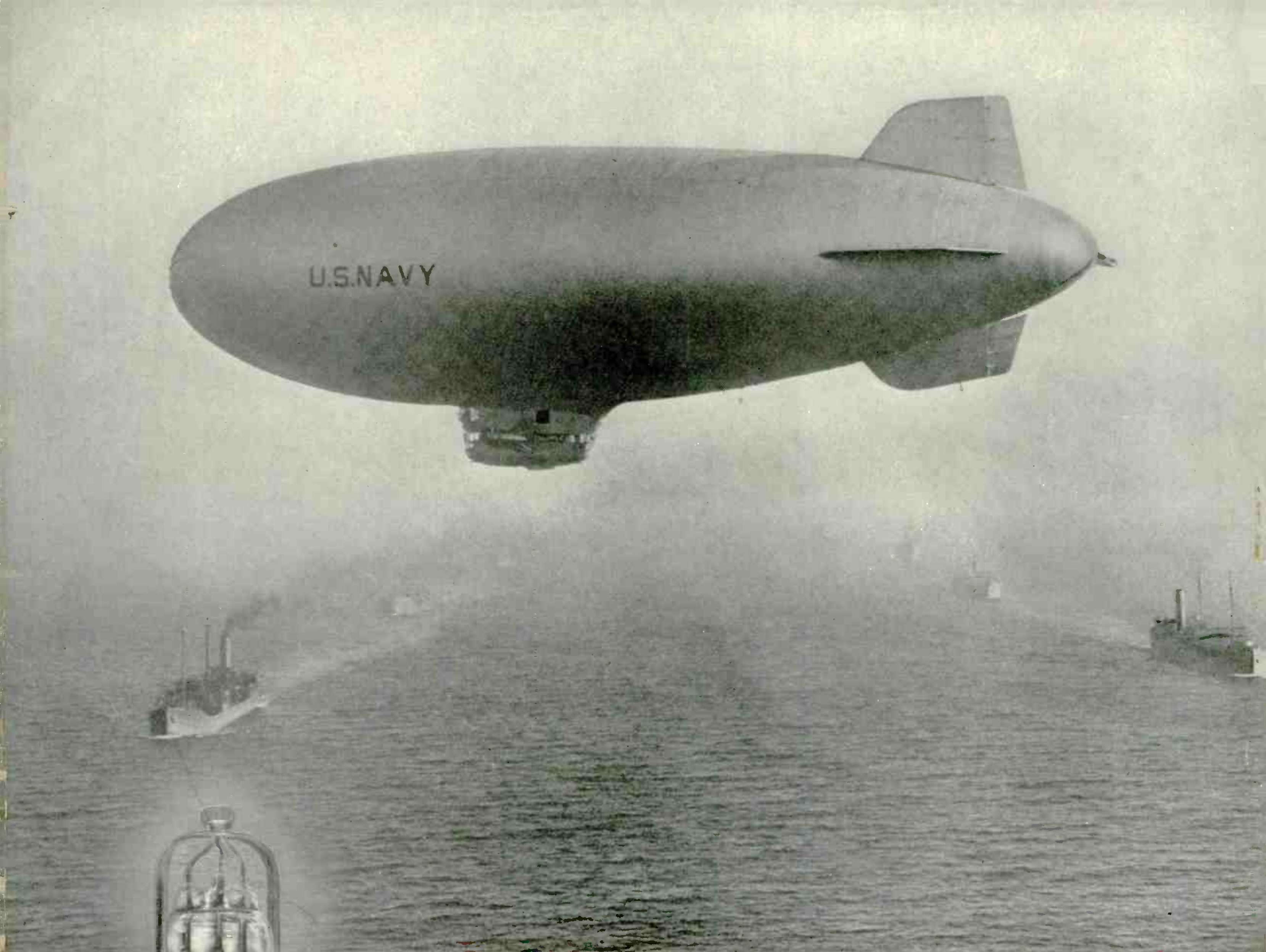
DECEMBER • 1942

electronics

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

IN THIS ISSUE

AIRCRAFT ANTENNA CHARTS will help the men who design radio equipment for such ships as the Douglas "Dauntless" dive-bombers, above.



MILITARY today — INDUSTRIAL tomorrow

U. S. NAVY OFFICIAL PHOTO

AMPEREX Electronic Tubes are incorporated in vital protective equipment serving an alert convoy system speeding vital materials over vast and dangerous distances.

And AMPEREX, now building for battle, is working steadfastly to produce electronic tube designs with highly important military significance. Coincidentally, we are contributing, in these same wartime engineering advancements, to the myriad of practical industrial applications which are already evident . . . for tomorrow.

AMPEREX ELECTRONIC PRODUCTS

79 WASHINGTON STREET **BROOKLYN, N. Y.**

electronics

DECEMBER • 1942

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To ....

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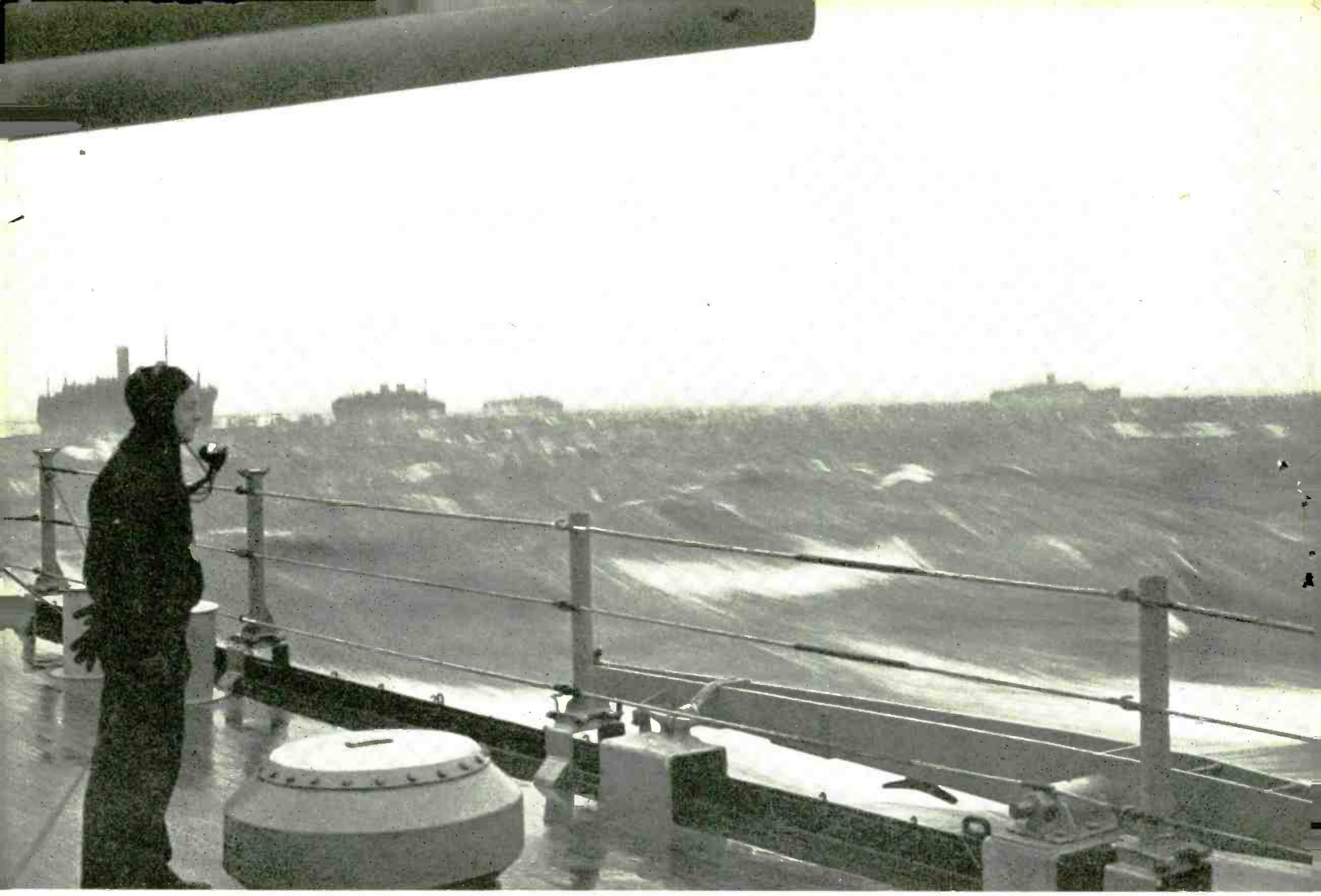


U. S. NAVY OFFICIAL PHOTO

"Adolph, did you mean it?


*FORTUNE, JULY 1939

The Gateway to Germany

AMERICA'S great network of railroads, airlines and highways terminates at New York. From here the sea and air lanes lead across the Atlantic. Every one is a road to Germany.

Less than four short years ago you inserted the travel ad at the left in one of our finest magazines:

Remember it? You actually invited us. Now, take a good look at that convoy on one of the sea lanes, crossing the Atlantic . . . to Germany. The air lanes are open, too.

And we, Adolph, are doing our utmost to produce a sufficient amount of materiel*, so that our "travellers" will not disappoint you.

* *Typical users of UTC materiel are . . . RCA, GE, Western Electric, Westinghouse, Bendix, Farnsworth, IBM, Philco, etc. . . .*

UNITED TRANSFORMER CO.

150 VARICK STREET ★ NEW YORK, N. Y.

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

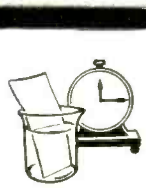
DEFY ERASURE-GHOSTS
with this new tracing cloth

Here is a tracing cloth that holds erasure scars at a minimum—that won't show water marks or perspiration stains. Now you can have clean tracings, in pencil or ink, free from these untidy "ghosts" that reproduce on blueprints!

For PHOENIX is ghost-proofed by a remarkable new process that defies moisture and gives you an unusually durable working surface. You can use harder pencils with this improved cloth and get sharper lines with less tendency to smudge. Even 6H lines show clearly, and reproduce sharply! Erasing does not mar the drawing surface; erased areas take pencil smoothly—and ink without feathering. Its new white color and increased transparency give you excellent drawing contrast and produce strong blueprints.

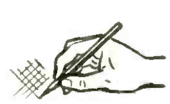
Let PHOENIX prove its virtues on your own drawing board. See your K&E dealer, or write for a generous working sample and an illustrated brochure.

EST. 1867
KEUFFEL & ESSER CO.
NEW YORK · HOBOKEN, N. J.
CHICAGO · ST. LOUIS · SAN FRANCISCO · LOS ANGELES · DETROIT · MONTREAL



PHOENIX DEFIES MOISTURE GHOSTS

Perspiration and water splashes on ordinary tracing cloth create "ghosts" which reproduce on blueprints. PHOENIX Tracing Cloth withstands actual immersion in water for fully 10 minutes at a time! *Perspiration and water marks will not stain it!*



PHOENIX LESSENS SMUDGE GHOSTS

The new improved surface of PHOENIX Tracing Cloth permits you to use harder pencils (5H and 6H) and to get sharper lines with less tendency to smudge.

Result: Cleaner tracings and blueprints.

PHOENIX REDUCES ERASURE GHOSTS

Ordinary tracing cloths become scarred when erased... erased spots produce ghosts on blueprints.

PHOENIX has a durable drawing surface that reduces working scars to a minimum.

K&E
Phoenix
REG. U.S. PAT. OFF.
TRACING CLOTH
for pencil and ink

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.

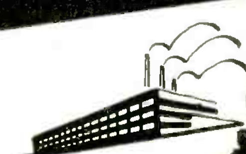
1930 Centralab pioneered a fixed resistor of "hard-as-stone" ceramic material.

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

1940 Centralab added a trimmer condenser with temperature compensating characteristics

Ceramics by Centralab

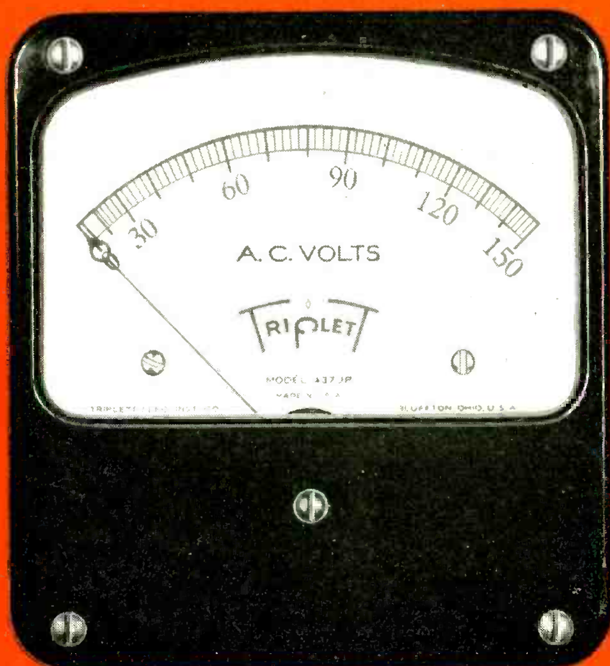
1942 Centralab added a STEATITE plant to take care of its own needs and those of the industry.



TRIPLETT

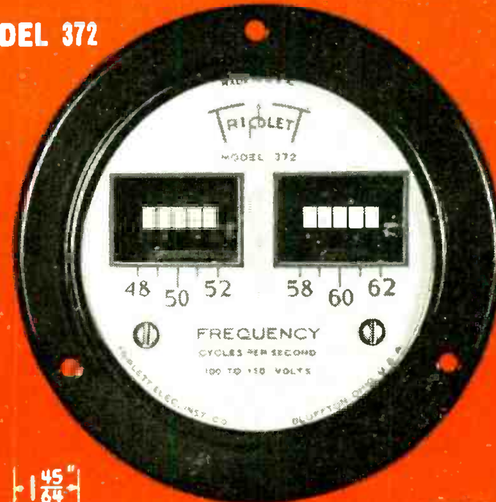
NEW *Combat Line* INSTRUMENTS

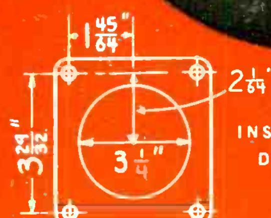
THESE PHOTOGRAPHIC REPRODUCTIONS ARE THREE-QUARTER SIZE



MODEL 437-JP

MODEL 372





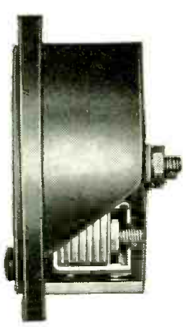
Model 437 - J P

SIMPLE INSTALLATION DIAGRAMS

Model 372

Maximum Service in Minimum Space

TRIPLETT *Thin Line* INSTRUMENTS



Precision performance by new *thin* instrument with *standard* Triplett movement housed in either metal or molded case. No projecting base; wider shroud to strengthen face; simplified zero adjustment; balanced bridge support; metal bridges at both ends; doubly supported core. For "Precision in limited space" write for Triplett Thin Line Bulletin.

The Triplett Combat Line

New Answers to specialized needs of War: Production Speed-up and Standardization; Performance under the Stress and Vibrations of Combat Service.

Model 437 J P—A rectangular line of meters to meet dimensions shown (see diagram). Wide-open scale for maximum readability. Complete coverage AC-DC Voltmeters, Ammeters and Wattmeters. Magnetic or static shielding provided on order. Molded Plastic Case for maximum protection in high voltage circuits. Pivots, Jewels and other component parts designed to meet severe vibration requirements.

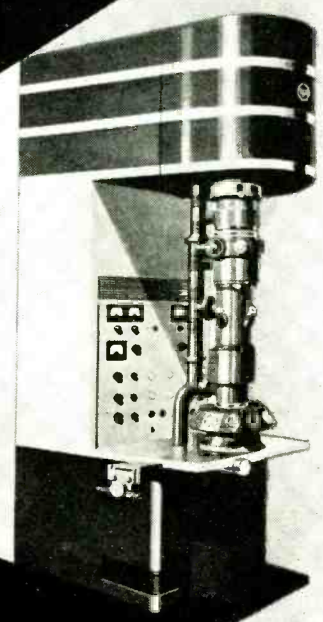
Model 372—Frequency Meter—"All-American make" Vibrating Reed Frequency Meter. Maximum readability by grouping of Reeds. Range-Frequency-Voltage to meet specific requirements. Protected against excessive panel vibration. In standard 3 inch mounting or on special order in any cataloged Triplett Case.

A WORD ABOUT DELIVERIES

Naturally deliveries are subject to necessary priority regulations. We urge prompt filing of orders for delivery as may be consistent with America's War effort.

TRIPLETT ELECTRICAL INSTRUMENT CO.
BLUFFTON OHIO

RCA ENLISTS THE ELECTRON TO



An electron is so infinitesimal that it weighs only .000,000,000,000,000,000,000,000,000,000,899 grams.

OPEN NEW DOORS OF RESEARCH!

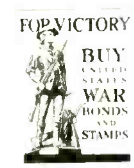
An example of how RCA electronic research is leading to new progress in science and industry

The RCA Electron Microscope is one of the hundreds of practical tools for progress that RCA electronic research has developed. Using electrons instead of rays of light, and electro-magnetic fields instead of lenses, the RCA Eléctron Microscope enables man to peer deeper into the hidden, sub-microscopic world than ever seemed possible before. Magnification as high as 100,000 diameters can be easily obtained—*fifty times* greater than is possible with the best optical oil-immersion microscópe.

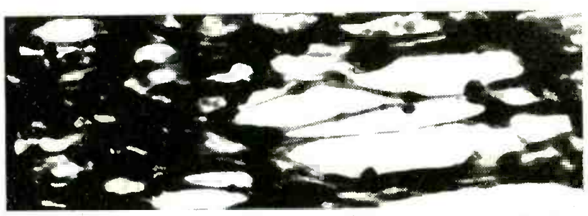
For industry it has meant closer insight into many processes, a better understanding of the methods for making, treating, and preserving materials.

For chemistry it has meant the opportunity to study, for the first time, details of molecular design and structure, so that there can be a continued advance in the creation of such products as nylon, rayon, synthetic rubber, and plastics.

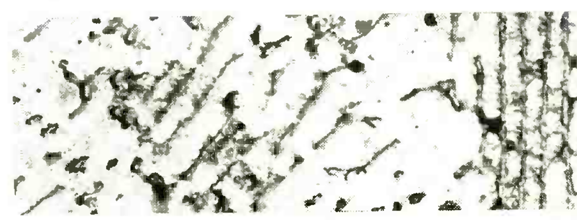
For medical science it will mean the opportunity to observe, for the first time, how the body fights bacterial and virus diseases—such as infantile paralysis, smallpox, influenza, the common cold and many others.



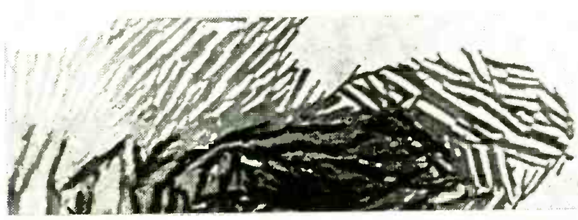
For all America—and when peace returns, for all the world,—this product of RCA electronic research will lead the way to a richer and fuller life.



Micrograph showing Vinylite in one of its many stages of polymerization. The study of plastics is aided by the RCA Electron Microscope, which enables observation of the polymerization process, typical of the plastics.



Micrograph of Pearlite steel, a carbon steel formed by controlled annealing. By using very thin replicas of the surface, the structure of practically all metals can be studied with the RCA Electron Microscope.



Tobacco mosaic virus, seen for the first time by the human eye through the RCA Electron Microscope. The virus represents a large protein molecule, very injurious to tobacco. These observations may lead to the development of an anti-virus serum or antibody.

Micrograph of staphylococcus bacteria,—pus producing organisms which can attack any part of the body and cause painful and dangerous infections. The RCA Electron Microscope enables scientists to observe their actual structure, thus leading to important work in protecting man against this bacteria.

RCA

RCA LEADS THE WAY

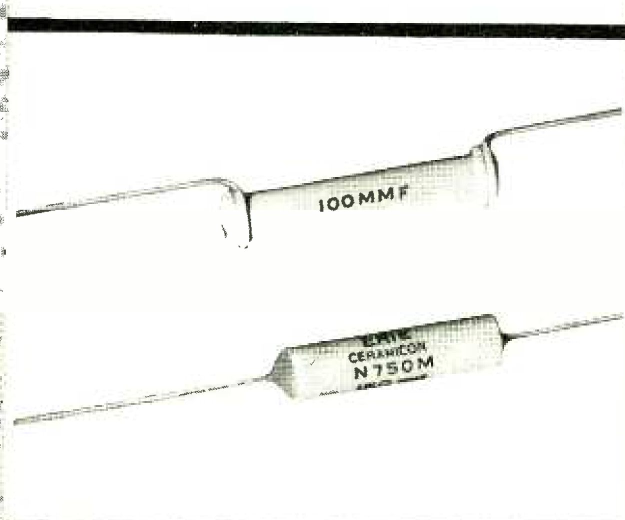
IN RADIO — IN ELECTRONICS — IN TELEVISION

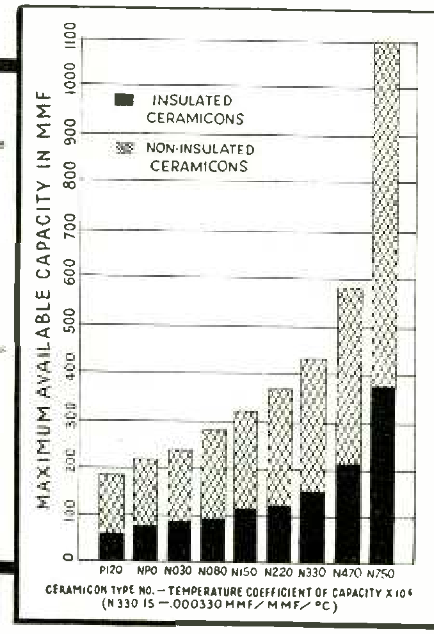
RCA Manufacturing Co., Inc., Camden, N. J.

USE *Erie Ceramicons*

REG. U.S. PAT. OFF.

FOR MICA CONDENSER REPLACEMENTS





THE scarcity of high grade mica makes it essential for manufacturers of electronic equipment to switch to other types of condensers.

The dependability of the silvered-ceramic construction of Erie Ceramicons has been definitely proved by their use in many types of installations over 6 years.

In using Ceramicons for mica replacements, the function of the capacitor in question should be considered in selecting the proper type. When practically no change of capacity with temperature is permissible, zero coefficient (type NPO) should be specified. Where moderate variations are allowable, maximum negative coefficient (type N750) or some intermediate value should be used to take advantage of the smaller size of Ceramicons available in the higher negative coefficients.

Where rather large variations are allowable, and where power factor is not critical, a new series of high dielectric constant Ceramicons, which will be available shortly, should be specified, since very high capacities will be available in this type of unit.

The chart reproduced above shows the range of standard Ceramicons. The new high dielectric constant Ceramicons will be available up to approximately 5,600MMF in the insulated style and to approximately 16,000MMF in the non-insulated style.

Write for literature that fully describes the operating characteristics of standard Erie Ceramicons.

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

Product of

UNITED

Skills in Electronics

"UNITED" electronic power tubes cannot be spun out on swift, automatic assembly lines. The painstaking manufacturing of these sensitive devices requires the skill of human hands.

Here at the "United" Plant, incredibly accurate hands perform under a system of personal supervision by electronic engineers. One by one, the steps of forming and fitting the stems, leads, plates, grids, wires and rods combine to produce transmitting tubes of such flawless precision that they consistently win top rating for performance. Never before were the hands of craftsmen and the brains of scientists so superbly "United" in advancing the scope and purpose of electronics.

Consistent technical advances in tubes, now required for war, some day will be more readily available to you for radio communication, physiotherapy and industrial electronics. Remember to look for "United" on the tubes.

UNITED ELECTRONICS COMPANY

NEWARK, NEW JERSEY

CHECK THESE VITAL TURBO PRODUCTS AGAINST ELECTRICAL INSULATION PROBLEMS

VARNISHED OIL TUBING
SATURATED SLEEVING
VARNISHED GLASS TUBING
EXTRUDED TUBING
WIRE IDENTIFICATION MARKERS
BLOCK MICA, MICA PRODUCTS
VARNISHED CAMBRICS, TAPES, ETC.

EACH HAS SPECIFIC ADVANTAGES REQUIRED TO OBTAIN HIGHEST OPERATING EFFICIENCY

There's the whole story behind the extensive use of TURBO flexible tubing—all the essential attributes to meet the urgent demand for an insulation that 'can keep coming back for more'.

Flexible Varnished Oil Tubing—meeting the all-purpose requirements of a sleeve insulation to stand guard against breakdown, moisture absorption, etc.

Varnished Glass Tubing—for those applications where extremely high heat resistance is a prerequisite.

Extruded Tubing—where extreme sub-zero temperature resistance to any effects of embrittlement becomes the important consideration.

Wire Identification Markers—when strict compliance with Army, Navy and Air Corps specifications is necessary.

Various Insulation Materials—for the diversity of requirements in which tapes, cloths, sheets, etc., are needed.

For proof, ask for samples of each. Specimen board and list of sizes will be sent promptly without obligation.

IF ITS TURBO IT SAFE-GUARDS

WILLIAM BRAND & COMPANY

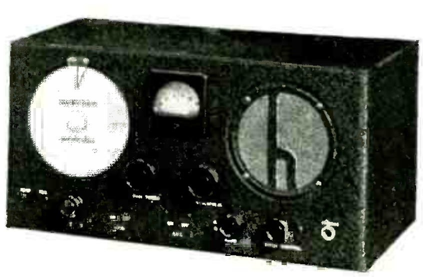
276 FOURTH AVE., NEW YORK, N. Y. ● 325 W. HURON ST., CHICAGO, ILL.

the Sky Buddy was good...but—

THOUSANDS of *Hallicrafters Sky Buddies* gave faithful service . . . years of excellent performance! Sky Buddy owners will be amazed at how far-reaching the progress of research and new electronic development has been, even in the past year.

When Hallicrafters are again permitted to sell communications receivers for civilian use your new Sky Buddy will have so many improvements, comparison with the old models will be a difficult accomplishment.

Illustration (top) partial view of Hallicrafters Signal Corps communications equipment.

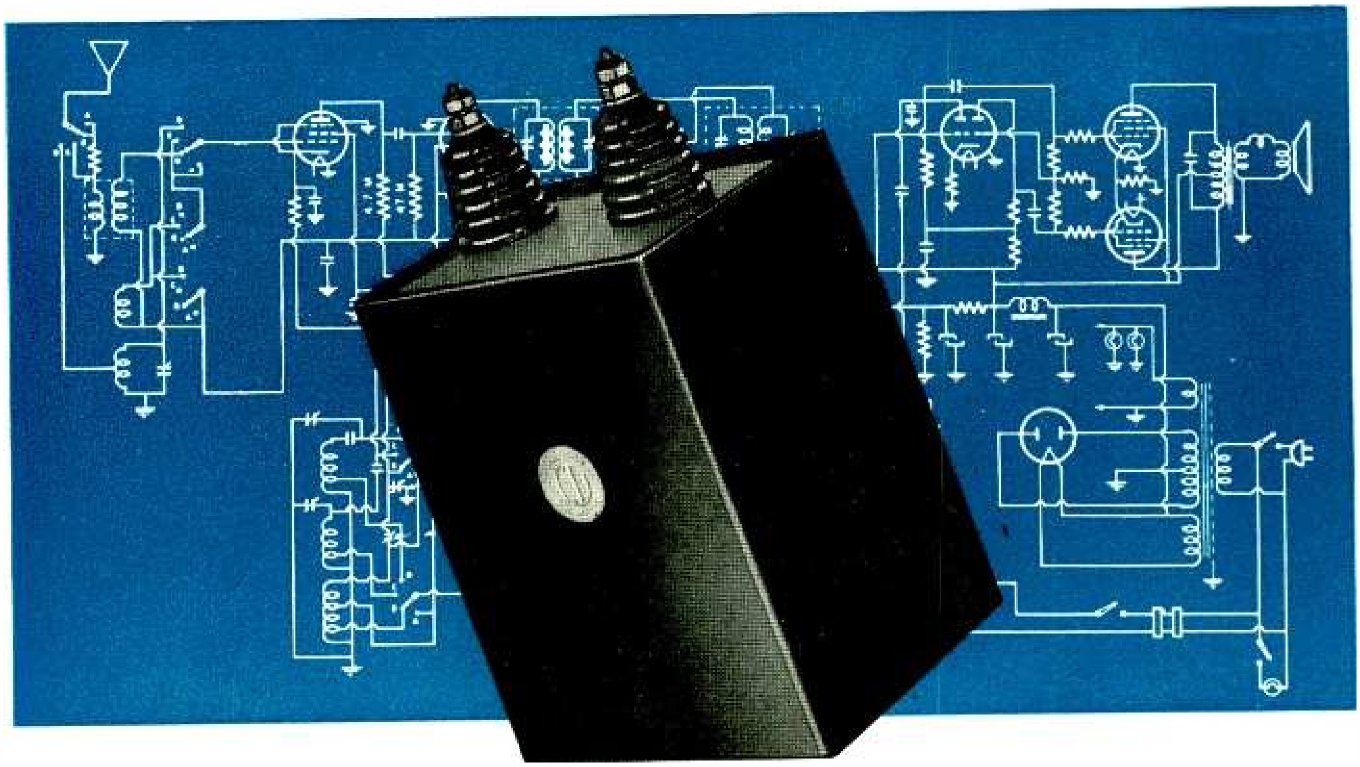


the hallicrafters co.

CHICAGO, U. S. A.

keep communications open!

ARMY E NAVY



WHEN THE BLUEPRINT CALLS FOR CAPACITORS

give your equipment maximum reliability by using C-D Capacitors

Capacitors may look alike but C-Ds are engineered and manufactured by specialists who have made them their lifework. The combined, accumulated experience of 32 years' concentration on capacitors exclusively — is translated into the significant *extra* component that gives C-Ds their *extra* measure of stamina and longer life. C-D means "capacitors dependability"—a very good reason why there are more Cornell-Dubilier Capacitors in use today than any other make. Isn't that worth remembering . . . when the blueprint calls for capacitors?

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

C-D HIGH VOLTAGE DYKANOL CAPACITORS

Type **TK**

These capacitors are universally accepted as the finest ever offered in larger capacity and higher voltage for filter service. Because of their compact construction the design engineer will find them suitable where space limitations are a problem.

Typical features of these outstanding capacitors are:

- Impregnated and filled with non-inflammable, non-explosive Dykanol, the impregnant noted for its high dielectric constant and stability under all operating conditions.
- Hermetically sealed and therefore not affected by moisture, time or temperature up to 93°C.
- Dried, impregnated and filled under continuous vacuum resulting in lower equivalent series resistance, longer life.
- Conservatively rated—will safely operate continuously at 10% above rated voltage.
- Encased in sturdy, arc-welded steel case, painted with a special blue-gray weather-proof, non-corrosive lacquer.
- Supplied with heavy-duty wet-process glazed porcelain insulator. These insulators are pressure-sealed resulting in leakproof joints and high dielectric strength.

For further details write for Catalogue No. 160T
Cornell-Dubilier Electric Corporation
South Plainfield, N. J.

more in use today than any other make

Cornell Dubilier capacitors

Mica • Paper • Dykanol • Wet & Dry Electrolytic Capacitors

FOR VICTORY
BUY
UNITED STATES
WAR
BONDS
AND
STAMPS

...where they'll do the most good

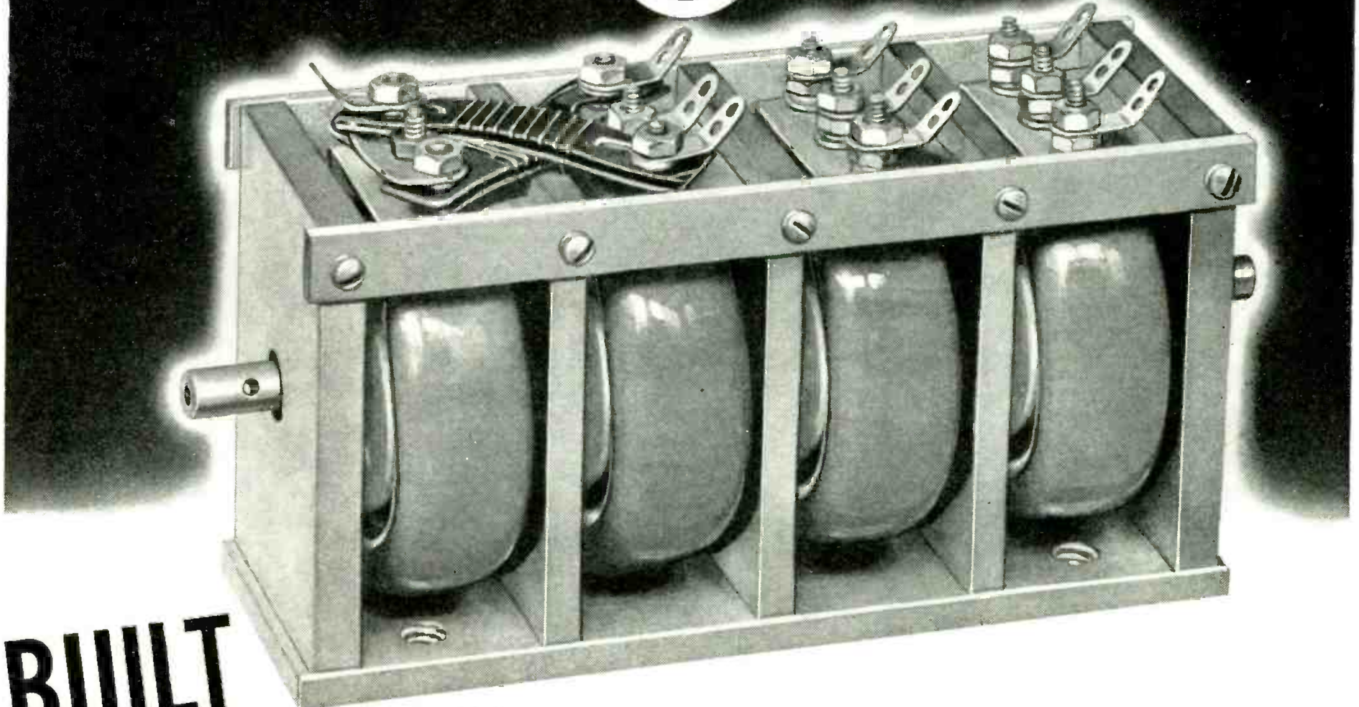
Latest Jefferson-Travis two-way radio communication equipments are limited to the Armies and the Navies of the United Nations. Only the men in combat units or in the most vital services have them. *They are where they'll do the most good.*

JEFFERSON-TRAVIS RADIO MFG. CORP.

Manufacturers of Aircraft, Marine and Mobile Radio Communication Equipment

NEW YORK, N. Y. — RADIO COMMUNICATION EQUIPMENT — WASHINGTON, D. C.

HARDWICK, HINDLE



BUILT TO TAKE IT . . .

This special 4 gang assembly of 50 watt rheostats is exceptionally rugged and compact. It's a fine example of the great adaptability to unusual conditions of our metal base design.

It is gear operated for equipment in important combat units; and it is standing up under terrific use. This special assembly has withstood a 2000 foot-pound shock giving an acceleration to the unit of 300 G.

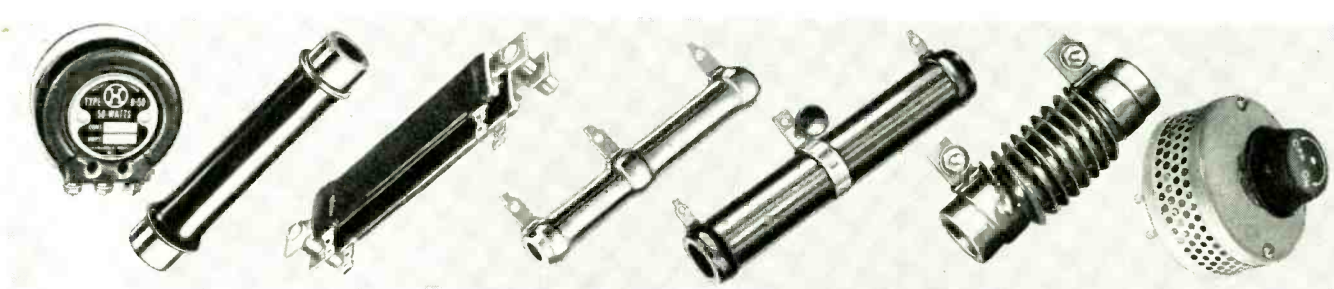
As in all Hardwick Hindle rheostats of this type the exclusive features assure you of 25% more capacity for handling possible overloads—and consequently more heat dissipation—less temperature rise without taking up more space. Our deeper winding form gives more wire, more surface area.

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

Please consult us—

HARDWICK, HINDLE, Inc.

Newark, N. J., U.S.A.



NEW THINGS—

ARE COMING *Fast!*

IN laminated plastic materials, as in so many others, the new conditions imposed by war have led to intensified research which has developed new products and new qualities that are certain to be valuable after the war.

Formica, with the assistance of customers and suppliers, has had a share in this progress. Some of the new things: laminated plastic name plates, glass cloth base insulating material to serve some of the uses of ceramics; arc resistant insulation, "Pregwood", a light, strong, impregnated wood that serves many mechanical uses, and fluorescent instrument panels visible in the dark.

When the war is over let us tell you about the new things in Formica that might serve you better.

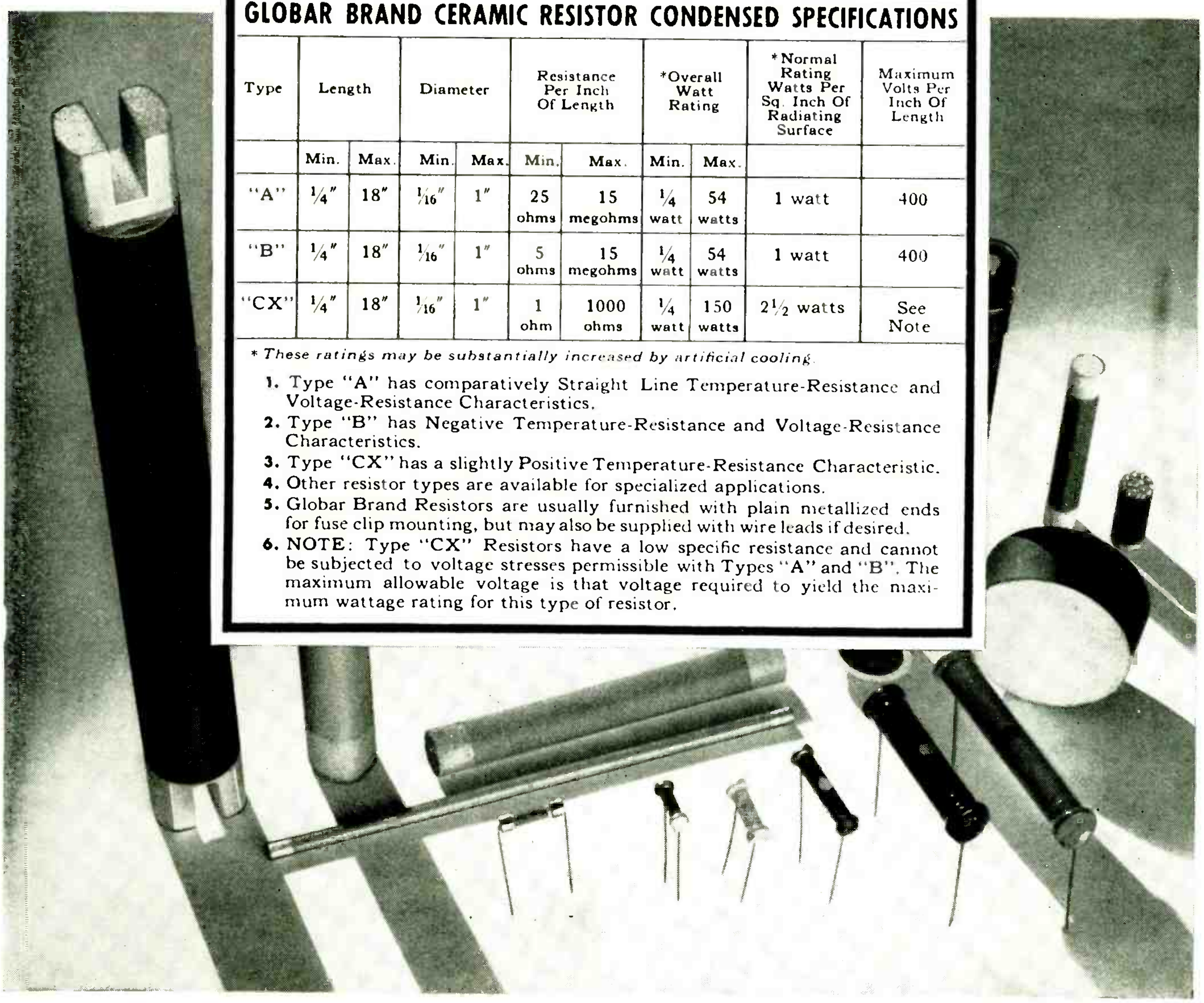
FORMICA

THE FORMICA INSULATION COMPANY, 4661 SPRING GROVE AVE., CINCINNATI, OHIO

Are you choosing your resistors with wartime care?

LET THIS "GLOBAR" CHART GUIDE YOU!

"GLOBAR" Ceramic Resistors are non-inductive and have excellent radio frequency characteristics. They are rugged, have liberal overload capacity. Standard terminals consist of metallized ends; permitting neat, orderly assembly in fuse clips or other types of mountings. "Globar" Resistors are available in many shapes and sizes in the types whose characteristics are briefly outlined below. "Globar" Resistors are available in three tolerances on specified resistance: 5%, 10% and 20%. In designing or ordering please do not specify 5% tolerance when 10% will do the job, or 10% when 20% will suffice. The closer tolerances slow up production. To conserve your time and to assist you in selecting the resistor best suited to your purpose our long experience in specialized resistor manufacture is at your service. Send us full details of your requirements and your problem will have our immediate consideration.



GLOBAR BRAND CERAMIC RESISTOR CONDENSED SPECIFICATIONS

Type	Length		Diameter		Resistance Per Inch Of Length		*Overall Watt Rating		*Normal Rating Watts Per Sq. Inch Of Radiating Surface	Maximum Volts Per Inch Of Length
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
"A"	1/4"	18"	1/16"	1"	25 ohms	15 megohms	1/4 watt	54 watts	1 watt	400
"B"	1/4"	18"	1/16"	1"	5 ohms	15 megohms	1/4 watt	54 watts	1 watt	400
"CX"	1/4"	18"	1/16"	1"	1 ohm	1000 ohms	1/4 watt	150 watts	2 1/2 watts	See Note

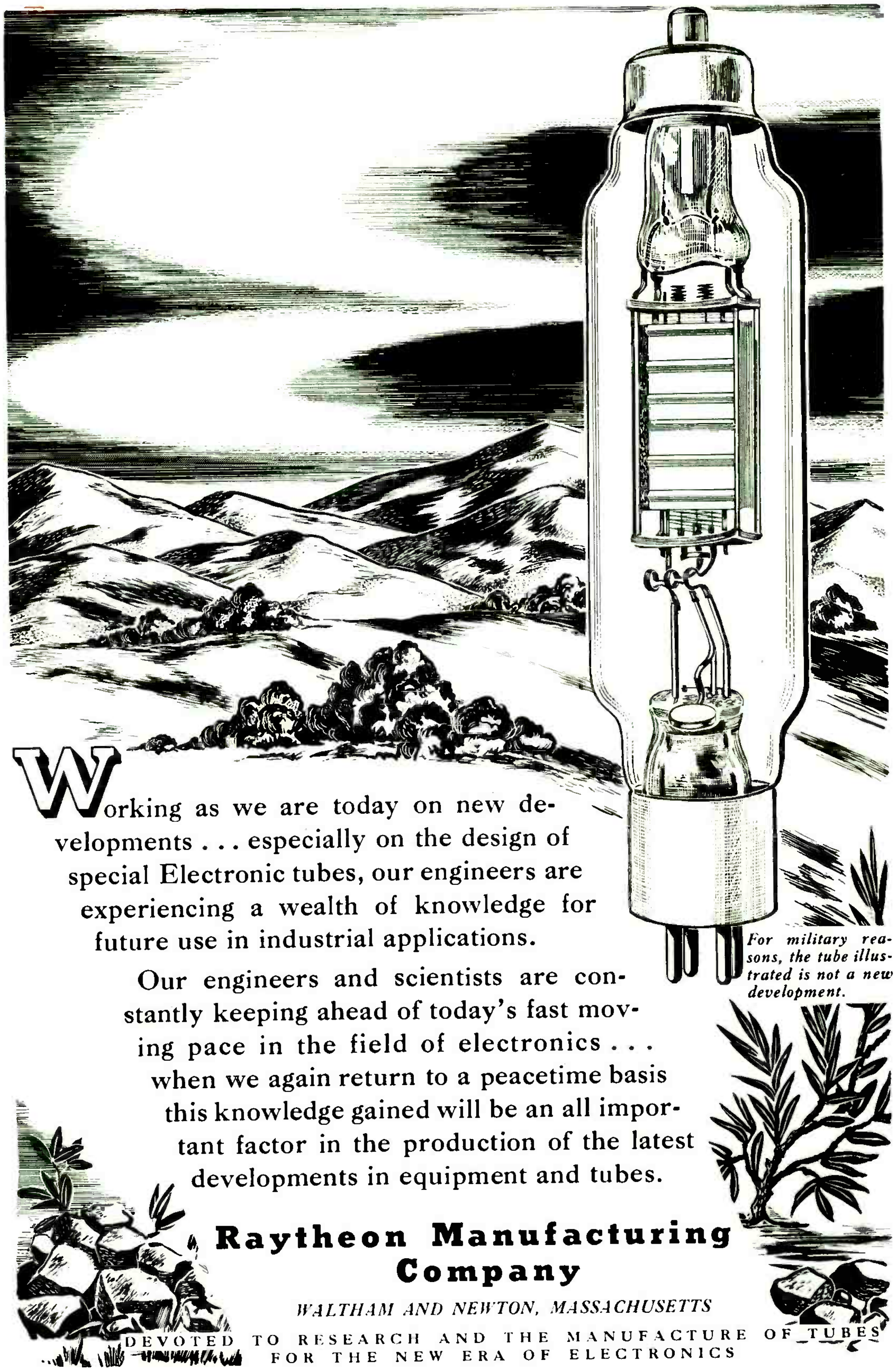
* *These ratings may be substantially increased by artificial cooling.*

1. Type "A" has comparatively Straight Line Temperature-Resistance and Voltage-Resistance Characteristics.
2. Type "B" has Negative Temperature-Resistance and Voltage-Resistance Characteristics.
3. Type "CX" has a slightly Positive Temperature-Resistance Characteristic.
4. Other resistor types are available for specialized applications.
5. Globar Brand Resistors are usually furnished with plain metallized ends for fuse clip mounting, but may also be supplied with wire leads if desired.
6. NOTE: Type "CX" Resistors have a low specific resistance and cannot be subjected to voltage stresses permissible with Types "A" and "B". The maximum allowable voltage is that voltage required to yield the maximum wattage rating for this type of resistor.

Globar BRAND **CERAMIC RESISTORS**

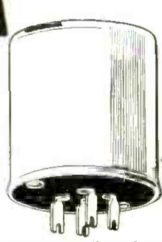
Globar Division **THE CARBORUNDUM COMPANY** *Niagara Falls, N. Y.*

REG. U. S. PAT. OFF.


Working as we are today on new developments . . . especially on the design of special Electronic tubes, our engineers are experiencing a wealth of knowledge for future use in industrial applications.
Our engineers and scientists are constantly keeping ahead of today's fast moving pace in the field of electronics . . . when we again return to a peacetime basis this knowledge gained will be an all important factor in the production of the latest developments in equipment and tubes.
For military reasons, the tube illustrated is not a new development.
Raytheon Manufacturing Company
WALTHAM AND NEWTON, MASSACHUSETTS
DEVOTED TO RESEARCH AND THE MANUFACTURE OF TUBES FOR THE NEW ERA OF ELECTRONICS

THERMADOR THERMATITE TREATED TRANSFORMERS

Defeat humidity and Extreme heat problems



Aviation Audio Transformer (Thermatite treated)

THERMADOR transformers are "THERMATITE" treated. THERMATITE is a process of accurate heat controlled vacuum impregnation, using the best grade of materials.

