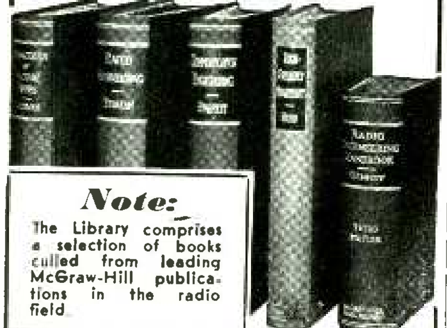

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size. Data prepared in this form have been found more convenient to work with than long lengths of film or charts, particularly when a large number of such records have to be compared and studied for interpretation. It is, of course, necessary to prepare a scale for each different film speed ratio employed.

Examples—Figures 12 and 13 are examples of the method of analysis described, in which the data have been arranged to give a direct comparison between the frequency spectrum from a direct pickup and a subsequent sweep of a recording from the same source. While the oscillograms are not identical it should be realized that the data shown were all taken from sources not producing an absolutely steady-state waveform. Successive direct pickup sweeps from these sources showed about the same variation as observed between the recorded and direct sweeps illustrated.

It is believed that the technique of transcribing sound or vibration data in the manner described offers a reasonably accurate means of securing information in cases where direct analysis is impractical.

The method also holds interesting possibilities for extension of the normal range by frequency conversion. For example, if the recording speed is 33⅓ rpm and the playback 78 rpm, a frequency of 40 cycles on the playback would indicate a source frequency of 17.1 cycles. Modification of the recording equipment would, of course, be required. Amplifier designs are available capable of responding in the subaudible range, and there is no reason to believe that a cutting head could not be made to respond if properly driven. Conversely, extension of the upper frequency limit might be accomplished, although here cutter head design would prove a more serious problem.

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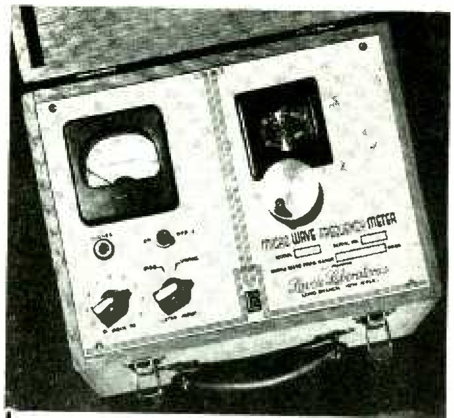

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Nazi Aircraft Radio

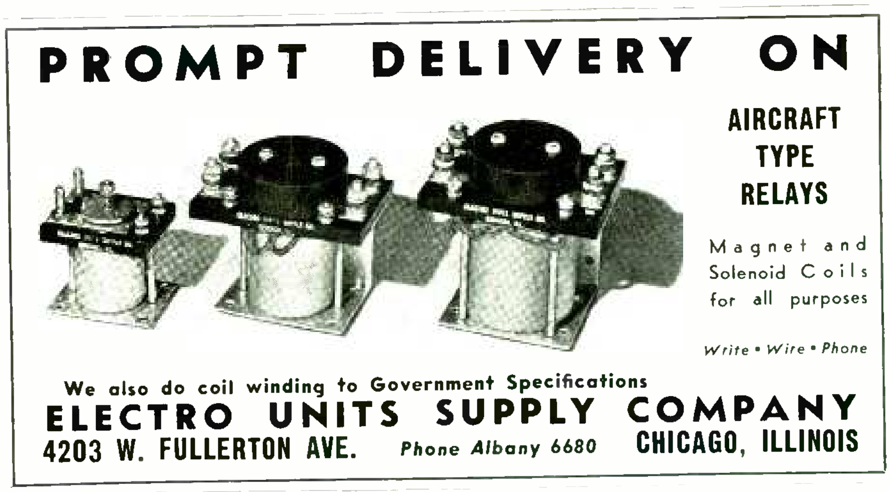
(Continued from page 59)