This process has been developed and improved by ten years of daily use by the same personnel and supervision.

THERMATITE impregnated transformers will therefore stand extreme conditions of climatic change. This is very important with their wide use all over the world.

EXPERIENCED ENGINEERS AT YOUR SERVICE

May we be of assistance in engineering and producing transformers to meet your specific requirements?

THE THERMADOR TRANSFORMER LINE

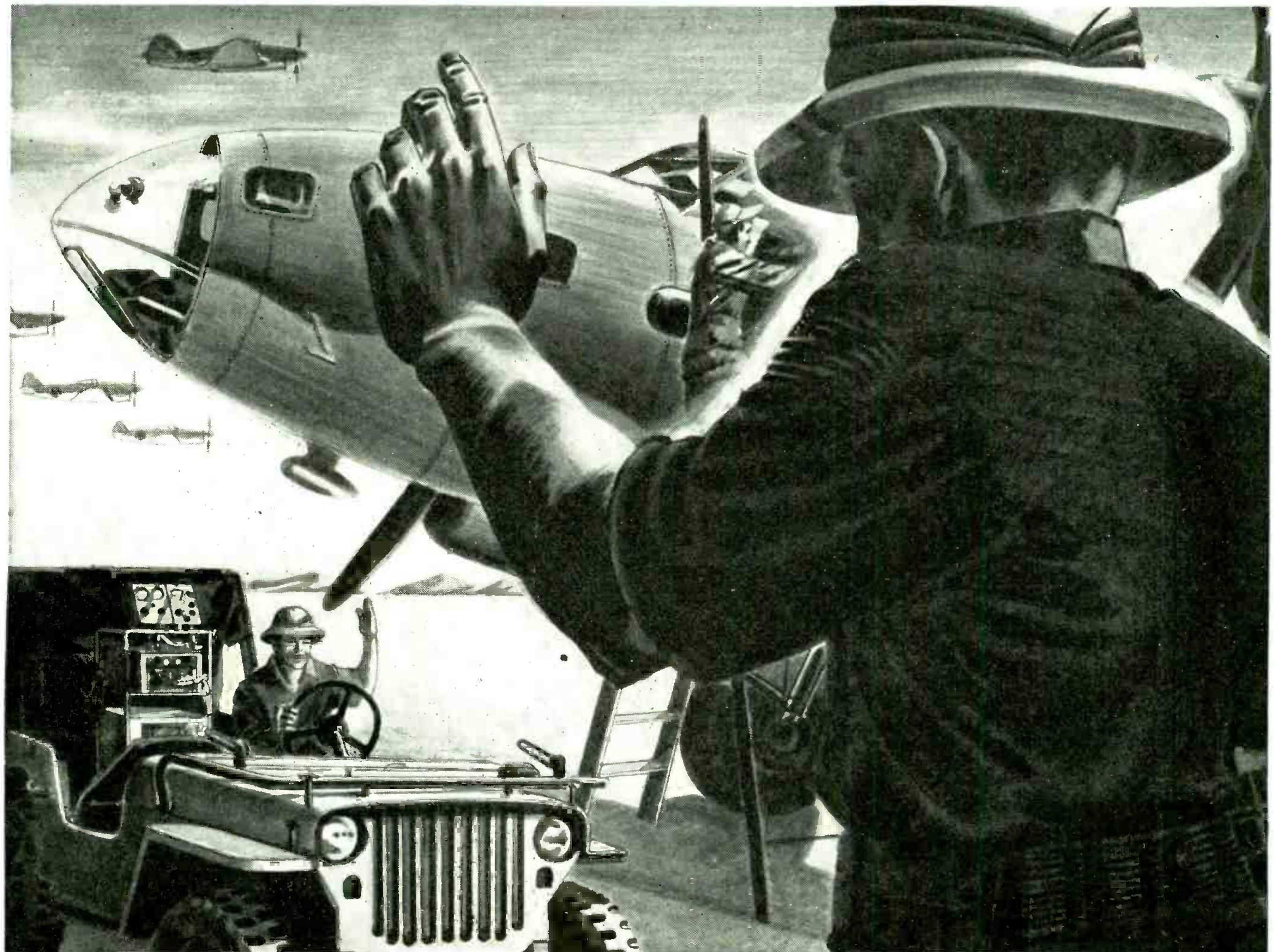
Included in the Thermador Transformer line are audio, auto, geophysical, bias supply, bridging, cathode modulation, coupling, driver, field supply, filament, high fidelity audio, input, midget plug-in audio, mixing and matching, modulation, output, plate, power (combined plate and filament), television,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

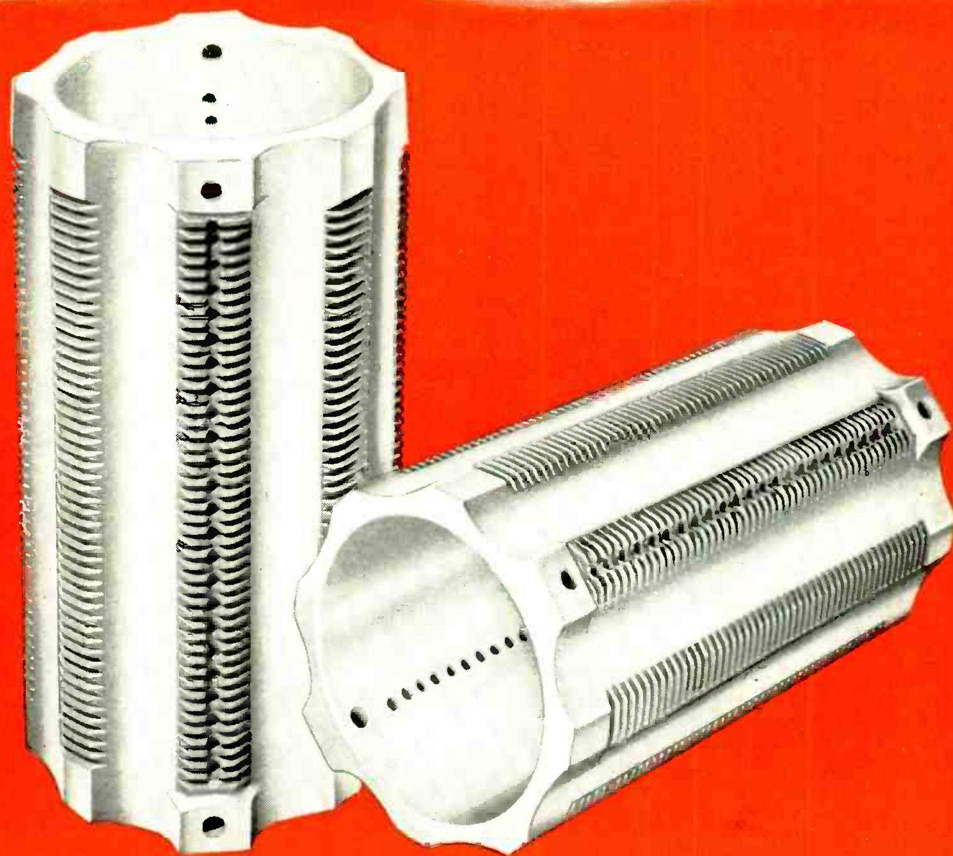
"SEVEN LEAGUES AHEAD"

THERMADOR THERMATITE TREATED TRANSFORMERS

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

REPRESENTATIVES – Les Logan, 530 Gough St., San Francisco, Calif. • Verner O. Jensen, 2607 Second Avenue, Seattle, Washington • M. J. Klicpera, P.O. Box 3113, Houston, Texas.





Pressed—for time
AND TIME SAVED BY PRESSING

A customer needed a large quantity of these 7½-inch coil forms — in a hurry. The normal processing called for extruding, cutting-off, threading, drilling and other machining that would have made "on time" delivery impossible as all equipment necessary for these processes was tied up for months ahead.

We could have thrown up our hands and said "Sorry" We could have found plenty of alibis. But that is not our way.

Our Engineering Department went to work. "What about pressing?" asked someone. Pressing? A piece 7½ inches long with 52 holes and eight flutes and 52 threads on each flute? A stiff problem. It had not, to our knowledge, been done before.

"All right, let's try it!"

The die was probably the most complicated one that ever came out of our tool shop.

To make a long story short — we did it, and, pardon us for saying so, we are rather proud of this achievement.

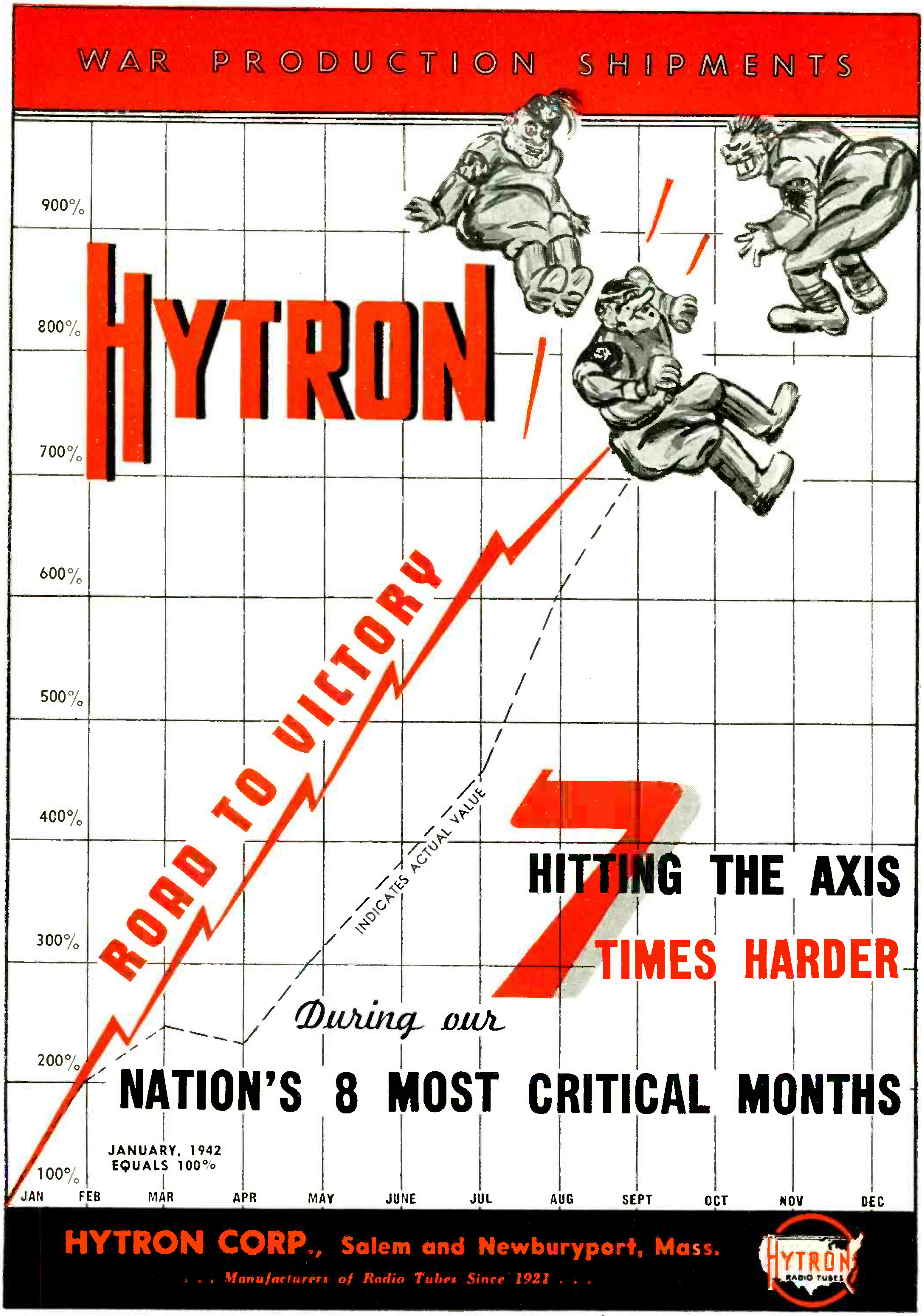
If *you* have any special steatite problems, we would like to have a shot at them.

GENERAL CERAMICS AND STEATITE CORPORATION

KEASBEY, NEW JERSEY

GENERAL
CERAMICS AND STEATITE CORPORATION
STEATITE INSULATORS

3330



WAR PRODUCTION SHIPMENTS
900%
800%
700%
600%
500%
400%
300%
200%
100%
HYTRON
ROAD TO VICTORY
INDICATES ACTUAL VALUE
7
HITTING THE AXIS
TIMES HARDER
During our
NATION'S 8 MOST CRITICAL MONTHS
JANUARY, 1942
EQUALS 100%
JAN
FEB
MAR
APR
MAY
JUNE
JUL
AUG
SEPT
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NOV
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HYTRON CORP., Salem and Newburyport, Mass.
. . . Manufacturers of Radio Tubes Since 1921 . . .
HYTRON
RADIO TUBES

Here was the job!

U. S. military gas mask lenses must be pear-shaped, dimensioned accurately to 1/64", curved to meet exact specifications. Center panel thickness—.100" minus .020" plus nothing. Outer ⅛" wide edge thickness—.090" minus .010" plus nothing. 5 Lumarith Plastic lenses to a sprue—no finishing necessary.

Would you have turned to the *Custom Molder?*

To manufacturers new to plastics, the most amazing thing about custom molders is that in one operation they convert raw material into a finished product. Modern production calls for fullest use of the important work of custom molders. Yet many manufacturers don't know how to avail themselves of this work, quickly and without confusion.

So as founder of the plastics industry, we undertake this program, in the hope it will help you find the right custom molder to execute any plastic part you may seek . . . and to speed your production from *start* to *finished* product. Here is what you do:

1. Tell us what qualities you want in the molded part—impact strength; resistance to water, acids or solvents; dielectric strength, etc., etc. We recommend the Lumarith Plastic that fits your specifications.

2. We put you in touch with the available custom molders best equipped to mold the piece.

3. The custom molder gives you a quotation.

4. We work with the molder in furnishing the formulation of the Lumarith Plastic selected, that suits all factors of production technique . . . in relation to dies, heat, pressure, etc.

We welcome your inquiries and questions.

LUMARITH *Plastics*

REG. U.S. PAT. OFF.

Lumarith Molding Powders (Cellulose Acetate)

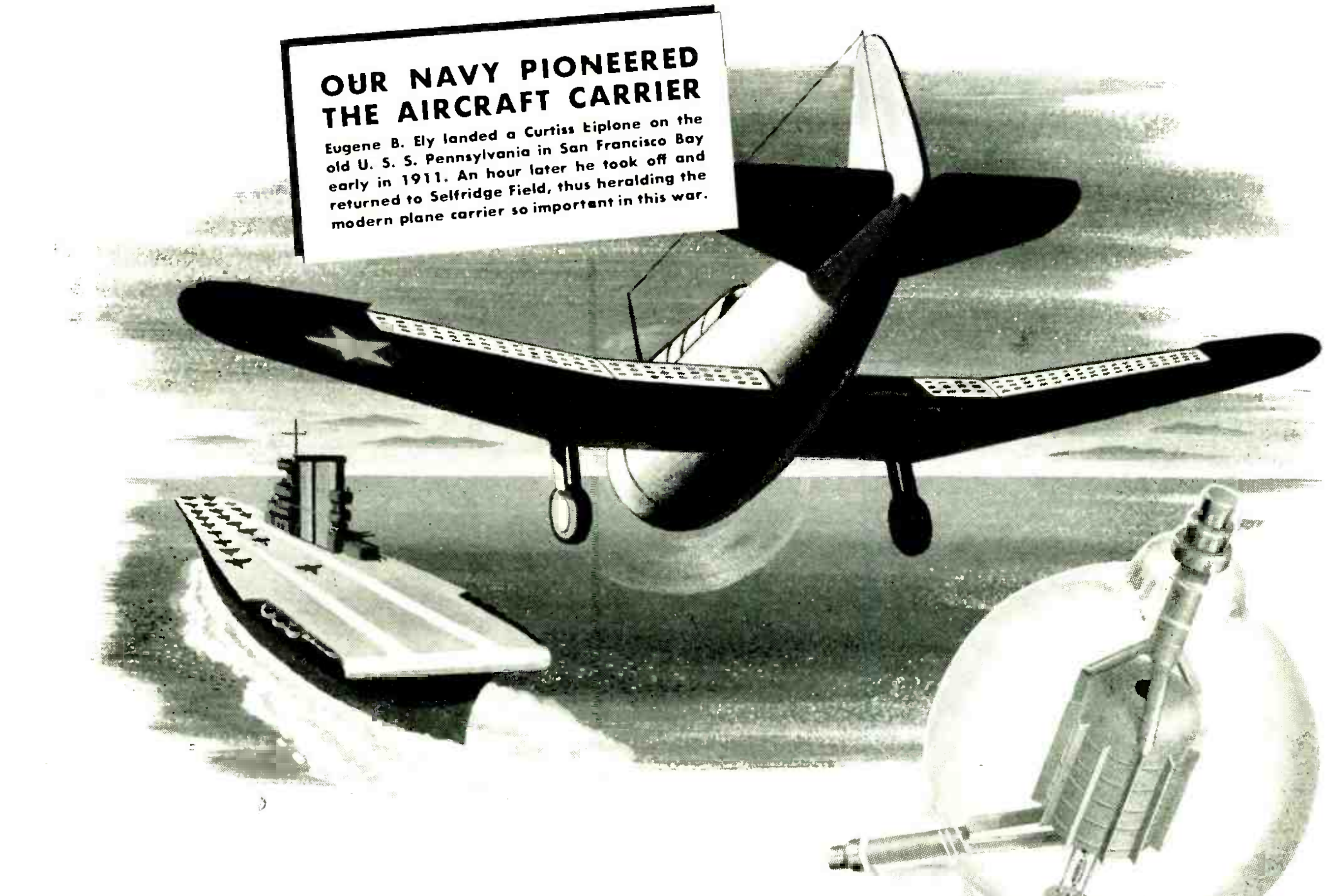
Lumarith E. C. Molding Powders (Ethyl Cellulose)

CELANESE CELLULOID CORPORATION, *a division of Celanese Corporation of America*, 180 Madison Avenue, New York City. *Representatives:* Dayton, Chicago, St. Louis, Detroit, San Francisco, Los Angeles, Washington, D. C., Leominster, Montreal, Toronto.

CELANESE CELLULOID CORPORATION

the first name in plastics

PIONEERS...in war and peace



HK-1054
MAXIMUM POWER OUTPUT 3000 WATTS

GAMMATRON BUILT THE FIRST TANTALUM TUBE

Heintz and Kaufman engineers designed the first tantalum tube in 1928 to provide the ruggedness and reliability needed in marine transmitters. Today nearly 30 Gammatron types, with power ratings from 50 to 5000 watts, are engaged in handling America's wartime communications.

By now tantalum is recognized as the ideal element for plates and grids. It has the lowest gas content of all metals, gives up this gas readily during the pumping process, and then acts as a powerful absorbent for any gas released during operation.

Tantalum construction explains the remarkable ability of Gammatron transmitting tubes to withstand tremendous overloads without producing free gas which would cause filament emission failure.

Our electronic engineers are now pioneering remarkable new types of tantalum tubes for the service of America at war . . . and some day for the world at peace.

GAMMATRON SALES REPRESENTATIVES

MARSH AGENCIES
104 Battery Street
Seattle, Washington

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Buffalo, New York

KENNEDY SALES CO.
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Philadelphia, Pa.

D. R. BITTAN SALES CO.
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New York City, N. Y.

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

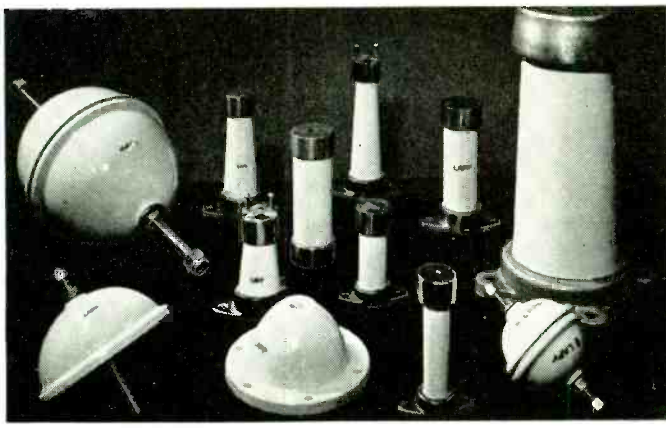
GAMMATRONS...OF COURSE!


ARMY
E
NAVY
E
Awarded
TO THE MEN AND WOMEN OF
CONNECTICUT TELEPHONE & ELECTRIC CORPORATION
MERIDEN ★★ CONNECTICUT
FOR DOING THEIR DUTY AS THEY SAW IT
We, the men and women of "Connecticut", shall fly our burgee and wear our "E" pins with a deep sense of pride. We have done what it is every American's duty to do: our all-out best. The "E" will be an inspiration to find ways of doing still better. The communications equipment and precision electrical products we are privileged to manufacture have direct and important military assignments. We undertake that our output shall not be less by a single unit than the maximum of which we are capable.

FOR HIGH-FREQUENCY POWER SOURCES

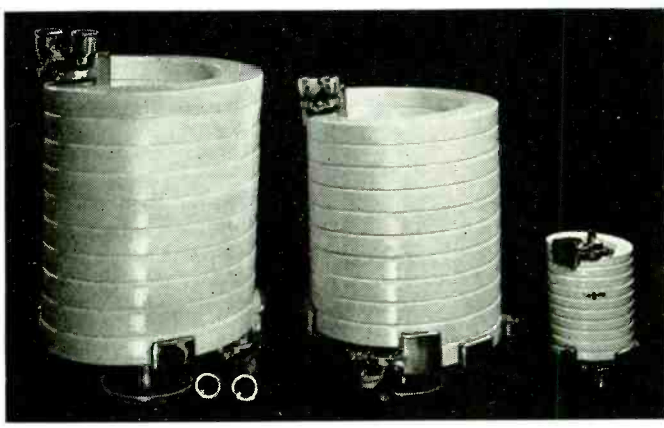
LAPP GAS-FILLED CONDENSERS

In any electronic circuit, wherever lump capacitance is needed, Lapp condensers will save space, save power and save trouble. Available for duty at almost any conceivably-useable voltage rating and capacitance, they bring to any application notable mechanical and electrical advantages: practically zero loss, smallest space requirement, non-failing, puncture-proof design, constant capacitance under temperature variations. *Shown, at left, Unit No. 25934, rated at 200 amp., 6500 volts, capacitance variable 4300 mmf. to 11000 mmf.; right, Unit No. 23722, rated at 50 amp., 7500 volts, capacitance 45 mmf. to 75 mmf.*



STANDOFF, BOWL, ENTRANCE INSULATORS

Standoff, bowl, entrance and other special-purpose insulators are available in wide range as standard Lapp catalog items. Other insulators of special design are easily produced by Lapp methods, either in porcelain or steatite. The wide choice of such insulators available from Lapp simplifies the design of high-frequency equipment. Also, Lapp is equipped for production of many special assemblies, of porcelain or steatite, and the associated metal parts.



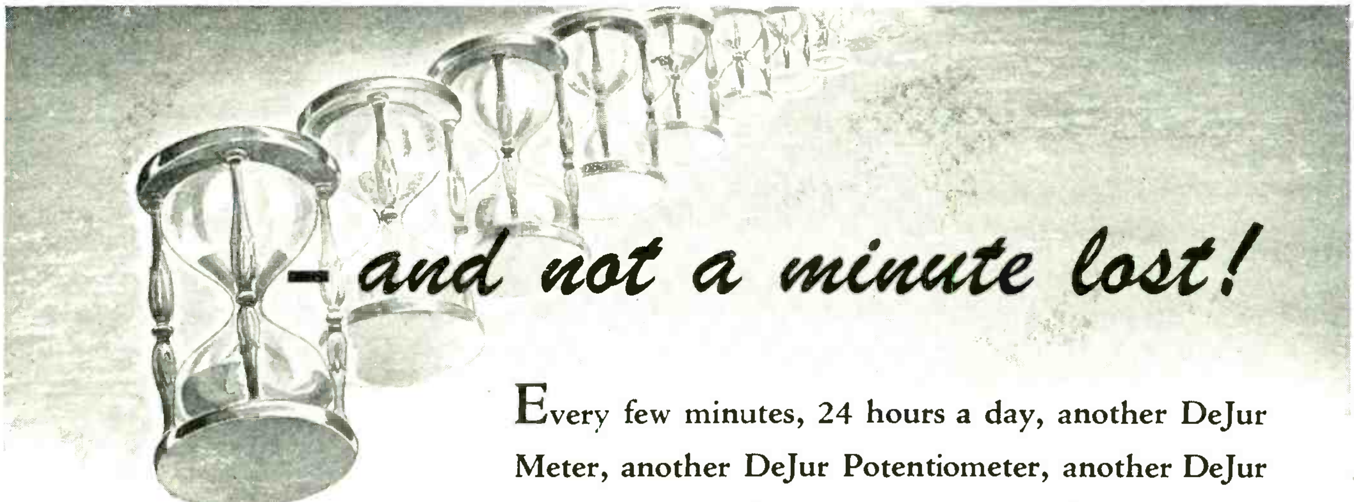
LAPP PORCELAIN WATER COILS

For cooling of high-frequency tubes in radio transmitters and other electronic power sources, Lapp porcelain water coils have been widely used. With nothing about the porcelain to deteriorate, sludging is eliminated, and with it the need for cleaning and water changes. Porcelain pipe and fittings in any needed size are also available as catalog items. We welcome inquiry on any Lapp equipment for experimental or industrial electronic application.

Lapp INSULATOR CO., INC.

LEROY, N. Y.

ARMY E NAVY



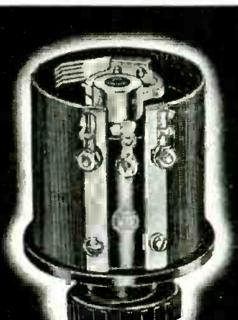
— and not a minute lost!

Every few minutes, 24 hours a day, another DeJur Meter, another DeJur Potentiometer, another DeJur Rheostat is on its way to join up with America's fighting forces on land and sea and in the air.

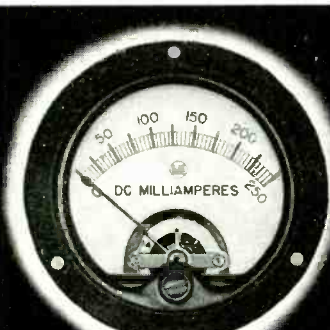
Here is as thrilling a story as any that American industry has recorded so far. A dramatic merger of men, mind and materials . . . an overnight swing from peacetime pursuits to wartime speed-up, and not a single minute lost . . . a transition from normal working habits in a small Connecticut town to never-ending production which is reflected wherever the flag flies.

Out of all this — with your help and ours — will come final victory. Equally important, will come new developments, new discoveries that will far transcend anything in the past.

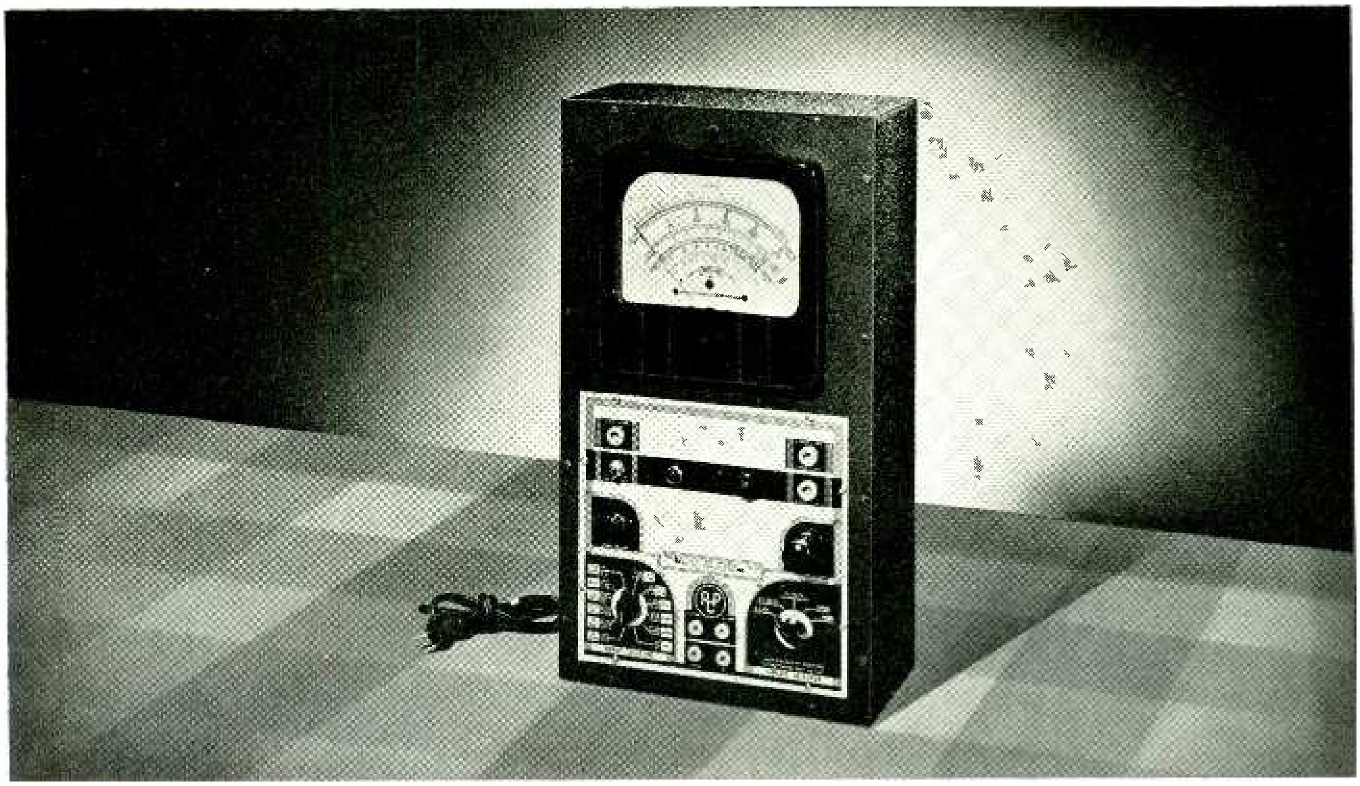
Write, wire or phone for New Catalog 1-61, Dept. G



DeJur Potentiometer
Type 270



DeJur Milliammeter
Model 310



MASTER MULTITESTER

A. C. & D. C. VOLTMETER • D. C. AMMETER • CAPACITY & INDUCTANCE METER

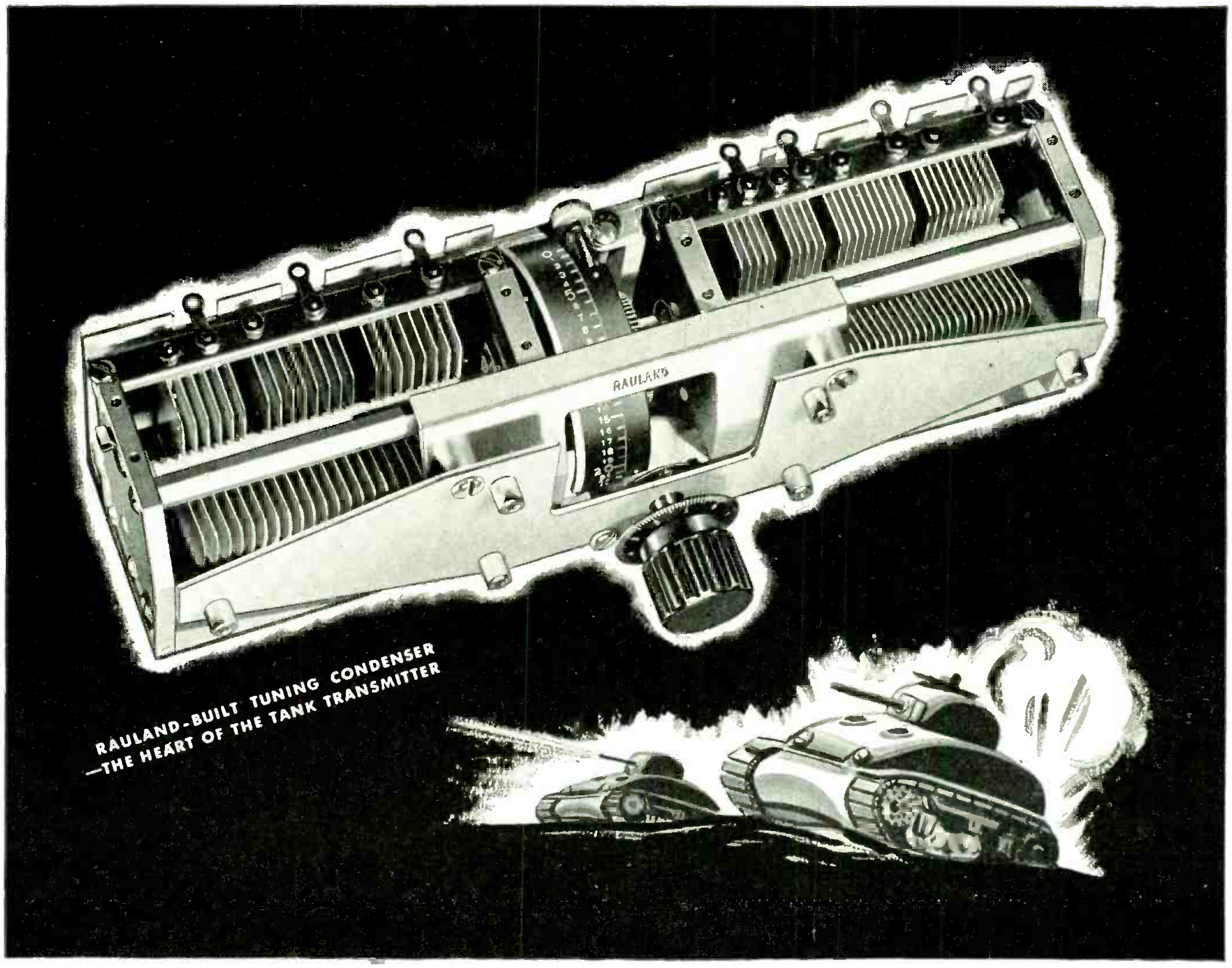
The original engineering design features of this precision Master Multi-tester makes it ideal for a large variety of tests in both the laboratory and factory. Incorporates the exclusive R.C.P. system of A.C. measurements eliminating the troublesome copper oxide rectifier. Rectifier used is rugged, extremely sensitive and easily replaced. A.C. scales are practically linear and coincide with D.C. scales. Capacity measurements are direct reading. Ohmmeter has self-contained power supply. Meter sensitivity 2000 ohms per volt. D.C. voltmeter range: 0-5-50-250-2500-5000. A.C. voltmeter range: 0-10-100-500-1000-5000. D.C. milliampere range: 0-10-50-250-1000. D.C. ammeter range: 0-1-5-25. Capacity meter range: 0-.03-.3-3-30-300 mfd. Low ohm scale: 0-100. Center ohmmeter scale range: 0-15,000-150,000. Megohm scale: 0-.1-.5-15. Inductance meter: .25-1000 millihenries — .25-100-1,000-10,000 henries. Meter and power line completely fused. Supplied in handsome, black crackle wear-resistant steel case. Operates on 105-135 AC. Model 414 V-7 ready for operation . . . $36.95.

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 — either for production line or laboratory work — our engineers will be happy to cooperate in finding the most efficient and economical solution.

RADIO CITY PRODUCTS COMPANY, INC.

127 WEST 26th STREET **NEW YORK CITY**

MANUFACTURERS OF PRECISION ELECTRONIC LIMIT BRIDGES — VACUUM TUBE VOLTMETERS — VOLT-OHM-MILLIAMMETERS — SIGNAL GENERATORS — ANALYZER UNITS — TUBE TESTERS — MULTI-TESTERS — OSCILLOSCOPES — AND SPECIAL INSTRUMENTS BUILT TO SPECIFICATIONS



"Taking it" . . . together

Communications...are key factors in every movement and action of the tank in combat. Orders must be received and sent right through a tortuous mixture of mechanical noise and artillery thunder . . . and these orders *must get through!* Time, at such moments is precious as life and RAULAND shortwave equipment is *Electroneered* to meet Uncle Sam's demand that communications for tanks be as "tough and dependable as the tank itself." They must have "the stuff" to stand up under all the shocks and hard treatment sustained in battle action.

To make RAULAND communication transmitters even more dependable, only RAULAND *Electroneered* tuning condensers are used. They are designed and built to minutely controlled variations and a fine degree of tuning . . . and this is maintained through the roughest periods of tank maneuvers and battle operations.

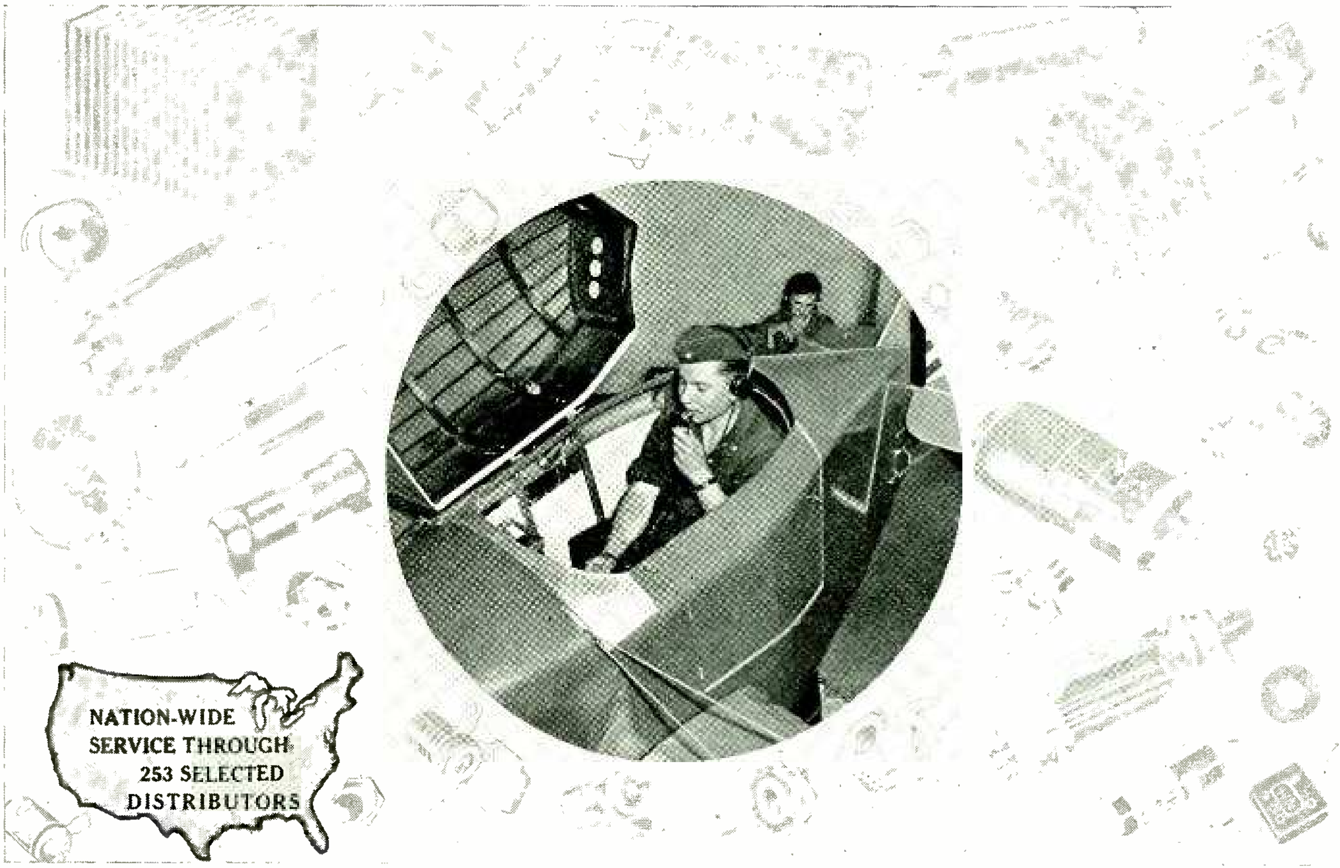
• *Electroneering* is our business •

Rauland

RADIO — SOUND — COMMUNICATIONS

The Rauland Corporation . . . Chicago, Illinois

Buy War Bonds and Stamps! . . . Rauland employees are all doing their part as members of the 10% savings club.



OFFICIAL PHOTOGRAPH, U. S. ARMY AIR CORPS

Mallory Approved Precision Products, Keep Him "Flying"... 300 Miles an Hour Sitting Still!

When he pulls down the hood of this Link Instrument & Radio Pilot Trainer, the flier at the controls acts just as if he were in actual flight over fog-bound or blacked-out terrain. He has to rely on a panel of flight instruments and on his radio earphones to guide him to his "objective" . . . at 300 miles an hour sitting still!

To keep Uncle Sam's airmen learning in Link Trainers, several Mallory precision products are used. Potentiometers to control the volume of simulated radio signals—themselves selected by Mallory selector switches. Rheostats for cockpit lights; pilot light assemblies; and push button switches to control signal lights. Phone plugs and jacks for both instructor's and student's microphones and head phones. Thus the communications and navigation of a Link Trainer . . . just like similar systems in actual fighting planes . . . depend on Mallory parts.

Perhaps *you* are in the market for precision parts for some device you plan to manufacture. Maybe you need a replacement part for present plant equipment . . . or an electronic element for laboratory or testing apparatus. If so, you'll want to investigate Mallory Approved Precision Products, the choice of leading engineers in the aeronautical, automotive, geophysical, electrical, radio and other industries.

It's easy to get the Mallory parts you need *promptly*. Just call your nearest Mallory Distributor. Ask him, or write to us, for a copy of the latest Mallory Catalog. Use this book as your buying guide . . . and depend on your Mallory Distributor as your source of supply. He has the experience and ability to help speed and simplify your purchasing.

Write today for this catalog and the name of your nearest Mallory Distributor

P. R. MALLORY & CO. Inc
MALLORY
APPROVED PRECISION PRODUCTS

P. R. MALLORY & CO., Inc. **INDIANAPOLIS, INDIANA** • *Cable Address*—PELMALLO

Electronics—Secret Weapon of War

Presager of a New Scientific and Industrial Era

THE END of World War I left scientists with a new plaything. They did not know it at the time but they had their hands on a revolution. Within two years the world had radio broadcasting. Within ten years the whole art of motion pictures had been transformed as talking pictures replaced silent movies. Within twenty years television was born and people were seeing pictures in motion by radio.

The fulcrum of this revolution is the electron tube, a new tool of illimitable possibilities. One form of the electron tube is the familiar radio tube; the much publicized electric eye is another. There are many other forms, each having distinct capacities for saving time, saving energy, saving money, protecting life, limb and property.

The electron tube puts the electron to work—and the electron is the basic building-block of the universe.

Electronics is the new art, the new science of putting the electron to work. Radio and sound pictures and television are aspects of electronics; but there are many other facets of this revolution which have been brewing since the last war.

The electron tube has a typical American family tree. Edison made the basic discovery of the "Edison effect" some sixty years ago. This was followed by the invention of the "Fleming valve" and the "de Forest grid". Then Armstrong contributed his share, and hundreds of engineers in garret and cellar workshops and in the great university and industrial laboratories went to work on the tubes which employ electrons. The tube was a plaything before the last war but the world conflict brought it out of the toy stage and made it a practical, powerful tool.

Today the electron tube is guiding the destinies of the greatest armies and fleets ever engaged in the history of the world.

It is a part of the nerve center of the battleship, directing its course, finding its adversaries, broadcasting running accounts of air battles to its crews, directing gun fire and determining ocean depth.

In the air it is the means of locating and identifying enemy planes, piloting planes automatically, giving communication from plane to plane and to shore. It is even operating the controls of the plane.

In the maneuvering tank, in the officer's car, on the back of a foot soldier it transmits and receives vocal messages from every unit of the fighting forces.

Along our borders, and those of our Allies is an electronic screen which counts, follows and identifies enemy planes a hundred miles away through darkness and through fog.

In industrial plants there are electronic counters that enumerate passing articles faster than the eye can see; automatic sorters which discard defective, oversize, undersize, off-color articles; automatic cutters; devices which inspect the inside of things which the eye cannot see; controls which protect workers; controls of temperature; smoke eliminators; intruder alarms; automatic controls for whole batteries of machines.

In its October progress report on American industry, the War Production Board points out that the radio business is *five* times greater than a year ago. From 20 million dollars a month last fall, it has increased to well over 100 million dollars a month. Unfilled war orders are in excess of 4 billion dollars.

From such vast growth will emerge a new engineering of products which will immeasurably improve our peace-time living.

After the war broadcasting will be infinitely more satisfactory: radio receivers will perform with a new fidelity which will amaze us. Television reception will be as flawless as the motion picture. Present secret war developments will readily be convertible to peace-time devices that will improve our standard of living.

No longer will ships collide with other ships, with icebergs or the shore. No longer will trains collide and aircraft crash in flight.

Garage doors will open as we approach and automatically close themselves. Electric lights will automatically go on and off according to our wants and needs. Furnaces and boilers will be controlled and smokestacks will cease to belch wasteful smoke. Air will be made dust free and germ free. Food contamination will be checked, meat made tender.

Grade crossings will be made safe and auto traffic will be automatically controlled.

Medical science sees new wonders ahead. Already it is possible to see "whiskers" on germs, germs which heretofore had been but a blur when viewed through the strongest optical equipment available.

Today so much secret development is going on in the ultra-high-frequency field that little can be said of its great future. But, without divulging military secrets, it can be said that ply-wood is being dried electronically in minutes instead of hours. Ultra-high-frequency welding (not to be confused with flame welding controlled electronically) is being done dramatically and efficiently.

Ultra-high-frequency heating promises to revolutionize the baking industry—it may even heat our homes.

What is this miracle working tube that can see, hear, taste, feel and smell a thousand times more sensitively than was possible heretofore?

What is the electron? No one knows, not even the scientists who know how to employ it. Electrons cannot be seen or felt; but if 6¼ million million million electrons are pushed through a 100-watt electric lamp per second, it will light up to full brilliance. For electric current merely is a mass movement of electrons. Each electron carries its share of electricity, and since the electron has so little weight it can be moved easily and quickly. Therefore, electricity transported by electrons can be turned on or off with great ease and speed. The electron tube merely is a device that controls the flow of electricity. It is an amplifier of power which can be made to do wondrous things. The sound of a termite gnawing inside of a log can be amplified a million times . . . to a roar that can be heard over great distances.

Colors can be classified and matched to a degree not possible by any other means.

Chemical or vitamin consistency can be recognized by counting radio activity within the subject being analyzed.

There is no industry in which electronic circuits cannot be used to speed up production, to increase accuracy, to do heretofore impossible tasks of calibration and measuring.

The opportunities afforded the engineers who are developing this new "electronic age" are limitless.

* * * *

Today the electronic industry is 100% at war. It is meeting the exacting demands made upon it.

Never before was electronic equipment called upon to withstand temperatures ranging from 75 degrees below to 150 degrees above zero Fahrenheit. Never before did radios and transmitters have to withstand the shaking and abuse to which they are being subjected today.

War demands have called for much redesign, much change of materials and a new conception of operating to tolerances never dreamed of in peacetime material. As a result, electronic parts and equipment makers are building better devices.

Universities and colleges are working at top speed to produce electronic engineers, for every radio operator in a plane, every radio man in the ground forces and on ships, every man operating radar equipment or electronic control devices in ordnance . . . and there are many thousands of them . . . must be a trained technician.

The wall of military censorship is high but it is no secret that one of Britain's best weapons that keeps the Luftwaffe from exterminating London is a radio locator, a device that gives alarm of approaching planes long before they can be seen with telescopes. Scanning the horizon constantly the locator warns of the enemy's approach. In the nose of a night fighter, the locator informs pilot and gunner when the enemy is within range. Neither is it a military secret that gunfire can be controlled by electronics, and that electronics is having a big share in training our new armies.

Necessity draws a veil over the most dramatic uses of electronics in warfare, but among those who know there is nothing secret about the fact that many of today's wartime applications will revolutionize our peace-time lives. Electronics will invade every industry with totally new devices and machines. The future of the electronics industry is limited only by man's imagination.

Such is electronics, and its destiny!

James H. McGraw, Jr.

President, McGraw-Hill Publishing Company, Inc.

This is the sixth 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.

CROSS TALK

► **PRP** . . . OWI WPB states that during the peak activity of processing fourth quarter Production Requirements Plan applications, some 1300 people were employed on a three shift basis on clerical work alone. This is not nearly all the people, just in Washington, who worked on this job.

PRP may be sickening in Washington, but to get an idea of the great national headache it is, multiply these clerks by the number of plants working under the Plan, 30,000. All the aspirin in the nation cannot cope with this situation. The truth is that PRP is becoming hopeless. It is driving everyone nuts.

Priorities started off pretty well. So long as full production was not attained, there was enough raw material to go round. Then things got tough. A new letterology had to be devised; A1 jobs became A1A jobs. Now if it makes a manufacturer any happier to get no raw materials under an A1 rating than to get no raw materials under an A2 rating, some psychological benefit has been secured, but that seems to be about all that has been accomplished.

The system creaks and groans. Under allocations, a man may need two items to make up a gadget, but one item is scarcer than the other although both are critical. So he gets allotted to himself, 80 percent of one item, 50 percent of the other. His production is reduced thereby to 50 percent and is he going to refuse to take the extra 30 percent of the item he cannot use? Don't be silly!

The fact is there is no longer enough material to go round. Critical materials must soon be allotted on a technological basis and not upon a statistical basis.

PRP must soon be on the way out.

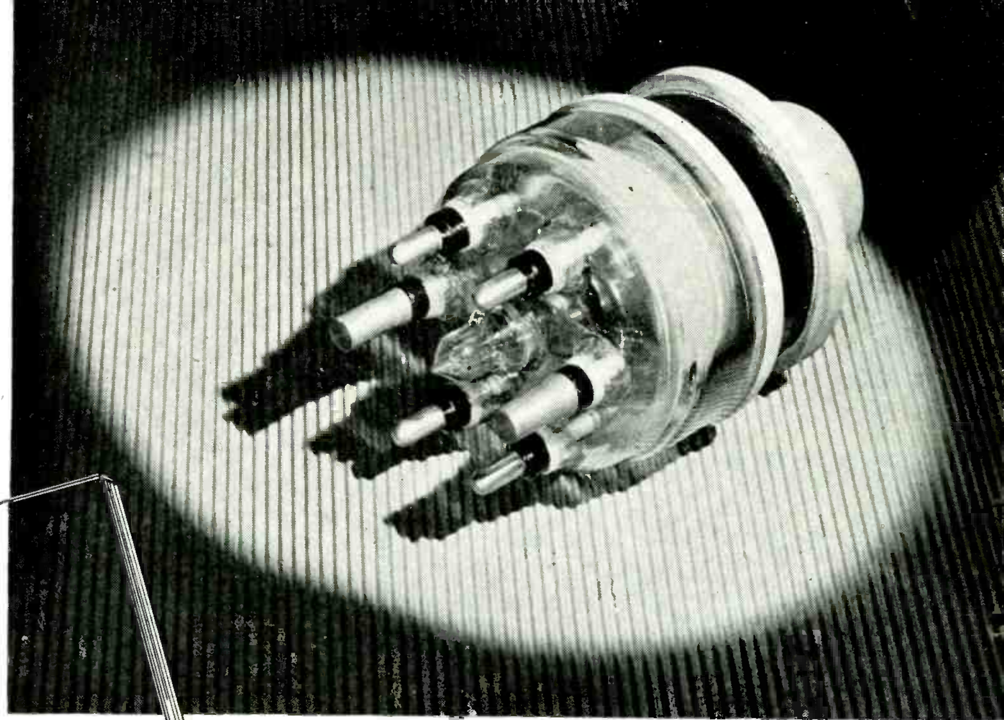
The new Controlled Materials Plan (CMP) deals at the outset only with aluminum, copper and steel.

► **TEMPERATURE** . . . Some time ago the editors of ELECTRONICS became interested in the application of electron tubes to the measurement and control of temperature. The result of this sudden, and perhaps temporary, interest was the article by Craig Walsh in October. At the time the article was edited, it was decided to send it to our fellow editor, M. F. Behar of *Instruments*, who has spent so much of his life in a crusade for better instrumentation of certain variable industrial factors, including temperature. We wanted a foreword to point the article up.

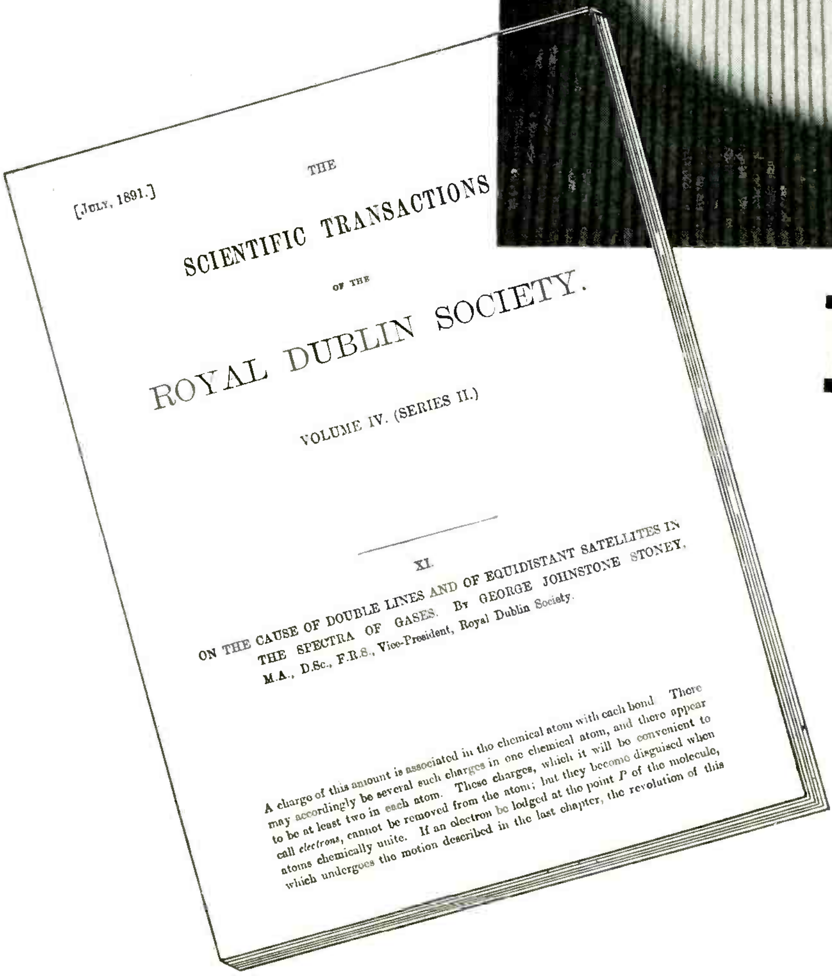
At the time Mr. Behar was busy, and then he went away somewhere, and when he came back and was not so busy and wrote the foreword, the article was on the press and subsequently appeared under its own steam without the benefit of Mr. Behar's foreword.

Later on the foreword arrived. Mr. Behar had really gone to town with the idea when he got around to it. It seems that electronic engineers have a golden opportunity in the measurement and control of temperature; but that the ground is only scratched so far. The foreword, appearing in this issue, is really an essay on the whole subject of temperature control, telling us where to start, and what the problems are. It is, therefore, published after Mr. Walsh's article and not before it but we do not believe either article suffers from this strange editorial behavior.

Anyone having a yen to hitch a vacuum tube to a thermometer will do well to scan Table I of this present article. This table should re-direct the efforts of electronic engineers into channels most likely to produce success; it should stimulate invention and development of automatic temperature control systems combining precision and speed; it should serve to stop the waste of energy of so many engineers who have been intermarrying the most incompatible mechanical and electronic devices.



A modern transmitting tube, representing three and one-half decades of progress since the first three element tube was built



[July, 1891.]

THE

SCIENTIFIC TRANSACTIONS

OF THE

ROYAL DUBLIN SOCIETY.

VOLUME IV. (SERIES II.)

XI.

ON THE CAUSE OF DOUBLE LINES AND OF EQUIDISTANT SATELLITES IN THE SPECTRA OF GASES. By GEORGE JOHNSTONE STONEY, M.A., D.Sc., F.R.S., Vice-President, Royal Dublin Society.

A charge of this amount is associated in the chemical atom with each bond. There may accordingly be several such charges in one chemical atom, and there appear to be at least two in each atom. These charges, which it will be convenient to call *electrons*, cannot be removed from the atom; but they become disguised when atoms chemically unite. If an electron be lodged at the point *P* of the molecule, which undergoes the motion described in the last chapter, the revolution of this

Title page and paragraph of Stoney article in which the word "electron" first appeared

ELECTRON

WHAT is believed to be the first published record of the word "electron" occurs in the *Scientific Transactions of the Royal Dublin Society* for July 1891, in an article by George Johnstone Stoney, M.A., D.Sc., F.R.S. A reproduction of the original printing of the article title page as well as the paragraph in which the word 'electron' was proposed and first appeared, is attached. It is interesting to note that italics were used in this original printing of the word, thus giving it emphasis.

Stoney was born in Ireland in 1826. His whole life was devoted to academic and government service. His interests were wide-spread as indicated by the fact that he published papers on astronomy, education, physical optics, kinetic theory of gases, and music. Many of his ideas were somewhat ahead of his time and he is a recognized contributor to the beginnings of our modern physical concepts.

In connection with the origin of the word 'electron,' it is interesting to note what was said of Stoney in a biographical note[6] at the time of his death in 1911:

> **"Stoney invariably invented a nomenclature for the quantities he was dealing with, where none already existed. Such new terms are continually to be met with in his writings. Many of them have been found by others to be most convenient, and have consequently taken root in science, as, for example, his term wavelet, employed advantageously in his papers on microscopic vision, in connection with his method of resolution into plane wave fronts. This facility in suggesting suitable terms proved most useful when serving on the now famous committee of the British Association which devised our present system of electrical units, and of which he was one of the early members."**

It is apparent, therefore, that the origin of the suffix "tron" is not in any way tainted with recent commercialism but, on the contrary, is more than 50 years old and has a thorough academic origin and background.

Professor Millikan's book "The Electron"[1] devotes a portion of a chapter to the origin of the word and both the early and later conceptions of its proper use and definition.

This new word, however, did not come into common use to any great extent in the years immediately following its initial publication. This is indicated by the fact that the second edition of J. J. Thompson's book "Conduction of Electricity Through Gases,"[2] does not appear to use the word anywhere in the text. This book was used widely and considered one of the standard works on the subject by scientists and engineers in the field at that time. In looking over the text of this book, it is interesting to note the manner in which the author discusses at length such

A discussion of such terms as "electron", "electronic", and "electronics"; some history dealing with the early tube names and some suggestions for proper naming of electron tubes by one who has been closely associated with vacuum tube engineering since the beginning and is familiar with its communication and industrial applications.

By W. C. WHITE

Electronics Laboratory
General Electric Company,
Schenectady, N. Y.

TUBE TERMINOLOGY

subjects as ionization by incandescent solids, photoelectric effects, determination of the value of e/m, discharges through gases at low pressures, cathode-rays, all without the use of the word 'electron.'

Another book used by all radio engineers during the early years of the century was "The Principles of Electric Wave Telegraphy and Telephony" by J. A. Fleming.[3] The second edition, published in 1910, although not showing the word 'electron' in the index, does use it in describing the use of the Fleming valve and does contain the phrase "the electron emission from the tungsten. . . ."

Use of Terms "Electron Tube," "Vacuum Tube," "Electronic Tube"

It will be noted that in this article the names "vacuum tube" and "electron tube" are both used. "Electronic tube" is also sometimes encountered in publications. The recently issued (1942) American Standard Definitions of Electrical Terms (ASA Standards C42, published by the A.I.E.E.) under Group 70—Electronics, gives in Section 10 the following broad definition:

> **"Vacuum Tube**
> **A vacuum tube is a device consisting of an evacuated enclosure containing a number of electrodes between two or more of which conduction of electricity through the vacuum or contained gas may take place."**

Use of the Words "Electron," "Electronic," and "Electronics"

There appears to be some confusion in the use of the word 'electron' and its derivatives 'electronic,' and 'electronics.'

Electron. The word 'electron' is a noun. It is popularly defined as "an element of electric charge," or "the elementary charge of negative electricity." The ASA (American Standards Association) defines it as follows: "An electron is the natural, elementary quantity of negative electricity."

In most cases this word is used in modifying another noun and thus is a noun used as an adjective. For instance, it is correct to speak of an "electron tube," "electron camera," "electron discharge," "electron gun," "electron lens," "electron microscope," "electron emission," "electron multiplier," "electron bombardment," etc. As regards "electronic tube" versus "electron tube," the latter is analagous to steam engine, water tank, and vacuum pump, where the meaning of the qualifying substantive is: operated by, containing, or producing. It is true that we speak of an electric motor, but this is because the noun "electricity" is awkward. All modern tendency is toward using the substantive rather than the adjective in such cases. It is apparent from the grammatical viewpoint, therefore, that "electron tube" is preferable to "electronic tube."

Thus, it is correct to say "Electron Tube Department," "Electron Tube Engineering Department," "Electron Tube Product Committee," and "Electron Microscope Sales Engineer."

Electronic. This word is an adjective and is used only as an adjective. It is defined as "of or pertaining to an electron or electrons." The suffix "ic" signifies "of the nature of, consisting of, characterized by, of or belonging to, after the manner of, characteristic of, resembling, connected or dealing with." Therefore, on this basis, the following terms should incorporate this word: "electronic formula," "electronic device," "electronic research," "electronic phenomena," "electronic engineering," "electronic equipment," "electronic regulator," "electronic instrument," "electronic motor control," "electronic rectifier," and "electronic telemetering."

Electronics. This word is a noun and is defined as "the science which deals with the behavior of electrons." The ASA defines it as follows: "Electronics is that branch of science and

TABLE 1—Classification of Electron Tubes

Generic Term	Output Energy	Character of Space	Control Means	Type Cathode	Names	Definitions
Electronic Tubes (or Tanks)	Electrical	High-Vacuum	None	Thermionic	Kenotron	A kenotron is a high-vacuum thermionic tube in which no means is provided for controlling the unidirectional current flow.
				Photoelectric	Phototube*†	A phototube is a vacuum tube in which electron emission is produced directly by radiation falling upon an electrode. A high-vacuum phototube is one which is evacuated to such a degree that its electrical characteristics are essentially unaffected by gaseous ionization.
			Electro-static	Thermionic	Pliotron	A pliotron is a high-vacuum thermionic tube in which one or more electrodes are employed to control the unidirectional current flow.
			Electro-magnetic	Thermionic	Magnetron*	A magnetron is a high-vacuum thermionic tube in which a magnetic field is employed to control the unidirectional current flow.
		Gas-Filled	None	Thermionic	Phanotron	A phanotron is a hot-cathode, gas-discharge tube in which no means is provided for controlling the unidirectional current flow.
				Cold	Glow Tube*	A glow tube is a cold-cathode, gas-discharge tube in which no means is provided for controlling the unidirectional current flow.
				Pool	Pool Tube* (or Tank)	A pool tube (or tank) is a gas-discharge tube (or tank) with a pool-type cathode (liquid or solid) in which no means is provided for controlling the unidirectional current flow.
				Photoelectric	Phototube*†	See phototube definition under "High-Vacuum Tubes". A gas phototube is one into which a quantity of gas has been introduced, usually for the purpose of increasing its sensitivity.
			Electrostatic Electrode	Thermionic	Thyratron*	A thyratron is a hot-cathode, gas-discharge tube in which one or more electrodes are employed to control electrostatically the starting of the unidirectional current flow.
				Cold	Grid-Glow* Tube	A grid-glow tube is a cold-cathode, gas-discharge tube in which one or more electrodes are employed to control electrostatically the starting of the unidirectional current flow.
				Pool	Grid-Pool* Tube (or tank)	A grid-pool tube (or tank) is a gas-discharge tube (or tank) with a pool-type cathode (liquid or solid) in which one or more electrodes are provided for controlling electrostatically the starting of the unidirectional current flow.
			Ignition Electrode	Pool	Ignitron*	An ignitron is a gas-discharge tube (or tank) with a pool-type cathode (liquid or solid) in which an ignition electrode is employed to control the starting of the unidirectional current flow in each operative cycle.
			Electro-magnetic			(Not used at present)
	Light					
	Ultra-Violet					
	X-Ray					
	Cathode-Ray					

* NEMA Standard
† IRE Standard

technology which relates to the conduction of electricity through gases or in vacuo." Thus, we speak of the "science of electronics," "experience in electronics," and "teacher of electronics." Again, as in the case of the word "electron," it is frequently used to modify another noun, and thus act as a noun used as an adjective. Therefore, it is also correctly used in such expressions as "Electronics Department of the Company," "Electronics Laboratory," "Electronics Engineering Department," and "Electronics Committee."

Early Tube Names

It is generally agreed that Dr. Lee deForest was the first to apply a new and special word to a vacuum tube. This he did in calling his wireless detector an "Audion." In the *Transactions American Institute Electrical Engineers* for October, 1906, Dr. deForest, in his discussion following this paper, said "Dr. Pupin's opening remarks may serve as an argument why the study of Greek and Latin should be thoroughly introduced into our engineering schools. My knowledge of Greek is almost nil; I knew, however, that *aud* was of Latin and *ion* of Greek derivation. But they are both expressive. Where we use a term one hundred times a day, it is necessary to have something brief; we could not expect the wireless telegraph operators to use a long technical description of the apparatus in speaking of it, and when several types are in use it is necessary clearly and briefly to distinguish them".

Dr. Pupin's remarks referred to read as follows: ". . . . If there must be a new name for each new detector —a new name for everything that comes up in the course of the development of the electrical art—pretty soon the science of electrotechnics will be a maze of new names; and the learning of the names will be much more difficult than the learning of the facts connected with the art. For that reason I am oppoosed to new names. Although Dr. deForest is very enthusiastic about the elegance of the name audion, I must say that I am not very much impressed by it. It is a mongrel. It is a Latin word with a Greek ending. If he had said acouion or acousticon it might have been better, but more difficult to pronounce."

It is clear, therefore, that from the very beginning there has been an urge to create new names for new electron tubes and, on the other hand, the studied opinion that such artificial words are not proper or needed. Remarks of these two pioneers in radio sum up pretty well the arguments that are still used today for and against new names for electron tubes.

Probably the first vacuum tube names containing the suffix "tron" were suggested by Dr. Irving Langmuir more than twenty-five years ago in an article entitled "The Pure Electron Discharge".[4] Dr. Langmuir introduced the name "kenotron" in the following paragraph: "In order to distinguish these devices from those containing gas and in most cases depending upon gas for their operation, the name 'kenotron' has been adopted. This word is derived from the Greek *kenos*, signifying empty space (vacuum), and the ending, *tron*, used by the Greeks to denote an 'instrument'." By usage the name 'kenotron' has been applied only to the two-electrode, high-vacuum tube.

Dr. Langmuir introduced the name "pliotron" as follows: "The term 'pliotron' has been adopted to designate a kenotron in which a third electrode has been added for the purpose of controlling the current flowing between the anode and cathode. This word is derived from the Greek *pleion* signifying 'more'. A pliotron is thus an 'instrument for giving more' or an amplifier. A similar use of the prefix 'plio' occurs in the geological term 'pliocene'."

In these times when proof of citizenship is such an important factor, it is improbable that any other electron tube can show as clear and undisputed a birth certificate as these two.

Probably the next two electron-tube names to appear were "dynatron" and "pliodynatron."[5] It is interesting to note that although these two later names are very infrequently used and the tubes which they describe are not commonly employed, the two names themselves are among the "trons" most frequently included in technical dictionaries.

These beginnings are what orginated the phrase "Graeco Schenectady," the creation of which is probably correctly accredited to Dr. Lee deForest. Following these early names, many tube and device names were created. Some of these were registered as trade marks. Some, such as "Radiotron," "Tungar," and "Rectigon," still are registered trade marks. However, in the year 1937, the General Electric and Westinghouse Companies relinquished trade-mark rights on 'ignitron', 'pliotron', 'kenotron', and 'thyratron'.

TABLE 2

Name	Number of Times Word Appears in 10 Dictionaries: 3 General Dictionaries	7 Technical Dictionaries
Kenotron	1	3
Phototube	0	3
Pliotron	3	2
Magnetron	2	4
Phanotron	0	1
Glow Tube	1	2
Tank	0	0
Thyratron	1	4
Grid-Glow Tube	1	3
Ignitron	1	1

In the years that have intervened since the early use of special tube names, some have been more or less frequently employed in publications. In other cases, the adaptation of special names has been slow. This is easily accounted for. For instance, the word 'pliotron' was not used to a great extent for many years because practically the only form in which this tube type could be purchased and used was under the tradename "Radiotron." On the other hand, the words 'thyratron' and 'ignitron' came into quite general use as soon as the devices themselves became known and used because they were such a simple, one-word description of devices that otherwise had to be described by several words.

Classification of Tubes

In classifying devices such as electron tubes, certain fundamental decisions must be made. One of these is whether the name of the tube is to be based on the way it is used or on the manner in which it is built. In other words, should the naming be functional, such as 'dynatron', or descriptive, such as 'triode'? It would appear that the descriptive term is best because electron tubes are used in so many fields and in so many different ways that much duplication and confusion would result if the application were the basis of naming it.

TABLE 3

Name	Number of Times Word Appears in 10 Dictionaries: 3 General Dictionaries	7 Technical Dictionaries
Dynatron	1	4
Klystron	0	2
Negatron	1	4
Pliodynatron	0	3
Radiotron	2	3

Of course, there are bound to be some border-line cases, and exceptions will quickly come to mind. For instance, the term "cathode-ray tube" is only partly descriptive. Also "magnetron" is simply a high-vacuum, hot-cathode diode and thus is similar to a kenotron. In this latter case, however, structurally these two tubes will always be very different.

Another fundamental is in a broad classification into which tubes are grouped. Here again, it can be descriptive of the tubes themselves. Such a classification contains four variables: (1) Number of electrodes; (2) the bulb content; (3) the nature of the cathode; (4) special features, such as control methods or other unique items.

The words to describe this grouping of variables are pretty well established.

(1) The number of electrodes is covered by the words 'diode,' 'triode,' 'pentode,' 'tetrode,' etc.

(2) The content of the bulb may be high-vacuum, gas, or mercury-vapor.

(3) The cathode may be thermionic, pool, photoelectric, etc.

(4) The special features of a tube may involve specific methods of control, such as the ignitor, or special features such as the fluorescent screen, or the use of a pump to maintain vacuum.

By keeping the above group of variables in mind, it is easy to describe practically all of the tubes in existence at the present time. Thus we have a gas-content, hot-cathode triode, or a mercury-vapor, pool-cathode triode with an ignitor.

It is very apparent, therefore, why special words have come into accepted use for specific classes of tubes. For instance, the word 'thyratron' is much easier to use than the phrase 'gas-content, hot-cathode triode' mentioned in the last paragraph. In a similar way, 'ignitron' is preferable to the cumbersome 'mercury-vapor, pool-cathode triode with ignitron starting.' It is undoubtedly

(Continued on page 154)

AIRCRAFT ANTENNA

Pratt & Whitney-powered Vought seaplane designed for use as a scout bomber and normally catapulted from the decks of battleships and cruisers. Characteristics of this particular ship's radio antenna, from cockpit mast to tail-fin, are readily estimated

By PAUL J. HOLMES

*Chief Engineer
Stoddart Aircraft Radio Co.
Hollywood, Calif.*

THE ACCOMPANYING CHARTS provide a simple means of determining the approximate electrical characteristics of fixed aircraft antennas by measuring their length, making some slight allowance (dictated by experience) for their proximity to the fuselage or for the size of the ship.

Data obtained through the use of the charts facilitates actual measurement of antenna characteristics and is, ordinarily, sufficiently accurate to permit design of dummy antennas needed when bench-testing aircraft radio equipment.

Quarter-Wave Resonance

Chart 1 is used in determining the approximate length of fixed aircraft antenna for quarter-wave resonance. The intersection points of the vertical lines (measured length of antenna) and the horizontal lines (quarter-wave frequency) with the plotted angular lines indicate the quarter-wave resonance frequency for any length between 10 and 100 ft.

The variation of the angular lines on the right of the vertical dotted line (lengths over 45 ft.) depends largely upon the physical size of the airplane as compared to the length of the antenna. The upper dashed line on the right side of the chart is representative of a small airplane and the solid line represents a large airplane.

The variation shown on the left of the vertical dotted line (lengths under 45 ft.) depends largely upon the proximity of short antennas to the metal fuselage of the airplane. The solid line on the left side of the chart is representative of an antenna reasonably distant from the fuselage, such as one running from a wing-tip to the aft portion of the fuselage. The dashed line immediately below the solid line on the left side of the chart represents a short antenna close to the fuselage, such as one run from a short mast near the cockpit directly aft over the fuselage to the fin of the plane.

The following example illustrates the use of Chart 1: Assume a measured length of antenna as 47 ft. From the chart, the quarter-wave resonance frequency is seen to be approximately 5 Mc. If the plane is small, the resonant frequency will be greater than 5 Mc, if large it will be less than 5 Mc.

Inductance, Capacity, Resistance

Chart 2 is used in determining the equivalent electrical components of an antenna at various operating frequencies. In addition to determining such characteristics at the quarter-wave resonance frequency the equivalent capacitive or inductive reactance and radiation resistance at operating frequencies above or below quarter-wave resonance may be readily determined.

As an example, the equivalent electrical components of the 47 ft., 5 Mc quarter-wave antenna discussed above may be determined for an operating frequency of 3 Mc.

The vertical lines marked across the bottom of the chart from 0.1 to 3.0 represent the ratio of the selected operating frequency to quarter-wave resonant frequency, the latter being determined by use of Chart 1, i.e.

$$\frac{\text{selected operating frequency}}{\text{quarter-wave resonant frequency}}$$

CHARACTERISTICS

By measuring the length of a fixed aircraft antenna, making some empirical allowance for its proximity to the fuselage or the size of the ship, reactance and radiation resistance may be estimated with sufficient accuracy to permit the design of a dummy antenna

The horizontal lines marked on the right of the chart represent the antenna's reactance in ohms. Those below the center or zero line indicate negative or capacitive reactance (operating frequency less than quarter-wave). Those above the zero line indicate positive or inductive reactance (operating frequency greater than quarter-wave). The common intersection point of the horizontal lines with the dashed reactance curve and the vertical lines indicates the reactance of the antenna at the selected operating frequency.

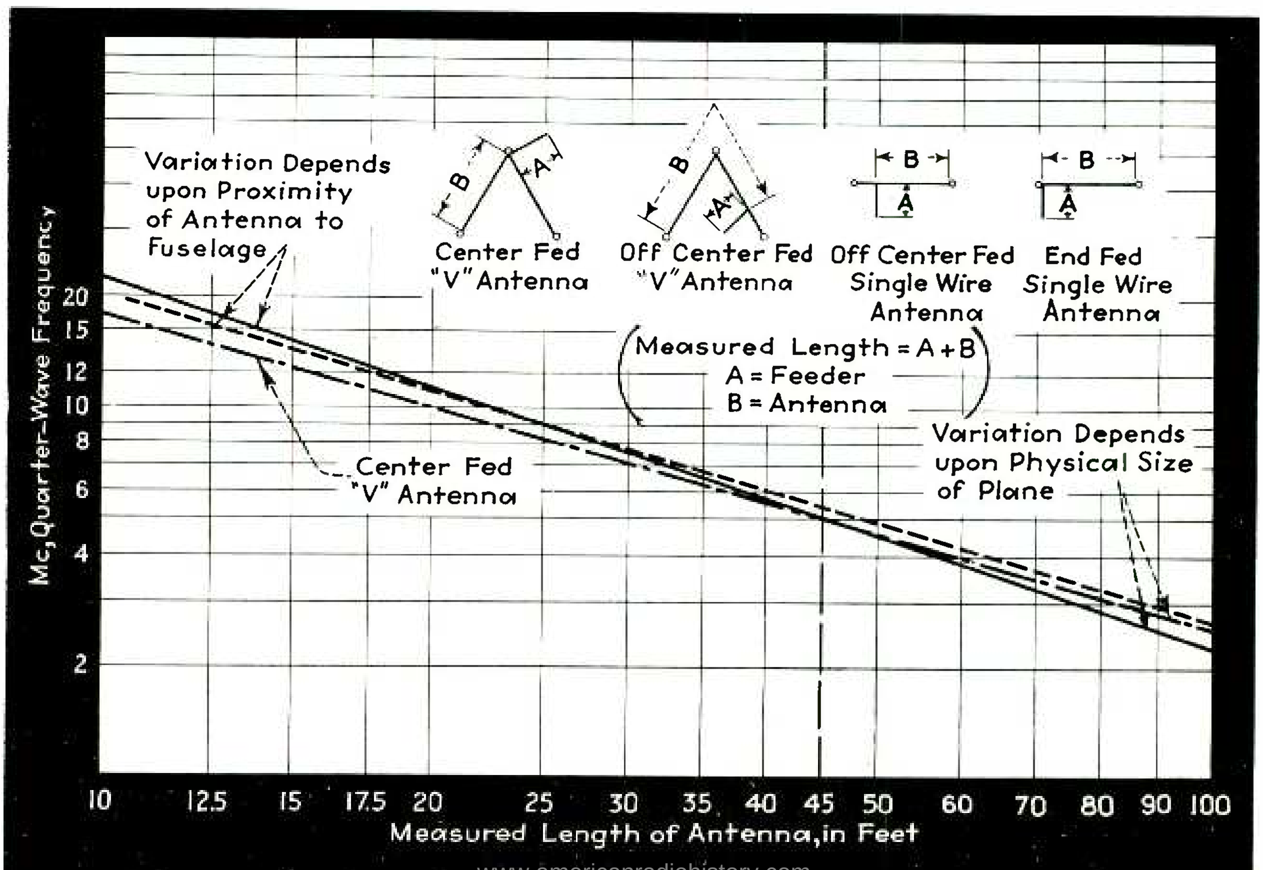
Assume the quarter-wave resonant frequency as 5 Mc (measured length 47 ft.). The reactance of this antenna at an operating frequency of 3 Mc is found as follows: Divide the 3 Mc operating frequency by the 5 Mc quarter-wave resonant frequency. The quotient is seen to be 0.6. Following the vertical 0.6 line to the point where it intersects the dashed rectance curve and then proceeding to the right, the reactance is seen to be about − 325 ohms.

Referring again to the chart, the upper horizontal lines are marked on the left. These numbers at the left represent the radiation resistance in ohms of the antenna. The common intersection point of these horizontal lines with the solid resistance curve and the vertical lines (ratio of operating frequency to quarter-wave resonant frequency) indicates the radiation resistance of the antenna at the particular operating frequency chosen. Thus, the radiation resistance of the 47 ft., 5 Mc quarter-wave antenna at an operating frequency of 3 Mc is seen to be approximately 1.9 ohms as the 0.6 vertical line intersects with the resistance curve and the 1.9 ohm horizontal line as read on the left.

The lower, solid angular lines mark in terms of capacity values which, when multiplied by a factor shown on the chart, produce a capacitive reactance equal to that of the antenna. For example, the effective value of capacitance of a 47 ft. 5 Mc quarter-wave antenna at an operating frequency of 3 Mc is found as follows: The vertical 0.6 line intersects the reactance curve at a point just slightly higher than that of the 75 μμf capacity line, indicating a value of capacity greater than 75 μμf or approximately 80 μμf. This value of 80 μμf, when multiplied by the 10Mc/5Mc is 160 μμf, which is the effective capacity of the 5 Mc antenna under discussion when operated at 3 Mc.

The upper, solid angular lines mark in terms of inductance values which, when multiplied by a factor

CHART 1—Approximate lengths of fixed aircraft antennas for quarter-wave resonance are shown graphically. Empirical variations caused by proximity of the antenna to the fuselage and the physical size of the ship are indicated



shown on the chart, produce the equivalent inductance of the antenna at the particular operating frequency chosen. The inductance value is found the same way as capacitance, outlined above, using the angular inductance lines instead of the angular capacitance lines.

(It is important to note when using the chart that the capacitance lines are used only when the antenna has capacitive reactance at the operating frequency, i.e less than quarter-wave frequency. The inductance lines are used only when the antenna is inductive, i.e. greater than quarter-wave frequency.)

Estimating Procedure

To review the examples illustrated, by the use of the antenna charts a 47 ft. aircraft antenna is found to be quarter-wave resonant at a frequency of 5 Mc. At an operating frequency of 3 Mc it is found to have a capacitive reactance of − 325 ohms and a radiation resistance of 1.9 ohms. The value of reactance is equivalent to a capacitance of 160 μμf. Thus, a good grade air dielectric capacitor having a capacitance of 160 μμf, in series with a non-inductive resistance of approximately 2.0 ohms would simulate a 47 ft. antenna at a frequency of 3 Mc. This would constitute a suitable dummy antenna for the bench testing of aircraft radio equipment to be installed in an airplane having an antenna 47 ft. long and operated on a frequency of 3 Mc.

The characteristics of an aircraft antenna at various operating frequencies may, then, be readily determined by the following procedure:

(a) Measure the length of the antenna from the antenna insulator on the skin of the fuselage to its farthest point. If the antenna is an off center fed "V", do not include the short side. Measure the length of lead to the "V" plus the length of the longest side of the antenna proper to determine the measured length of the antenna.

(b) From Chart 1, determine the quarter-wave resonant frequency, taking into consideration the size of the airplane if the antenna is long or the proximity of the antenna to the fuselage if the antenna is short.

(c) Determine the ratio of selected operating frequency to the quarter-wave resonant frequency by dividing the operating frequency by the previously noted quarter-wave frequency. This numerical value coincides with the numerical value of one of the vertical lines on Chart 2.

(d) Determine the reactance by the common intersection of the applicable vertical line, the dashed reactance curve and the nearest horizontal line, reading the reactance value on the right side of Chart 2.

(e) Determine the effective capacitance or inductance by multiplying the value of capacitance or inductance found on the solid, angular line intersecting the point on the reactance curve obtained in connection with (d) above, by the factor shown on the chart.

(f) Determine the radiation resistance by the intersection of the vertical line obtained in (c) with the resistance curve and the nearest horizontal line, reading the value on the left.

Both charts were compiled empirically and are the average of the characteristics of a number of antennas of different lengths and types on various types of airplanes.

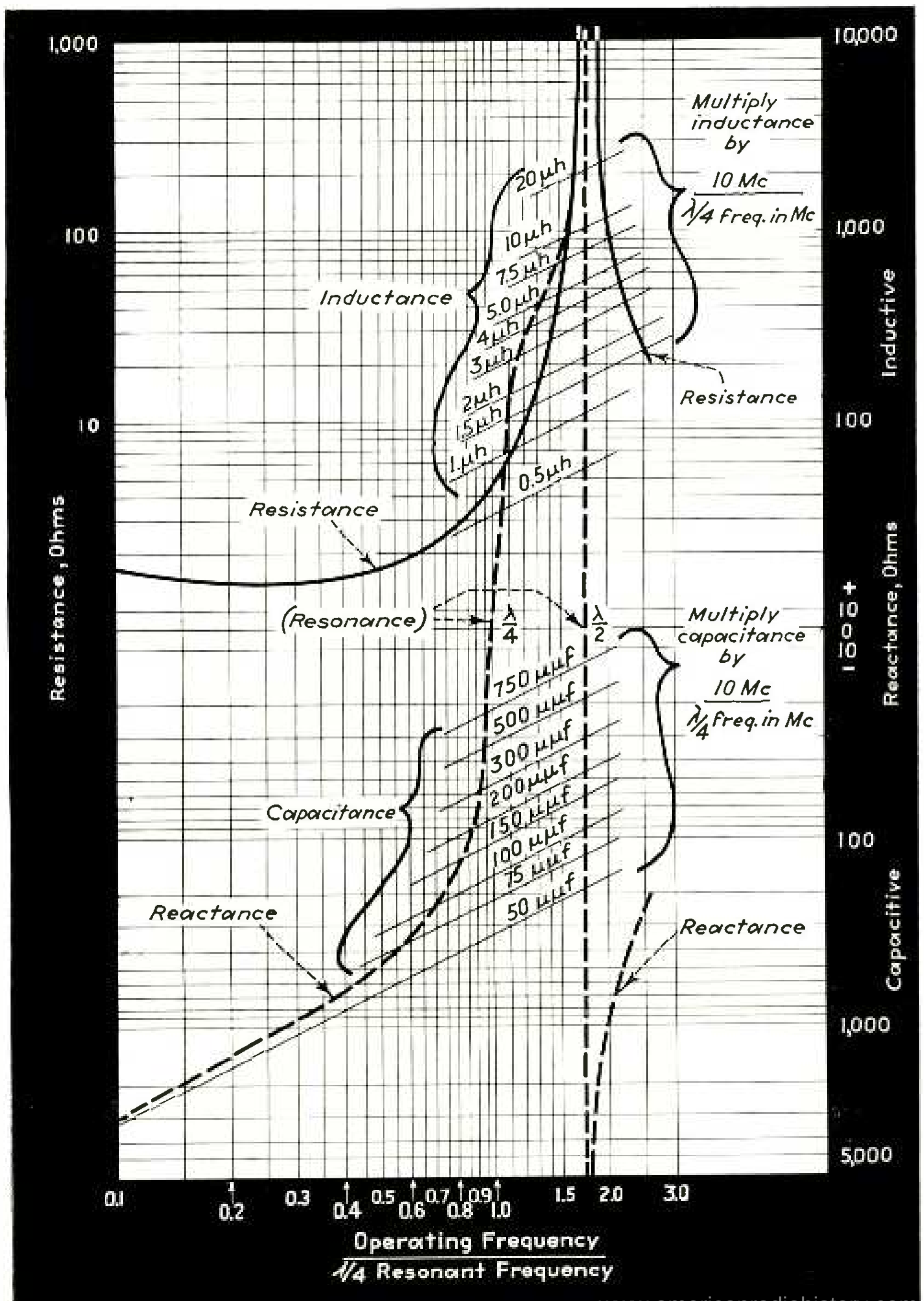
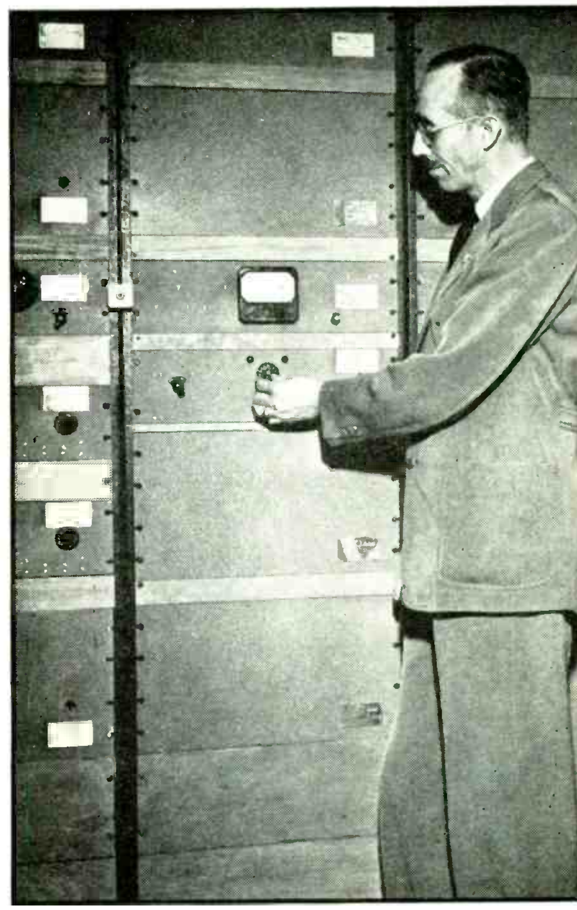


CHART 2— Approximate electrical characteristics of a fixed aircraft antenna operated above or below the quarter-wave resonant frequency may be determined by using the chart as outlined in this text

Amplified tuning-fork output power supply avoids synchronous clock variations caused by wartime overloading of a-c mains. Accurate to one-third second per day

Precision TIME CONTROL



NBC's O. B. Hanson adjusts a control on one of the four panels comprising the Radio City precision clock control system

A HIGHLY ACCURATE time-keeping power supply system is now in operation in National Broadcasting Company studios and control rooms at New York. Synchronous electric clocks connected to this precision system do not vary more than one-third second a day. Similar installations are being made at divisional headquarters in Chicago, Hollywood, San Francisco, Washington, Cleveland and Denver. Affiliated stations on the network may compare their own clocks with the precision system by listening to the NBC time signal, transmitted twice daily from Radio City.

Wartime conditions created the need for this time system. Most electrical power distributing systems throughout the country have been affected by the heavy demands of war industries. As a result, many network operating divisions have encountered deviations in the frequency of a-c supply lines to which electric clocks are ordinarily connected. As far as the public is concerned, these deviations are not important since they are small in magnitude. In network operation however, seconds count and any lack of synchronization between stations may confuse the switching operations of an entire coast-to-coast network.

Special Tuning Fork

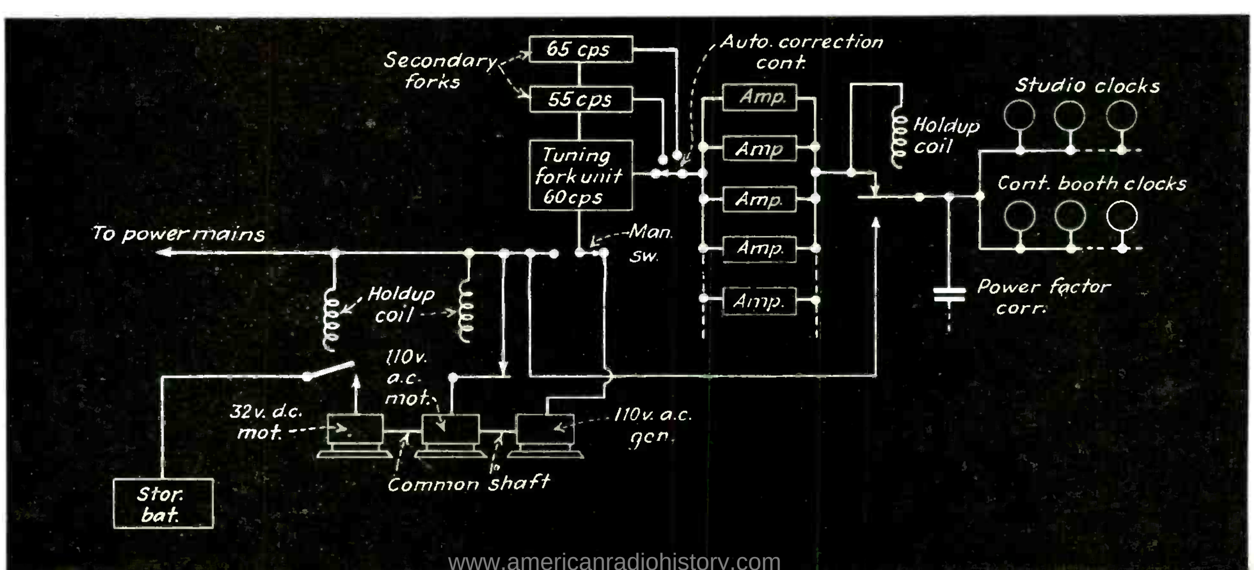
The precision clock control system, perfected under the direction of O. B. Hanson, NBC vice president in charge of engineering, is based fundamentally on the use of a special tuning fork operating in a vacuum chamber. The output of this fork, vibrating at a natural rate of 60 cps, is amplified by vacuum tube equipment generating sufficient power to operate 200 synchronous clocks.

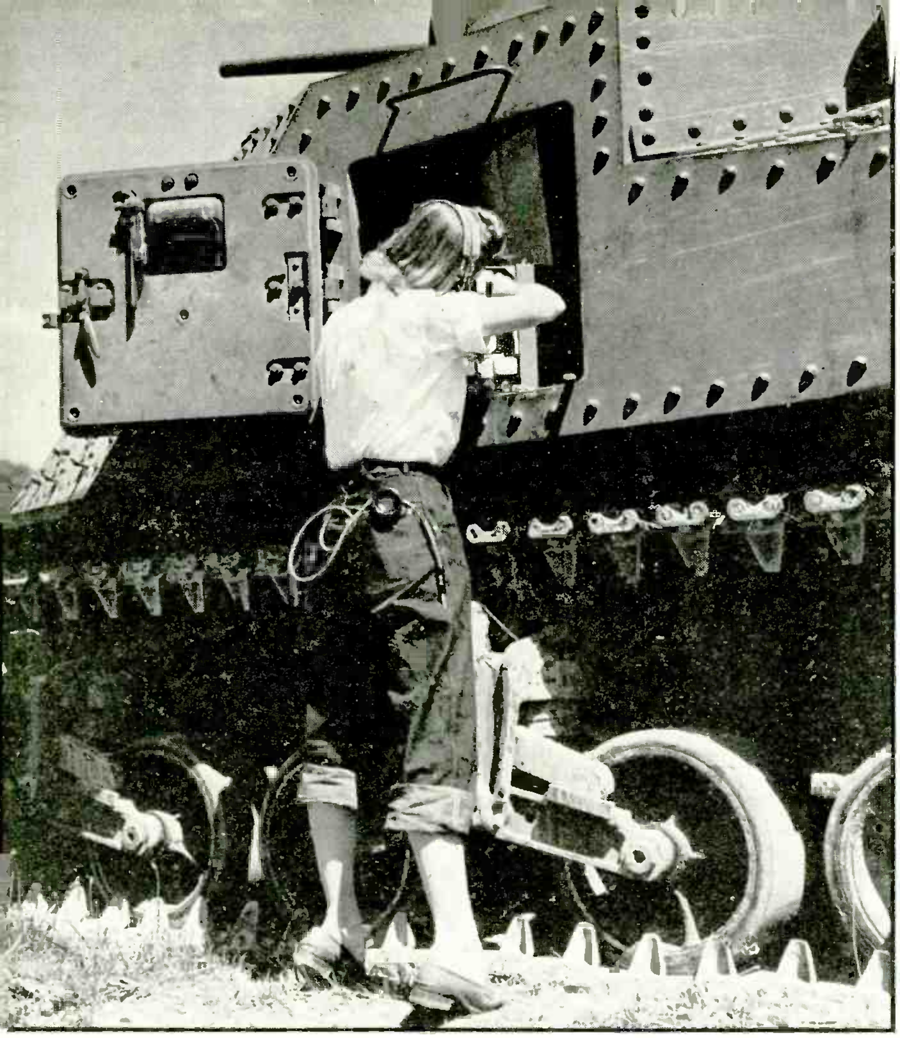
As a check on the absolute accuracy of the system, the master clock in each divisional headquarters will eventually be compared daily with the time signals transmitted by radio from the U. S. Naval Observatory.