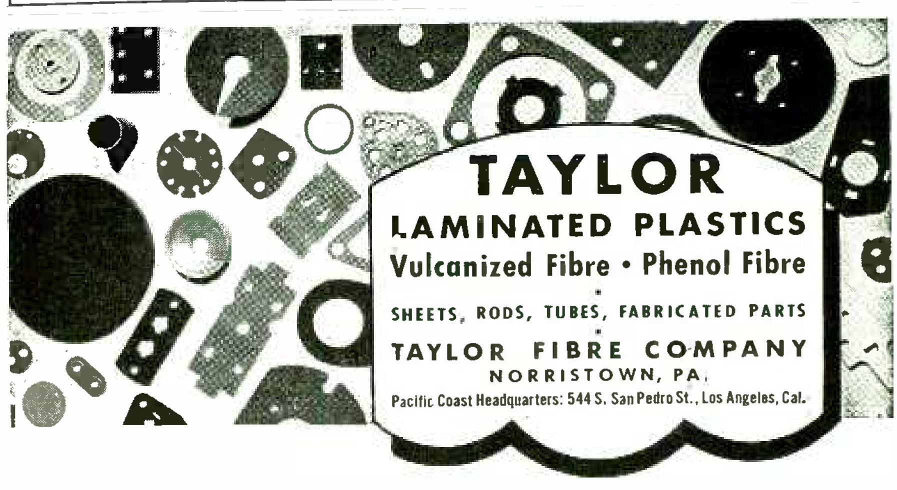
for the pilot and navigator and a homing indicator giving rough indications of distances is provided on the dashboard. Pulse transmission is possible from the long wave transmitter, enabling bearings in the aircraft to be obtained on the ground, free from night errors.

Tuning of the radio is by means of electrical remote control, using two a-c motors (110 v, 250 cps). Long and short-wave superheterodyne receivers are of more or less conventional design but without automatic volume control and chiefly meant for continuous wave working. They occupy a space 8 inches x 8½ inches x 7 inches.

The intermediate frequency of the receivers is 140 kc for the long waves and 1.4 Mc for the short. All coils have powdered iron cores and the oscillator of the frequency changer is temperature compensated by means of ceramic condensers with positive and negative temperature coefficients. The tubes are perhaps the outstanding feature of the receivers. They are pentodes, a little larger than the usual acorn types, and with ring seals. The suppressor grid and screen grid are connected to the anode when the tubes are used as triodes. Long and short-wave transmitters both use a master oscillator driving two power amplifier tubes in parallel. Only a single type of tube is used throughout, with the following characteristics. Heater voltage 12.6 volts. Heater current 0.68 ampere. Maximum anode voltage 800 volts. Maximum anode dissipation 30 watts. Maximum screen voltage 200 volts. Maximum grid current 4 ma.

Continuous waves only are used with the short-wave transmitter, keying being carried out in the grid circuit of the master oscillator. Both fixed and trailing antennas are used but are distant from the apparatus and remotely controlled tuning circuits are fitted, ending in special units at the base of each antenna. Switching from "send" to "receive" is carried out by relay and the antenna winch is also remotely con-





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trolled, a choice of two trailing lengths being possible. Long and short-wave transmitters have a frequency stability of 20 parts in a million per degree C and the weight of the complete radio equipment is 362½ lbs.

Messerschmitt 109 (Fighter). This equipment comprises a transmitter and receiver built only for telephony and operating between 2.5 and 3.75 Mc. The transmitter contains a master oscillator, grid modulation and two output tubes in parallel and together with the receiver is preset while the craft is on the ground. Although the transmitter and receiver can be worked on different frequencies it would appear that if they were so used there would be considerable loss of received signal as they are both connected to the same antenna which is tuned by a variometer in the transmitter.

Output is about 2½ watts and the pilot only has access to an on-off and send-receive switch. For the receiver, a not very recent type of superheterodyne circuit is used, employing pentagrid tubes. The inter-

• • •

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mediate frequency is 509 kc and both air core and iron core tuning inductances are used. The send-receive switch is arranged to apply extra bias to the frequency changer tube and, by rendering it inoperative, cut the receiver out of action.