Since reliable and continued operation of a time control system depends upon the unfailing continuity of its power source, precaution was taken during design to prevent interruptions due to power line failures. The equipment provides for such contingencies. Normally, the apparatus draws power with which to drive the tuning forks and energize the amplifiers from city power mains. If this source fails, automatic devices connect the clock control equipment to a reserve power source derived from storage bat-

(*Continued on page* 156)

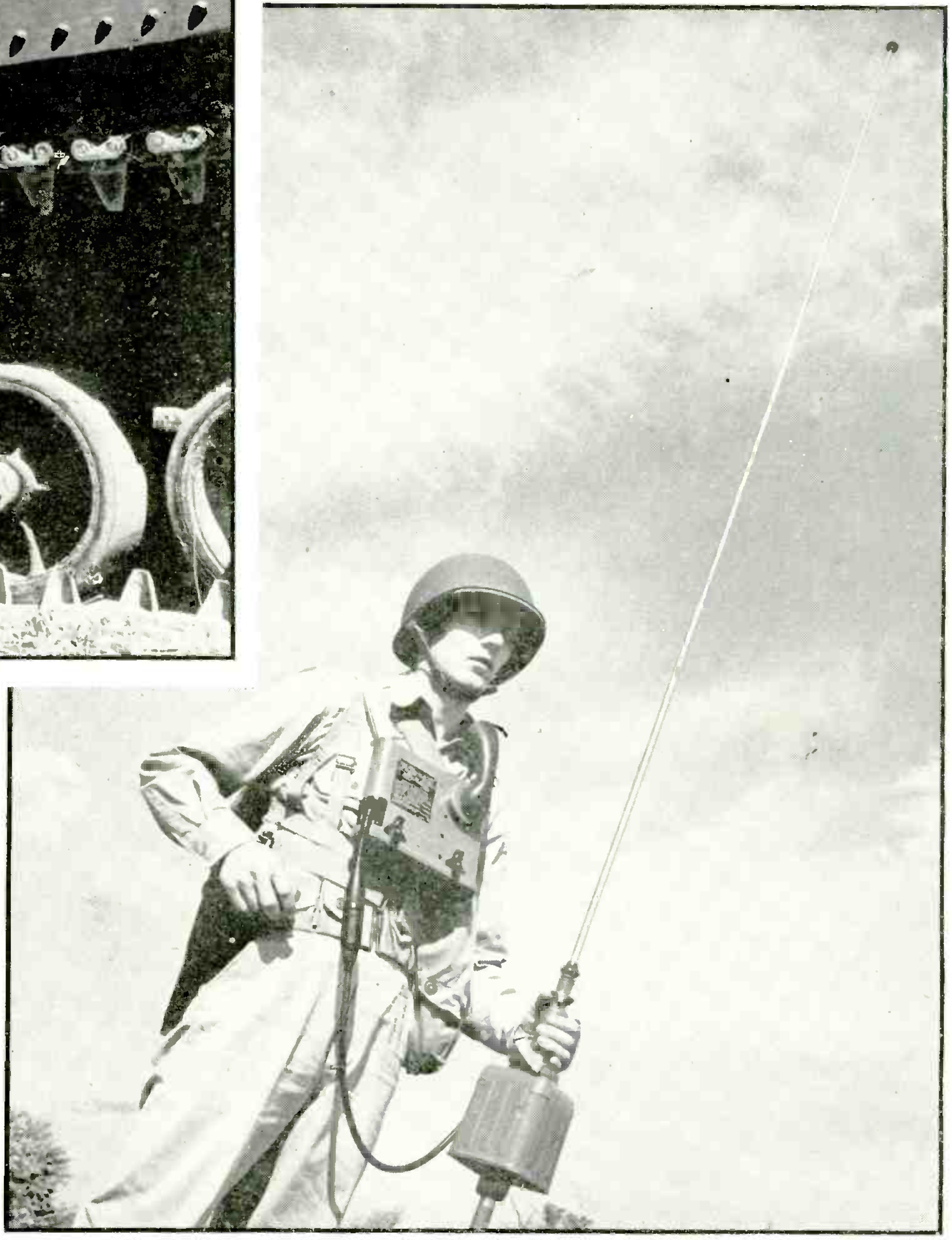
Simplified diagram of precision clock control system. An a-c generator, driven by an a-c motor powered from the mains, drives a 60 cps tuning-fork unit and the amplified output of the fork operates the synchronous clocks. Should the mains fail, the a-c generator is immediately driven by a d-c motor operated from storage batteries. To speed up or slow down the clocks, a 65 cps or 55 cps fork is substituted for the 60 cps fork





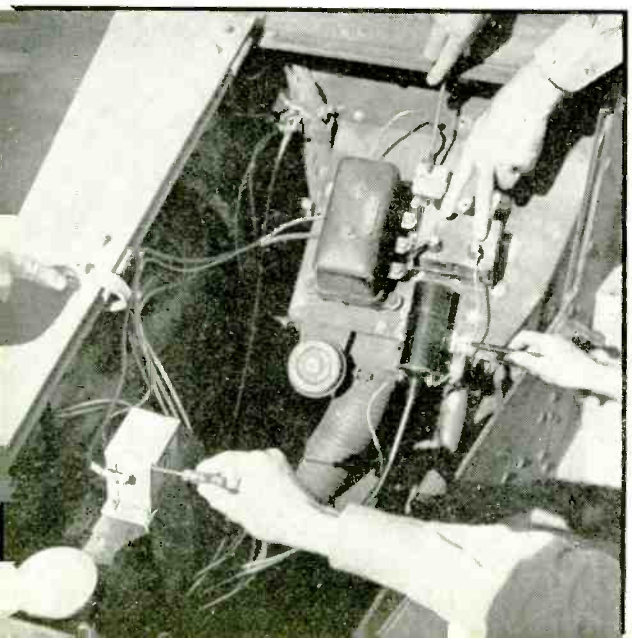
A woman civilian checks up on the communications equipment of a tank

RADIO in



New "guidon" radio, a combination transmitter-receiver. (right) Reminiscent of the lance carried by mounted knights and, more recently, of cavalry pennons, it may be spiked into the ground

Electrical noise affecting radio reception is suppressed at six points in Army vehicles

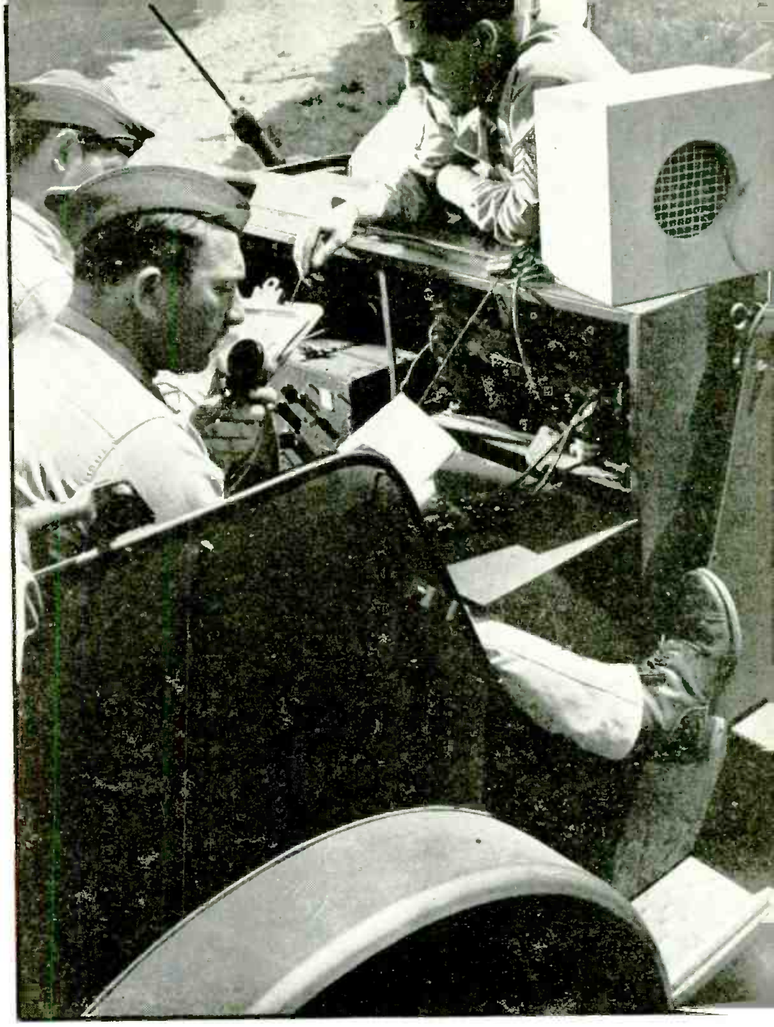


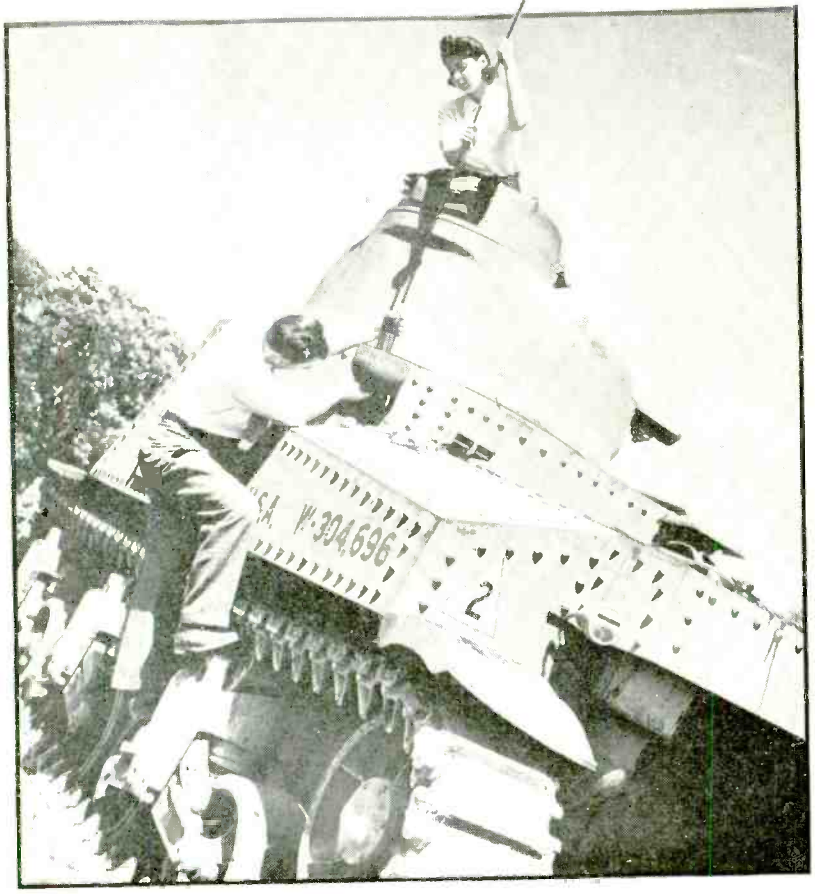
COMMUNICATIONS EQUIPMENT representing the last word in technical design is essential in modern warfare and the Signal Corps is seeing to it, with the help of the nation's electronic equipment makers, that American Army men have the best there is.

Telephone, telegraph and other wire-connected devices are playing a vital part in the winning of the war but upon radio and closely allied "airborne" services falls the exacting burden of keeping highly mobile units in close contact with each other.

Equipment used by the Infantry, Artillery, Cavalry, Motorized Divisions and the Air Force is as reliable as loving care in construction by home-front workers with a growing appreciation of the importance of their labor can make it. Installation and maintenance in the field must be handled with equal efficiency and it is here that the Signal Corps can use all the technical skill that men or, for that matter, women with electronic experience offer.

the U. S. ARMY





Command car gear includes 'phone and icw. Radio apparatus installed in these galloping gas-buggies must be built to "take it"

Stepping a base-loaded antenna on a tank (left) requires considerable gymnastic ability as well as a thorough knowledge of what the equipment itself is all about

Signal Corps men erect a rotary beam antenna. Some of the arrays now required for military purposes exceed commercial varieties in complexity

Two feminine workers from the General Development Lab release a transmitter-equipped meteorological balloon. More and more women are being trained for such work

Graphical Determination of Power Amplifier Performance

Complete performance of Class B and C power amplifiers may be obtained graphically from static characteristics of tube, through use of plastic calculating device. Results obtained quickly from routine schedule involving only arithmetic operations

By ROBERT I. SARBACHER
Illinois Institute of Technology
Chicago, Ill.

WHEN it is desired to obtain the complete dynamic characteristics of a power tube, it is often more convenient to employ a method of graphical analysis to obtain this information, than to test the tube directly. A number of such methods of analysis have been developed which involve graphical integrations of the current waveform, obtained from the static characteristic curves of the tube. The calculating device to be described here may be adapted to these various graphical analyses. By its use the calculating process may be simplified and the time required to make the calculations appreciably reduced.

In the example prepared in the following discussion the harmonic analysis, developed by E. L. Chaffee, has been employed. This method of analysis, which has been discussed elsewhere,[1] is exceptionally accurate and is easily adapted to the calculating device. It is based upon the determination of selected ordinates along a cosinoidal voltage axis, and the advantages and simplicity of this method of harmonic analysis lie in the fortuitous selection of these ordinates. In general the ordinates are not equally spaced, nor are they erected at equal intervals along the voltage axis, although both of these conditions may be true in certain special cases. Moreover, the ordinates chosen depend upon how complete it is desired to make the analysis and will, in general, be different for a five-point analysis than for a seven, nine, or eleven-point analysis. For an analysis of any number of points, the proper selection of ordinates may be determined from the method outlined in Dr. Chaffee's article, but a detailed understanding of this article is not necessary for the present application.

Design of Calculator

The calculating device consists of a sheet of clear acetate-base plastic, having a thickness of thirty or forty thousandths of an inch. Its over-all size depends upon the size of the sheet upon which the static characteristic curves of the tube to be analyzed are plotted. The device is especially adapted for use on the plate voltage-grid voltage characteristics of the tube. These characteristics are often referred to as the $e_b - e_c$ plane of the tube. When this plane is not available, it may be used in a manner to be described later. If the static characteristics of the tube are plotted on conventional 8½ by 11 inch paper, the dimensions indicated on Fig. 1 have been found convenient. Lines which are marked *A*, *B*, *C*, *D*, *E*, *F*, are drawn or scratched with a sharp metal object on the surface of the plastic sheet. These lines are spaced in such a way as to divide a straight line passing through *Q* and any point on the curve *A* in a definite proportion, depending on the type of analysis used. The proportion required by the Chaffee analysis is indicated in the figure. A small strip of plastic about ½ inch wide and 12 inches long, with a straight line ruled down its center, is pivoted to the plastic sheet at *Q*, as shown in the figure, in such a way that the line on the strip passes through the point *Q*. This strip is designated *G* in the figure. A hollow rivet is used in order that a thumb tack or glass push pin may be inserted through the device at this point. The hole in the rivet should be of the proper diameter to provide a close fit with the shaft of the push pin.

The curves *A* through *F*, shown in Fig. 1, may represent any convenient spiral such as $r = a^\theta - 1$ or $r = A\theta$ in polar form. The data for these spirals may be calculated from tables available in a standard handbook. In the construction of the series of spirals shown in the figure, the following procedure was used. The curve *A* was first plotted carefully according to the equation $R = a^\theta - 1$,

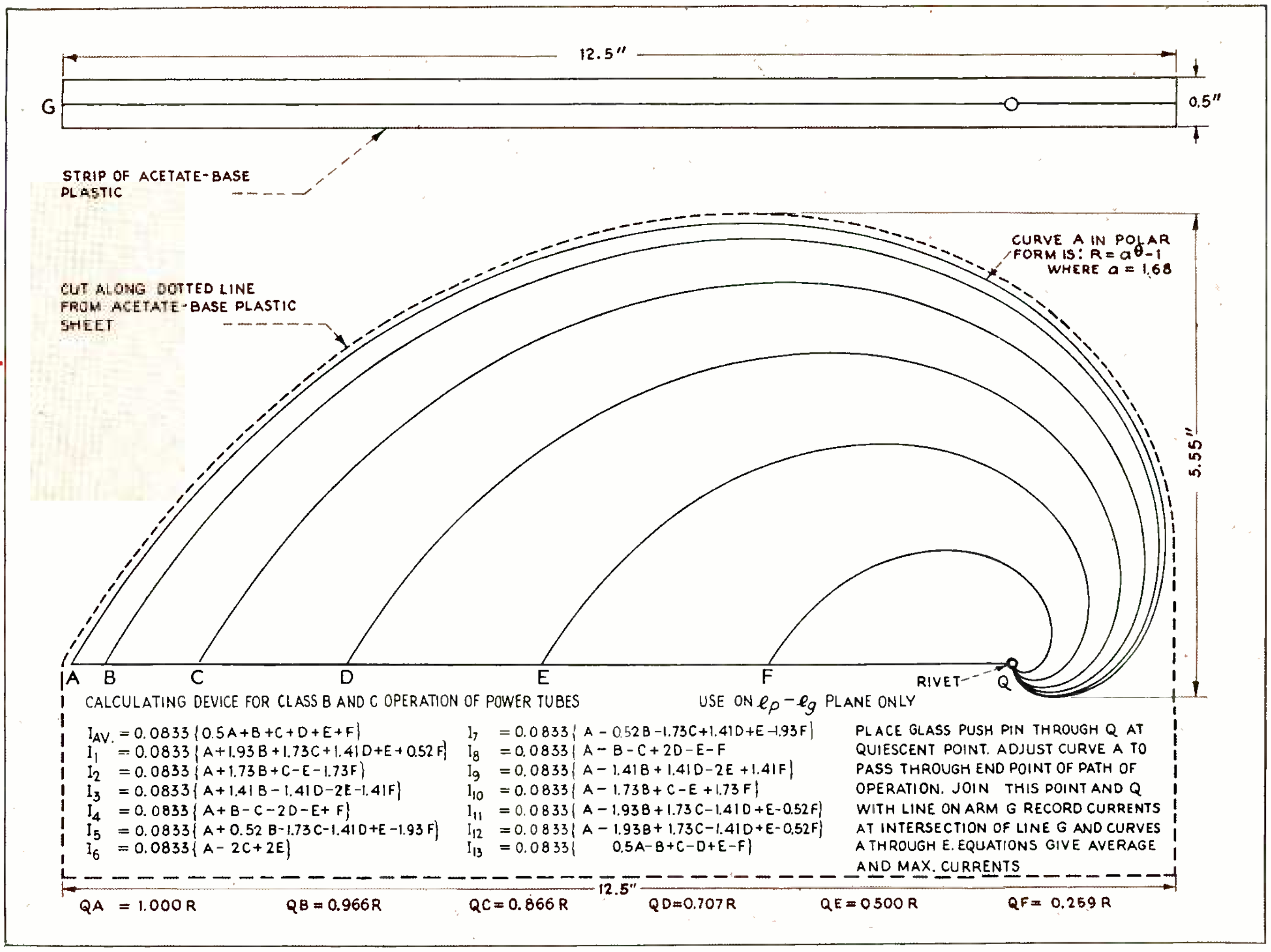


Fig. 1—Calculating device for power tube analysis in Class B and C operation consists of two pieces of plastic, marked as shown and fastened together at Q by means of hollow rivet

where $a = 1.68$ for values of θ in steps of 10 deg. from $\theta = 0$ to $\theta = 270$ deg. Radial lines were drawn from Q spaced 10 deg. apart to facilitate the plotting. The length of these radial lines lying between the curve A and the point Q were then divided proportionately, in accordance with the schedule given in the figure. The remaining curves B through F were then drawn in as shown. The plastic plate was placed over the drawing, and the curves traced on the plate with a sharp pointed scriber. The scratched grooves were filled with black ink. When the thin strip G with the straight line drawn on it is riveted to the plastic plate, as mentioned above, the calculator is ready to use.

Application of Calculator

An example is shown in Fig. 2 of the way the calculator is used. Representative characteristics of a power tube plotted on the $e_b - e_c$ plane are shown in this figure. The first step in the process of obtaining information for the dynamic characteristics of the tube is to locate a desirable quiescent point on this diagram. This follows from the pre-selection of the polarizing potentials to be applied to the tube. This will, of course, be done in accordance with the particular conditions and requirements of the problem. The next step is to select several likely positions for the end point of the path of operation. Let point A of Fig. 2 represent one such end point. Then insert a glass push pin through Q on the calculator at the quiescent point, so that the calculator is hinged at this point. Adjust curve A to pass through the end point of the path of operation. Join this point and A with the line on arm G. Record both plate and grid currents under the intersection of the line G and the curves A through F. These values may be substituted in the equations of Chaffee, as illustrated in the following example.

Examples of Use

With the plate polarizing potential $E_{bb} = 2000$ volts, and the grid polarizing potential $E_{cc} = -160$ volts, (twice cutoff) the quiescent point Q is located as shown in Fig. 2. An arbitrary end point A* for the path of operation is located as shown in this diagram. It was chosen in this case to be at the intersection of the line $e_b = e_c = 240$ volts and the line of constant plate current, 700 ma. For this end point the maximum grid excitation voltage $e_{g_{m1}} = 240 - (-160) = 400$ volts and the maximum alternating voltage across the plate tank circuit is $E_{p_{1m}} = 2{,}000 -$

* At this point the total instantaneous current is $i_b + i_c = 700 + 235 = 935$ ma. Since the total emission of the filament for this tube is 400 ma., the choice of this operating point represents a factor of safety for the filament of more than 4.

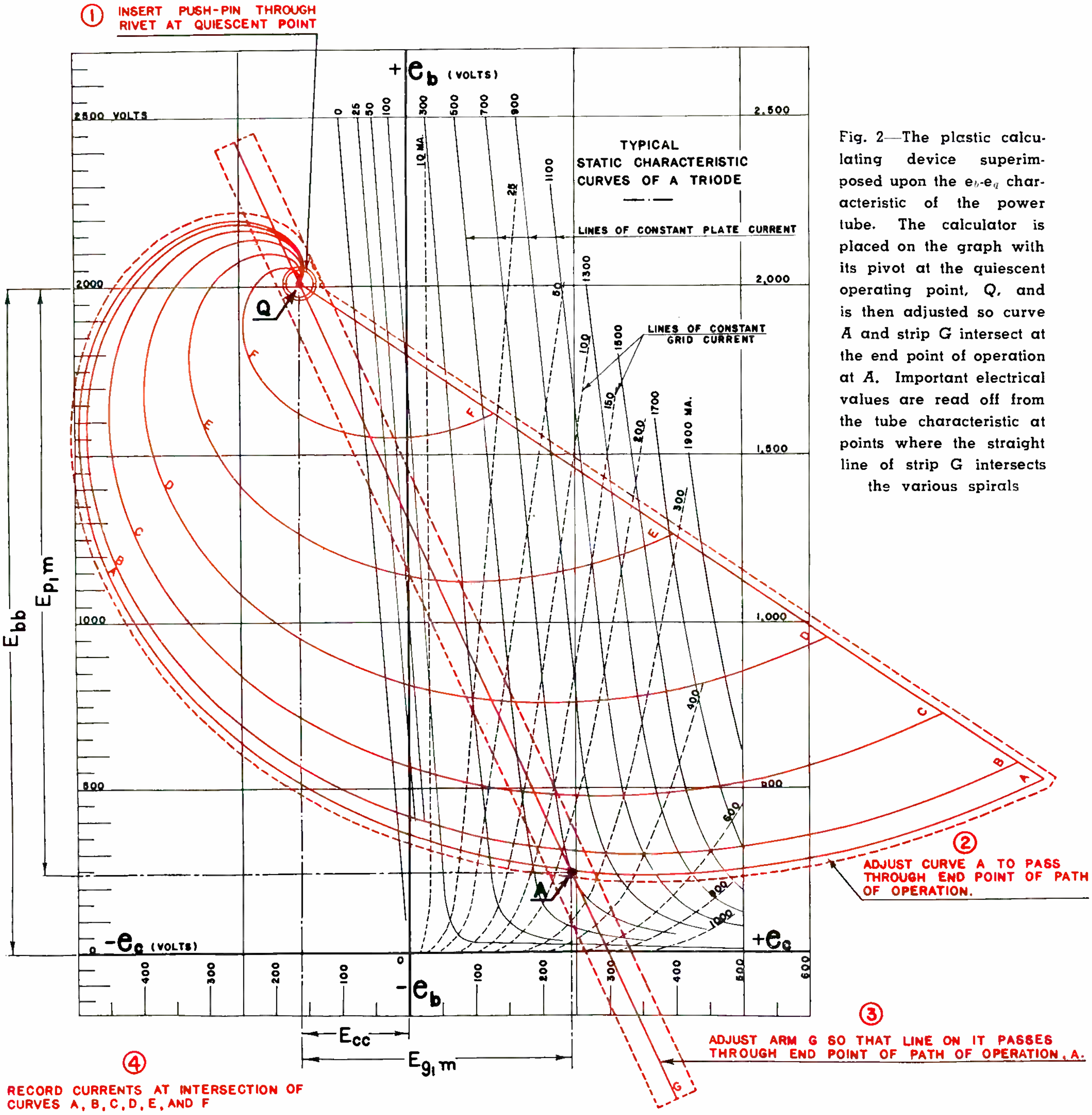


Fig. 2—The plastic calculating device superimposed upon the e_b-e_q characteristic of the power tube. The calculator is placed on the graph with its pivot at the quiescent operating point, Q, and is then adjusted so curve A and strip G intersect at the end point of operation at A. Important electrical values are read off from the tube characteristic at points where the straight line of strip G intersects the various spirals

240 = 1,760 volts, peak value.

The currents recorded at the intersection of the curves A, B, C, D, E, and F, and the line G for the case shown in Fig. 2 are

Plate Circuit	Grid Circuit
A = 700 ma	A = 235 ma
B = 675 ma	B = 200 ma
C = 575 ma	C = 120 ma
D = 400 ma	D = 40 ma
E = 165 ma	E = 11 ma
F = 2 ma	F = 0 ma

Equations for the currents given by the Chaffee thirteen point analysis are as follows:

$$I_{av} = 0.0833\ (0.5A + B + C + D + E + F) \quad (1)$$
$$I_1 = 0.0833\ (A + 1.93B + 1.73C + 1.41D + E + 0.52F) \quad (2)$$
$$I_2 = 0.0833\ (A + 1.73B + C - E - 1.73F) \quad (3)$$
$$I_3 = 0.0833\ (A + 1.41B - 1.41D - 2E - 1.41F) \quad (4)$$
$$I_4 = 0.0833\ (A + B - C - 2D - E + F) \quad (5)$$
$$I_5 = 0.0833\ (A + 0.52B - 1.73C - 1.41D + E + 1.93F) \quad (6)$$
$$I_6 = 0.0833\ (A - 2C + 2E) \quad (7)$$
$$I_7 = 0.0833\ (A - 0.52B - 1.73C + 1.41D + E - 1.93F) \quad (8)$$
$$I_8 = 0.0833\ (A - B - C + 2D - E - F) \quad (9)$$
$$I_9 = 0.0833\ (A - 1.41B + 1.41D - 2E + 1.41F) \quad (10)$$
$$I_{10} = 0.0833\ (A - 1.73B + C - E + 1.73F) \quad (11)$$
$$I_{11} = 0.0833\ (A - 1.93B + 1.73C - 1.41D + E - 0.52F) \quad (12)$$
$$I_{12} = 0.0833\ (0.5A - B + C - D + E - F) \quad (13)$$

Where I_{av} represents the average current,

I_1 represents the fundamental current,

I_k represents the kth harmonic current.

By inserting in Eq. (1), the plate current values read from the graph and tabulated above, we obtain the average plate current: $I_{ba} = 0.0833\ (0.5 \times 700 + 675 + 575 + 400 + 165 + 2) = 180.6$ ma. From Eq. (2) we may obtain the maximum value of the fundamental plate current by similarly inserting the appropriate

Fig. 3—A set of static characteristics in the i_b-e_b and i_c-e_b planes corresponding to the e_b-e_c curves of Fig. 2. This type of characteristic can be used with the calculator by converting them to the curves of Fig. 4

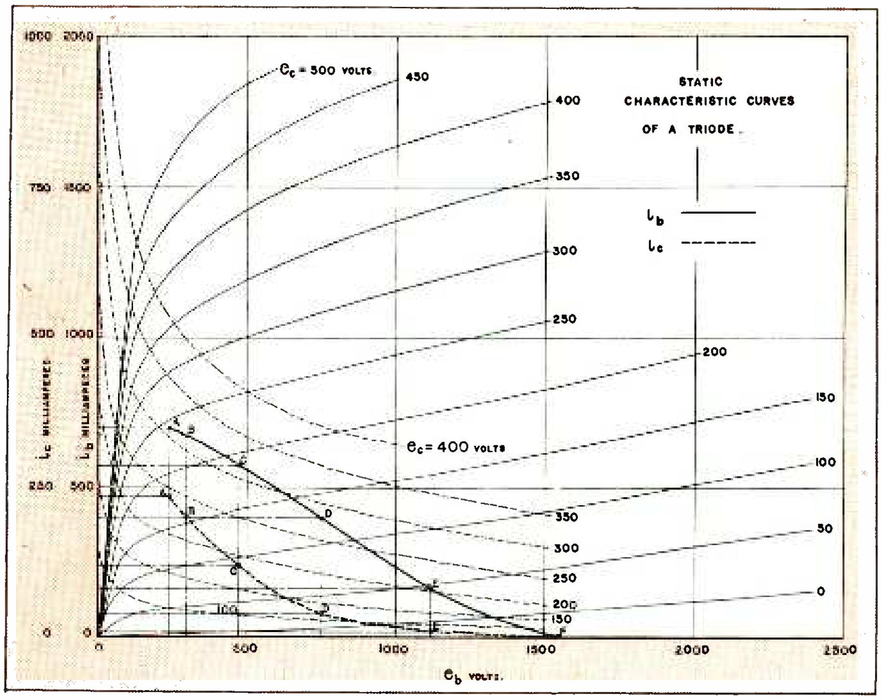
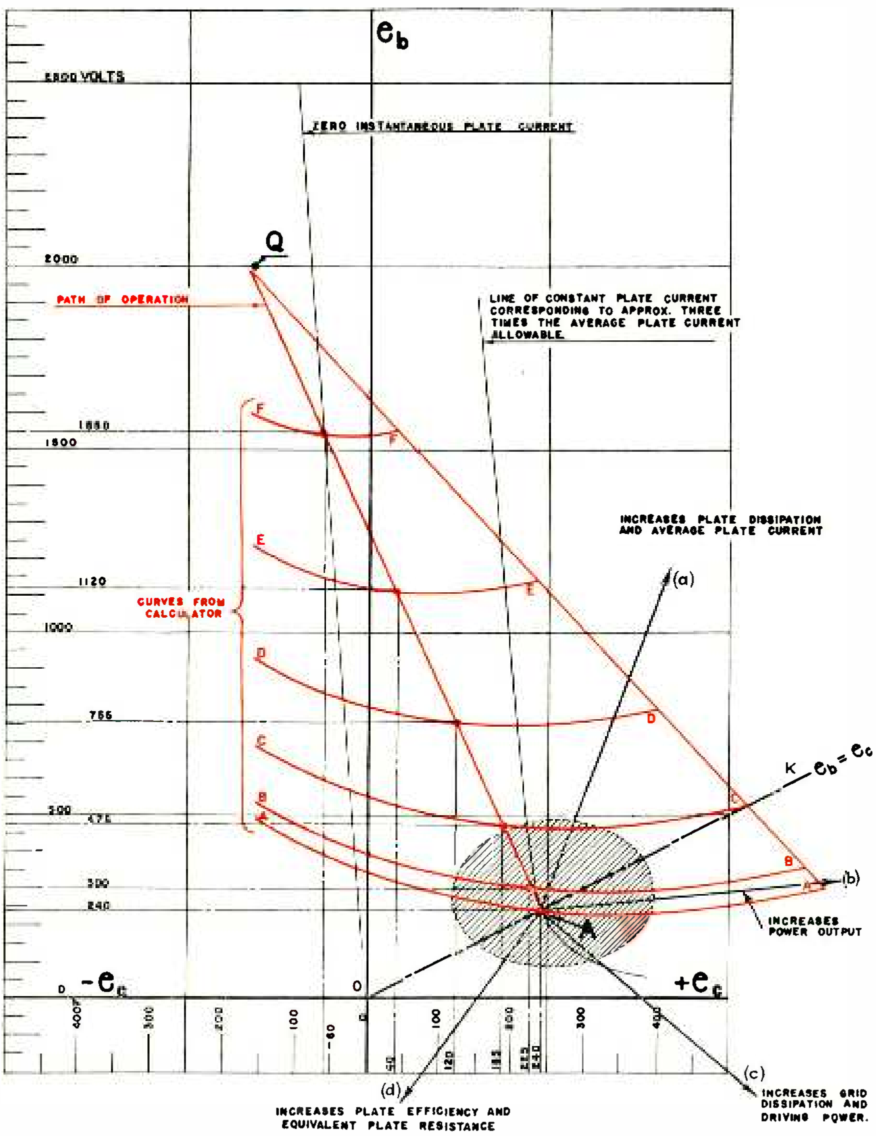


Fig. 4—Static curves in the e_b-e_c plane, constructed from Fig. 3, with calculator superimposed. Note the arrows, radiating from point A, indicating means for improving certain types of performance of power tubes



current recorded above $I_{p_{1m}} = 0.0833 (700 + 1.93 \times 675 + 1.73 \times 575 + 1.41 \times 400 + 165 + 0.52 \times 2) = 310.5$ ma.

From Eqs. (3) through (13) we may obtain in a similar manner the maximum value of any of the harmonics flowing in the plate circuit.

In the grid circuit the average grid current is obtained through a similar procedure to give: $I_{ca} = 0.0833 (0.5 \times 235 + 200 + 120 + 40 + 11 + 0) = 25.3$ ma, and the maximum value of the fundamental grid current is $I_{g_{1m}} = 0.0833 (235 + 1.93 \times 200 + 1.73 \times 120 + 1.41 \times 40 + 11 + 0.52 \times 0) = 117$ ma. Similarly the harmonic amplitudes in the grid circuit may be calculated.

With this information, the operating characteristics of the amplifier may be calculated as follows: The power output is given by

$$P_o = \tfrac{1}{2} E_{p1m} I_{p1m} = \tfrac{1}{2} \times 1760 \times 0.3105 = 273 \text{ watts}$$

The d.c. power input to the amplifier is $P_B = E_{bb} I_{ba} = 2000 \times 0.1806 = 361.2$ watts.

The apparent** plate dissipation is $P_p = P_B - P_o = 361.2 - 273 = 88.2$ watts.

This value is well within that specified by the manufacturer as the maximum allowable plate dissipation. The plate efficiency is then

$$\eta_p = \frac{P_o}{P_B} \times 100 = \frac{273}{361.3} \times 100 = 75.6 \text{ percent}$$

The equivalent load resistance, R_L may also be calculated as follows:

$$R_L = \frac{L_{eff}}{CR_{eff}} = \frac{E_{plm}}{I_{plm}} = \frac{1760}{310.5} \times 1000 =$$
5680 ohms

This relation together with that of the effective selectivity

$\left(Q_{eff} = \frac{\omega L_{eff}}{R_{eff}}\right)$ and the frequency desired enables us to calculate the constants for the tank circuit.

In the grid circuit, the driving power is given by

$P_d = \frac{1}{2} Eg_{1m} I_{g1m} = \frac{1}{2} \times 400 \times 0.117 = 234$ watts.

The power supplied to the grid resistance to maintain the grid bias, or the power delivered to the grid polarizing source is

$P_c = E_{cc}I_{cc} = 160 \times 0.0253 = 4.05$ watts.

If a grid resistance is used to supply the grid bias, its value is

$$R_{cc} = \frac{160}{0.0253} = 6320 \text{ ohms.}$$

The apparent power dissipated at the grid is $P_g = P_d - P_c = 23.40 - 4.05 = 1935$ watts.

Other assumed positions of the end point of the path of operation may be investigated in a similar manner. When the results of these calculations are collected, it is possible to select the conditions which will best meet the requirements of the problem on hand, while keeping within the manufacturer's tube ratings. If complete dynamic characteristics are desired, they may be obtained by calculating the performance data for a number of paths of operation whose end points are evenly spaced over the entire characteristic surface. These data may be prepared as suggested by Chaffee in his discussion of the operating characteristics of power tubes.[2] One will then have available all of the information concerning the possibilities of the tube for the given polarizing potentials chosen.

** The true plate dissipation may differ from the apparent plate dissipation because of the existence of secondary emission or ion currents in the tube.

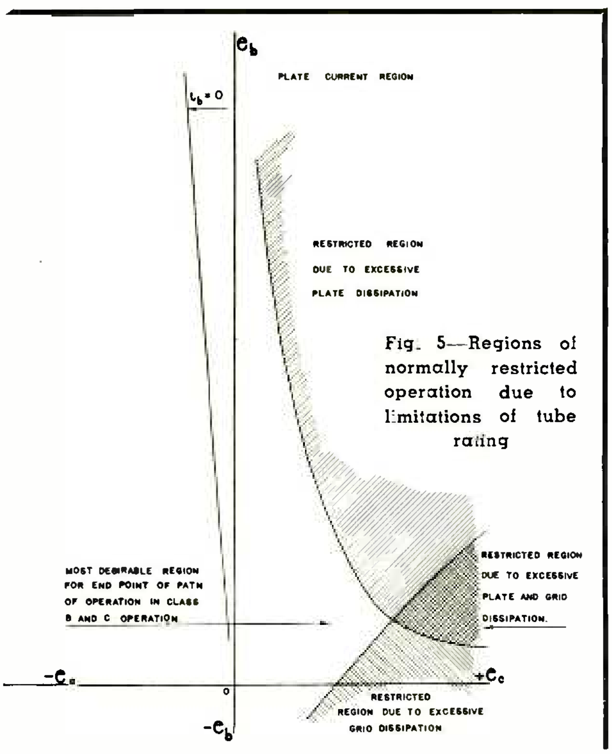


Fig. 5—Regions of normally restricted operation due to limitations of tube rating

An example of how the calculator may be used when the static characteristics are not available on the $e_b - e_c$ plane, but are available on the $i_b - e_b$ and $i_c - e_b$ planes will be given. For convenience characteristics for the same tube are used. Naturally the same final results are obtained.

Suppose it is desired to determine the performance of a tube, operating as a Class C amplifier, whose static characteristics are shown in Fig. 3. The maximum variations in grid voltage shown in this figure are from $e_c = -100$ volts to $e_c = +500$ volts, and the plate voltage variations are from $e_b = 0$ to $e_b = 2500$ volts. Construct the $e_b - e_c$ axes shown on Fig. 4 on suitable graph paper. The voltage scales for these axes are selected to include at least the maximum voltage variation mentioned above. It is convenient to draw on Fig. 4 the line of zero plate current. This is approximately a straight line passing through the origin of the $e_b - e_c$ plane, having a slope equal to the negative of the amplification factor of the tube. Now the manufacturer's specifications for a tube usually give the maximum plate voltage that is permissible in this class of service. Using this value of voltage which is consistent with the requirements of maximum power output and efficiency for the tube, we may now select the grid polarization to be used. This voltage may be chosen as twice the cut-off value.† This establishes the quiescent point, as indicated in Fig. 4. Construct a line, *OAK*, on the $e_b - e_c$ plane for $e_b = e_c$. On this line indicate the point at which the instantaneous plate current is approximately three times the maximum average plate current allowable. This point will now be used as the end point of the path of operation as is indicated in Fig. 4. A numerical example will be carried through for this end point. If similar calculations are carried through for others in the neighborhood of this one, the conditions of operation which are best suited to the design requirements and which are within the manufacturer's limitations specified for safe operating conditions, may be found. If the above procedure is followed, the operating conditions which will be obtained will be very nearly the correct conditions for the tube. If, instead of using the line $e_b = e_c$, we use a line $e_b = 0.8e_c$, it is possible that the power output and efficiency may be slightly better than in the former case.

After adjusting the calculating device as indicated in the previous example, we may tabulate the voltages, both plate and grid, which lie under the intersection of the arm *G* and the curves *A* through *F* as follows:

	A	B	C	D	E	F
e_b	240	300	475	755	1120	1550
e_c	240	225	185	120	40	−60

At the points indicated in the $i_b - e_b$ diagram, Fig. 3, we may read the instantaneous plate current that exists at these points. Similarly, on the $i_c - e_b$ diagram we may read the instantaneous grid currents.†† For the case illustrated they are

	A	B	C	D	E	F
i_b	700	675	575	400	165	2
i_c	235	200	120	40	11	0

We may now substitute these instantaneous values of current in the equation given previously and proceed with the calculations in a similar manner to that done in the first example.

The arrow directions shown in Fig. 4 indicate the general way the operating conditions vary as the end point of the path of operation is moved within the region enclosed by the dotted lines. If, for example, efficiency is a primary consideration, we may choose to move *A* in the direction (*d*). This will increase the efficiency and equivalent plate resistance required, but will reduce the power output. There will be but

† The value of twice cut-off, although widely used is not an optimum. Experience with a variety of tubes indicates that 1.6 times cut-off voltage is more nearly correct.

†† Note that these values do not form a straight line when plotted in Fig. 3. The difference is, of course, due to the harmonic currents which flow.

(*Continued on page* 158)

CIRCUIT ELEMENTS IN

Electrical Remote Control

PART 2

Relays are used to solve many industrial and communications problems. They are capable of providing time delay, generating impulses, handling interlock requirements and performing selection functions. Methods of utilizing quick-acting, slow-operating, slow-releasing, polarized, double-wound and rotary-switch types for these purposes are discussed here

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and

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TO THE UNINITIATED, circuit diagrams of electrical remote control apparatus such as the automatic or dial telephone may appear to be extremely complex. Yet all such remote control apparatus consists of combinations of more or less standard circuit elements which are in themselves simple.

Circuit elements, in the main, break down into four distinct classifications. These are: *time delay, impulse, interlock and selection.*

Time Delay Methods

Time delay has as its function the performance of circuit switching operations in proper sequence. In a radio transmitter, for example, it is frequently necessary that tube cathode voltages be applied before anode voltages. While there are many different types of mechanical, electrical and electronic timers, it is often desirable to use relatively simple telephone type relays to achieve time delay.

Figure 1A shows a scheme in which quick-acting relay *A*, equipped with an adjustable-weight armature spring and used in conjunction with slow-operate relay *B*, provides *operate* delays up to approximately 2 sec. When the initiator key is closed relay *A* is energized by a battery or other power supply and its armature spring pulls up but the weight on the armature causes the spring to vibrate and make and break contact 1 for some time before it settles down in the pulled-up condition. As the armature vibrates, increasingly longer current pulses flow through relay *B*. As soon as the length of the impulse transmitted exceeds the pick-up time of *B*, the latter operates and closes or opens circuits to other equipment.

A similar arrangement, shown in Fig. 1B, is available for *release* delays of from 1 to 15 sec. Energizing of relay *A* closes contact 1 and operates relay *B*. Then, when the circuit to *A* is opened, the weighted armature spring vibrates between springs 2 and 3, transmitting decreasingly shorter impulses to *B* through contact 4 of *B*, which temporarily remains closed as *B* is a slow-release type relay. *B* drops out when the length of the impulse becomes less than its release time.

Figure 1C illustrates a combination slow-operate and slow-release arrangement using a large capacitor *Z*. Voltage from the control circuit divides and part of it goes through winding x while the rest goes through the capacitor and winding y. Since windings x and y produce opposite flux, the relay will not operate until the capacitor has approached full charge, when current flow through winding y ceases. The relay is then operated by the current flowing through winding x. On opening the control circuit, the capacitor discharges through windings x and y in a series-aiding direction, holding the relay operated until the capacitor approaches a discharged condition.

Impulse Generators

Remote control selection is frequently accomplished by transmission of current impulses. Consequently, *impulse generators* play a very important role. The ordinary telephone dial is a mechanical impulse generator. The capacitor-relay combination shown in Fig. 1C may have its control circuit wired through a break contact and thus become an electrical impulse generator, operating in very much the same manner as does an electric bell or buzzer. Such a contact is shown at 1 in Fig. 2A. Time delay features similar to that of Fig. 1C provide, in this instance, control of impulse timing rate. The length of the impulses may, for example, be varied by changing the size of the capacitor.

Figure 2B shows a chain of relays, wherein relay *A* is operated from a control circuit. Relay *A* op-

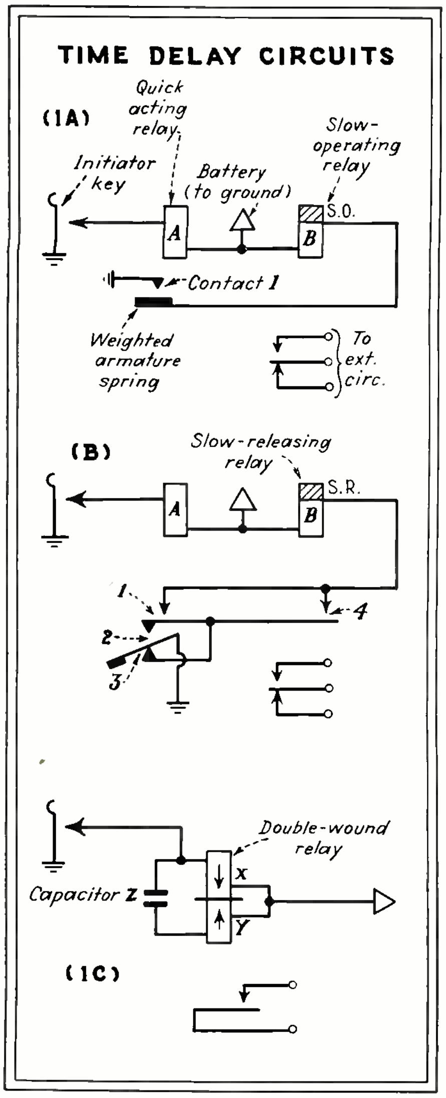

FIG. 1— (1A) Slow operating combination. (1B) Slow releasing combination. (1C) Time delay circuit using capacitor and double-wound relay

erates relay *B* and relay *B* operates relay *C* and *C* opens the circuit to *A*. Relays *A*, *B* and *C* then release successively and the cycle is repeated, thus generating impulses on *C* at a rate dependent upon the number of relays in the chain and the operate and release time characteristics of the individual relays. Such an impulse generator may be used in conjunction with a rotary switch, as shown, to successively step the rotary switch wiper. One specific application is the case of an airplane engine under test, where thermocouple leads are progressively connected to a pyrometer.

In telephone and telegraph practice the character of an impulse may become so altered by line resistance and capacity that the impulse at the remote end is incapable of reliably operating the final equipment. Some means must then be used to restore the character of the received impulse. A relay combination which accomplishes this is shown in Fig. 2C. The received impulse operates fast-operate relay *A*, which locks itself, by closing contact 1, to contact 2 on *B*. Operation of relay *A* also energizes slow-operate relay *B* by closing contact 3 and simultaneously closes local repeated impulse circuit *p*. As soon as *B* operates, it opens the locking circuit to *A*, thus allowing *A* to release. The repeated impulse then is equal to the operate time of relay *B* plus the release time of *A*, regardless of the length of the received impulse, provided the impulse is at least long enough to operate *A* and no longer than the operate time of *A* plus *B*. If there is a possibility that the received impulse will be longer than the operate time of *A* plus *B* then repeated impulse circuit *q* may be employed, in which case the repeated circuit is opened as soon as *B* operates.

If a received impulse is always of the same length but this length is too short to reliably operate local equipment, then the simple pulse-lengthening circuit shown in Fig. 2D may be used. In this case, *A* is a fast-operate type relay which functions satisfactorily on a short impulse, but is slightly slow-release in character because of its parallel non-inductive resistor shunt. Thus the repeated impulse is lengthened by the amount by which the release time of *A* is longer than its operate time.

Interlock Devices

Interlock circuits may be broadly classified as simple interlock and lockout-interlock types.

In the simple interlock circuit of Fig. 3A, when relay *A* is energized from a pushbutton it locks itself operated by closing contact 1. Operating the second key operates relay *B* and releases *A* by opening contact 2. A circuit of this kind may be used wherever it is necessary to accomplish a power function by the momentary closure of a pushbutton and then to discontinue that function by the momentary closure of another pushbutton. It is often used in conjunction with selection equipment wherein the pushbuttons are specific contacts (dialed numbers, for example) on the selection switch and where, because of various other functions to be performed, the selection switch cannot be allowed to remain on the selected contacts for the full time that it is desired to keep the power function in operation. Remote control of radio transmitters, where one of several transmitters must be turned on by dialing a number and then one of several frequencies must be selected by dialing a second number, is an example. In a case of this kind, several *A* selection relays may be locked to one *B* release relay and all selections released at once by dialing the release number.

A variation of this same kind of circuit, but using a single relay instead of two relays, is shown in Fig. 3B. Closing the "on" pushbutton operates the relay through winding *x* and the relay locks itself oper-

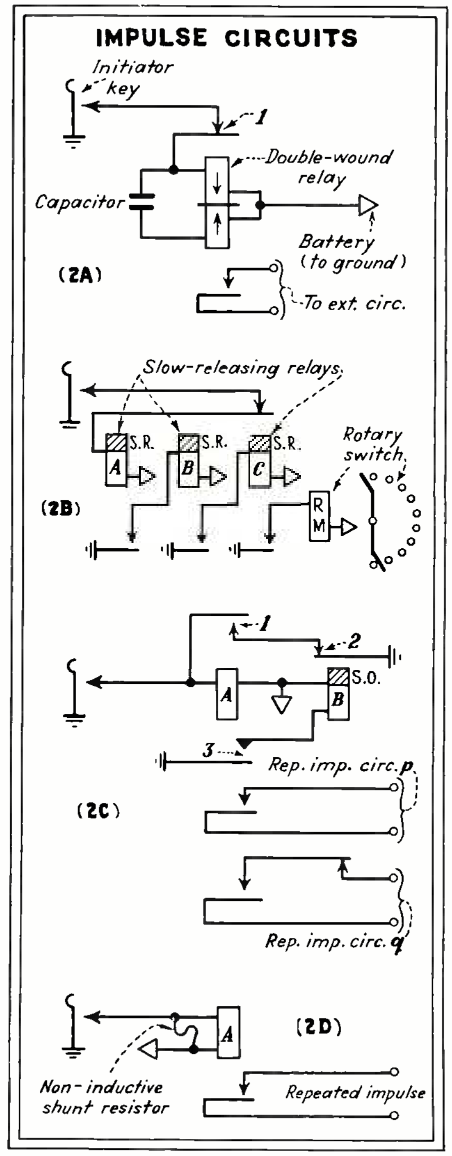

FIG. 2— (2A) Capacitor and double-wound relay combination. (2B) Impulse generator operating rotary switch. (2C) Impulse regenerator. (2D) Impulse repeater

ated by closing contact 1. Contact 2, included to prevent accidental operation of the relay by operation of the "off" button, is simultaneously closed. When winding x has first been energized, closing the "off" button energizes winding y in opposition to winding x and causes the relay to release.

Another variation of the interlock relay is shown in Fig. 3C. The first time the pushbutton is operated, relay A operates on winding y and locks itself operated by closing contact 1. Contact 2 is opened. Relay B windings x' and y' are energized but, since these windings are in opposition, relay B does not operate. When the initiating pushbutton is released, winding x' of relay B is de-energized and consequently relay B operates, opening contact 3 and closing contact 4. When the pushbutton is again closed, winding x of relay A is energized through contact 4 of relay B. Since winding x is connected in opposition to winding y, relay A releases and contact 2 closes. Winding y' of relay B remains energized, at first through contact 1 of relay A and, after A releases, through contact 2 of relay A and the pushbutton. When the pushbutton is released, winding y' of relay B is de-energized and relay B releases, opening contact 4 and closing contact 3 to restore the original circuit condition. In brief, then, relay A operates at the beginning of every other closure of the initiating key and B operates at the end of every other closure. Relays A and B release at the beginning and end, respectively, of the intermediate operations of the key. A circuit of this nature is useful when it is desired to perform two functions over a single line, without the necessity of having current flowing in the line after the selections have been made.

A variation of this same scheme is shown in Fig. 3D. The first closure of the initiating key connects the negative terminal of the energizing battery or power supply to B through contact 1 and contact 2, thus operating B. As soon as B operates, it prepares a circuit for A through contact 3 but, since relay A is effectively short-circuited inasmuch as both ends of the coil are connected to the negative power supply terminal, A does not operate. As soon as the initiating key is opened relay A is no longer short-circuited and operates in series with B. Operation of A changes the polarity of voltage appearing at the contacts of the initiating key from negative to positive and also closes contact 4. The next time the key is closed, relay A is held operated through contact 3 and relay B releases because it is effectively short-circuited. Opening the key again allows A to release. As in Fig. 3C, one relay operates at the beginning of every other closure and the other relay at the end of every other closure. The circuit of Fig. 3D is slightly slower in operation than that of Fig. 3C because of the shunting method of operation but has the advantage of utilizing single-wound relays. The fact that both battery or power supply legs are connected to one set of springs on relay A introduces a possible source of trouble from short-circuits at this point under improper conditions of relay adjustment and, consequently, it is desirable to introduce a slight amount of resistance into the power circuit to limit any such shorting current.

A lockout-interlock relay arrangement is shown in Fig. 3E. This type of circuit prohibits interference by the operation of a second key while a selection is in progress from a first key. For example, if key a is operated, relay A is energized through its contact 1, similar contacts on relays B and N, contact 2 and connection through a resistor to the battery. Contact 3 is arranged to close before contacts 1 and 2 open, thus

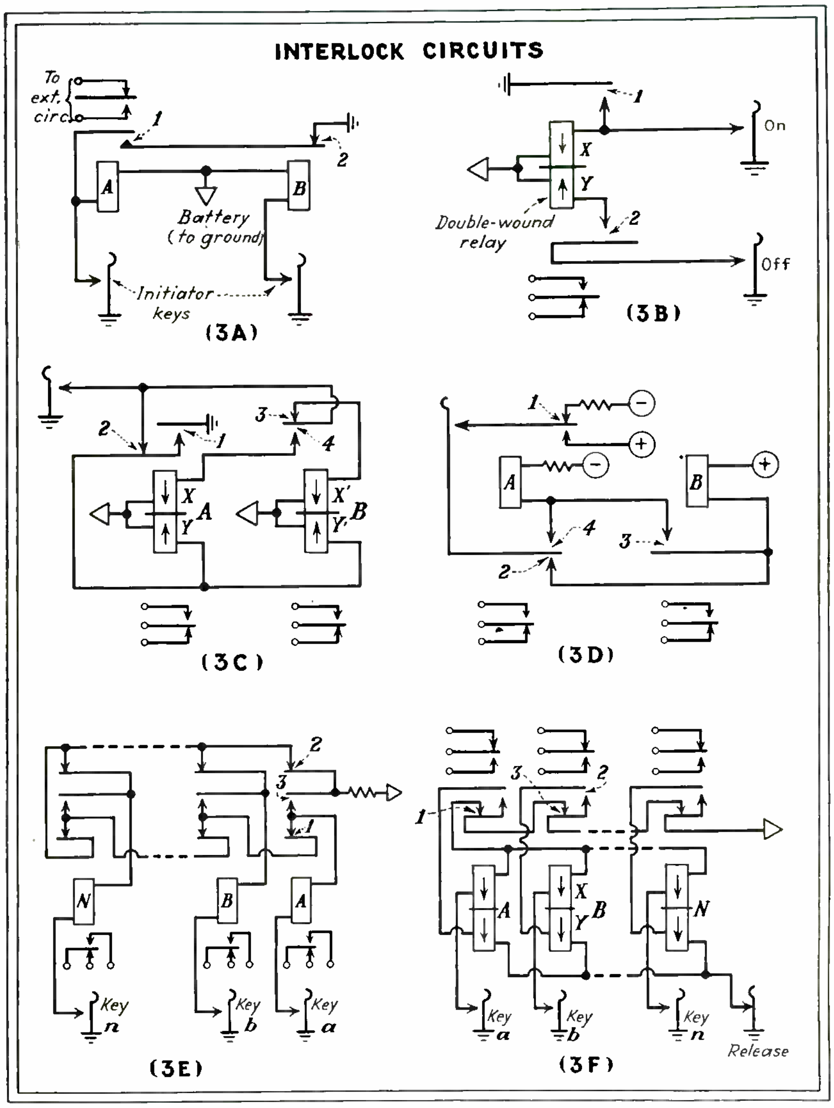

FIG. 3— (3A) Simple interlock circuit. (3B) Interlock using one double-wound relay. (3C) Alternate on-and-off interlock. (3D) Another alternate on-and-off interlock scheme. (3E) Lockout-interlock system. (3F) Lockout-interlock system using self-locking relays

relay *A* remains energized through contact 3 after it initially operates. As soon as relay *A* operates, however, it is impossible to operate the other relays because the battery circuit has been opened at contact 1. If two keys are operated simultaneously, then the relay nearest the battery (in this case relay *A*) remains operated while the other relay operates momentarily and immediately releases. A circuit of this nature might be used on a radio transmitter which has to be operated alternately from two or more separate sources of modulation, where regulations require protection against simultaneous connection of several speech amplifiers to the transmitter.

Another lockout-interlock arrangement is shown in Fig. 3F. Operation of, for example, key *b* energizes winding x of relay *B* and operates relay *B* through a chain circuit starting at contact 1 and running through similar contacts of all other relays in series to the battery at the end of the chain. As soon as relay *B* operates, the battery is connected through contact 2, winding y of relay *B*, to ground at the release key. Winding y of relay 3 is thus energized so relay *B* is held operative. The x winding circuits for all relays is simultaneously opened at contact 3 of relay *B*. If two keys are depressed simultaneously and the associated relays operate simultaneously, the relay nearest the battery end of the chain will remain operated while the other relays will operate momentarily but quickly restore. This circuit provides for the locking of any selection until it is released by the operation of the release key, even though mechanically non-locking selection keys are used. It is used when a selection once made must not be interfered with by the operation of other initiating keys until the first selection function is concluded. It is obvious that the release key could be replaced by a break contact on a release relay, which could be automatically operated after some sequence of events initiated by the selection had been completed.

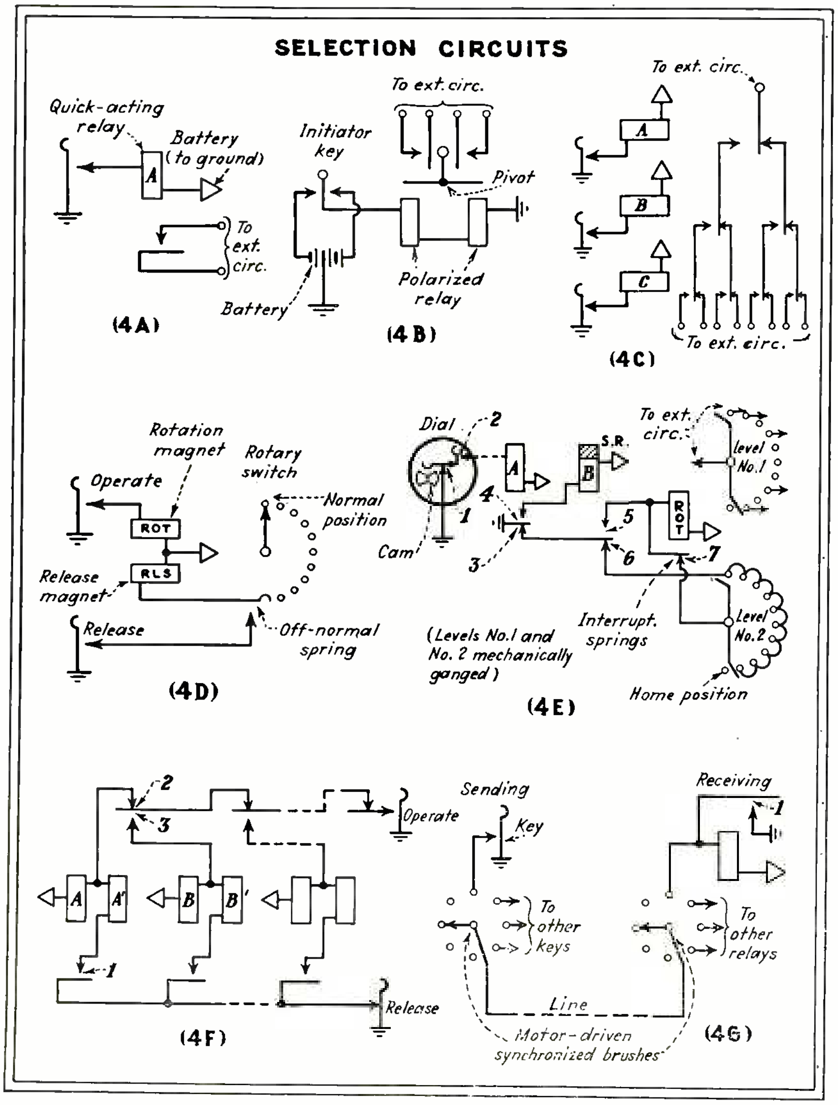

FIG. 4— (4A) Simple direct selection scheme. (4B) Direct selection using polarized relay. (4C) Coded selection method. (4D) Simple step-by-step selection system using switch with separate rotation and release magnets. (4E) Another step-by-step selection method. (4F) Relay "counting chain." (4G) Elemental time-relation selection system

Selection Circuits

Selection circuit elements are probably the most basic of all electrical remote control tools. They are the design starting point, insofar as desired end-actions are concerned, when it is desired to perform one of several functions at a distance over a small number of wires. Many applications require such wiring simplification. In a general way, selection circuits are divided into four basic groups. These are: direct, step, time-relation and continuous types.

Direct selection is that type of control involved in closing a single switch to perform a single function, as in Fig. 4A. The insertion of a relay between the switch and the load permits the control of a large amount of power at a distance without the necessity for a heavy-duty switch and heavy inter-connecting wiring.

By employing a polarized relay, either one of two selections may be made over a single wire, as illustrated in Fig. 4B. Throwing the key to the right operates the polarized relay in one direction, while throwing the key to the left operates the polarized relay in the other direction.

A somewhat more elaborate means of direct selection is the "coded" method shown in Fig. 4C. Selection is accomplished by actuating one or more of the initiating keys, to energize one of several circuit paths. The number of possibilities is equal to $2^n - 1$, where n equals the number of relays. This is true since the condition applying when none of the relays are energized is not generally considered a selection.

Figure 4D represents perhaps the simplest of step-by-step selection schemes, utilizing a type of rotary switch having both rotary and release magnets. Successive closures of the operate key advance the rotary

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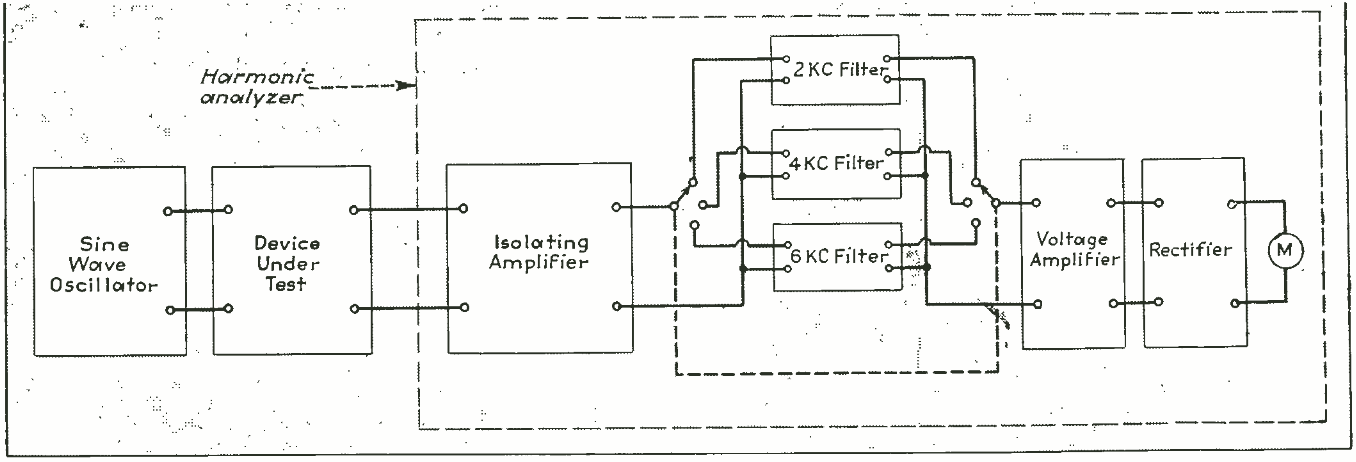
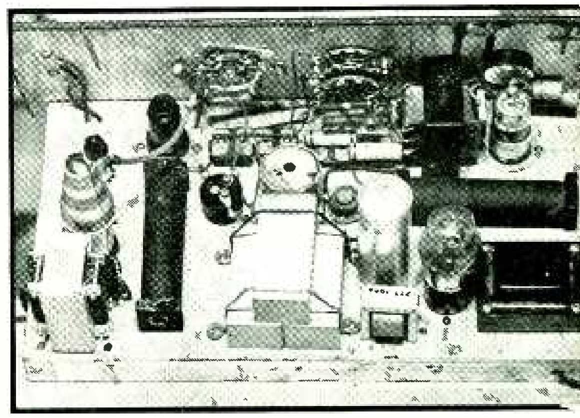


Fig. 1—Functional block diagram illustrating the application of the harmonic wave analyzer and its essential component circuits. Photograph of completed instrument, from rear, shown below



Simple HARMONIC WAVE ANALYZER

By R. F. THOMSON

Cambridge, Mass.

Speed of testing and inspection of audio frequency devices is facilitated through use of a simple amplifier-filter-rectifier instrument, designed to read directly the amount of second and third harmonic distortion

THE primary requisites of any audio amplifier are uniform frequency response and freedom from distortion. The frequency response can readily be found by point to point measurements with relatively inexpensive equipment. The harmonic distortion is a difficult problem to solve, since it is done by analysis of the wave shape, which is a tedious job, or by means of a wave analyzer which involves an expensive piece of apparatus.

A simple and relatively inexpensive harmonic wave analyzer has been designed and constructed which provides a means for determining the second and third harmonic content of an amplifier or similar piece of apparatus operating in the audio frequency range. Fundamentally the method is based on the assumption that the harmonic content of the equipment under discussion is reasonably independent of frequency. This assumption is fulfilled quite well in audio amplifiers so long as the output load is a pure resistance. The instrument for making these harmonic measurements operates on the same principle as that of a wave analyzer. An adjustable sinusoidal voltage of fixed frequency is applied to the equipment under test and a variable gain amplifier incorporated as part of the wave analyzer is adjusted until the output meter, fed through a filter of fundamental frequency, reads 100 percent. The reading is also obtained for the magnitudes of the second and third harmonics, respectively, by noting the meter reading when the appropriate filter is switched into the circuit.

As shown in the block diagram of Fig. 1, the fundamental parts of this instrument are an isolating amplifier, band-pass filters, a voltage amplifier, a rectifier and meter. The first amplifier is used to isolate the instrument from the circuit under test. The band-pass filters are tuned to pass only the desired fundamental, second or third harmonic frequencies. Following the filters is a two-stage audio amplifier feeding a diode rectifier which in turn actuates a milliammeter having a range of 0-1 ma.

A schematic wiring diagram of the wave analyzer, complete with power supply is shown in Fig. 2. A type 6J7 connected as a triode, and transformer-coupled to the filter, is used in the first stage. This stage must be free from harmonics and must be capable of feeding sufficient voltage into the filter. Several methods of feeding the filter without a transformer were tried but none were satisfactory due to the low impedance of the filter. The matching transformer T, has a turns ratio of 3.6 to 1 and is a universal plate-to-line transformer of good quality. This reflects a load of approximately 7,500 ohms back to the plate. The

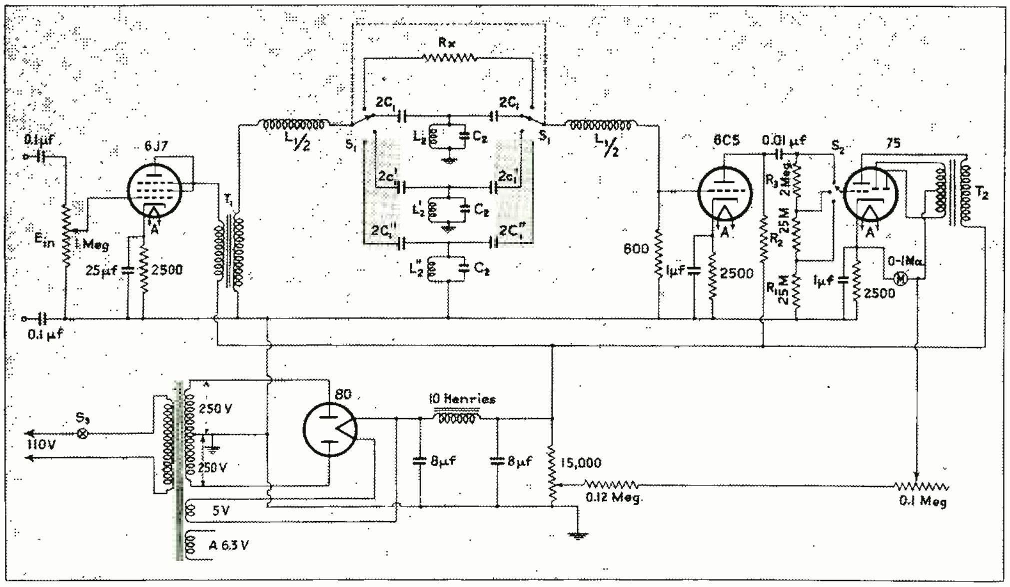


Fig. 2—Schematic wiring diagram of the harmonic analyzer

filters provide a reactive load at frequencies removed from the pass frequency so this stage has to be matched near the point of maximum power transfer.

Filter Considerations

The band-pass filters used in this instrument were of the conventional constant K prototype T section type. The input or characteristic impedance of this filter was 600 ohms and the bandwidth 500 cps. As the input and output inductances, $\frac{1}{2}L_1$, are independent of the frequency and a function of only the characteristic impedance and bandwith, they were connected directly into the circuit ahead of the band switch. The inductance used in this part was a telephone retardation coil with the iron core removed. These coils have an inductance of 0.191 henry and a comparatively high Q. The coils L_2 were receiving type radio frequency choke coils with sufficient turns removed to give the desired inductance. These inductances were measured by resonating them at the desired frequency with laboratory standard condensers. The filter condensers were chosen by again resonating them, with the corresponding inductance, at the desired frequency. This procedure was followed with each of the three arms of each filter. It is essential that the coils of the filters be of a relatively high Q to lessen the losses throughout the pass band. For this reason available iron-core coils were not feasible. The Q of these coils is about 10 which provides an attenuation of about 16 db over the pass band. Values for the various parameters of the filters are given in Fig. 3. These filters gave approximately 71 db attenuation at the unwanted frequencies.

Because the voltage output of the filters is very small (a maximum of 0.07 volts), two additional stages of amplification are necessary to raise this voltage to a reasonable amount. This is accomplished by means of a 6C5 connected as a conventional voltage amplifier, and resistance coupled to the succeeding stage. Distortion in this stage is of no consequence as the change of wave shape would only tend to cause a slight change of the meter reading which would automatically be compensated for in the calibration.

The signal is then amplified by the triode portion of a type 75 and is then fed into the diode section of the tube which acts as a full wave rectifier. The rectified current is read from the 0-1 milliammeter. This type of metering circuit was

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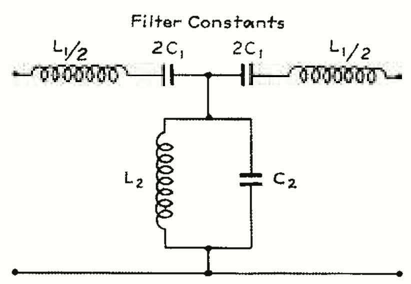

	Resonant Frequency of Filters		
Arm	2,000 cps	4,000 cps	6,000 cps
$\frac{1}{2}L_1$	0.191 h	0.191 h	0.191 h
L_2	5.96 mh	1.49 mh	0.662 mh
C_2	1.06 μf	1.06 μf	1.06 μf
$2C_1$	0.0332 μf	0.0083 μf	0.00379 μf
Z_0	600 ohms	600 Ohms	600 Ohms
Band Width	500 cps	500 cps	500 cps

Fig. 3—Diagram of band pass filters, with circuit constants for filters for fundamental, second harmonic and third harmonic frequencies

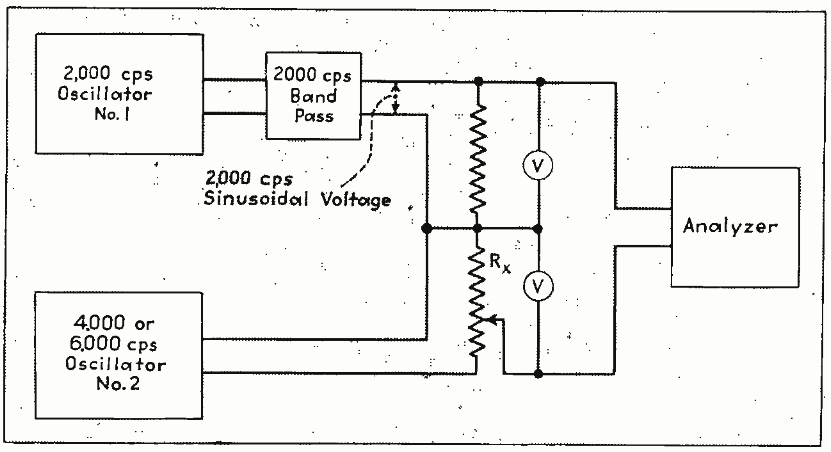

Fig. 4—Circuit connections used in calibrating the harmonic analyzer

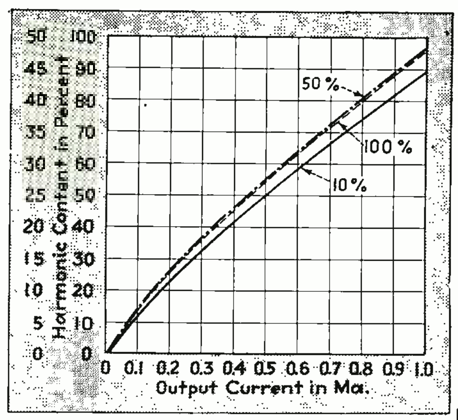

Fig. 5—Typical calibration curve for analyzer. The harmonic content in percent is directly readable from meter indication

Energy Storage
WELDING CONTROLS . . . Part 5

Resistance welding of non-ferrous metals requires larger currents of shorter duration. This greatly increases the peak power demand upon an industrial plant's a-c line. Magnetic and electrostatic energy storage systems described here reduce the burden

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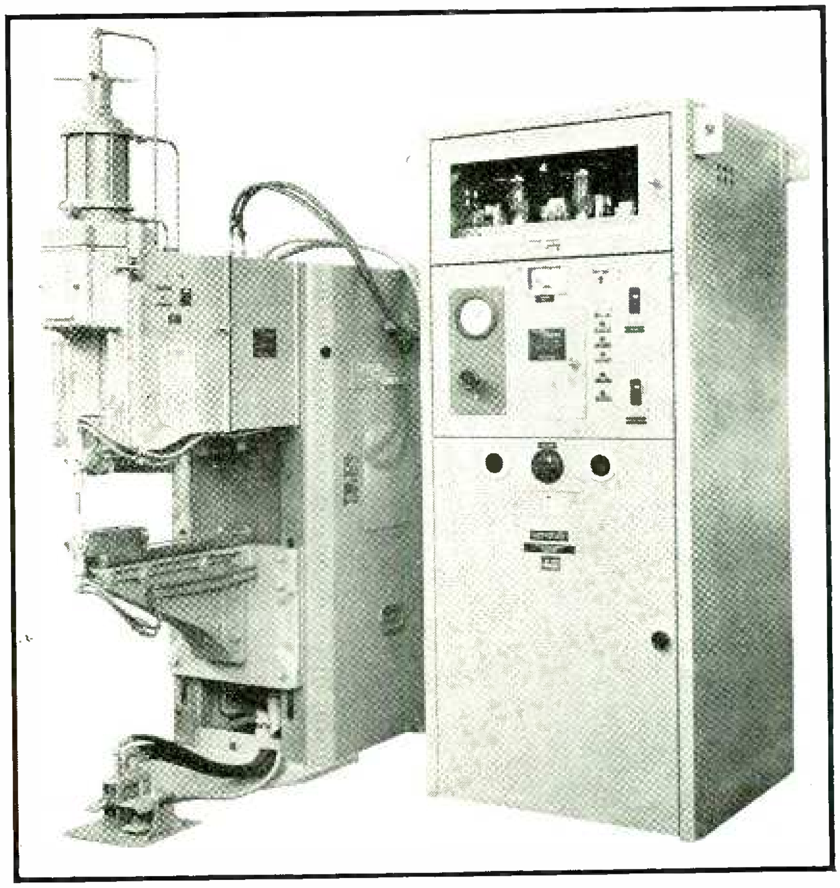


Capacitor discharge control applied to a stored energy type welder which handles up to two thicknesses of 0.081-in. 24 ST Alclad

OF THE MANY methods devised by man for attaching one piece of metal to another, resistance welding is one of the most important today. Machines and techniques have been developed to the point where it is possible to resistance-weld most of the available metals and alloys.

The welding of non-ferrous metals has required that increased welding currents be used and that control be more and more precise. The reason for this greater demand on welding equipment and controls is that when heated, most non-ferrous metals pass quickly from the solid to the fluid state. During the transition there is only a very narrow temperature range within which they exhibit a plastic tendency. Consequently, in welding them satisfactorily a considerable amount of concentrated heat must be applied and the rate of heating must be carefully controlled.

Through extensive research, welding machine manufacturers have been able to develop machines and techniques for welding non-ferrous alloys with conventional a-c welders. The desired result has often been obtained, however, at the expense of large single-phase peak line demands. That is, heavy demands are made on the power supply system for a very short time, with relatively long waits between. To reduce the burden on power supply systems two methods of "energy storage" have for some time been applied to the welding of non-ferrous metals, particularly aluminum and its alloys. These two energy storage methods are magnetic storage and electrostatic storage.

Magnetic Energy Storage

Magnetic energy storage makes use of the ability of a magnetic field to store electrical energy. The elements of the system require a welding transformer having the usual primary, excited from a source of power, and a low-voltage secondary. Work to be welded is introduced between suitable electrodes in series with the transformer secondary, as in a conventional spot welding machine.

The transformer is, however, different from those used in conventional welders. It has a relatively large cross section and air gap and exhibits a highly inductive characteristic, with consequent ability to store considerable energy in its magnetic field. The primary is energized by d-c voltage instead of the a-c voltage used by conventional welders. Current that builds up through the primary rises along an exponential curve characteristic of circuits containing inductance and resistance and is ultimately limited by the resistance of the winding. As the primary current increases, some voltage is induced in the secondary. But, since the rate of change of primary current is relatively slow, insufficient current flows in the secondary to heat the work appreciably during this energy storage phase.

When the primary current has reached a value sufficient to store enough energy in the transformer to weld the particular metal being worked, the primary circuit is opened. Stored energy is released and, since it cannot dissipate itself in the opened primary circuit, a high current at low voltage is developed in the secondary circuit. This produces sufficient heat to weld the material between the electrodes. Welding current in such a system is characterized by a rapid rise to the maximum value and a somewhat slower decay. It may be seen that by controlling the current value at which the primary circuit is opened a wide range of controlled secondary circuit currents may be obtained.

The circuit elements are illustrated in Fig. 1A. Fig. 1B depicts the primary and secondary currents in the welding transformer. The primary interrupting means, shown simply as a switch in Fig. 1A, is actually a series of contractors so arranged that they may be progressively and automatically operated to introduce series resistors until operation of the last contactor completely opens the circuit. The contactors are actuated by a series-current relay which may be adjusted over a wide range to govern the energy stored for the weld.

Power Supply Considerations

While magnetic energy storage welders may be operated from any d-c source of suitable voltage and current capacity (usually 130 to 170 volts at a peak current of from 200 to 1500 amp), they are almost invariably supplied through rectifiers. Very few industrial plants have d-c systems of sufficient capacity and the use of rectifiers also provides additional refinements of control. The basic rectifier is three-phase, half-wave in character, using ignitrons anode fired through phanotrons (high-vacuum diodes). An anode transformer suitable for the supply voltage and frequency and the output voltage required is provided along with necessary protective devices. The basic rectifier is illustrated schematically in Fig. 2. The ignitrons are operated in the usual maner, with phanotrons providing an unidirectional current pulse to the ignitor at the beginning of each positive half wave to ionize the ignitron and permit it to pass current. The rectifying action of the phanotrons prevents reverse current through the ignitors during negative half cycles. This type of rectifier is capable of passing very high current of short duration, using relatively small tubes. On a duty-cycle basis the tubes may be operated at ratings similar to those used for a-c welders with the exception that peak current ratings are based on the capabilities of a single tube and average ratings on three tubes in parallel.

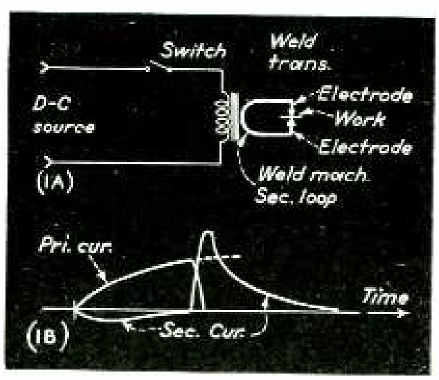
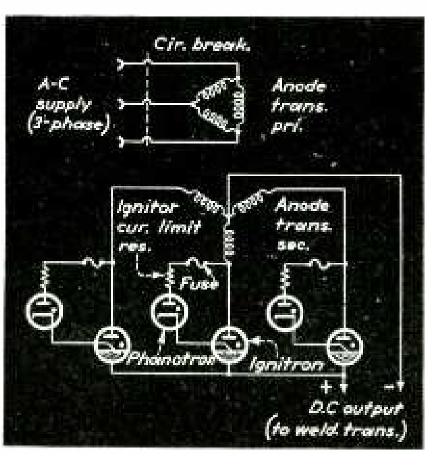


Fig. 1—Schematic illustrating basic elements of magnetic energy storage spot welder circuit and curves showing currents obtained in the associated transformer

Fig. 2—Elementary diagram of three-phase, half-wave ignitron power certifier for magnetic energy storage spot welder



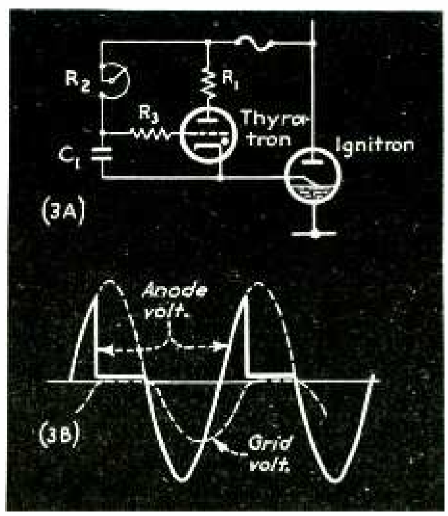
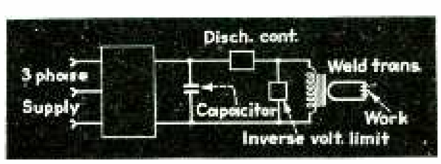


Fig. 3—Circuit showing a method of phase-controlling the output voltage of a single tube ignitron rectifier and graphical analysis of the resulting relationship between grid and anode voltages. Three such circuits would be used to control the rectifier of Fig. 2, one in each leg, with the control rheostats ganged

Fig. 4—Block diagram of elemental electrostatic energy storage spot welder circuit



Voltage Control Method

For operation of larger welders of the magnetic energy storage type, an adjustable rectifier d-c output voltage becomes desirable. Large welders may be called upon to weld the metals for which the energy stored in the welding transformer must be relatively small compared to the available maximum. In attempting to control precisely the current at which the primary circuit is opened, at low values of current, the rate of rise is rapid and any variation in relay operating time takes on increasing importance. By lowering the applied d-c voltage, the entire current-time curve is flattened and the same order of control may be obtained at low currents as is possible at high currents.

A simple phase control which may be applied to rectifiers to obtain an adjustable output voltage, is illustrated in Fig. 3A. This figure illustrates the control applied to a single tube. In practice a similar circuit is used for each ignitron, with the voltage control rheostats ganged on a single shaft. The operation of the circuit is as follows: The rheostat R_2 and capacitor C_1 act as a delay circuit to hold the grid of the thyratron negative during a portion of the positive half cycle, thereby reducing the conduction angle of the ignitron and, consequently, the d-c

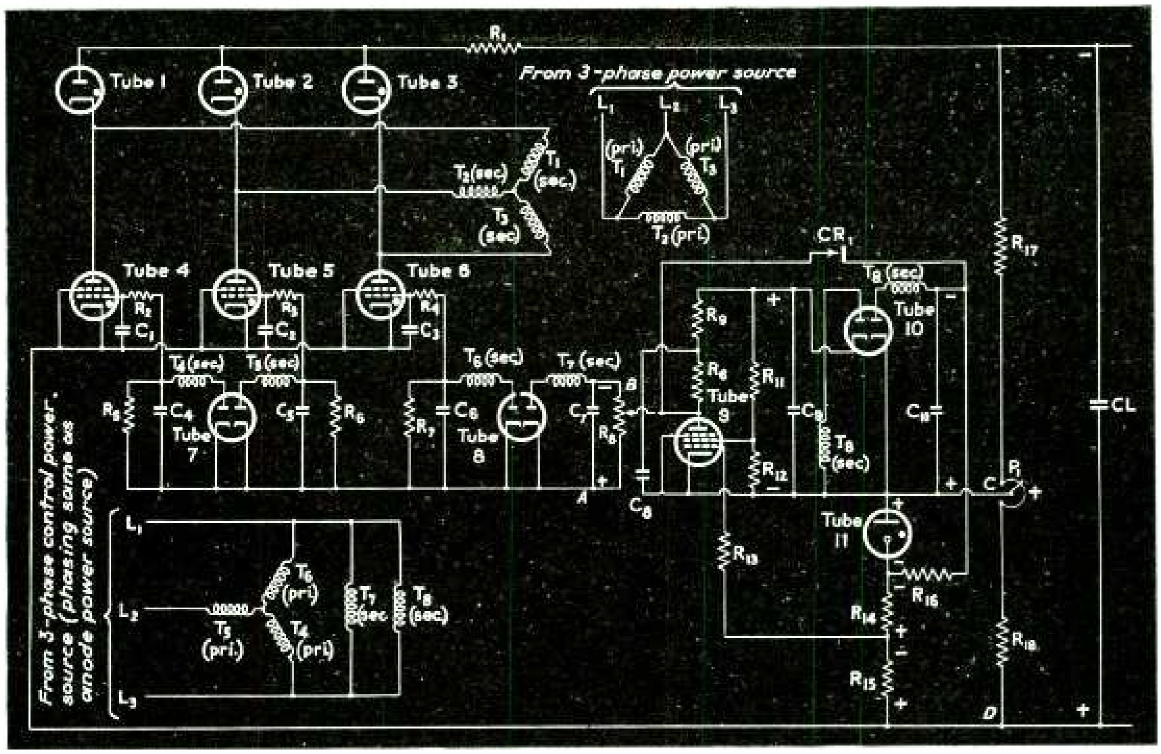


Fig. 5—Schematic of typical electrostatic energy storage spot welder charging rectifier. Component parts unnecessary for an understanding of the operating principle are omitted for the sake of simplicity

output voltage of the rectifier. With no resistance at R_2, the thyratron grid becomes positive at the same time as the anode and full output is obtained. As resistance is inserted at R_2, the voltage across C_1 lags behind the anode voltage to reduce the output. This action is illustrated for a single tube in Fig. 3B. When applied to all three phases with an inductive load, the wave shapes of Fig. 3B are modified by commutation from one phase to the next and by the highly inductive load. The end result is the same, however, and the more complex wave shapes involved are omitted for the sake of simplicity.

In practice three-phase rectifiers such as the one described are usually used to operate two welding machines. Interlocking circuits are provided to prevent operation of both machines at one time and selection of the proper voltage for each machine is automatically made by the use of two separate voltage adjusting rheostats and interlocking relays. The usual cathode protective time delay relays, as well as overload and loss-of-water protection, are provided.

Electrostatic Energy Storage

Electrostatic energy storage makes use of the ability of a capacitor to store electrical energy. Reduced to bare essentials, such a system requires that a capacitor bank be charged to a predetermined voltage and then discharged through the metal to be welded. The total capacitance, the voltage to which it is charged and the inductance and resistance of the discharge path determine the amount of available energy and the rate at which it is delivered to the weld.

Because enormous capacitors would be required in the welding transformer secondary circuit in view of the very low-voltages available there, electrostatic energy storage welders usually incorporate capacitors in the primary circuit. Primary circuit capacitances range from 120 μf upward, charged to between 1000 and 3000 volts. The principal elements of one typical capacitor discharge welder control to be described are: a three-phase, full-wave, grid-controlled rectifier for charging the welding capacitors to an adjustable voltage between 1000 and 3000 volts and a series-and-shunt ignitron system for discharging the capacitors into the welding transformer primary. A block diagram of the system is illustrated in Fig. 4.

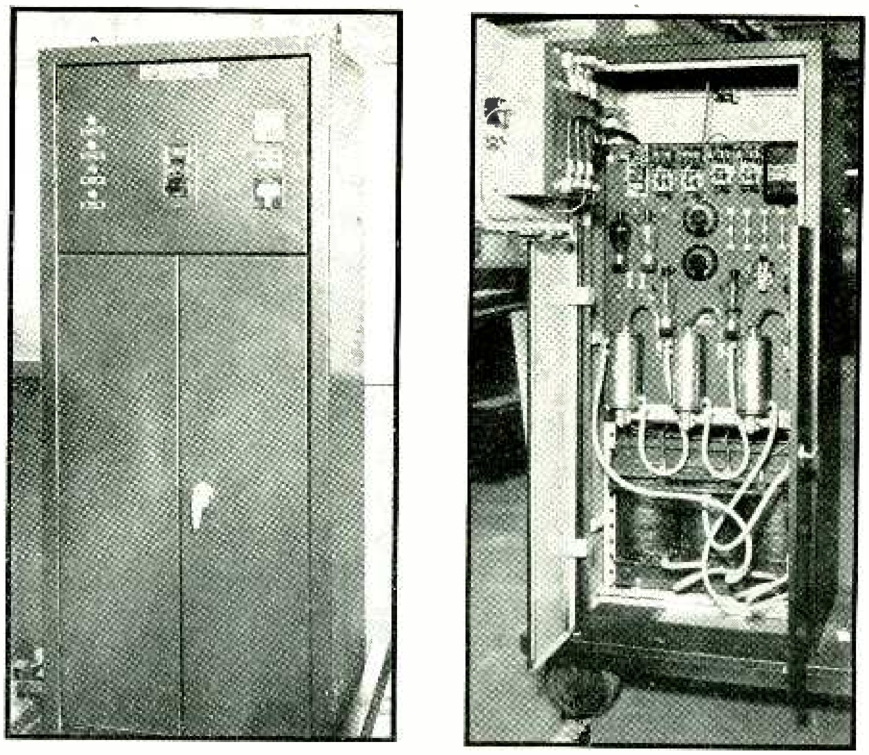
The rectifier and voltage control amplifier shown schematically in Fig. 5 consists of three phanotron tubes 1, 2 and 3 and three thyratron tubes 4, 5 and 6, in a conventional three-phase, full-wave arrangement fed from the three-phase transformer bank T_1, T_2, and T_3. Since an energy storage capacitor of the size used acts as a virtual short circuit, sufficient reactance is included in the anode transformers to limit initial charging current to a reasonable value. In this particular control, the anode transformers deliver 3800 volts line-to-line and limit the short circuit current to approximately 15 amp d.c.

Analysis of Typical Circuit

Control of the output voltage is obtained by grid-controlling the three thyratrons. It may be seen that if these tubes are completely cut off all return paths for d-c are blocked and, consequently, full control of the output may be obtained by controlling these three tubes. Since each thyratron operates in conjunction with first one and then a second phanotron and has two successive return paths as long as its anode is positive with respect to either cathode, the possible angle over which it may conduct is 240 deg. instead of the 180 deg. or less associated with half-wave rectifiers. Therefore, in order to obtain full control over the entire conduction angle, a grid phase control voltage differing somewhat from the conventional displaced sine wave must be used.

In order to obtain 240 deg. control, each thyratron grid is supplied with a saw-tooth wave obtained as follows: Taking the grid circuit of tube 4 as an example, grid transformer T_1 supplies a sine wave voltage which is so displaced that its maximum negative value is reached as the anode of tube 4 starts positive. This voltage is rectified by one half of tube 7 and is used to charge capacitor C_4. During the time that the voltage of T_1 (sec.) is less negative than the voltage across C_4 the capacitor charge bleeds off through resistor R_5. The resultant grid voltage is the saw-tooth wave illustrated in Fig. 6 in conjunction with the anode and exaggerated grid characteristics of tube 4. Examination of Fig. 6 shows that by applying a d-c voltage in series with the voltage across C_4, the voltage applied to the grid of tube 4 may be made to cut the grid characteristic at a point determined by the value of d-c voltage applied. Thus the conduction of this tube may be varied by a variable d-c voltage. Tubes 5 and 6 are similarly controlled.

Since the output of the grid circuit networks is essentially negative, the second half of tube 8, in connection with the secondary of T_7 and filter capacitor C_7, is used to furnish a constant d-c bias to displace the zero line to a more convenient position. This displacement brings the zero line to a position more nearly at the average zero of the a-c component of grid voltage. It is now possible to obtain control of the rectifier by displacing point B in Fig. 5 both positive and negative from the cathode potential of the thyratrons. Connection of point B to the slider of potentiometer P_1 would provide one possible method of voltage regulation by proper selection of the fixed bias across R_8. If this was done, as the voltage across the load capacitor C_1 increased the rectifier would be progressively cut off until is passed only sufficient current to maintain the capacitor voltage against leakage and bleeder current. However, in order that more accurate voltage control may be obtained, an amplifier tube 9, and a voltage-standard tube 11 (along with the necessary power supply from transformer T_8, tube 10 and filter capacitors C_9 and C_{10}) is provided.



Closed and open front views of an ignitron rectifier unit for magnetic energy storage spot welders

Refinements in Control

Considering first the grid circuit of tube 9, the standard voltage across tube 11 in series with any voltage appearing from the slider of P_1 to the positive output line is applied across the two equal resistors R_{14} and R_{15}. With zero voltage on the load CL, the standard voltage is divided equally and one half is applied to the grid of tube 9. This voltage is negative with respect to the cathode of tube 9 and achieves complete cut-off. As the voltage across CL increases, the total voltage across R_{14} and R_{15} increases; consequently the drop across R_{14}, which subtracts from the standard, increases. When the load capacitor voltage reaches a value such that for a given setting of P_1 the potential applied to the grid of tube 9 reaches zero, a slight further increase of CL voltage drives this grid positive. Thus it will be seen that as the load capacitor voltage increases tube 9 is cut-off until nearly the desired voltage is reached. Upon further load capacitor voltage increase, the tube is driven to saturation.

The voltage applied to point B in Fig. 5 consists of two combined voltages, one voltage between points C and D and the other the drop across tube 9. Remembering that tube 9 remains cutoff until nearly the desired output voltage is reached, at the beginning of the charge point

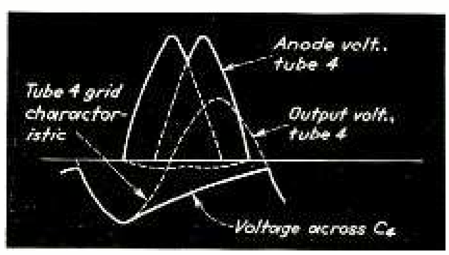


Fig. 6—Anode voltage and phase controlled grid voltage waveforms, illustrating the operation of tube 4 in Fig. 5

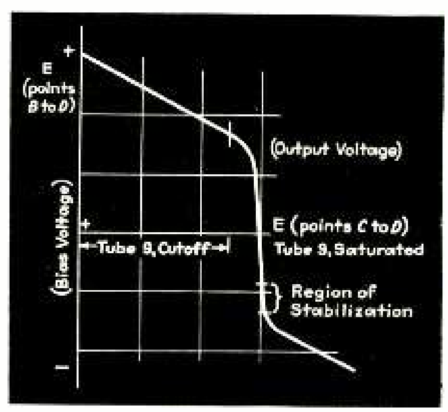
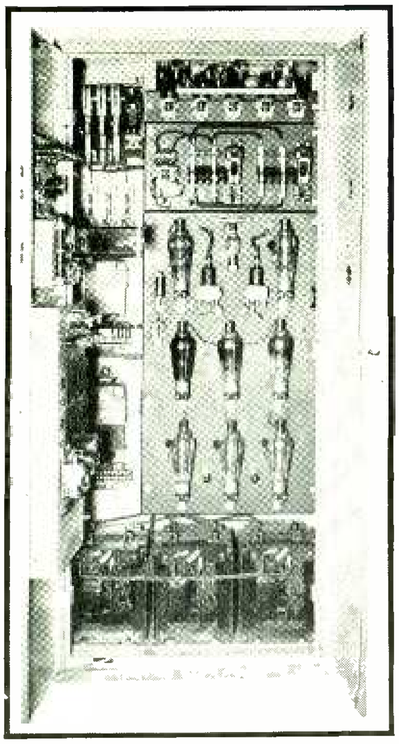
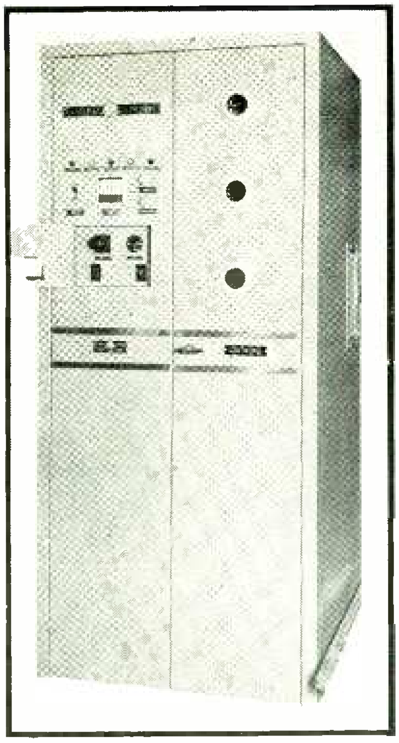


Fig. 7—Output vs. input voltage of regulating amplifier for electrostatic energy storage spot welder charging rectifier

Closed and open front views of a capacitor discharge welder control. Capacitor tap-switch, voltage control and "squeeze" and "hold" timer adjustments may be locked behind the small door

B is practically at C_9 potential so the grids of the thyratrons are positive and these tubes are fully conducting. As the capacitor charge proceeds, the voltage between points C and D increases, substracting from the positive voltage applied to the thyratron grids. So long as tube 9 is in a nonconducting state this action is not sufficient to affect the rectifier output. However, as the output voltage approaches the desired value tube 9 begins to conduct and reduce the positive component of control voltage. Thus, over a small range of output voltage the grids of the thyratrons swing from a positive potential to a negative potential. At some point along this curve, depending upon leakage and bleeder currents, the thyratrons reach a conduction angle just sufficient to furnish these currents, and the circuit stabilizes at that output voltage, as determined by the setting of P_1. The variation of voltage between points B and D is shown in Fig. 7.