Forced Landing Sets. The Nazis are also using small portable transmitters capable of continuous wave transmission by hand or automatic keying. On automatic sending they transmit SOS three times, followed by a long dash, then repeat. One type is built into a bright yellow weatherproof container 18 inches x 18 inches x 10 inches and operates on the waveband 320 to 532 kc; 500 kc being a spot tuned frequency. In a separate container two antennas are provided. One of these is a five-section aluminum tube, five meters in length with an umbrella type top; the other is 165 feet of steel wire wound on a reel and held aloft by means of a box kite which is stowed away in the antenna box when not being used. Four batteries, each of 120 volts, supply the anodes and a 4-volt storage battery feeds the heaters, total weight is 50 pounds. Another type of emergency transmitter, intended to be used in the rubber boats carried in each aircraft, is built into a container 11 inches x 10 inches x 7½ inches with an alloy accessory container 24 inches x 8 inches x 5 inches holding a kite, two balloons with filling tubes, two hydrogen generators and an instruction booklet. The antenna consists of 260 feet of stainless steel wire and when the wind is less than 13 miles per hour is carried by a balloon instead of a kite. The balloon is inflated by attaching it to a gas generator and immersing the generator in the sea.

Transmitter frequency is 500 kc and it is the only kind of crystal controlled transmitter so far discovered in Nazi aircraft radio. Optimum antenna tuning is indicated by a neon lamp and the tuning coil is tapped to compensate for variations in the antenna capacity. Power is supplied from a hand driven generator which also incorporates an automatic keying device. The power output to antenna is 6.2 watts of which 0.9 watt is radiated, and with an antenna of 200 feet, the maximum range over land has been found to be 120 miles for good direction finding. Over water the communication range has been estimated at 250 miles.

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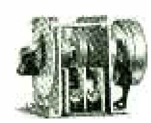

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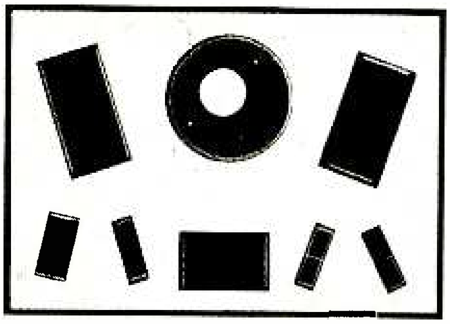

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Welding Control Part 4

(*Continued from page 69*)

is closed and the operation of the panel after closing the foot switch (which must be maintained in the closed position) will be the same as outlined above for non-repeat operation down to the point where the hold timer times out. The additional operation will then be as follows.

Repeat Operation

When the hold timer times out, relay TD_5 closes, dropping out relay CR_1, which de-energizes the solenoid valve to open the welder electrodes and drops out relays CR_3 and TD_4 as explained previously. The closing of the TD_5 contacts 2-73 initiates the off timer, which starts timing and allows the operator to shift the work piece during this time period. As soon as the off timer times out, relay TD_6 is energized and its contacts 56-71 open to drop out relay TD_5, whose contacts 2-16C re-close to energize relay CR_1 since the foot switch has been closed during this time for repeat operation. TD_6 relay contacts 34-34A close to reduce the charge on timing capacitor C_{31} by discharging through resistor R_{30}. This prepares the cool timer circuit for the next repeat cycle of operation. When the hold timer relay TD_5 drops out, its contacts 2-73 open to drop out the off timer relay TD_6, completing the first sequence of operation. The reclosing of relay CR_1 starts the sequence of operation

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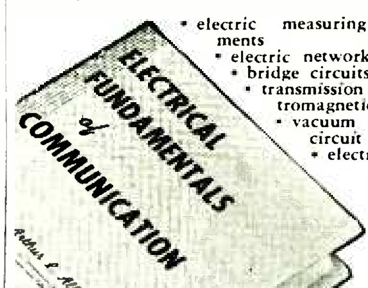

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When this particular timer is used for spot welding instead of pulsation welding, switch S_1 is in the open position. This causes the weld interval timer relay TD_4 to close without time delay and its contacts 3-5 open the cathode circuit of the cool timer. This prevents further operation of the cool timer, thus the heat timer operates only once to time the spot weld.