A contact of relay CR_1 controls the rectifier during periods in which the capacitor CL is discharged for welding. When this contact is closed, the rectifier is effectively blocked by driving the thyratron grids negative to C_{10} potential. Capacitor C_8 serves a dual purpose. It prevents transient loads at the beginning of the charging cycle and serves to "watch" the rate of output voltage rise, preventing "overshooting" when charging small values of capacitance. For the first function of C_8, R_9 and R_{10} are so selected that with CR_1 contact closed their junction is just sufficiently negative to prevent conduction of the thyratrons. Upon opening CR_1 contact to release the rectifier, potential at point B snaps to that at the junction of R_9 and R_{10}. Capacitor C_8 then delays further change of potential in the positive direction sufficiently to require two or three cycles for the rectifier to reach a "full-on" condition. The second function of C_8 is to drive the junction of R_9 and R_{10} and the grids of tubes 4, 5 and 6 negative with a rapid rise in output voltage. The magnitude of this effect is proportional to the rate of rise of output voltage and holds down the charging rate of small load capacitors.

Undervoltage Indicating Device

When it is necessary to operate an energy storage type welding machine at very high speeds, it is possible to attempt to weld before the system has been completely charged to the desired voltage. A low capacitor voltage, for example, may result in a defective weld.

To forestall faulty operation, an undervoltage indicating device is included. It's circuit is shown schematically in Fig. 8. Tube 12 is a small thyratron and points C and D are those similarly identified in Fig. 5. Operating in a manner similar to that of tube 9, the grid of tube 12 is

(*Continued on page* 174)

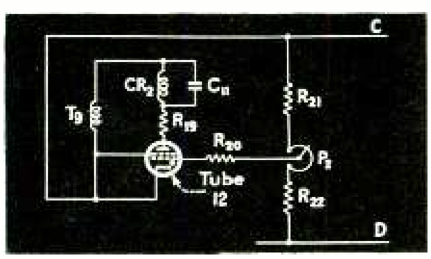


Fig. 8—Undervoltage indicating circuit for electrostatic energy storage spot welder shown in elemental form

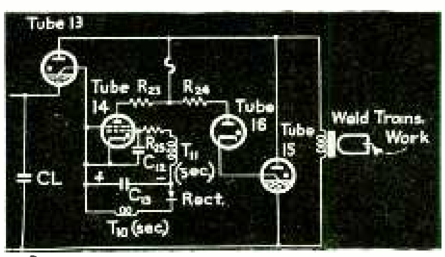


Fig. 9—Discharge and shunt-tube oscillation suppression circuits of electrostatic energy storage spot welder

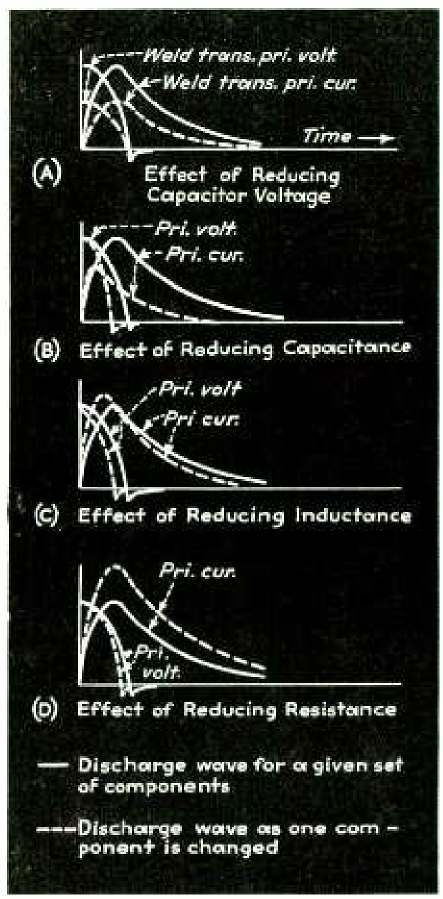
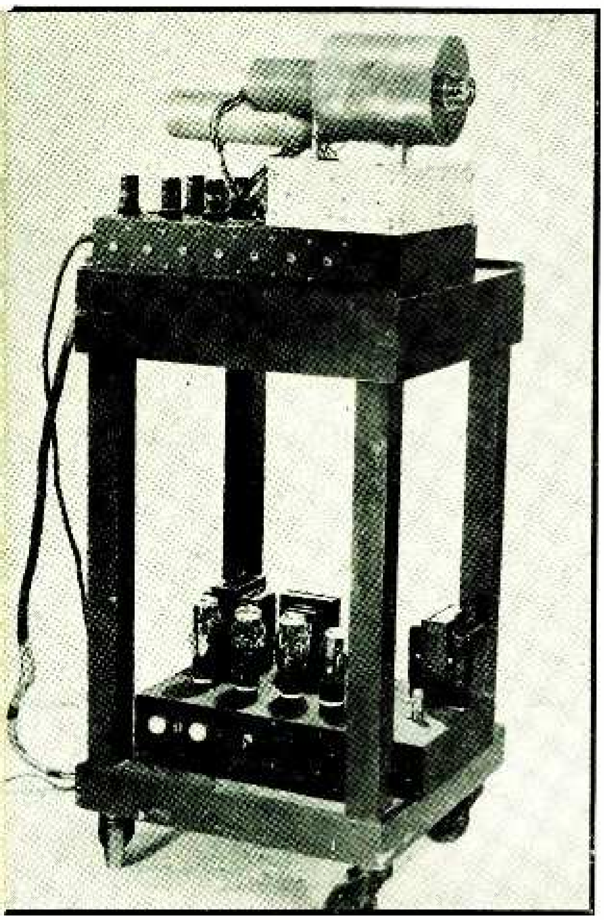


Fig. 10—Effects of changing constants in discharge circuit of electrostatic energy storage spot welder

An Experimental Television

Successfully operated in the 114 Mc band just before the war, the inexpensive video equipment described is semi-portable and susceptible to adjustment without elaborate test equipment. It should, therefore, be of immediate practical value to educators and of interest to men storing up knowledge of the art for future commercial application



Television camera and monitor, complete with pre-amplifier

CONSTRUCTED just before the war and operated for several months in the 114 Mc band, the television system to be described provided the authors with supplemental data on video technique which should be invaluable when the art assumes major commercial significance. Low in cost, semi-portable and susceptible to adjustment without elaborate test instruments, much of the equipment will be of immediate practical interest to educators since it provides a source of most of the waveforms peculiar to video transmission. In certain instances, study of such waveforms may be efficious in the wartime personnel-training program.

While the following text includes a brief overall picture of the entire system it deals particularly with the design and construction of monoscope test equipment, the radio-frequency portion of the video transmitter, the video modulator and the receiver converter unit. Some data concerning other units and circuits is included, particularly where designs previously described in the literature have been simplified, but readers interested in details concerning such units are liberally referred to published material. Sync-signal generators have, for example, been described by Wilder and Brustman[11] and the design of receiving equipment has been described by Fink[6,7].

Overall Video System

Throughout the design and construction of the transmitter, an attempt was made to build video equipment which would conform to the original RMA standards for television transmission. The equipment was thus originally designed for 441 lines but it is a simple matter to adapt it to the standard of 525 lines promulgated by the NTSC. Some limitation on the quality of the received picture results from the use of an amateur-type 2-inch iconoscope in the telecamera, but otherwise the transmitter has features equivalent to those possessed by modern commercial equipment.

A block diagram of the elements of the video transmitter and receiver-converter is given in Fig. 1. An iconoscope camera and a monoscope are provided for producing visual images, the camera being equipped with a 2-inch cathode-ray tube monitor. Both image producing units use the same timer and shaper units, but each has its own pre-amplifier. Either the iconoscope or the monoscope can be fed individually to the line amplifier. The modulator pre-amplifier and the modulator are fed from a common 400 v power supply. A crystal-controlled oscillator-doubler and two additional frequency-doublers form the radio frequency generating equipment of the transmitter. The output of the last doubler is fed into a driver amplifier. The output of the driver amplifier is link-coupled to the modulated r-f amplifier, which is cathode-modulated and produces a carrier in the 114 Mc band. A 500 v power supply provides plate power for all r-f stages of the transmitter.

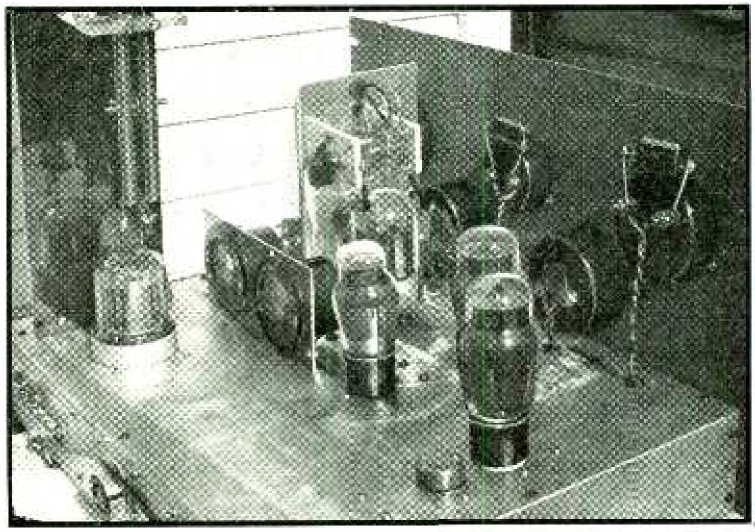
The receiver consists of a 114 Mc converter, the 12.75 Mc output of which is fed to the first i-f amplifier of a commercial television receiver.

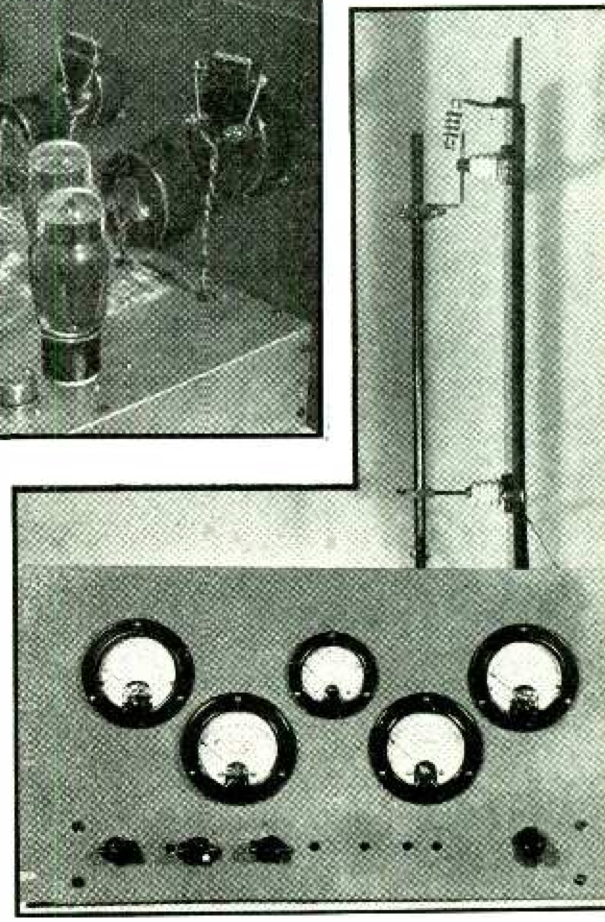
The Monoscope

A type 1899 monoscope tube provides a video signal for testing external equipment and is useful in checking the operation of the scanning generator and auxiliary equipment used with the transmitter. The monoscope pre-amplifier consists of five tubes and is similar to that used for the conventional iconoscope camera, except for the fact that a high frequency peaking stage compensates for the decreased high frequency response[29] resulting from the method of coupling to the monoscope. The peaking adjustment is made by means of a variable resistor in the third stage of the pre-ampli-

System

By ROBERT MAUTNER
and FRANK SOMERS





Front and back views of the transmitter r-f section

fier and can be set correctly by observing the reproduced pattern in a kinescope. A sharp following edge on all vertical lines in the reproduced pattern and the absence of "smearing" or "tails' is obtained when the control is properly adjusted.

To maintain perfect synchronization with the generator sync-signal, control circuits were employed to permit the sync pulses to generate the sawtooth waves necessary for scanning. This constitutes direct drive of monoscope deflection. While it is possible to use a conventional blocking oscillator or gas tubes for scanning, use of such methods results in more elaborate circuits and the necessity for frequent readjustment of the speed control.

The output of the monoscope pre-amplifier is cathode-coupled to a transmission line and is then fed to the line amplifier. No gain control is necessary on the pre-amplifier but shielding of the monoscope is important for stable operation. At the screen end of the tube a clearance of two inches in every direction is maintained to avoid capacitance by-pass of the higher video frequencies. Size, positioning, linearity and peaking controls are brought out to the top of the monoscope front panel. Other details involved in the design and construction of the monoscope pre-amplifier are discussed by Barco[16].

Timer and Pulse Generator

The timer and pulse unit used is similar to equipment developed by H. B. Deal of the RCA License Laboratories and described by Fink[25]. This unit was built for the original RMA standard of 441 lines. Adjustment to conform with the NTSC standard of 525 lines would necessitate increasing the oscillator frequency from 13,230 to 15,750 cps (which can be achieved by merely resetting the tuning of the oscillator condenser) and resetting the divider ratios.

The frequency dividers used in the shaper unit are similar to those already described elsewhere[23]. Further information, including notes on the adjustment of the various parts of the circuit, may be found in a series of articles published in 1940[11]. Some modifications to permit operation of the frequency divider on the 525 line standard will be necessary. Using the former standard of 441 lines, the ratios of frequency division were 7, 7, 3, 3. If it is desired to use the same series of four multivibrators a dividing sequence of 7, 5, 5, 3 can be used for 525 line operation. It is quite probable that adjustment can be made on the second and third multivibrators to accomplish this without employing new circuit constants. In any new equipment, however, it will probably be desirable to employ counter circuits rather than multivibrators for the appropriate frequency division. Counter circuits are somewhat less critical in their adjustment and have the additional advantage of maintaining the required frequency division over wide limits of voltage. Brief discussion of a suitable counter circuit has been published by Bedford[22].

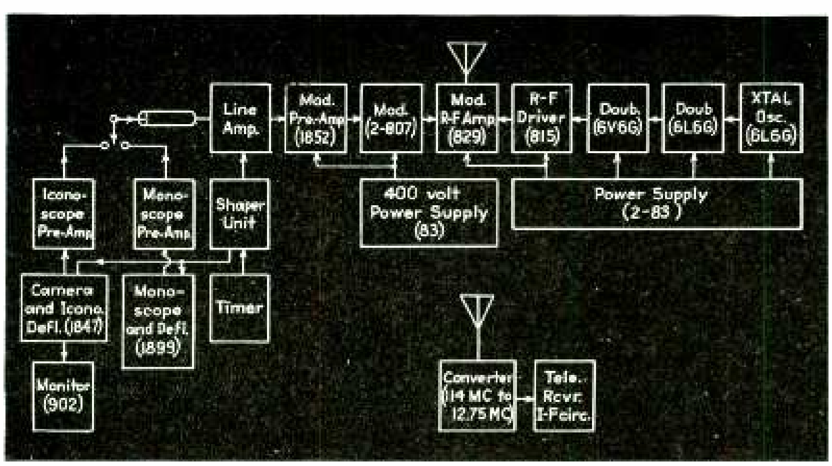


Fig. 1—Block diagram of complete television video transmitter and associated receiving equipment

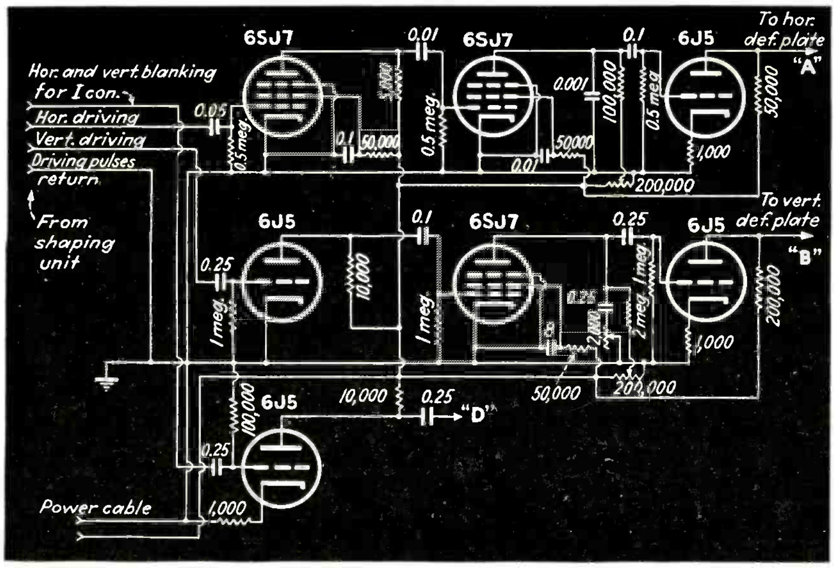


Fig. 2—Circuit showing method of adapting driving pulses for unbalanced electrostatic deflection of 902 monitor tube and 1847 iconoscope camera tube

A two-inch iconoscope (type 1847) was employed in the camera unit. All of the deflecting circuits (Fig. 2) were designed for a larger type iconoscope with the expectation that a tube of this type might be substituted at some future date.

Camera

A considerable amount of time was spent in investigating the action of the 1847 in the camera circuit. At the full gain of the original pre-amplifier and line amplifier it was impossible to obtain sufficient amplification to produce a satisfactory iconoscope signal. Part of the difficulty appeared to be due to excessive capacitance between iconoscope and ground. In an effort to reduce capacitance to a minimum the mount for the iconoscope was rebuilt and two additional stages of amplification were added to the pre-amplifier. When these changes had been effected it was possible to advance the gain well into the noise level. To remove all traces of hum pattern, it was found desirable to use direct current on the heaters of the pre-amplifier tubes. Careful adjustment of the bias on the iconoscope then produced a satisfactory image on the kinescope. Adjustment of the bias to permit higher beam current and greater iconoscope output produced excessive "dark spot" voltages, while lower beam current caused the signal to be lost in the noise voltage. Adjustment was sufficiently critical to indicate the desirability of incorporating a shading-voltage generator, and the construction of a suitable unit has begun. Methods of developing such voltages are discussed in Part III of the series of papers by Wilder and Brustman[11] and in a paper by Sherman[26]. If no shading voltages are used it is desirable to use a lens whose maximum aperture is $f/2$ or larger and to have the scene brilliantly illuminated.

Care must be taken to avoid internal light deflection within the camera tube itself. In one experiment, a 16 mm moving picture projector was focused directly on the iconoscope mosaic, providing a high intensity light source. While a considerable output voltage was obtained, light reflected from internal portions of the gun structure produced an excessive dark spot. It is also necessary to position the raster so that no portion of the scanning field or image touches a section of the wire used to support the mosaic at the end of the iconoscope tube. Failure to observe this produces erratic operation.

The mechanical construction of the camera pre-amplifier is such that it can be easily adapted to a large iconoscope if and when desired. Horizontal and vertical blanking voltages are available from the shaping unit. The vertical blanking voltage has been found most useful when operating the iconoscope.

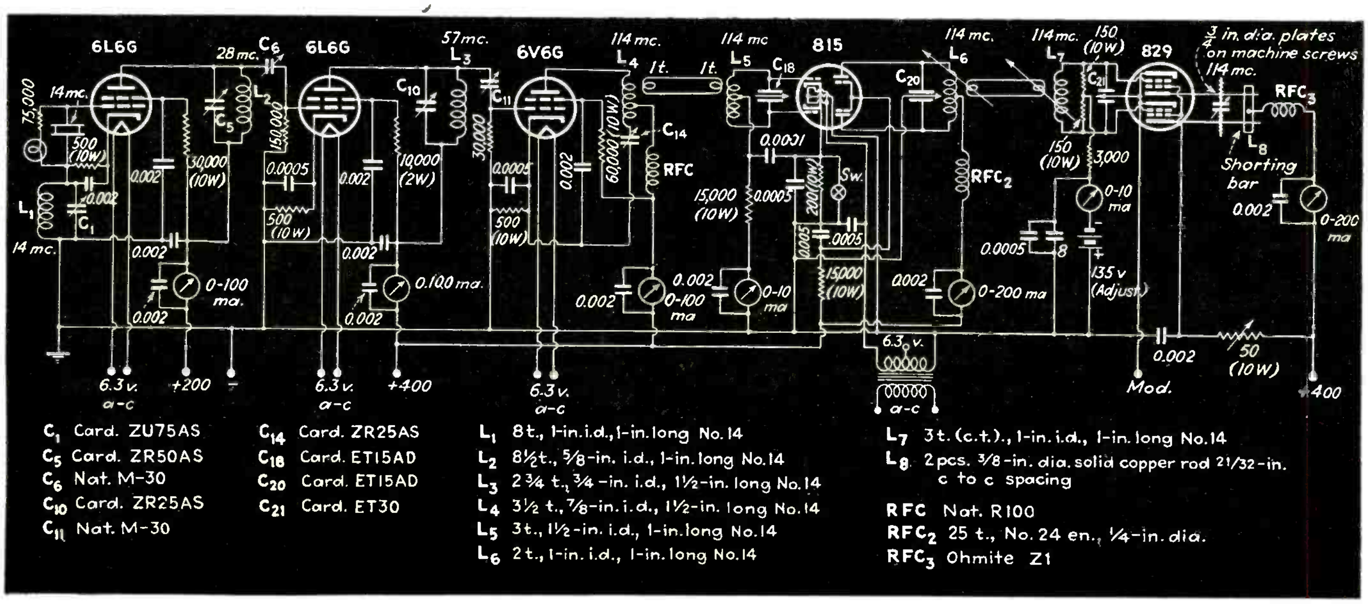
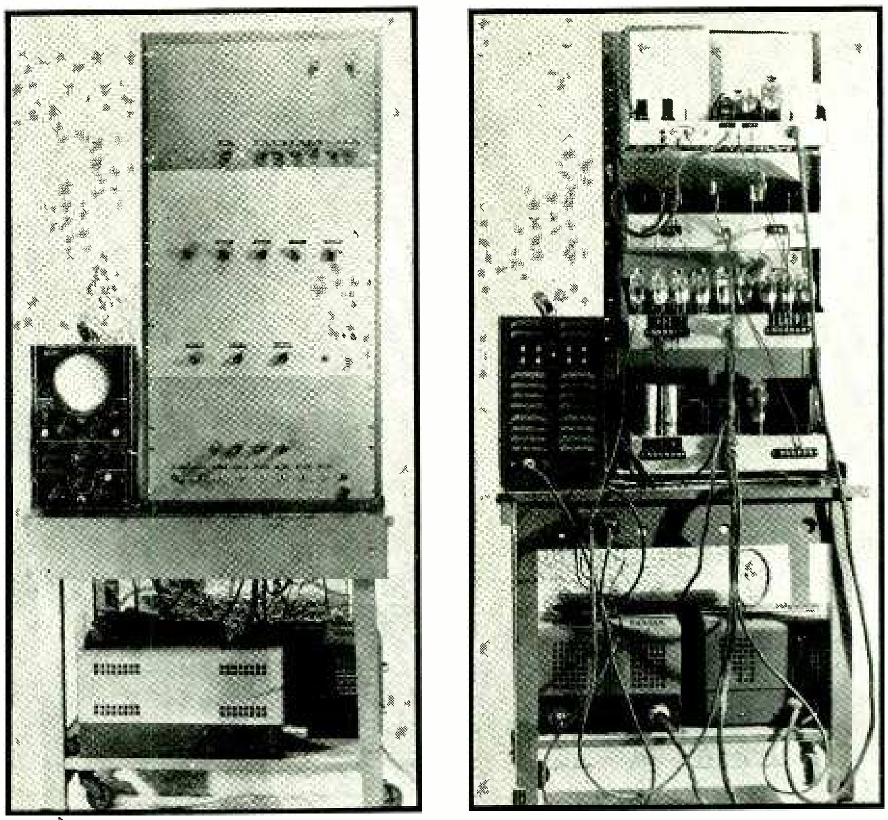


Fig. 3—Schematic diagram of r-f section of the television video transmitter discussed in the text

A two-inch kinescope was originally built into the camera unit for focusing and to serve as a check on the size of the scanning raster. However, the better resolution obtained with the 9-inch kinescope in the receiver provided somewhat greater ease in focusing and was therefore used for this purpose. The smaller kinescope was then used only as an indicator of scanning raster size and position.

Sawtooth scanning voltages required by the 1847 tube are obtained from the line and field pulses produced by the shaping unit in a manner similar to that outlined in connection with the monoscope and, consequently, there are no frequency adjustments in the scanning circuit. Power supply and positioning circuits were adapted from those recommended by Sherman[27]. The circuit employed to adapt driving pulses for electrostatic deflection of the 902 and 1847 tubes is shown in Fig. 2.



Front and back views of the monoscope and signal generator unit. Panels, from top down, contain the monoscope and associated circuits, video mixing amplifier, pulse generator, timer. Regulated power supplies are on the bottom shelf

The Transmitter

The transmitter proper consists of two units: (1) the r-f driver stages and modulated radio frequency amplifier and (2) the modulator unit.

The radio frequency section contains five tubes. The first tube is a 6L6G crystal-controlled oscillator and frequency multiplier, followed by a 6L6G multiplier stage and another frequency multiplier using a 6V6G tube. The output of the 6V6G multiplier feeds into the grid circuit of a driver amplifier using an 815 tube, which drives the final (modulated) amplifier utilizing a type 829 tube. Controls on the front panel of the transmitter include those for oscillator plate circuit tuning, tuning for the 6L6G and 6V6G multipliers and tuning for the grid circuit of the final amplifier. Tuning controls for the driver amplifier grid and plate circuits are on the back of the transmitter. Final amplifier plate circuit tuning is accomplished right at the plate line.

The transmitter was designed for 114 Mc, double sideband, transmission using the RMA standard of 441 lines and 30 frames per second, or 60 fields per second. It has, however, been used at various frame frequencies from 15 to 30 per second and at many other numbers of lines per frame.

The schematic wiring diagram of the transmitter is shown in Fig. 3. The crystal has a fundamental frequency of 14.251 Mc. The output of the "tri-tet" oscillator is tuned to the second harmonic of the crystal. The succeeding 6L6G doubles and the 6V6G doubles again so the output frequency in the plate of 6V6G tube is 114.008 Mc. The 6V6G stage is coupled to the input of the 815 driver-amplifier by means of a link circuit.

R-F Driving Unit

It is usually quite difficult to obtain tank circuit impedances at 112 Mc comparable with those obtained at lower frequencies and it will frequently be found when ordinary lumped circuits are used that the plate current of an unloaded stage doubling to this frequency is close to rated load value. So-called "series" tuning (actually not series-tuning but a method of trimming the tank inductance to resonate with tube and stray capacities) is sometimes helpful and may be used as in the 6V6G plate circuit. It should be noted that the inductance used when series tuning should be very slightly greater than that necessary to

(Continued on page 170)

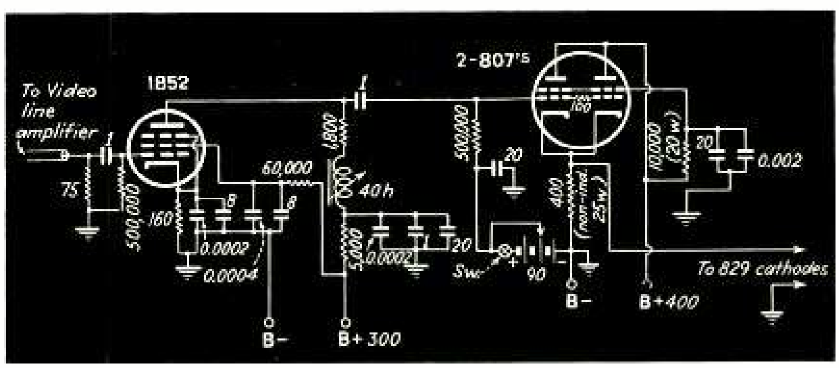


Fig. 4—Schematic diagram of pre-amplifier and modulator unit suitable for cathode-modulating the transmitter diagrammed in Fig. 3

Opportunities for Electronics in

INDUSTRIAL TEMPERATURE INSTRUMENTATION

TEMPERATURE measurement and control* is one of twenty-odd major fields of industrial instrumentation among which may also be listed the measurement and control of: (1) humidity, (2) pressure (and vacuum), (3) chemical processing conditions, (4) electrical processing conditions, (5) liquid level (and position), (6) speed (and acceleration), (7) processing time and schedules, (8) fluid flow, (9) physical properties of materials, (10) chemical properties of materials, (11) radiant energy (light, infrared, ultraviolet, x-ray irradiation, etc.), (12) dimensions, and (13) quantities (i.e., traffic count, etc.)

In considering the widely different rates at which electronic developments have penetrated these major fields of industrial instrumentation during the last decade, the writer was astonished to discover that it is in the field of industrial temperature measurement and control that the science of electronics has made the least relative progress in relation to the possibilities in the field of temperature. A smaller percentage of the practicable methods of measuring and controlling temperature has been "electronized" than has been the case with the practicable methods of measuring and controlling pressure, pH, position, plasticity, porosity, packing or power.

Three important reasons for this state of things are as follows: (1) The number of ways of measuring temperature is beyond reliable count and is still growing, (2) the great majority of inventors and development engineers in the field of electronics are unaware of the rich possibilities, and (3) consequently, they devote their energies to electronizing the best-known forms of thermometers and pyrometers—the types and varieties which were developed before the advent of electronic devices. As a result there are excellent opportunities for the application of electronic principles to the measurement and control of temperature in industry.

*For some background relative to this article the reader is invited to read an item labelled "Temperature" in Crosstalk. this issue.

Of all measurable magnitudes there are only a few which are ubiquitous. Such magnitudes are weight, length, time, and temperature. Of all measurable magnitudes, however, temperature is the most variable both in time and space. It is the one whose effects are most likely to play havoc with mankind's intentions, from going out for a walk to building a huge synthetic-rubber manufacturing plant.

Only a century ago, temperature was one of a scant score of known magnitudes; today it is one of hundreds. But the unique thing about temperature is that it affects the measurement of nearly all of these hundreds of known measurables. Ambient temperatures, conductor temperatures and various local temperatures affect nearly all the thousands of distinct methods of measuring these athermal conditions and properties. Consequently, almost every time a new method is devised for determining a physical or chemical value, the temperature coefficient must be taken into account.

Often, a dreaded "temperature *error*" became a respectable temperature measurement *method*. Today the classes, types and varieties of temperature measurement methods are innumerable, as is indicated in Table I. Even if the Bureau of Standards or a richly-endowed institute succeeded in counting all known methods today, the published count would probably be out-of-date tomorrow.

The author recognizes the necessity of "working with what you've got." Admirable solutions of difficult problems have been achieved in this way, and their commercial embodiments are worth their weight in gold. Such problems come up where the nature of the equipment (furnace, still, or vulcanizer) and the nature of the process (normalizing of steel, curing of rubber, or fractional distillation of petroleum) are both such that a non-electronic primary element has been found most acceptable and is firmly entrenched. Likewise the electronic engineer has usually found the final elements of the automatic-control system already selected for him—for example a particular type and make of valve with the desired lift-flow characteristic, operated by a particular type and make of electric motor with the desired speed-torque or other characteristic. On a large job he may even find that the electrical engineer has already specified a particular type and make of motor controller.

Problems of Temperature Specialist

In some extreme cases the electronic engineer would find that he was only called in because the insurance underwriters, with explosive atmospheres to reckon with, had specified the elimination of ordinary relays and contactors from a temperature control system which in all other respects was considered entirely satisfactory. He would stick in an oscillator tube here, a power tube there, perhaps a pair of thyratrons—and that was that!

This sort of work is not altogether a waste of effort. It is decidedly useful. But it is not the penetration of electronics into the field of industrial temperature measurement.

An analogy may drive home the point. Imagine that the field of industrial illumination control has

By

MAJOR M. F. BÉHAR

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never been penetrated by modern electronics. You—a modern electronic engineer—are called to a certain factory where the illumination level from a battery of arc lights above a conveyor belt has to be maintained at a certain value in order to process the sheet material passing under the lights. The control is manual: an old-fashioned selenium-resistance primary element is connected to a large switchboard milliammeter in front of the operator whose duty it is to operate an old-fashioned water rheostat by a block-and-tackle arrangement. You are acked to automatize this installation by electronizing it. Now then, how would you solve this problem?

First of all, since light must be controlled automatically, it will be necessary to employ a light-sensitive primary element at the initial or starting point. But will you scrap the 1910 model selenium-resistance element and substitute a more modern blocking layer photocell or caesium-oxide phototube? Not necessarily! The old selenium cell is itself an electronic device and should not be discarded too hastily. Its spectral response curve may more closely match the spectral sensitivity curve of the photo-chemical process under control than the response of the latest blocking-layer cells or caesium-oxide tubes. The chances are, of course, that from the rich variety of new models of photocells and phototubes on the market, you will find one whose output is a better indication of the particular variable to be measured and controlled.

To Control One Must First Measure

Here then is the first point! The author laid down as one of the cornerstones of instrumentation seventeen years ago the dictum that before a condition can be controlled it

Table I CLASSIFICATION OF METHODS OF MEASURING TEMPERATURE*

I. Methods Utilizing Discontinuous Reversible Effects

1. Freezing point
2. Boiling point

   A line must be drawn (both meanings) between equilibrium temperature effects which include the International Standards, and all others.

3. Molecular transformation point
4. Solubility
5. Color

   Etc.

II. Methods Employing Continuous Effects

1. Properties of bodies
   - a. Thermal expansion, expansivity, expansibility
     - (1) of gases
     - (2) of liquids
     - (3) of solids

       Instruments are classified by utilized coefficient (linear, cubical); also as cathetometric, extensometric, volumetric, etc.
   - b. Electrical conductivity or resistivity
     - (1) metals, of alloys
     - (2) other solids
     - (3) electrolytes
     - (4) ionized gases, etc.

       Resistance measurement methods classifiable by type of circuit, by type of instrument (deflection, self-balancing, etc.) and in other ways
   - c. Viscosity, fluidity
   - d. Refractivity
   - e. Vapor pressure
   - f. Magnetic susceptibility
   - g. Sound velocity
   - h. Dielectric " constant "
   - i. Elasticity
   - j. Rotatory polarization
   - k. Color of transmitted light
   - l. Color of reflected light
   - m. Hydrogen-ion concentration
   - n. Specific heat
   - o. Compressibility
   - etc., etc.
2. Effects between bodies
   - a. Simple differences of properties
     - (1) Expansivities
       - (a) Bimetallic
   - b. Effects at interfaces or junctions
     - (1) Solid vs solid
     - (2) Solid vs liquid
     - (3) Liquid vs liquid

       Instruments classified also by utilization of effects, modes of conversion of energy: thermo-electricity, etc.
   - c. Effects at a distance (radiometry)
     - (1) Methods utilizing Stefan-Boltzmann fourth-power law
     - (2) Methods utilizing displacement of maximum energy density. (Color temperatures, of stars, etc.)
     - (3) Methods utilizing selected band or effective wavelength
       - (a) Measurement of the monochromatic energy by visual matching
       - (b) Measurement by " extinction " methods
       - (c) Combinations of (a) and (b)
       - (d) Selection by filtration as in use of red glass
       - (e) Selection by special curve of receiver; phototube or photocell, plate emulsion, etc.,
     - (4) Methods utilizing ratio of energy at two effective wavelengths
     - (5) Spectroscopic, spectrographic or spectrometric methods
   - etc.

III. Methods Utilizing Irreversible Effects

1. Fusion
2. Color change

etc.

IV. Combination Methods

1. Methods using a temperature coefficient of an entire assembly
2. " Calorimetric pyrometers," " aspiration pyrometers " and other devices requiring transport or transfer or manipulation of the body or of a continuous sample
3. Methods requiring the introduction of an " indicator " as in line-reversal method

* Behar, M. F., in Temperature Symposium of American Institute of Physics. Reinhold Publ. Corp., New York, 1941. Page 350.

must first be measured. In entering the field of industrial temperature control, the electronic engineer must always keep in mind the importance of the primary element. He should always think of it as a measuring element. Its output (whether a current or a mechanical displacement or other effect) is the indication of the measured value of the temperature. A classification of industrial temperature measuring devices which may be suitable for the measuring element is given in Table II.

The final elements of a temperature control system likewise deserve careful study. Returning to our illumination-control problem, you probably will not hesitate to scrap the whole rope-lift water rheostat. There are four good reasons for so doing: (1) The muscular control of the operator can be replaced by a simple automatic device free from fatigue and the "human element," (2) the unnecessary slowness of the corrective action may be eliminated through the use of well-known current-regulating means, some of which are devoid of mechanical moving parts; (3) the difficulty of obtaining precise control through manual operation may be overcome through the use of electronic control devices with the negative feed back whereby a precision of 0.01 of 1 percent is not uncommon; (4) the possibility of reducing or of eliminating flicker through the use of highly-developed electronic control schemes such as the now-common automatic volume control. These four considerations sometimes play a part in electronizing the final elements of industrial temperature control system, but they do not and cannot dominate the decision as they would in the control of illumination or irradiation.

The reason for this is commonly referred to as application lag. Every industrial temperature control application is characterized by a time interval between the moment that the automatic controller has completed a corrective function and the moment that its primary element can begin to feel the effect of the corrective action. There never is any definite delay, but always a sort of wave—and not like any of the mathematically-definable waves of electrical phenomena but a complex wave—a ragged ocean breaker.

Some of the keenest brains in the field of temperature instrumentation have striven to express application lag mathematically but their equations are so over-simplified that they do not truly represent the hard physical realities and seldom help to solve the inherently difficult problems. One inherently difficult problem, for example, is the soaking pit—a vertical furnace into which a huge ingot is lowered and subjected to the soaking process. This process is officially defined by the American Society for Metals as "holding steel at *an* elevated temperature for the attainment of *uniform* temperature *throughout* the piece." The author has impishly italicized three words which, in the present state of the art, represent wishful thinking: the reality in a soaking pit is not one temperature but an exasperating set of temperature gradients that chase one another too fast to be plotted and too slowly to give an "averaging" effect of near-uniformity.

Electronic engineers may help to make furnaces, ovens, stills and other applications more controllable but their greatest opportunities lie in electronizing the primary or measuring elements of industrial temperature instruments in order to improve the measuring properties of these elements. In so doing it is important to give consideration to the industrially important measuring

(*Continued on page* 163)

Table II

CLASSIFICATION OF INDUSTRIAL TEMPERATURE INSTRUMENTS

I. Mechanical Effects

1. Liquid-in-Glass (Visible Column)
   - (a) Mercury (−38 to +540 deg. C)
     - (1) Etched stem (laboratory or chemical)
     - (2) Industrial
     - (3) Miscellaneous (pocket, wall, etc.)
   - (b) Spirit (Typical ranges: pentane, −180 to +20 deg. C; alcohol −70 to +120 deg. C)
     - (1) Etched Stem
     - (2) Industrial
     - (3) Miscellaneous (pocket, wall, etc.)
   - (c) Gallium-in-quartz (+31 to +1000 deg. C)
2. Pressure Spring
   - (a) Mercury (−38 to +538 deg. C)
     - (1) Non-compensated (tube length, 25 ft.)
     - (2) Head-compensated (tube length, 35 ft.)
     - (3) Fully-compensated (tube length, 150 ft.)
   - (b) Non-mercurial Liquid Expansion (−40 to +400 deg. C)
   - (c) Vapor Pressure (Range limits, −30 to +370 deg. C)
     - (1) Progressive Scale } tube length, 150 ft.
     - (2) Uniform Scale }
   - (d) Gas (−130 to +538 deg. C) (tube length depends on bulb volume)
3. Solid Expansion
   - (a) Bimetallic (upper limit about 550 deg. C)
   - (b) Metal and Refractory (upper limit for Monel about 650 deg. C)
4. Fusion (pyrometric cones)

II. Electrical Effects

1. Electrical Resistance
   - (a) Platinum (−180 to +1000 deg. C)
   - (b) Nickel, etc. (−180 to +200 deg. C)
2. Thermoelectric. Note dual classification

(a) Galvanometric	(a) Rare-metals (to 1600 deg. C)
(b) Deflection and semi-potentiometric	(b) Special alloys (to 1300 deg. C)
	(c) C-SiC (to 1800 deg. C)

3. Total-radiation (lower limit 400 deg. C)
   - (a) Hand
   - (b) Autometric and autographic
4. Selective-radiation (lower limit 550 deg. C)
   - (a) Photometric
   - (b) Disappearing filament
   - (c) Flux extinction
   - (d) Color ratio

   } { (a) Visual; (b) Autometric and autographic

IMPEDANCE

of Some Simple Electrical Circuits

The impedance and admittance of simple circuit elements, connected in series and in parallel, is presented as a means for simplifying and aiding in the analysis of complicated electrical circuits for communication or industrial applications

By BEVERLY DUDLEY
Managing Editor

IN circuit analysis it is frequently convenient to have available in convenient form the impedance functions of the more common types of simple electrical circuits. This is particularly true for those design applications where simple combinations of common circuit elements are frequently used, and where time is a consideration in design.

In this Reference Sheet* are compiled the expressions for the impedance and admittance functions of the simplest types of two-terminal circuits composed of lumped values of L, R, and C. The circuit elements are considered to be ideal in that they conform fully to the mathematical expression for their behavior and have no losses. Unless otherwise indicated, it is assumed that there is no coupling between the various elements of the circuit. For convenience, the impedance data is divided into two sections, one on series connected circuit elements, and the other on parallel connected circuit elements.

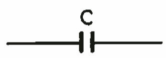
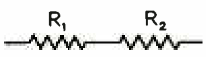
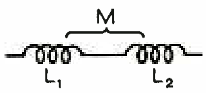
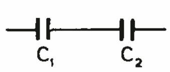
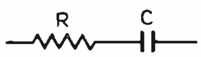
In each tabulation, the schematic diagram of the circuit is shown in the first major column. The second column gives the impedance of the circuit in Cartesian co-ordinates involving real and quadrature terms, the impedance being given in the form, $Z = R + jX$. The third column tabulates the absolute value or the magnitude of the impedance from the real and quadrature terms, using the familiar expression, $Z = \sqrt{R^2 + X^2}$. The fourth column gives the phase angle of the impedance in

TABLE OF IMPEDANCE OPERATIONS

OPERATION	RESULT
Addition	$Z = Z_1 + Z_2 = (R_1 + jX_1) + (R_2 - jX_2) = (R_1 + R_2) + j(X_1 - X_2)$
Subtraction	$Z = Z_1 - Z_2 = (R_1 + jX_1) - (R_2 - jX_2) = (R_1 - R_2) - j(X_1 + X_2)$
Multiplication	$Z = Z_1 Z_2 = (\|Z_1\| \angle \theta_1)(\|Z_2\| \angle \theta_2) = \|Z_1 Z_2\| \angle \theta_1 + \theta_2$
Division	$Z = \frac{Z_1}{Z_2} = \frac{(\|Z_1\| \angle \theta_1)}{(\|Z_2\| \angle \theta_2)} = \left\| \frac{Z_1}{Z_2} \right\| \angle \theta_1 - \theta_2$
Raising to nth power	$Z = Z^n = \|Z\|^n \angle n\theta$
Extracting nth root	$Z = \sqrt[n]{Z} = Z^{\frac{1}{n}} = \|Z\|^{\frac{1}{n}} \angle \frac{\theta}{n}$

* The tabular material in this Reference Sheet is taken from a forthcoming book, "Introduction to Radio Engineering", with permission of the publisher.

IMPEDANCE OF SERIES CONNECTED CIRCUIT ELEMENTS

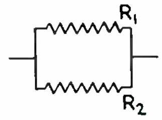
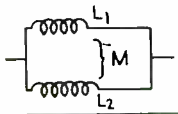
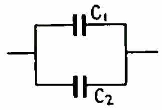
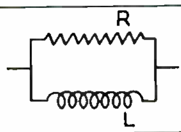
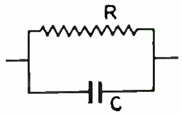
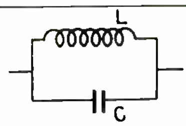
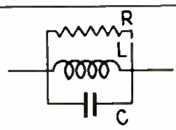
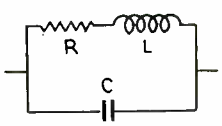
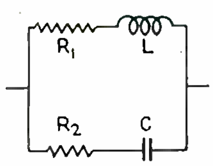
No.	CIRCUIT	IMPEDANCE $Z = R + jX$ (ohms)	MAGNITUDE OF IMPEDANCE $\lvert Z\rvert = [R^2+X^2]^{1/2}$ (ohms)	PHASE ANGLE $\theta = \tan^{-1}\frac{X}{R}$ (radians)	ADMITTANCE $Y = 1/Z$ (mhos)
1		R	R	0	$\frac{1}{R}$
2		$j\omega L$	ωL	$+\frac{\pi}{2}$	$-j\frac{1}{\omega L}$
3		$-j\frac{1}{\omega C}$	$\frac{1}{\omega C}$	$-\frac{\pi}{2}$	$j\omega C$
4		$R_1 + R_2$	$R_1 + R_2$	0	$\frac{1}{R_1+R_2}$
5		$j\omega(L_1+L_2\pm 2M)$	$\omega(L_1+L_2\pm 2M)$	$+\frac{\pi}{2}$	$-j\frac{1}{\omega(L_1+L_2\pm 2M)}$
6		$-j\frac{1}{\omega}\left(\frac{C_1+C_2}{C_1C_2}\right)$	$\frac{1}{\omega}\left(\frac{C_1+C_2}{C_1C_2}\right)$	$-\frac{\pi}{2}$	$j\omega\left(\frac{C_1C_2}{C_1+C_2}\right)$
7		$R + j\omega L$	$\left[R^2+\omega^2L^2\right]^{1/2}$	$\tan^{-1}\frac{\omega L}{R}$	$\frac{R-j\omega L}{R^2+\omega^2L^2}$
8		$R - j\frac{1}{\omega C}$	$\left[\frac{\omega^2C^2R^2+1}{\omega^2C^2}\right]^{1/2}$	$\tan^{-1} - \frac{1}{\omega RC}$	$\frac{\omega^2C^2R - j\omega C}{\omega^2C^2R^2+1}$
9		$j\left(\omega L - \frac{1}{\omega C}\right)$	$\left(\omega L - \frac{1}{\omega C}\right)$	$\pm\frac{\pi}{2}$	$-j\frac{\omega C}{\omega^2LC-1}$
10		$R + j\left(\omega L - \frac{1}{\omega C}\right)$	$\left[R^2+\left(\omega L-\frac{1}{\omega C}\right)^2\right]^{1/2}$	$\tan^{-1}\frac{\left(\omega L-\frac{1}{\omega C}\right)}{R}$	$\frac{R-j\left(\omega L-\frac{1}{\omega C}\right)}{R^2+\left(\omega L-\frac{1}{\omega C}\right)^2}$

radians, calculated from the magnitude of the real and quadrature terms. In general this phase angle is given by $\theta = \tan^{-1}(X/R)$, where X is the reactance and R is the resistance of the circuit. From these two columns, the impedance, in polar form, is readily obtained since $Z = \lvert Z\rvert \underline{/\theta}$. The last column tabulates the admittance for each circuit in rectangular co-ordinates.