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Electrical Remote Control

(*Continued from page 64*)

paratus as with power-contactor type of equipment. The usual telephone relay coil will dissipate from 5 to 10 times the power required for safe operation. However, where extremely high speed is desired, coil inductance has to be reduced to a minimum necessitating more current to provide sufficient relay operating power. Therefore, the coil temperature under permanently energized conditions must be considered. Where solenoids and selection switches are used, the relatively high current normally required has resulted in design of coils which are self-protecting under average ambient temperature conditions. If solenoids and switches are to be used where the ambient temperature is likely to be very high power may have to be sacrificed, with some accompanying sacrifice in reliability.

3. *Environmental conditions* such as humidity, salt air, ambient temperature and vibration may prove important factors. High humidity accentuates electrolysis of the small wires used in relay coils and may cause premature failure. This can sometimes be overcome by the use of special impregnated relay coils or by placing control equipment in a heated cabinet. In the latter case, if the control cabinet is small, a continuously lighted 40- or 50-watt lamp will sometimes suffice. High humidity conditions in conjunction with dusty atmosphere increase the possibility of breakdown of relay spring pile-up insulation. Some improvement can be effected by treating the relay spring pile-up and portions of the springs themselves with insulating varnish. Use of dust-tight cabinets is another solution. Dust also presents the additional hazard of excessive contact failures and consequently must be avoided if at all possible. Salt sea atmospheres frequently produce excessive corrosion of metal parts to the extent of making equipment inoperative and so special plating of metal parts must be employed.

The vibration conditions under which the equipment must operate are important considerations in many applications. Excessive vibration may not only cause mechanical failures but may also cause normally closed contacts to open and normally open contacts to close, giving false operation. Vibration at the instant of relay release may also introduce an undesirable variable factor, especially if delayed release has been obtained by means of slugs or other coil accessories. Therefore, it is well to design circuits free from the necessity of added delay features wherever vibration is a factor. Shocks encountered under severe conditions of operation must also be considered and made a specification item when purchasing equipment since certain manufacturing design precautions such as heavier relay spring tensions, balanced construction and heavy-duty bearings can be taken to make equipment withstand such shocks.

Extremely low temperatures such −40 to −50 deg. C may not seriously affect relay and rotary switch operation. However, if a great number of operations required of the equipment necessitate the use of lubricants, then, unfortunately, it may become necessary to sacrifice life, or accept reduced reliability. The major effect of high ambient temperature is in the limitation placed upon the heating of coils and this has already been discussed.

4. *Reliability*. The degree of reliabilty needed in the apparatus being designed will largely govern the type of equipment to be used, its quality, the precautions taken to overcome environmental conditions, the amount of maintenance necessary and the extent to which additional or duplicating equipment must be provided to supervise performance. For example, in a pinball machine, reliability is desirable but a failure is not a matter of life or death. Consequently, the added cost of precise apparatus plus supervising features is not warranted. On the other hand, railway block signal train control must not only utilize equipment of the highest quality, but must also employ supervisory circuits to insure that if there is any failure the remaining equipment will take over and prohibit additional action of any kind until the failure is corrected.

5. *Speed* (number of operations per second or available time allowed

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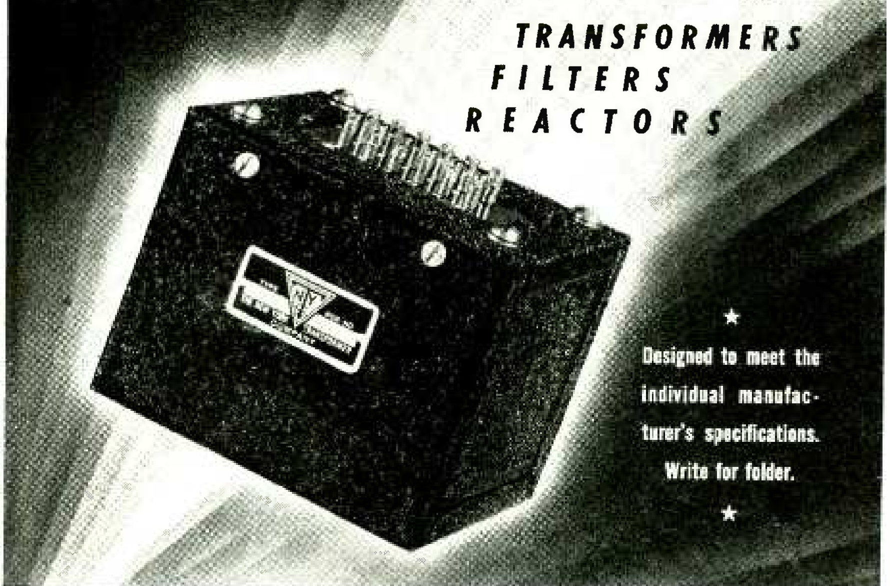
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for relay operation) is intimately associated with the current and voltage available. For example, extremely high speeds (less than 10 milliseconds operate time) may require the sacrifice of sensitivity because it is difficult to build up the magnetic flux in a coil of high inductance in the time available. Likewise, heavy mechanical loads (a multiplicity of contact springs or circuits) tend to make a telephone type relay slow to operate and thus must be avoided where extreme operating speed is required. On the other hand, where high speed on release is desired, the heavier spring loads actually assist the designer.

6. The number of operations a relay is expected to perform during its life cycle will also govern the initial selection of equipment. Telephone type relays, in general, may be expected to operate satisfactorily for 10,000,000 or more operations with maintenance at 300,000, 600,000, 1,000,000 and each 1,000,000 thereafter and at least once per year. Under certain operating conditions, such as in vacuum tube plate circuits where the pick up and drop out are somewhat "cushioned' as a result of gradually increasing and decreasing current, instances are on record where relays of the telephone type have operated satisfactorily up to 400,000,000 operations. Vibration may, however, cause bearing wear even though the relay has operated very infrequently and one relay located in the power cab of a Diesel electric locomotive became unusable within 24 hours of installation even though it was never operated. The solution in this instance was the use of special heavy-duty bearings and anti-vibration springs.

From the foregoing, it will be seen how important it is to consider all the factors discussed, both individually and collectively, in the selection of equipment and in the final circuit design. It is important, too, to make known to the supplier all the proposed operating conditions and it is frequently desirable to write a detailed specification outlining the precise conditions under which apparatus must function. It is especially vital that the supplier be informed exactly what the application is to be. In this way all the supplier's experience may be enlisted to make it doubly certain that equipment suited to the need is used.

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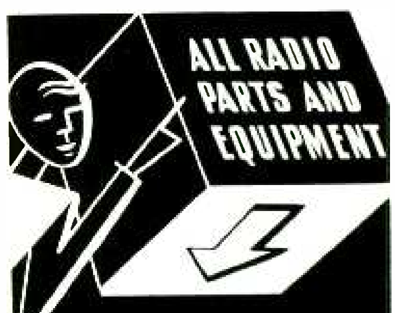