In all cases resistance, reactance, and impedance are measured in ohms, admittance is expressed in mhos, frequency in cycles per second. Inductance and capacitance are expressed in henries and farads, respectively. The phase angle is expressed in radians in the equations given in the tables. The phase angle may be expressed in degrees by multiplying by 57.2958; that is, 1 radian = 57.2958 degrees, or, 1 degree = 0.0174533 radian.

Circuit analysis often calls for the addition, subtraction, multiplication, division, raising to a power, or extracting a root of one or more impedances. These operations are facilitated by providing expressions for impedance in both the rectangular and the polar forms. The rectangular form is most useful in those instances involving the addition and subtraction of impedances, in which case the real and quadra-

IMPEDANCE OF PARALLEL CONNECTED CIRCUIT ELEMENTS

No.	CIRCUIT	IMPEDANCE $Z = R + jX$ (ohms)	MAGNITUDE OF IMPEDANCE $\lvert Z\rvert = [R^2 + X^2]^{1/2}$ (ohms)	PHASE ANGLE $\theta = \tan^{-1}\frac{X}{R}$ (radians)	ADMITTANCE $Y = 1/Z$ (mhos)
11		$\frac{R_1 R_2}{R_1 + R_2}$	$\frac{R_1 R_2}{R_1 + R_2}$	0	$\frac{R_1 + R_2}{R_1 R_2}$
12		$+j\omega\left[\frac{L_1 L_2 - M^2}{L_1 + L_2 \mp 2M}\right]$	$\omega\left[\frac{L_1 L_2 - M^2}{L_1 + L_2 \mp 2M}\right]$	$+\frac{\pi}{2}$	$-j\frac{1}{\omega}\left[\frac{L_1 + L_1 \mp 2M}{L_1 L_2 - M^2}\right]$
13		$-j\frac{1}{\omega(C_1 + C_2)}$	$\frac{1}{\omega(C_1 + C_2)}$	$-\frac{\pi}{2}$	$+j\omega(C_1 + C_2)$
14		$\frac{\omega^2 L^2 R + j\omega L R^2}{\omega^2 L^2 + R^2}$	$\frac{\omega L R}{[\omega^2 L^2 + R^2]^{1/2}}$	$\tan^{-1}\frac{R}{\omega L}$	$\frac{\omega L - jR}{\omega L R}$
15		$\frac{R - j\omega R^2 C}{1 + \omega^2 R^2 C^2}$	$\frac{R}{[1 + \omega^2 R^2 C^2]^{1/2}}$	$\tan^{-1} - \omega R C$	$\frac{1}{R} + j\omega C$
16		$j\frac{\omega L}{1 - \omega^2 L C}$	$\frac{\omega L}{1 - \omega^2 L C}$	$\pm\frac{\pi}{2}$	$-j\left(\frac{1 - \omega^2 L C}{\omega L}\right)$
17		$\frac{\frac{1}{R} + j\left(\omega C - \frac{1}{\omega L}\right)}{\left[\left(\frac{1}{R}\right)^2 + \left(\omega C - \frac{1}{\omega L}\right)^2\right]}$	$\frac{\frac{1}{R} + j\left(\omega C - \frac{1}{\omega L}\right)}{\left[\left(\frac{1}{R}\right)^2 + \left(\omega C - \frac{1}{\omega L}\right)^2\right]^{1/2}}$	$\tan^{-1} R\left(\omega C - \frac{1}{\omega L}\right)$	$\frac{1}{R} - j\left(\omega C - \frac{1}{\omega L}\right)$
18		$\frac{\frac{R}{\omega^2 C^2} - j\left[\frac{R^2}{\omega C} + \frac{L}{C}\left(\omega L - \frac{1}{\omega C}\right)\right]}{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$	$\frac{\left\{\left(\frac{R}{\omega^2 C^2}\right)^2 + \left[\frac{R^2}{\omega C} + \frac{L}{C}\left(\omega L - \frac{1}{\omega C}\right)\right]^2\right\}^{1/2}}{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$	$\tan^{-1} - \frac{\left[\frac{R^2}{\omega C} + \frac{L}{C}\left(\omega L - \frac{1}{\omega C}\right)\right]}{\left(\frac{R}{\omega^2 C^2}\right)}$	$\frac{R + j\omega[R^2 C - L + \omega^2 L^2 C]}{R^2 + \omega^2 L^2}$
19		$\frac{R_1 R_2(R_1 + R_2) + \omega^2 L^2 R_2 + \frac{R_1}{\omega^2 C^2}}{(R_1 + R_2)^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} + j\frac{\omega R_2^2 L - \frac{R_1^2}{\omega C} - \frac{L}{C}\left(\omega L - \frac{1}{\omega C}\right)}{(R_1 + R_2)^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$	$\left\{\left[\frac{R_1 R_2(R_1 + R_2) + \omega^2 L^2 R_2 + \frac{R_1}{\omega^2 C^2}}{(R_1 + R_2)^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}\right]^2 + \left[\frac{\omega L R_2^2 - \frac{R_1^2}{\omega C} - \frac{L}{C}\left(\omega L - \frac{1}{\omega C}\right)}{(R_1 + R_2)^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}\right]^2\right\}^{1/2}$	$\tan^{-1}\frac{\left[\omega L R_2^2 - \frac{R_1^2}{\omega C} - \frac{L}{C}\left(\omega L - \frac{1}{\omega C}\right)\right]}{\left[R_1 R_2(R_1 + R_2) + \omega^2 L^2 R_2 + \frac{R_1}{\omega^2 C^2}\right]}$	$\frac{R_1 + \omega^2 R_1 R_2 C^2 (R_1 + R_2) + \omega^4 L^2 C^2 R_2}{(R_1^2 + \omega^2 L^2)(\omega^2 R_2^2 C^2 + 1)} + j\frac{\omega[R_1^2 C - L + \omega^2 L C(L - R_2^2 C)]}{(R_1^2 + \omega^2 L^2)(\omega^2 R_2^2 C^2 + 1)}$

ture components are treated separately. The polar form is most convenient for the remaining types of operations, in which cases the magnitudes and phase angles are dealt with separately. The manner of carrying out these various types of operations is indicated in the accompanying table.

It is also convenient to have on hand means of converting from one form of expressing impedance to another form. The impedance may be expressed in the alternative rectangular and polar form, respectively, as follows:

$$Z = R \pm jX = |Z| \underline{/\pm\theta}$$

Having given the magnitude and phase angle in polar form, the resistance and reactance components in rectangular form are given by the expressions,

$$R = |Z| \cos\theta$$
$$X = |Z| \sin\theta$$

If the resistance and reactance are both given, the magnitude of the impedance is

$$|Z| = \sqrt{R^2 + X^2}$$

and the phase angle is

$$\theta = \tan^{-1}(X/R)$$

The use of these simple circuits results in a saving of time and aids in the analysis of more complicated electrical circuits employed in electronic applications.

Avoiding Patent Pitfalls

By RUDOLF F. WILD
Philadelphia, Pa.

PATENTS are granted for "new and useful" inventions. Much has been written on the subject of what constitutes a "patentable invention", because it is not always easy to draw a boundary line separating patentable from non-patentable matter. This subject is particularly important since the majority of all inventions does not relate to basically new devices, structures, and methods, but relates to improvements in known and existing ones.

A patent attorney may advise against filing a patent application, or the Patent Office or the courts may refuse to grant a patent for a newly developed device or method because it does not "amount to invention" or "merely involves mechanical skill". These seemingly disparaging remarks should not dishearten the inventor, because they refer only to the patentability of the device or method and are no measure of its usefulness or commercial success.

Since no exact definition of a patentable invention is possible, which could readily be applied in all cases, considerable controversy has arisen at times over this question, and the concept of a "patentable invention" tends to vary.

The following considerations may be helpful in an attempt to determine the patentability of an invention in doubtful cases.

If the device, structure, or method under consideration, which for the sake of brevity shall be termed the "invention", relates to a combination of elements or method steps in which one or more elements or steps have been added to a known combination so that the new combination operates in a new manner to produce an improved or different result, the invention is patentable, provided, of course, that it is new.

If the invention relates to a combination of elements, methods, or steps differing from a known combination only by substitution of one or more of the elements or steps by their known equivalents, the invention is not patentable, unless the result obtained by this substitution is such that it would not be expected by a person skilled in the art. The unexpected result may lie in a vast improvement of performance or efficiency, considerable reduction in space requirements or cost, or a great increase in the ease of manufacturing.

The same is true if the invention relates to a combination of elements or method steps which differs from a known combination only by the size, position, or degree of one or more elements or steps.

In the last two cases it is particularly important to convince the Patent Office that the invention represents an advancement of the art.

The above outline is rather crude but it is beyond the scope of this discussion to enter more deeply into this matter.

Embodiment of the invention

Patents are not granted on abstract ideas without the showing of an embodiment thereof, which consists in a description and illustration, if feasible, of an embodiment in such detail that it enables others skilled in the art to make and use this embodiment without the exercise of further inventive skill.

Abstract ideas relating to inventions of non-complex nature can often readily be translated into an embodiment. In cases of complex nature, however, the process of translating the idea into an embodiment may be a weary one. It may happen then, that a record is made of the idea, perhaps conveyed to a patent attorney, whereafter all activity ceases. In this case no invention has been conceived, because the abstract idea was not translated into an embodiment. From a patent viewpoint, therefore, the abstract idea alone is worthless, because it cannot form the basis for a patent. It may be assumed and relied upon in some cases, that the patent attorney is sufficiently familiar with the art to be able to translate the abstract idea into an embodiment. While this may be the case, the inventor, or rather the originator of the abstract idea, would not be able to prove inventorship if called upon to do so in interference proceedings, as will be discussed below. It is essential, therefore, that the inventor

(*Continued on page* 159)

INVENTORS and PATENTS

This article contains various suggestions which will be helpful to inventors in securing patents on their inventions. While the suggestions may be well known to employees having patent departments they may be unknown to inventors in small firms or to individual inventors who have little occasion to follow the basic requirements imposed by the Patent Laws upon an applicant for a patent.

TUBES AT WORK

A Photoelectric Densitometer

By Carl C. Smith

The device to be described was designed for the purpose of obtaining consistent densities in the production of separation negatives, comprising one phase of the color-separation process of making natural color photographic prints from Kodachrome transparencies. When used as recommended, the device is sufficiently accurate to insure uniformity of the gray-scale densities of negatives obtained through each of the tri-color filters used in this process.

Design Considerations

The essential elements comprising a densitometer include a source of light, a lens to concentrate and direct the light, an aperture to limit the area of the film to be examined and some means of determining the amount of light transmitted through the film area under consideration.

In order to maintain consistent accuracy of measurement, there are a number of variables which must be confined within prescribed limits. For example, the obstruction presented to the passage of light by the silver grains in the film emulsion is a function of the scattering and absorption of the light and both of these factors vary with the wavelength of the light beam used. If an incandescent source of light is used, as in the instrument described, it is essential that the filament voltage of the lightsource be closely regulated since the spectral distribution of the light varies greatly with small changes in filament temperature. When a phototube is used as the measuring element, an additional reason for close maintenance of spectral quality is introduced, since all known photosensitive surfaces possess spectral selectivity in that they are not equally sensitive to equal intensities of radiant energy of various spectral regions.

Since the output currents of photoemissive tubes are usually of the order of microamperes or fractions thereof, it is necessary to amplify the output of the phototube considerably in order to facilitate measurement of the phototube current variations on commercially available deflection types of meters of the order of one milliampere full-scale deflection. (Such a meter is definitely desirable in an instrument for use in the dark room, as compared to galvanometers or electrometers, as it is considerably more rugged.) A stable amplifier is therefore another necessary element.

Variable negative size and other considerations require limitation of the portion of the film under measurement and the necessity of using a small aperture in the measuring beam path imposes further problems in the design of the amplifier, in that its sensitivity must be sufficient for the range of densities which it is desirable to include. The density of a photographic emulsion may be expressed as the logarithm (to the base 10) of the ratio of the incident light to the light transmitted by the emulsion grains, thus:

$$d = \log_{10} \frac{I}{I'}$$

wherein d is the density and I and I' are, respectively, the incident light and the transmitted light. This expression is equivalent to the logarithm of the reciprocal of the transmission:

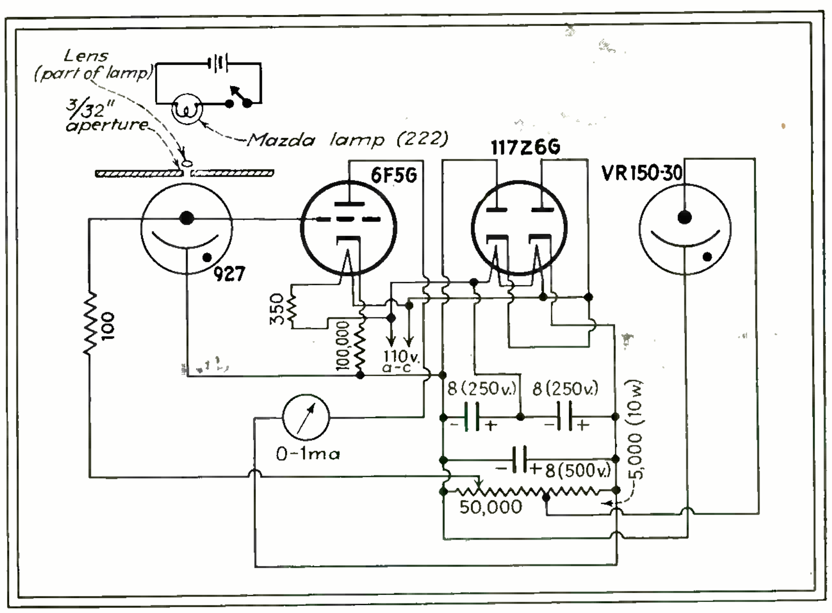
$$d = \log_{10} \frac{1}{T}$$

wherein d is the density, as before, and T is the transmission factor of the emulsion. From these considerations it is apparent that a densitometer designed to cover the range of density of the device described, 0.1 to 2.0, must be capable of measuring light intensity ratios of approximately 100 to 1.

Electronic System

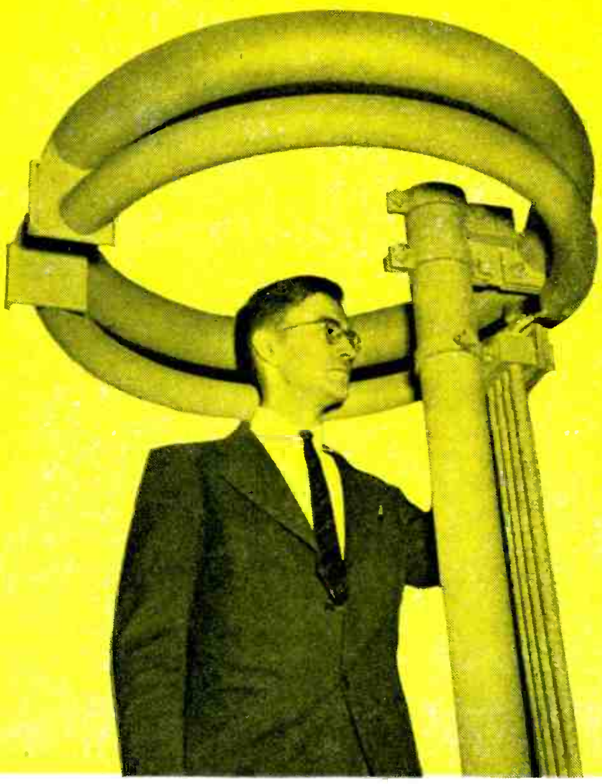
The electronic system incorporated in the instrument includes a voltage-doubler type a-c power supply and a single high-mu amplifier tube. Voltage delivered to the phototube is well-regulated by the VR 150–30 connected across the variable portion of the power supply load resistor. Amplifier plate voltage is regulated to some extent by the same VR 150–30. Amplifier plate current is measured by a zero-to-one milliammeter and increases with decreases in the amount of light incident upon the phototube surface. The complete densitometer circuit is shown in the accompanying schematic diagram.

Since simplicity was an essential requirement in this device, the light-source consists of a small lamp which has an integral condensing lens cast with the glass envelope. The lamp is



Simple photoelectric densitometer designed to insure consistent densities in color-photography separation negatives. It functions as a comparator, a photographic step-wedge rather than direct calibration being used in the process

What do THEY think of FM?



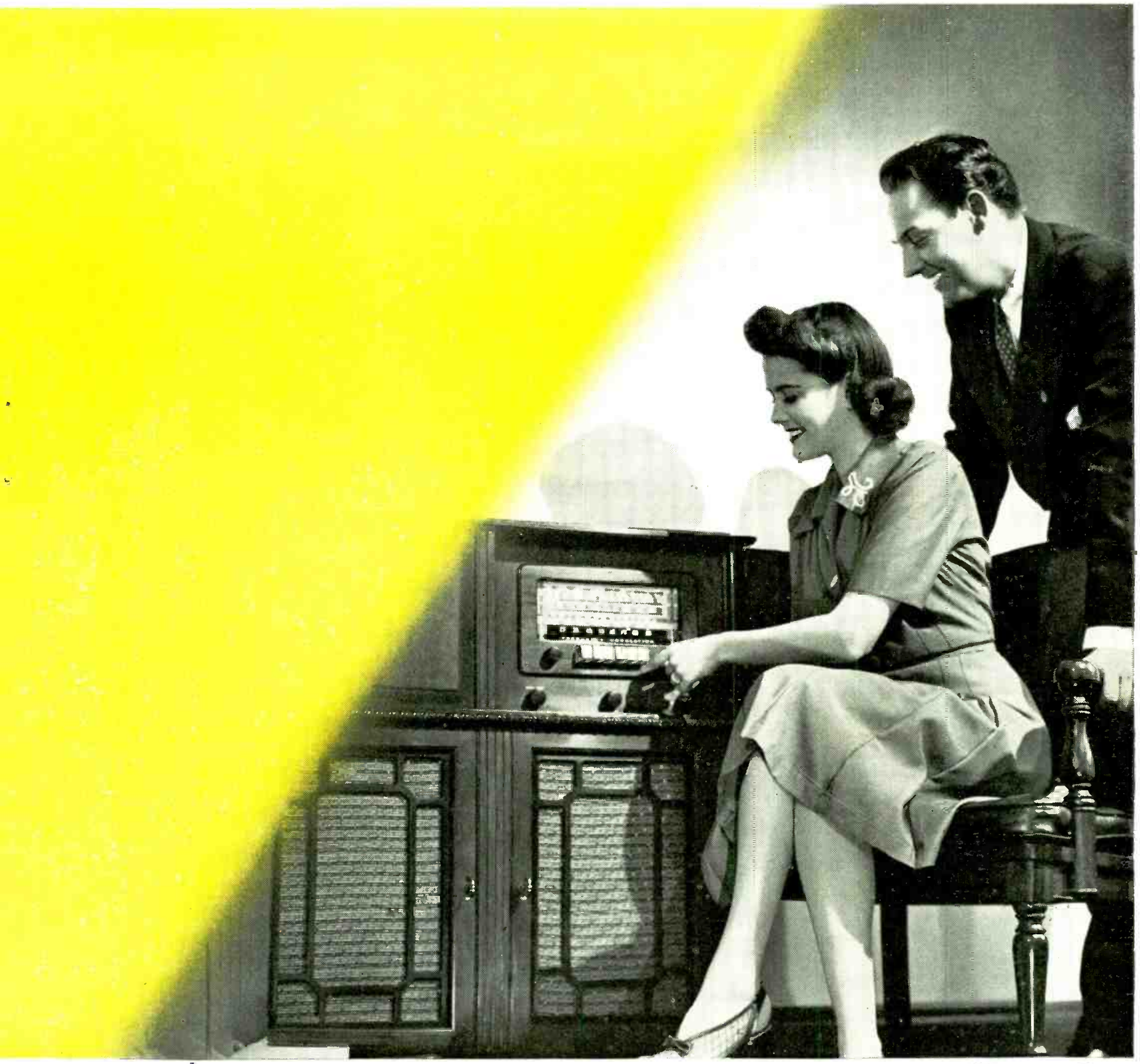
This new antenna by G. E., with circular bays, eliminates the usual complex, costly structure, yet radiates energy uniformly. It is an example of General Electric engineering leadership in FM equipment.

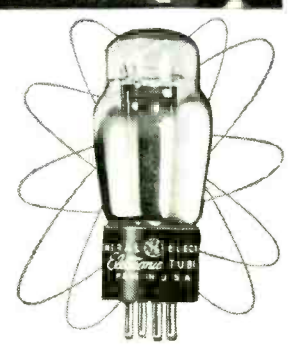
G.E. WENT TO THEM AND FOUND OUT!

AMONG owners of frequency-modulation receivers, a large majority like the quality of FM reception. For example, 85 per cent say it is better than regular broadcast reception, and 91 per cent would recommend it to their friends!

These are facts and figures taken directly from a survey made for General Electric in 14 cities by an independent research organization. Among owners of General Electric FM receivers, the approval registered was even greater.

FM Receivers
NO OTHER





mounted directly above the measuring aperture immediately below which the phototube is mounted. The lamp is battery-operated to obtain constancy of output during measurement and a switch is provided for opening the lamp circuit when measurements are not being made. This feature is desirable since it permits the amplifier tubes to remain at operating temperature while other photographic work is in progress and thereby contributes to the stability of the amplifier. since there is always some degree of drift in a d-c amplifier until operating temperature is reached.

Method of Use

The method of using this densitometer is quite simple. The amplifier tubes are energized and allowed to attain normal operating temperature with the lamp dark. After a five minute warm-up time the milliammeter reading is adjusted to full-scale deflection by adjustment of the variable arm of the 50,000 ohm phototube voltage control. When the lamp is turned on, the meter deflection automatically falls to about 5 percent of full-scale deflection. The portion or portions of the film to be measured are then placed over the aperture and the meter reading carefully noted. A photographic step-wedge of the desired range is next passed over the aperture until the meter again reaches the deflection noted from the film measurement. The density is then read directly from the calibration of the step-wedge.

It is possible, of course, to make the device direct-reading by expressing the meter readings as a function of density and preparing a curve. Due to such variable factors as lamp blackening, amplifier tube changes and battery voltage variation over long periods, direct calibration of a simple densitometer of this nature is not considered desirable. Little or no inconvenience is experienced when using a calibrated wedge and a great deal more accuracy is obtained since the known and unknown readings are taken within a short interval of time.

• • •

Thorium Detector

INCREASED PRODUCTION of high-power radio tubes being built at the Westinghouse Lamp Division has been made possible by the development of a detector that automatically sorts filament wire to determine whether it is made of pure tungsten or contains thorium.

The detection process consists of introducing a sample of filament wire into an electric carbon arc. As the wire burns completely, visible results are observed by means of a spectroscope. Two lines appear in the observed spectrum if the wire is pure tungsten while four lines appear if the wire contains thorium.

Device for "Blind Cashiers"

BLIND 29-year old Canadian George A. Lafleur has invented a portable machine which detects the denomination of United States paper currency. It buzzes once on dollar bills, twice on fives, three times on tens and four times on twenties.

In operation, the device requires that the bill to be examined be placed in a metal "billfold" compartment, where it is scanned by a light-beam. Light reflected from one of the four denomination-determining numbers in a corner of the bill is reflected into a phototube and the output of the phototube actuates the signalling mechanism.

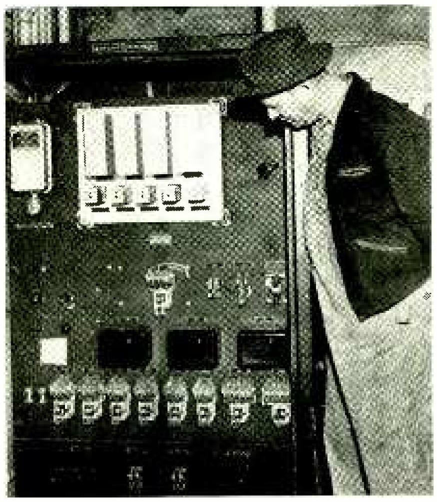
According to J. O. Kleber, chief engineer for the American Foundation for the Blind, under whose auspices the device was recently demonstrated, the operating principle could be readily adapted to detection of different cloth textures. He thinks the bill detector would probably cost about $25 to manufacture.

• • •

Control for One-Way Tunnel

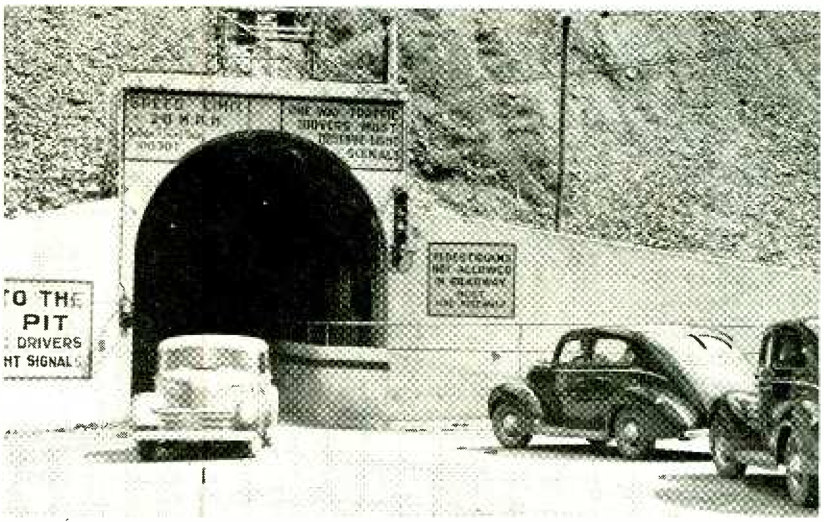
BINGHAM, Utah boasts a 6,000-ft. vehicular tunnel through which cars may pass in either direction but not at the same time. G-E automatic electronic controls set entrance traffic-lights so that traffic may flow in one direction only for three minutes, make sure that precisely the same number of cars come out as went in, then switches the lights in the other direction. If the tunnel is not completely cleared within five minutes after traffic starts to flow through it a signal sounds and a patrolman goes in to determine the cause of the jam, manually re-setting the system after he has the jam cleared.

Photoelectric relays just inside the tunnel at each end constitute the system's automatic traffic "cop", cars cutting light beams as they enter and again as they leave. Traffic lights remain set for traffic flow in one direction only until the number of cars counted at the exit equals the number counted at the entrance. In the absence of traffic in either direction, a conventional timing apparatus switches the traffic lights every three minutes. Entry of a car from either direction causes the photoelectric system to assume control.



Salt Lake County electrician Carlquist checks operation of the one-way tunnel traffic-control unit

In addition to controlling traffic, electronic equipment insures proper tunnel ventilation, turning on a blower when the carbon monoxide content of the air within the tunnel rises above a pre-determined value and turning the blower off again when the air is satisfactorily cleared. Traffic is automatically prohibited from entering the tunnel while the carbon monoxide is being cleared.



Traffic signals at the tunnel portals consist of one green and three red lights. Two of the red lights are in parallel to guard against burning out of a lamp. The other red light is connected to batteries through a throw-over relay, stops tunnel traffic in the event of a power failure

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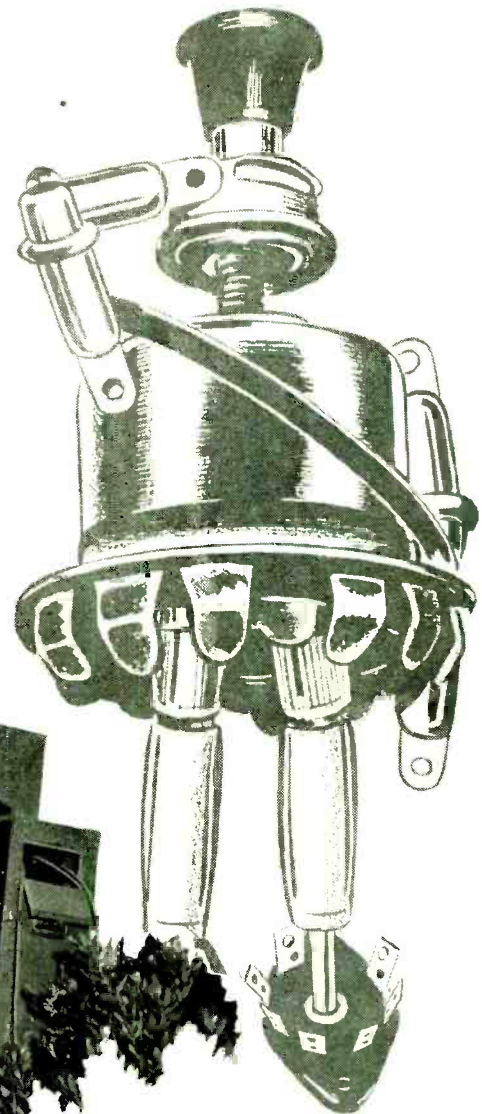

Photo by U. S. Army Signal Corps

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Hammered Iron Tips Last Longer

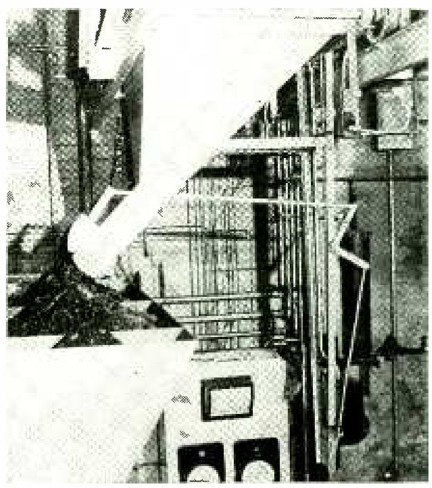
In order to save tin the percentage of this metal used in solder employed by many firms in the electronic equipment manufacturing field has been reduced. Solder containing less than the pre-war amount of tin appears to be satisfactory for most purposes but it requires the application of more heat to make it flow properly. The resulting use of hotter soldering irons has, in some instances, materially shortened the life of copper soldering-iron tips and copper, too, is a metal which must be conserved.

From Bill Schall, chief inspector of one of the Stromberg-Carlson Telephone Mfg. Co. plants, comes word that filing of soldering-iron tips hastens their demise. It is better, says Bill, to hammer them back into the required shape, and better still to have such hammering and the required re-tinning done by a few experts for the entire plant. S-C has standardized on three soldering-iron tip shapes to facilitate such wholesale re-conditioning.

• • •

Photoelectric-Controlled Coal Larry

At the Adolph Coors Company plant in Golden, Colorado, G-E photoelectric relays play an important role in effectively controlling the movements of a "larry" or movable coal-bin which evenly distributes fuel to a sectional hopper feeding a chaingrate boiler. The relays were installed to replace limit switches, eliminating mechanical wear, and are used in conjunction with an electronic time-delay relay which permits the larry to be brought to a smoother stop than is ordinarily pos-



Fuel is evenly distributed by this movable coal-bin traveling on an overhead track. One of two control units, comprising a lightsource and a phototube, may be seen in the upper right corner, immediately beneath the wheel

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2. **Good insulating quality at high operating temperatures.**

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General Ceramics has succeeded in producing a steatite that, as an insulator, is equal to natural lava, but requires no expensive Carboloy tools for machining. In addition, these insulators are made of domestic materials and therefore are available in quantities.

Outstanding electronic tube manufacturers have tested General Ceramic's Steatite Insulators and are using them with marked success. These insulators can be supplied in pressed or extruded shapes for every type of vacuum tube requirement.

GENERAL CERAMICS AND STEATITE CORPORATION

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3346

sible when a driving motor is plugged.

Attached to both lower rear corners of the larry are units comprising a lightsource and a phototube. As the larry oscillates slowly back and forth on an overhead track in front of the hopper, vertical metal strips suspended from the rear rail intercept a beam and stop the larry at corresponding hopper sections. Use of a photoelectric relay unit at each rear corner of the larry insures operation regardless of the direction in which the larry is travelling. The metal strips intercepting the light beam are hinged, so that they may be thrown up out of the way if a particular hopper section is to be skipped.

Photoelectric relays also control the movement of the larry when it requires re-filling. An end upright is swung up out of the way, permitting the larry to run a distance of thirty feet to the coal supply, where a similar upright intercepts the light beam and stops the larry so that it can be filled.

• • •

R-F Heating Aids Tin-Can Makers

TIN PLATING on many of the cans in which food is shipped to United Nation's fighters everywhere will shortly be less than thirty millionths of an inch thick, one pound of the precious metal doing a job that formerly required three.

Instead of dipping strip steel used in the manufacture of cans into molten tin, engineers have devised a means of depositing the tin by electrolysis. After electroplating, the tinplate must be heated so that the tin will flow and cover the plate without flaws. The heating is accomplished during the electrolysis process, without physical contact between the plate and the heating equipment, by induction. Thus danger of arcing or burning is minimized and the steel strip may run continuously through the "flow zone".

Equipment with which to test the practicability of the new electroplating process was originally set up by Westinghouse engineers in a radio manufacturing plant. Tubes designed for broadcasting service supplied the required high frequency current and, curiously, a clothes-wringer pulled the test strip through the heating unit.

• • •

Commercial Aircraft Aids

FROM THE Civil Aeronautics Administration comes word of several electronic communications and navigation innovations which will aid American commercial aviation:

A new uhf two-course radio range system has been developed to the point where initial installations can be made. Pilots will have visual indication of

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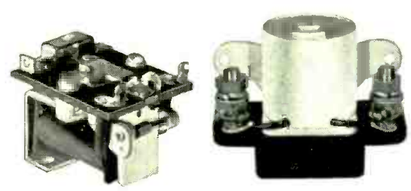
★ Yuletide joys of '42 will not include the many electrical gifts which brought us cheer, and ease, and comfort in other years. Relays by Guardian have marched on from peacetime industry to the firing lines of war. Doing war jobs in many ways . . . in planes . . . in tanks . . . in communications . . . in bomb releases and gun controls. Wartime jobs which Guardian anticipated and planned long before "Pearl Harbor".

But, while thinking, building, and engineering the tools of war today, Guardian again is looking *ahead* to peacetime applications of Relays, Solenoids, Electrical Controls of all kinds. If you are making plans for "after-it's-over", ask our engineers to plan with you. Write to Guardian. Our wartime experience can help you build better products for the future.



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GUARDIAN G ELECTRIC

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A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY the sector in which they are flying. Voice communication, when required, will over-ride the range signals, on the same frequency.

Simple and inexpensive monitors for radio airport boundary markers have been developed and are ready for widespread installation. The monitors are small receivers placed halfway between markers and airport. They actuate a siren if for any reason the marker transmissions fail, bringing repairmen in a hurry.

Unattended weather-reporting and traffic-control transmitters located at many isolated spots, such as on mountain-tops or islands, will henceforth be controlled by frequency modulated radio signals. This saves wire by avoiding the necessity for cabling between such stations and their remote control points, still permits them to be turned off at an instant's notice at the approach of any enemy. Small radio transmitters are being used as "obstruction markers." Installed atop high towers or buildings, they give approaching planes a distinctive warning. Warning signals come through to the pilot's earphones over regular aircraft radio communications channels and, in some instances, also actuate a warning light on the instrument panel.

Under development is a radio range monitor which not only warns CAA airways workers when a range transmitter drifts as little as three deg. off its proper compass points but also sends a distinctive warning to approaching planes, indicating when something is out of whack in the ground equipment.

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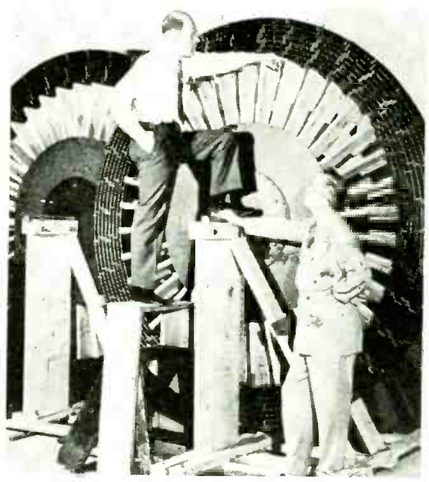
100,000,000-VOLT ELECTRONS



G-E's Dr. E. E. Charlton (right) and W. F. Westendorp examine coils of a new 100,000,000-volt "induction electron accelerator, which will, among other things, permit x-ray studies beyond the 8-inch armor plate depth achieved by present-day 1,000,000 volt machines

The high regard in which I R C Resistors are held by Engineers and Executives of America's leading electronic industries is clearly attested by the voluntary remarks quoted at the right. These are taken from among returns to a nation-wide marketing study recently made by a wholly independent research organization. This survey was completely unbiased, with no company name or product disclosed.

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THE ELECTRON ART

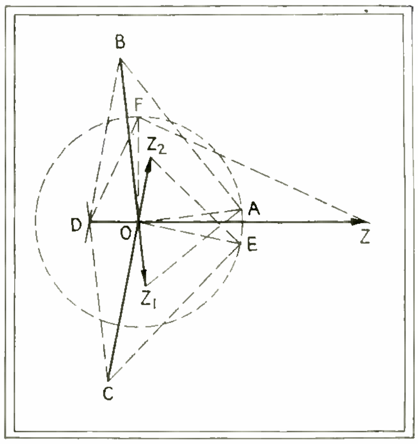


Fig. 3—Two impedances of opposite sign, OZ_1 and OZ_2, when connected in parallel produce the net impedance OZ

Some Graphic Solutions of Parallel Circuits

ROBERT C. PAINE

GRAPHIC SOLUTIONS of series circuits are familiar to every electrical student but solutions of parallel circuits are not so well known. This is probably because electrical properties of circuit elements are given on the basis of resistance, reactance, and impedance. Solutions of parallel circuits convert these values to conductance, susceptance and admittance for combining them and then convert back again for obtaining the answer usually required.

Some graphic solutions of parallel circuits are presented here which depend on the theorem in geometry which states that, "The perpendicular from the vertex of the right angle to the hypotenuse of a right triangle is a mean proportional between the segments of the hypotenuse." This theorem enables us to find the reciprocal of a number graphically.

In Fig. 1, a right triangle is shown in which, according to the above theorem, $DB/AB = AB/BC$ or $BC = AB^2/DB$. If $AB = 1$ in the scale used, then BC is the reciprocal of DB. DB can represent the absolute value of the impedance, Z, and BC will equal $1/Z$. If AB equals some other value than 1, such as 10, then $BC = 10^2/DB$ or 100 times the true reciprocal.

This method of finding reciprocals can be used in the formula for parallel impedance, $Z = 1/(1/Z_1 + 1/Z_2 + \ldots)$. We find the reciprocals, $1/Z_1$, $1/Z_2 \ldots$ graphically, add these values vectorially and find the reciprocal of the sum which equals the combined impedance, Z. If, due to the scale of the perpendicular, AB, the sum of $1/Z_1 + 1/Z_2 \ldots$ is changed by a factor such as 100 as in the illustration above, this error will be compensated for when finding the reciprocal of the sum by the same method. Therefore the perpendicular can be of any convenient value, but for greatest accuracy it should be about the length of the average impedance of the problem.

The general case of two impedances in parallel OZ_1 and OZ_2 is shown in Fig. 2. A circular arc is drawn about the point O with any convenient radius. On OZ_1 a perpendicular OA is erected. Its intersection with the arc at A is used to form the vertex of a right triangle, one side of which is formed by the line AZ_1 and the other by the line AB drawn at right angles to AZ_1. Then $OB = k\ (1/OZ_1)$. In the same way OC is drawn equal to $k(1/OZ_2)$.

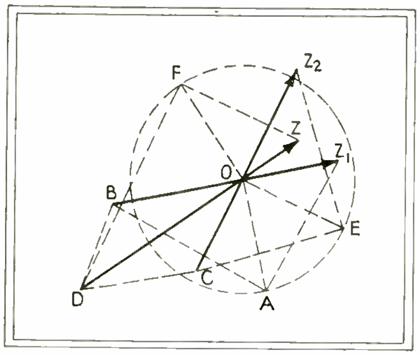


Fig. 2—Diagram illustrating the general case of the combination of two impedances connected in parallel, the resultant of OZ_1 and OZ_2 being OZ

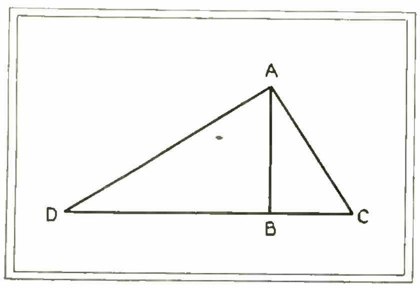
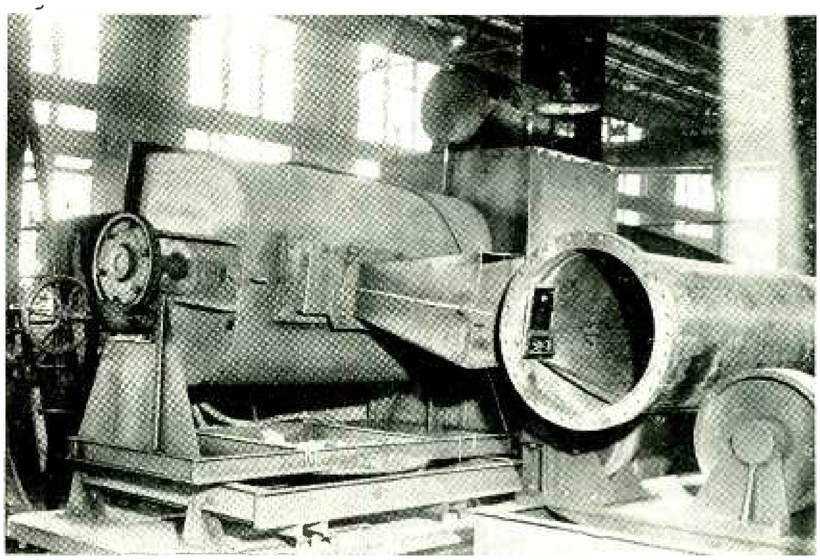


Fig. 1—Triangle illustrating that the vertical line, *AB* is the geometric mean of the two segments of the base, *DB* and *BC*

X-RAYS SPEED WAR PRODUCTION



This 300,000-volt x-ray machine is in everyday use inspecting welded joints. It inspects steel up to 4 inches in thickness. Note the photographic plate inside the pipe at the portion of the weld being inspected

OB and OC are then added in the parallelogram, $OBDC$, to form OD, equals $k\,(1/OZ_1 + 1/OZ_2)$. On OD a perpendicular OF is erected and a right triangle drawn as before, the segment of its hypotenuse OZ equals $k \times 1/k(1/OZ_1 + 1/OZ_2)$. This is the combined impedance desired and is shown in the correct phase relation to the given impedances, OZ_1 and OZ_2. Three or more impedances can be combined in a similar way, adding two at a time.

The combination of two impedances

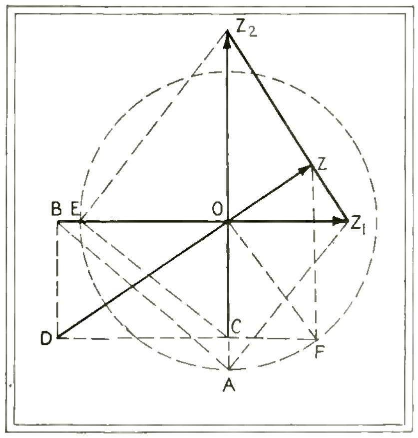


Fig. 4—The vector OZ represents the parallel combination of a pure resistance, OZ_1 combined with a pure reactance, OZ_2

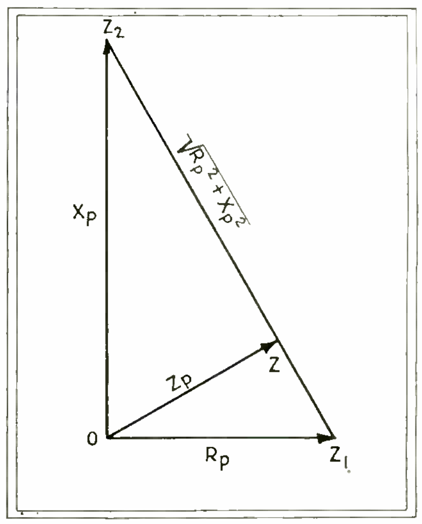


Fig. 5—A section of Fig. 4 illustrating that Z_p is the geometric mean of R_p and X_p connected in parallel

of opposite sign, as in resonant circuits is shown in Fig. 3. In this case unless the Q of the circuit is quite low the figure becomes impractically large.

The case of a resistance OZ_1 and pure reactance OZ_2 is indicated graphically in Fig. 4. In this special case the combined impedance OZ is seen to be equal to the perpendicular from the vertex to the hypotenuse of the right triangle OZ_1Z_2. This construction is redrawn in Fig. 5 to show a simple method of combining resistance and

pure reactance in parallel. This method for the parallel combination corresponds to the well known impedance triangle for series circuits. The proof of Fig. 5 is as follows: By similar triangles, we have proportion $Z_p/R_p = X_p/\sqrt{R_p^2 + X_p^2}$ or $Z_p = R_p X_p/\sqrt{R_p^2 + X_p^2}$. This is the mathematical formula for a resistance and reactance in parallel as given in many textbooks.

If it is not required to find the phase angle but only the absolute value of parallel impedances, another theorem of geometry can be used. This theorem states that in any triangle a line drawn parallel to the base divides the sides proportionally. Thus in Fig. 6, $AB/AC = AD/AE$, or $AD = AB \times AE/AC$. If $AB = Z_1$, $AE = Z_2$, $AC = Z_1 + Z_2$, and $AD = Z$, this equation becomes the well known formula for parallel impedance, $Z = Z_1Z_2/(Z_1 + Z_2)$.

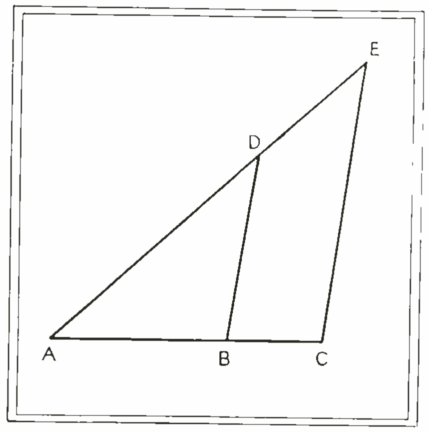


Fig. 6—Diagram which may be used to find the absolute value but not the phase of two paralleled impedance; *AD* is the resultant of *AB* and *AE*

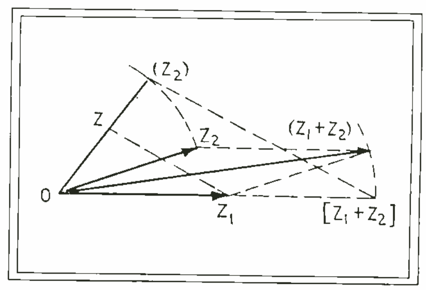


Fig. 7—Application of Fig. 6 to two impedances, OZ_1 and OZ_2, whose resultant when connected in parallel, is OZ

The application of this method to two impedances, OZ_1 and OZ_2 is shown in Fig. 7. OZ_1 and OZ_2 in correct phase relation are added graphically to form $O(Z_1 + Z_2)$. This sum is then transferred by compass to the same line as OZ_1. OZ_2 may then be redrawn in any convenient position, as $O(Z_2)$ to open up the angle between OZ_1 and OZ_2 for greater accuracy, ordinarily at about 60 deg. with OZ_1. A line is drawn from $(Z_1 + Z_2)$ to (Z_2), then a line through Z_1 drawn parallel to this line intersects $O(Z_2)$ at Z and OZ is the re-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quired value of the combined impedances. However, in this case the absolute value only of OZ is shown, and its angular position is meaningless.