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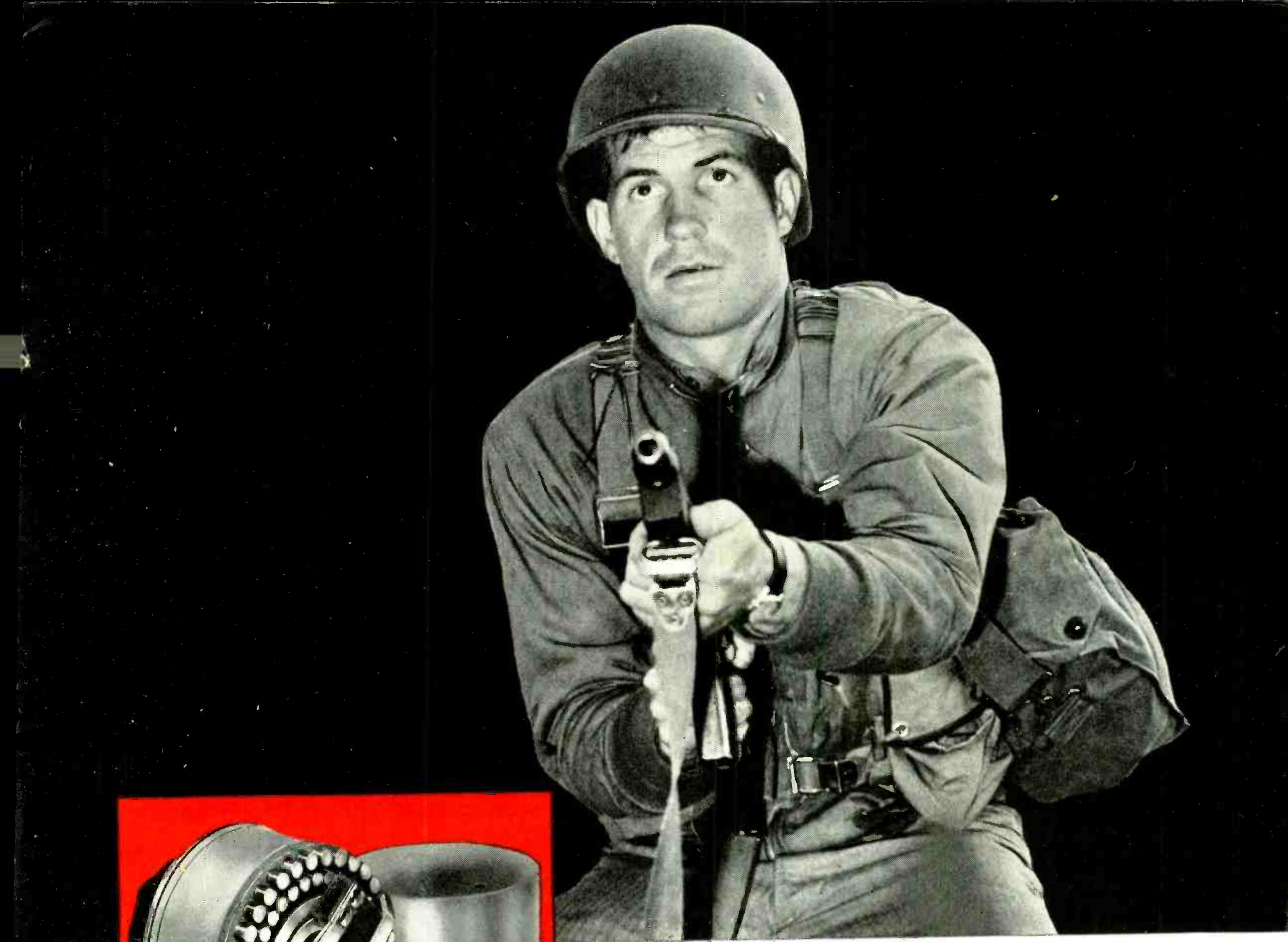

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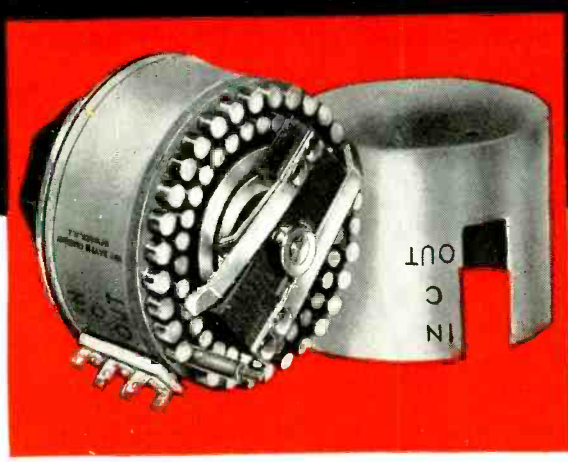

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