Figure 8 shows a combination of two impedances of opposite sign in which the combined impedance OZ is greater than either of its components. In this case for greater convenience OZ_1 has been transferred to the line of $O(Z_1 + Z_2)$.

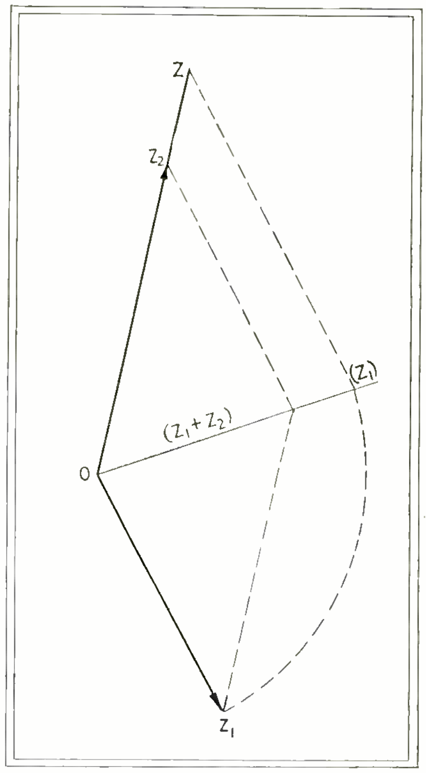

Fig. 8—Combination of two impedances of opposite sign in which the combined impedance, OZ, is greater than either of its components

The construction for two impedances of the same phase angle, AB and BC is presented in Fig. 9. These impedances are added linearly to equal AC. By a construction similar to Fig. 7 their combined impedance is found equal to AZ. If the lines AC and AE are drawn at 60 deg. with each other and another line, AF, equal to BC is drawn at 60 deg. to AE, a line from F to B will intersect AE at Z and also

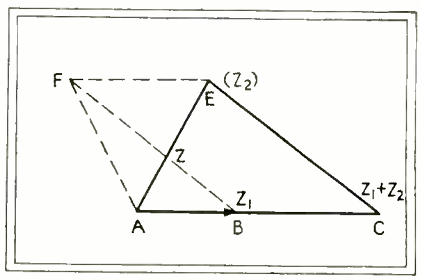

Fig. 9—Impedance triangle constructed for two impedances of the same phase angle

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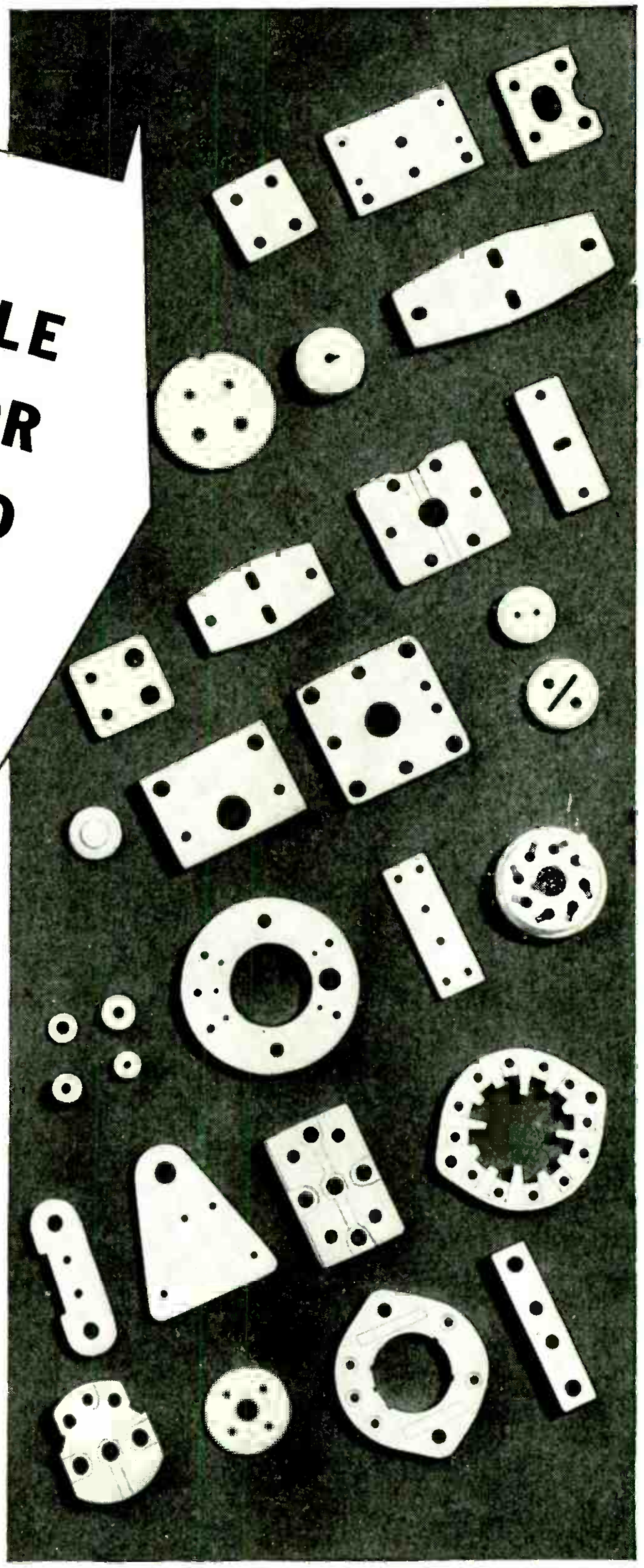

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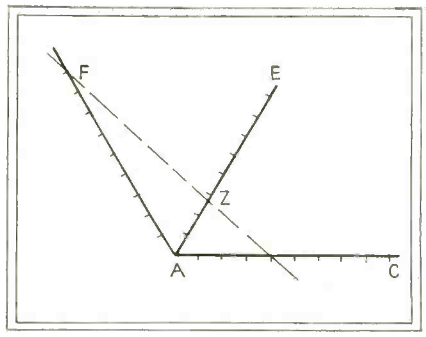

Fig. 10—Same diagram as Fig. 9, but partially redrawn to provide linear scale on each arm

determine the combined impedance AZ. The proof of this statement is as follows: $FE = AE$ (both are sides of an equilateral triangle), then $FE = BC$. FE is also parallel to BC. Therefore FB is parallel to EC and must intersect AE at Z. So it is seen that the combined impedance AZ can be determined by the lines AB, AE, AF, and FB only.

Figure 10 shows Fig. 9 partially redrawn with a linear scale on each arm. This forms a chart sometimes used for parallel resistances. To use this chart place a straight edge across the lines, intersecting AC and AF at the values for two resistances and their combined value can be read on AE. More than two resistors can be combined by combining the sum of the first two with the third and so on. This chart can also be used for parallel impedances if they have the same phase angle. It is also used for series condensers, using the scale to indicate capacity instead of impedance. This is possible because the formula for effective capacity,

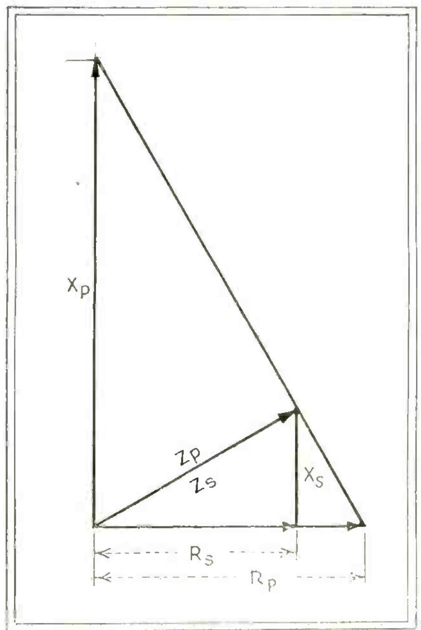

Fig. 11—Diagram showing method of converting series circuit in its equivalent parallel circuit or vice versa

$C = C_1C_2/(C_1 + C_2)$, is similar to the formula for parallel impedance.

A convenient means of converting a series circuit into an equivalent parallel circuit or vice versa is shown in Fig. 11. The familiar vector diagram for a series circuit, R_s, X_s and Z_s is here combined with the diagram for a parallel circuit R_p, X_p and Z_p previously shown in Fig. 5. Since the combined impedances Z_s and Z_p for the respective figures are equal in phase and magnitude, R_s and X_s for the series circuit is equivalent to R_p and X_p of the parallel circuit.

In all of these figures, all lines designation vectors in correct phase relation are indicated by arrows.

• • •

Ignitron Rectifier in Industry

AN ARTICLE under the above title by J. H. Cox and G. F. Jones appears in the October, 1942 issue of *Electrical Engineering*.

Although the first application of ignitrons was in transportation service in mines and railroads, the applications of these important electronic devices have been accepted by other industries, notably that of electrochemistry. At the present time more than 2,000,000 kilowatts of ignitron rectifier units have been purchased by that industry alone.

The article discusses primarily the installation and operation of the ignitron rectifiers for large power concentration and indicates the manner in which individual ignitron rectifier units may be combined to increase the power output.

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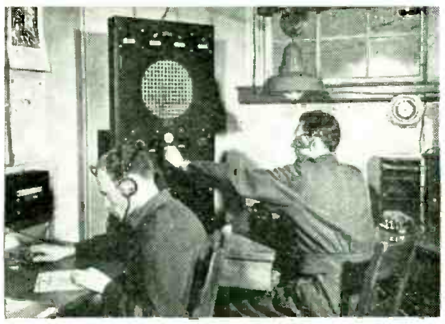
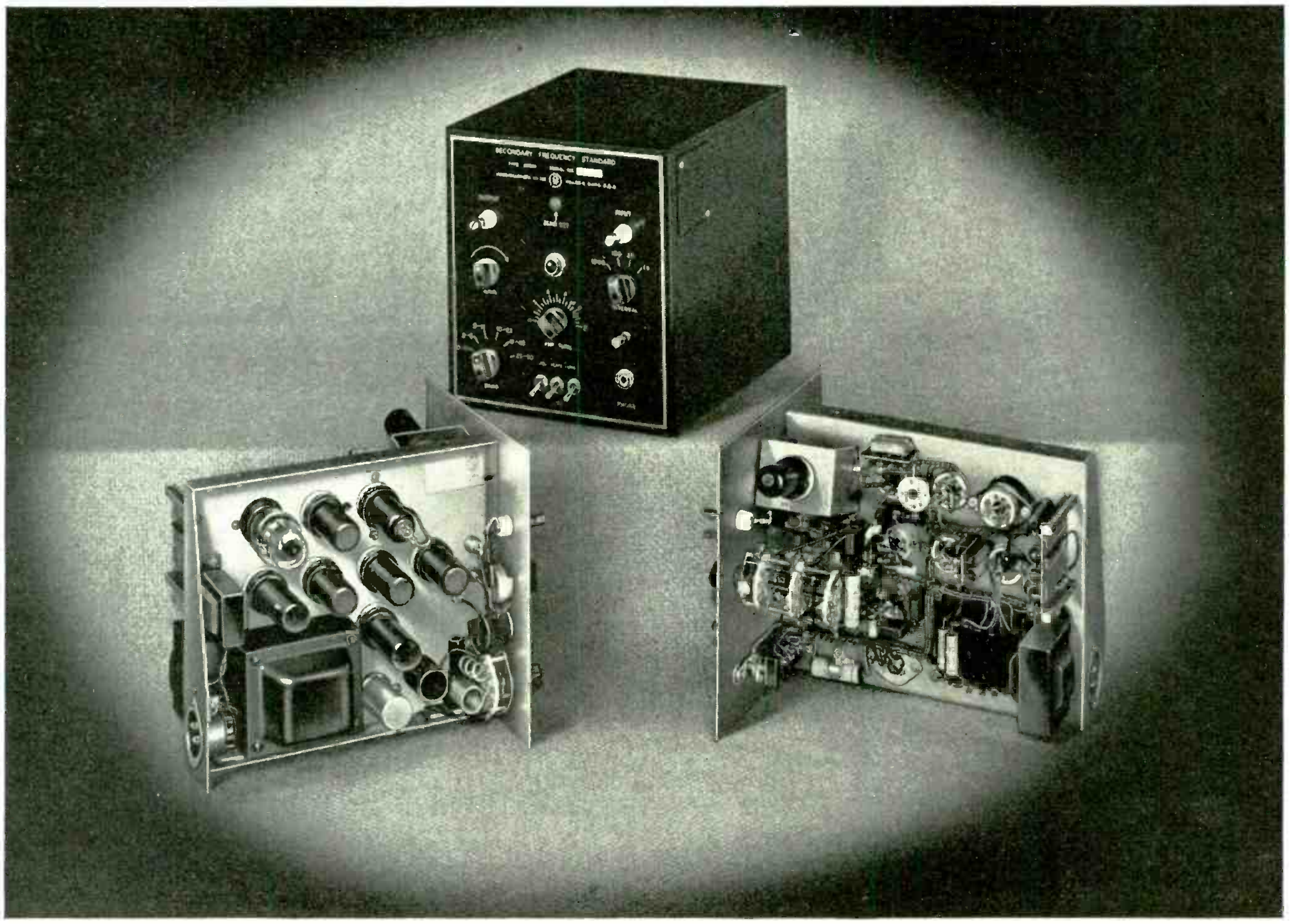
CANADIAN ARMY RADIO



The vast system of defense set up on Canada's eastern seaboard depends upon the network of communications built and maintained by the "Linemen in Khaki". Men of the Royal Canadian Corps of Signals work behind the scenes of the barriers Canada has erected against any enemy who might approach from the East. This photo shows a radio receiving and transmitting room. Shore batteries, naval stations and airdromes are linked together by an intricate set of electrical "nerves"



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The Mass Spectrometer

PROVIDING A CONVENIENT source of reference material, between two covers, the September, 1942, issue of the *Journal of Applied Physics* is devoted to mass spectrometry. The mass spectrometer is "essentially a high vacuum tube in which the gas studied is admitted to a pressure of the order of 10^{-4} mm of mercury. The molecules of the gas are ionized by electrons of controlled energy from a thermionic filament and accelerating grid. Ions of many different types are formed even in a pure gas corresponding to various modes of breaking down of molecule accompanied by ionization. The ions so formed are then drawn out of the ionizing chamber by an applied electric field and are caused to move to a combination of electric and magnetic fields designed so as to sort out the ions according to their m/e or mass to charge ratio."

Although still largely a laboratory device and not yet commonly applied in industrial analyses, the mass spectrometer may well become an important tool for industrial research as well as routine testing. One application of mass spectrometry recorded in this issue of the *Journal* is in the field of gas analysis, an application which appears to have important significance at the present time. It is hoped that additional information on this subject may be recorded in an early issue of ELECTRONICS.

The articles in this special issue on Mass Spectrometry are as follows:

Mass Spectrometer As An Industrial Tool (editorial).

Short History of Isotopes and the Measurement of Their Abundance, by E. Jordan and Louis E. Young.

Measurements of Relative Abundance with the Mass Spectrometer, by E. Jordan and M. A. Coggeshell.

Gas Analysis with the Mass Spectrometer, by John A. Hipple.

Some Applications of Mass Spectrometric Analysis to Chemistry, by D. Rittenberg.

The remaining articles in this issue, representing contributed articles on original research, deal with a diffraction adapter for the electron microscope, axial aberration of electron lenses and reflections of electromagnetic waves from a parabolic ionized layer.

• • •

Atmospheric Propagation of Sound

NEW PUBLICATIONS devoted to the advancement of science tend to be decreasing in numbers rather than increasing during the present crisis. Already a number of journals have been forced to change their editorial content or to modify the frequency of their appearance. Therefore, it comes as a rather refreshing note to record the appearance of a new quarterly review de-

A date with Destiny

These two modern weapons of battle ...the electronic tube and the bombing plane... have an important date with post-war industry. In the days to come Eimac tubes, like the airplane, will help achieve the better way of life for the common man.

Eimac TUBES

"First in Peace, First in War," First in the important new developments in the field of electronics.

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For high achievement in the production of war material ... the joint Army-Navy "E" awarded September 4, 1942.

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signed to record the progress of the sciences in the service of mankind, under the name *Endeavour*, published by Nobel House, Buckingham Gate, London, S. W.

The first issue of this publication to come to our attention is marked Volume 1, No. 3 and dated July, 1942. It contains approximately 40 pages, one of which is in full color. Page size is 8x11 inches and no advertising is carried.

Articles in the July issue include the following: The Scientist's Responsibility, The Red and Blue Coloring Matters of Plants, by Robert Robinson, The Substance of Heredity, by E. D. Darlington, Some 18th Century Chemical Societies, by James Kendall, Plastics and Their Application, by Edward Appleton, Disease Resistant Plants by F. T. Brooks, The Propagation of Sound in the Atmosphere, by E. G. Richardson, and finally, Progress in Bacterial Chemotherapy, by L. E. Garrod.

The article by Dr. Richardson, "The Propagation of Sound in the Atmosphere," will probably be of most interest to readers of ELECTRONICS. This 4-page article, containing eight references, gives a survey of past researches. It is shown that the transmission of sound in the air shows many peculiarities, frequently of a very surprising kind. Explosions and gunfire are often inaudible in regions comparatively close at hand, while distinctly audible at greater distances. Echoes of a fog horn may sometimes be heard for as long as 15 seconds after the original sound has been cut off. The article by Dr. Richardson provides an interesting account of recent investigations carried out on this subject by various workers in acoustics.

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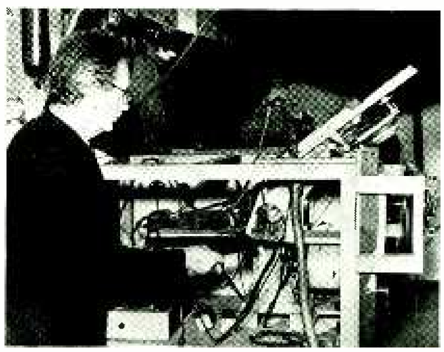
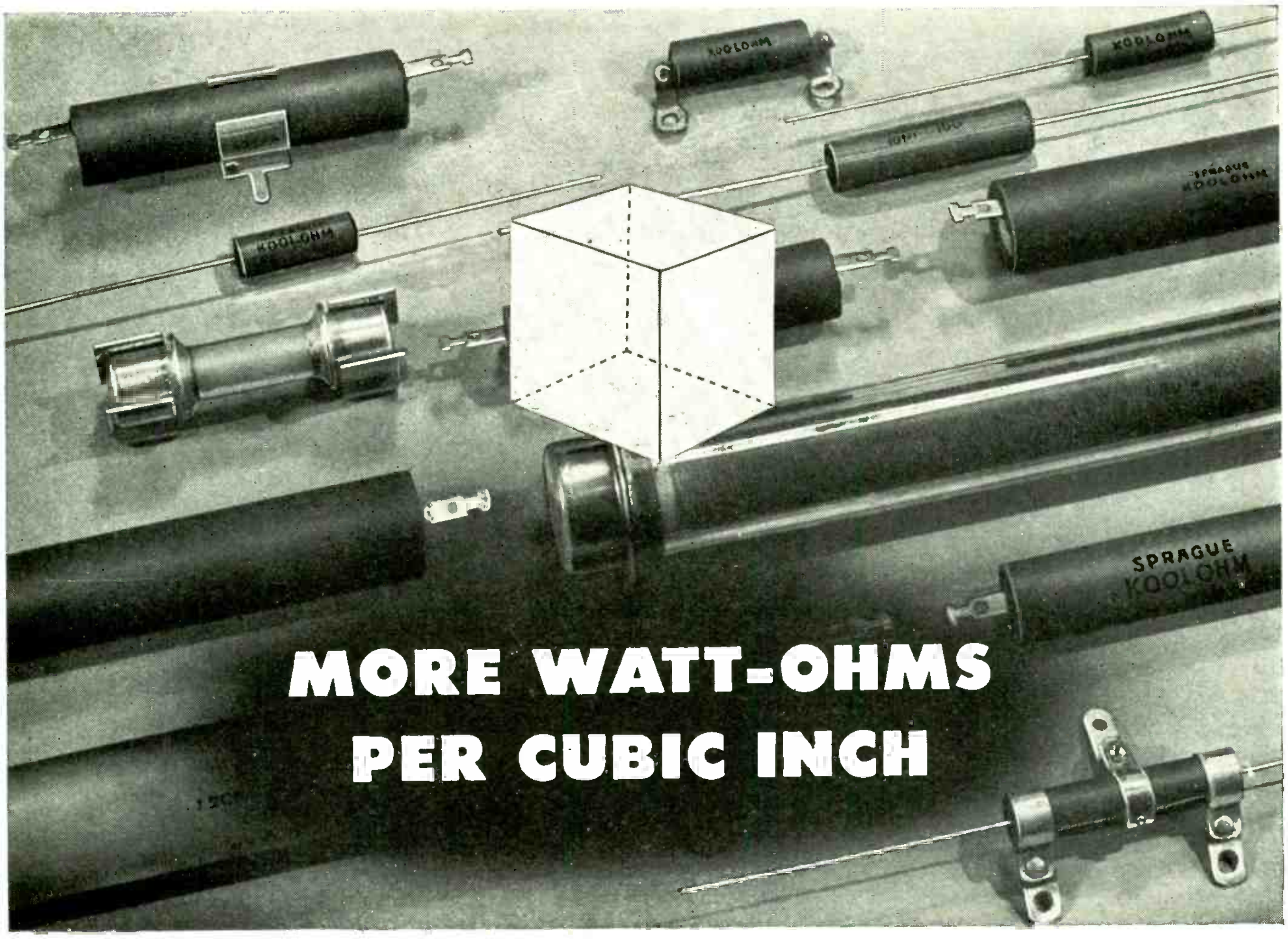
NEW TELEWONDER



John Logie Baird has a new invention called colored stereoscopic television, which he claims will revolutionize entertainment after the war. Instead of seeing a flat picture, as you do in the movies, the new television reproduces an image in color with the depth and appearance of solidarity and reality. The apparatus is also being developed to enable it to be used as the television telephone



...greater dependability...easier mounting...less weight

Yes, Mr. Engineer, this is an odd, non-standard technical term—but it is one easily understandable, and certainly one that best explains the tremendous advantages obtained with Koolohm Resistor construction.

...For Koolohms provide the highest wattage ratings and resistance values in a given volume, with safe resistance wire sizes.

...Moreover, Koolohms deliver their full wattage ratings regardless of resistance values.

...Koolohms can be mounted easier and quicker and in less space—directly to the chassis or to grounded parts.

...Koolohms give a big, extra measure of dependability on the high resistance values by using larger wire ($2\frac{1}{4}$ times the cross-sectional area of that used by other manufacturers for these same values).

Koolohms are made with wire that is insulated before it is wound. This insulation is a special ceramic material having a dielectric strength of 350 volts per mil. at 400° C. It is heat-proof to 1000° C; fully moisture-proof, and so flexible it can be wound on small forms, either in short-proof layer-windings, or in high-density progressively-wound interleaved patterns.

Write today for the complete Sprague Koolohm Catalog and sample resistors.

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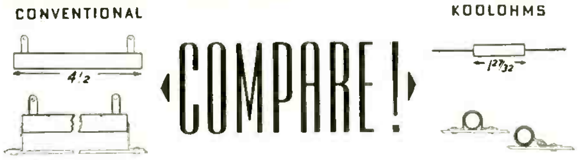


Here is an actual comparison between a Sprague Koolohm resistor and a conventional wirewound!

Conventional	Specifications	Koolohm
2.5 mil. minimum	Limiting Wire Size	2.5 mil. minimum
10 watts, 7500 ohms	Rating	10 watts, 7500 ohms
$4\frac{1}{2}$"	Length	$1\frac{27}{32}$"
$\frac{11}{16}$"	Diameter	$\frac{7}{16}$"
40 grams	Weight	14 grams
Must not come in contact with chassis or grounded parts	Mounting (see above illustration)	Can be mounted flat on chassis or to grounded parts

SPRAGUE
KOOLOHM
WIRE-WOUND RESISTORS

A Wire Wound Resistor Isn't Modern UNLESS It's Wound with CERAMIC INSULATED WIRE!

Telephone Set for Hard of Hearing

THE OCTOBER, 1942, issue of *The Bell Laboratories Record* describes "A New Telephone Set for the Hard of Hearing" in an article of this title by Alfred Herckmans. The telephone set is similar in appearance to that usually encountered in homes and offices, but differs in that it is provided with a three-position switch for determining the volume output, and in the fact that an additional amplifier is incorporated in the base of the antenna. This amplifier consists of a granular-carbon microphone whose diaphragm is actuated by a bipolar receiver element using permanent magnets. When the amplifier is in use, its receiver element is connected in place of the regular hand-set receiver, while the transmitter element is connected to the hand-set receiver in series with a 4½-volt battery which may be placed in any convenient location and is connected to the set by two wires. With this arrangement, the hand-set receiver is operated by the amplified speech from the transmitter element of the amplifier.

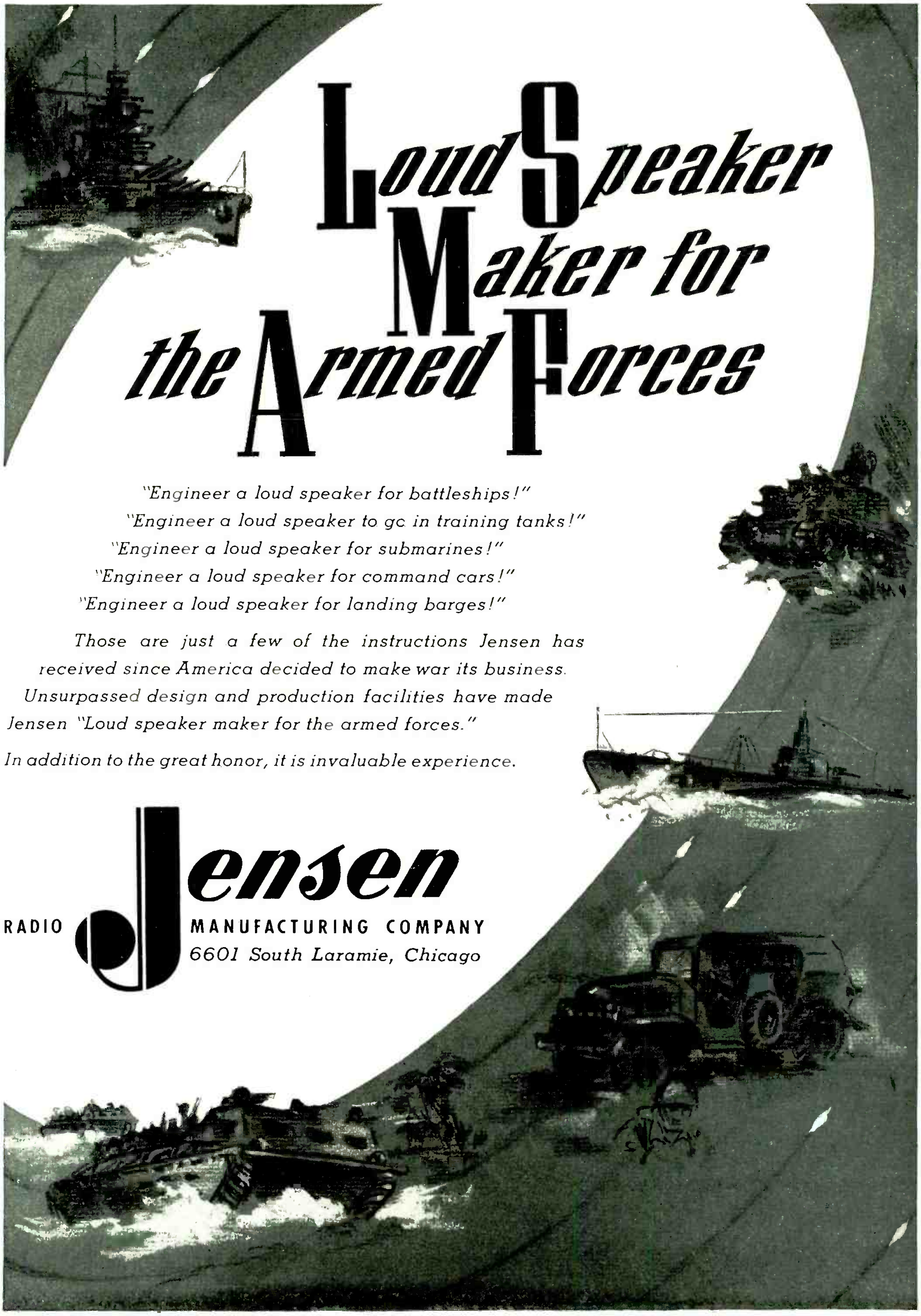
The employment of the receiver-transmitter mechanical amplifier provides an additional gain of 25 db and it is estimated that persons with hearing deficiencies as much as 60 db loss will receive adequate volume to conduct satisfactory telephone conversation. It is estimated that this type of instrument will be suitable for 90 percent of those conscious of hearing impairment.

The gain provided by the amplified element is sufficient to cause singing under certain conditions although this tendency is completely eliminated with the ordinary telephone hand-set in normal use.

• • •

Amplification Factor with Square Mesh Grids

FROM TIME TO TIME considerable effort has been spent on the mathematical or experimental evaluation of equations for expressing the amplification factor of multi-element tubes. A number of theoretical and empirical equations are already available expressing the amplification factor for tubes having grid structures of parallel wires for either plane or cylindrical structures. The analytical solutions available are mathematically complicated even though they apply to the simplest physical cases. In the October, 1942, issue of the *Wireless Engineer*, T. C. Eaglesfield offers an article, "Triodes with Square Mesh Grids—Calculating the Amplification Factor." This article deals with the experimental determination of the amplification factor for grid structures consisting of grid wires with square mesh openings. Because the theoretical approach is so complicated, experimental verifications were obtained by setting up a model of the triode and measuring the electrostatic screening effect produced by the mesh grid. The results of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6601 South Laramie, Chicago

this experimental determination are given by the expression

$$\mu = \frac{4.55\,x}{p \log_{10} \coth 5.24\, d/p}$$

where x is the distance from grid to anode, p is the mean distance between grid wires from center to center, and d is the diameter of the grid wire. This equation is derived on the basis of mesh grids having square openings so that as far as the grid is concerned two dimensional symmetry exists.

• • •

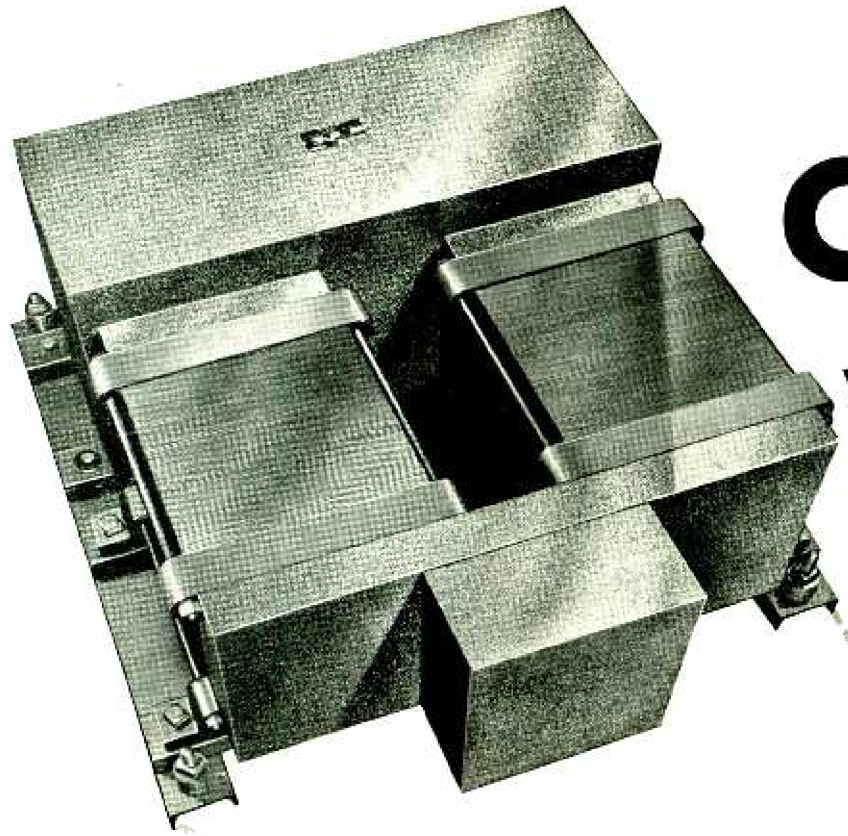
Measurements of Very Short Wavelengths

THE INCREASING use and application of frequencies corresponding to a wavelength of one meter or less gives added importance to the article, "Wavelength Measurements of Decimetric, Centimetric and Millimetric Waves", by A. C. Clavier in *Electrical Communication*, Vol. 20, No. 4, 1942. Even though the work reported by Mr. Clavier does not record the most recent developments in frequency measurement it does provide a survey of the state of the art up to the time when war broke out. Consideration is given to the following method of frequency determination: (1) Determination of frequency by beating the unknown with a standard frequency, (2) use of a tuned circuit of lumped constants as a wavemeter in accordance with the technique at lower frequencies, (3) applications of circuits with distributed constants, (4)

• • •

MORSE CODE TEACHER

Mrs. Dorothy Hall, amateur short-wave operator who, in 1938 established communication with the isolated inhabitants of Pitcairn Island in the South Pacific, will teach Morse code operation at Washington Square College, New York University. A class of 100 pupils, all potential Signal Corps members started on September 22. The course is open to all men and women who have high school diplomas, including two years of mathematics. She is shown at the receiving set in her home



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Even under normal conditions supply line voltages are rarely constant. And now, with power lines taxed beyond capacity by the unprecedented demands of war production, fluctuating voltages are a constant threat to the safety of sensitive, precision instruments . . . a constant handicap to the efficiency of production lines.

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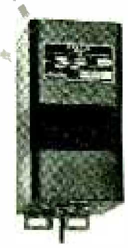
Compact, standard designs are available in capacities ranging from 15VA to 10 KVA, or special units for special applications can be built to your exact specifications.



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CONSTANT VOLTAGE TRANSFORMERS

use of the coaxial-line wavemeter, (5) dielectric guide for the measurement of centrimetric wavelengths.

It is shown that a very accurate and convenient means of measuring frequency at the usual wavelengths is to beat the unknown frequency with a known frequency of high stability and precision. This method is difficult to apply as the frequency increases in the ultrahigh frequency region because it is difficult to generate short wave oscillations of high stability whose frequency is precisely known. Quartz crystals are not suitable at the high frequencies because the thin crystals which must be employed are rather fragile. Furthermore, it is difficult to produce an amplified harmonic to a satisfactorily high degree with the types of tubes which were available when this research was originally undertaken.

Frequently the wavelength or frequency need not be known with a high degree of precision and in such cases tuned resonant circuits find considerable application, particularly in the region of decimetric waves. A resonant circuit of lumped constants may be used in this region and the technique is the same as that used in longer wave measurements of frequency.

An examination of the selectivity of such circuits and the different resistances present in the oscillating circuits show that this type of resonance indicator may be considered satisfactory only for wavelengths of at least 30 centimeters or greater.

A single turn spiral or a toroidal inductance produces a satisfactorily high value of Q in the desired frequency spectrum, but in practice it is difficult to attain the very low values of capacitance necessary for tuning and it is even more difficult to vary this capacity. Furthermore, a device of this sort is difficult to couple to the power source in measuring.

The necessity of finding an easy method of calibration in terms of wavelength, and the difficulty encountered with circuits of lumped constants have led to the use of circuits with distributed constants, and particularly to the use of transmission lines. A two-wire parallel line type of transmission line, commonly known as a Lecher wire system, has been used for this purpose for many years. If, as is usually true in practice, the separation between the wires is long compared with the wavelength, radiation is usually sufficiently small as to be negligible. In this case the impedance of the line will vary with distance from the source to which it is coupled, and this change of impedance along the line may be used to determine resonance points and hence the wavelength.

In such application the distance between two consecutive resonances is not exactly equal to half the wavelength in air since the velocity of propagation along the line is slightly less than that in free space. The error due to this cause is small on well constructed lines; usually much smaller than the inherent error in reading the distance between consecutive resonant points.

Lecher wire wavemeters are in current use for the measurement of decimetric waves. However, they have the following disadvantages: (1) The higher the frequency the more the line radiates; (2) it is difficult to localize the excitation at one point along the line; (3) it is not easy to eliminate effects due to surrounding objects and movement of the operator. For these reasons it is preferable to use coaxial lines where this is possible.

A coaxial line wavemeter is illustrated in diagrammatic form in Fig. 1. A test line, BC, whose length is adjustable by means of a micrometer screw M, is connected to the antenna, X and to the thermocouple, T, through the quarter wave line AB and CD. The line in front of A toward the antenna and behind D toward the thermocouple presents impedances at A and B which are pure resistances when the line is a half wavelength long.

In models which were constructed using this principle, it is possible to

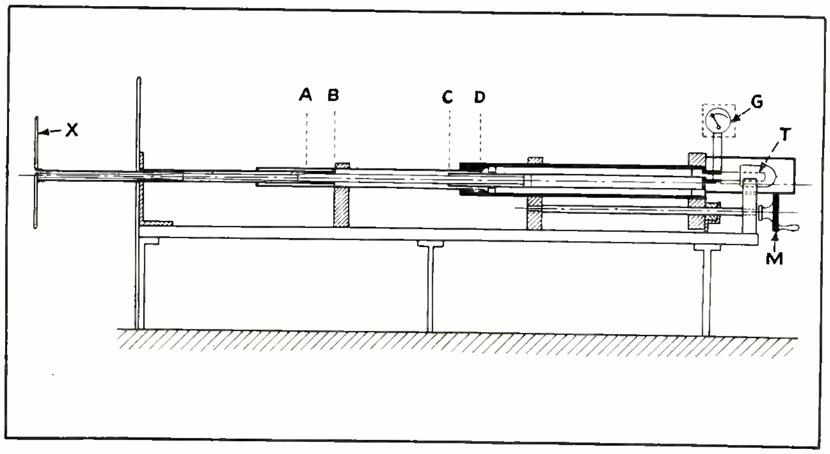
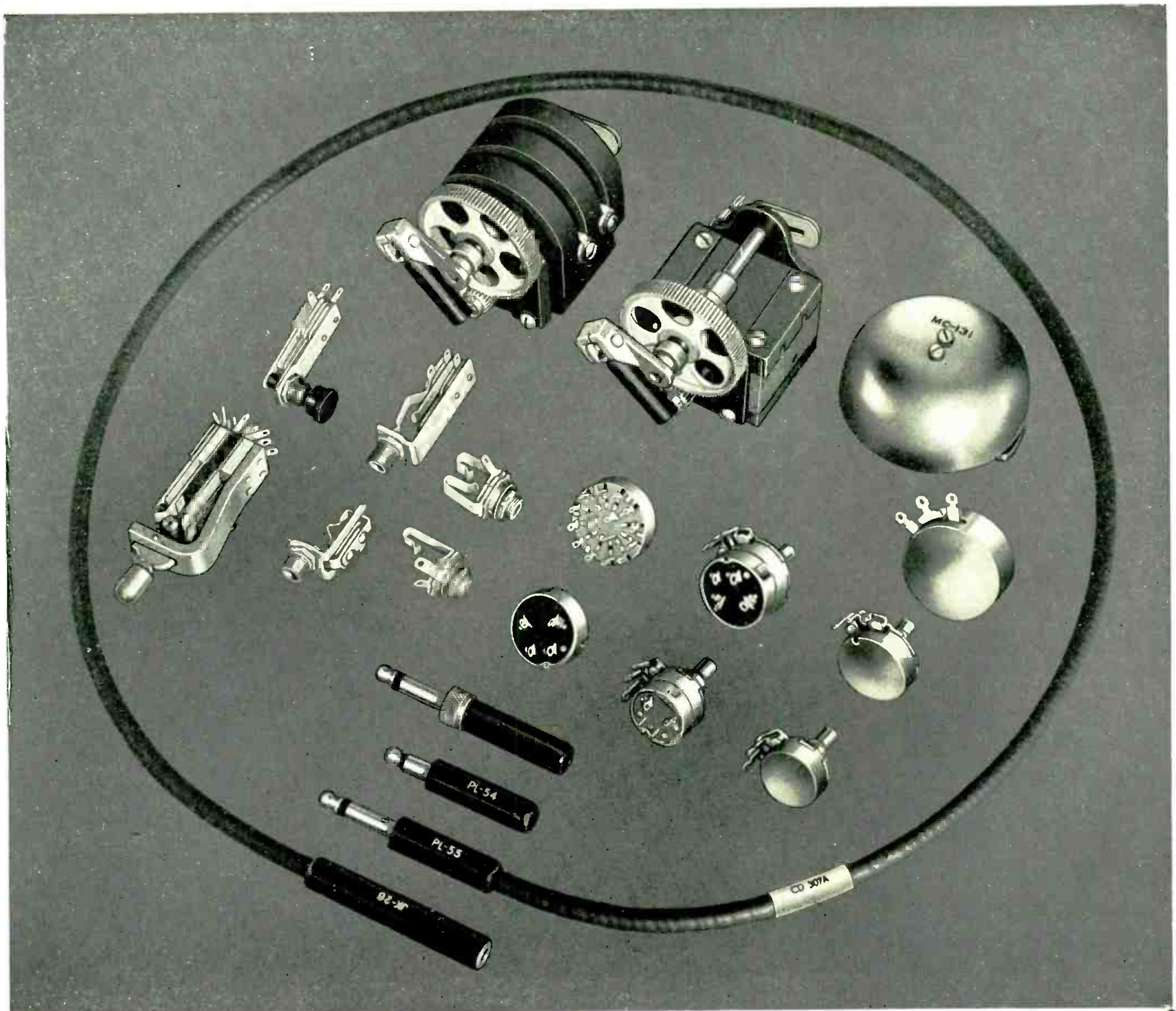


Fig. 1—Wavemeter with coaxial lines



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measure wavelengths to an accuracy of one part in two thousand. Just as in the case of measurements made with the Lecher wire system, the measurement is subject to an error resulting from the phase velocity along the lines being somewhat less than the propagation velocity in free space. However, this error is small at the frequencies for which the type of measurement is most suitable. It has been found that coaxial line wavemeters may be used for measurement of wavelengths down to the centimeter wave band. For wavelengths of a few centimeters, the influence of transverse dimensions of the coaxial line causes trouble and coupling problems arise. For frequencies higher than those corresponding to a few centimeters, dielectric guides are therefore necessary for the determination of wavelength.

The simplest dielectric guide consists merely of a metallic pipe without an inside conductor. Theory and experiment show that electromagnetic waves may be propagated through them provided that the wavelength in air is below the fixed limit which is of the order of the diameter of the guide. In making use of wave guides for the measurement of wavelengths, it is necessary to bear in mind that several different wave structures may be propagated along the lines, each one of which gives different values of attenuation and wavelength.

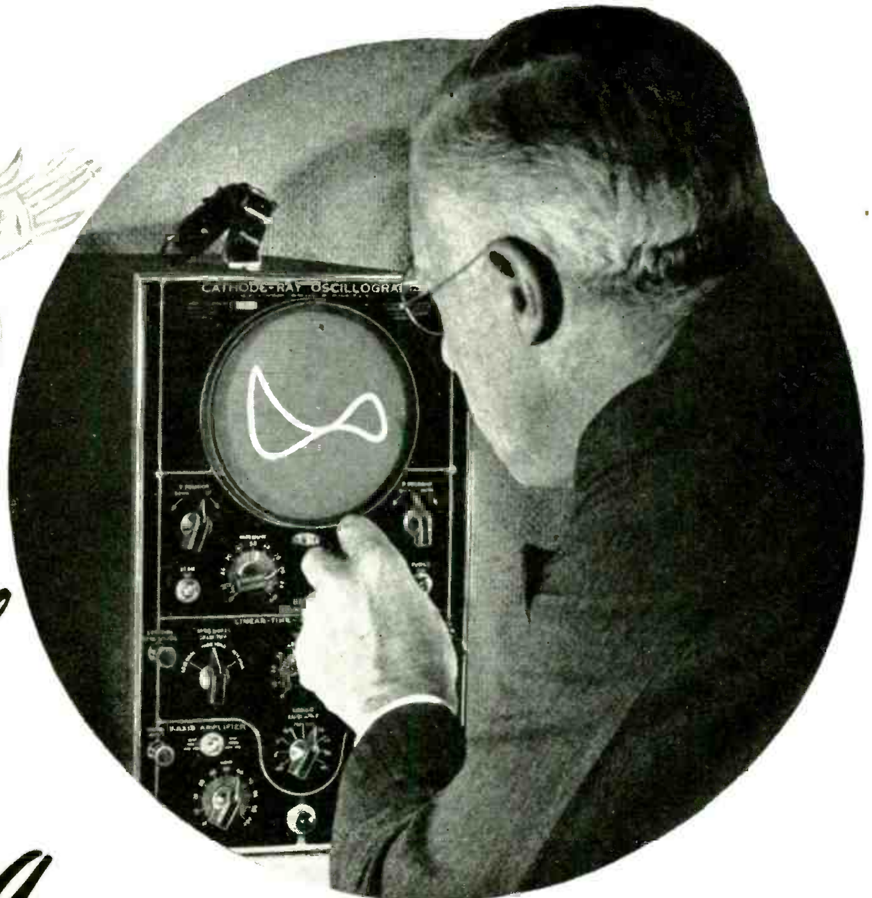
To measure wavelength with dielectric guides, it is necessary to transform the wavelength measured along the guide into the corresponding wavelength in free space. Experiments indicate that it is possible, in the present state of the art, and with transmitter frequency stability available at the present time, to rely on the theoretical relationships established between these wavelengths.

Very brief mention is made of the

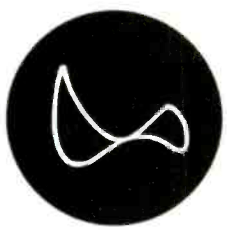
• • •

RECORDING AN OPERA

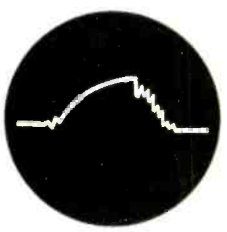
The first full recording of Rossini's opera, "The Barber of Seville", ever done in this country, was accomplished by the RCA Victor Co. in New York's Lotos Club. The machines at the upper right are used to cut the records, while the opera is being sung in the club's gallery



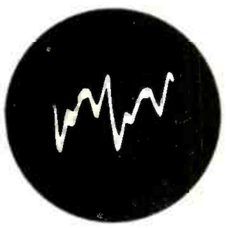
Crystal Gazing IN THIS ELECTRONIC AGE



Two batches of different steel alloys became mixed. They had to be sorted quickly, positively, economically. This oscillograph pattern served to identify one alloy from the other.



A manufacturer of ignition equipment wanted to check operating conditions. This is what he saw when a defective condenser was across breaker points.



A musical instrument manufacturer wanted an "electronic blueprint" of good tone. This oscillograph gave him the wave form to be matched for good-tone accordions.

★ Knobs are adjusted; a green dot gyrates to weave a weird pattern; the operator is fascinated by the graphic story unfolding before his eyes. Truly *crystal gazing,* in this electronic age. And dealing with the past, present and future of a host of details encountered in research, production, servicing—*scientifically*.

A decade ago the cathode-ray oscillograph was a scientific curiosity. A dozen or two such costly instruments existed in this country, mainly in lavishly equipped laboratories. But Allen B. DuMont pioneered the commercial cathode-ray tube and oscillograph. With advanced engineering and economical production methods, he brought such equipment within reach of everyone. Today DuMont equipment is standard in laboratories, engineering departments, plants, maintenance routine—and in military operations, of course.

Regardless what your job may be or what industry or war effort you serve, it can be done better, quicker, cheaper, if you resort to this *electronic crystal gazing*, with DuMont equipment.

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possibility of using the quasioptical properties of extremely high frequency oscillations for the determination of wavelengths through the use of interpherometers and gratings, but the article does not treat any of the topics in detail.

The article is concluded with a bibliography of twenty items, most of which were published between 1935 and 1939.

• • •

Extending Range of Meters

OUR BRITISH CONTEMPORARY, *Electronic Engineering*, carries an article in its July issue which is particularly significant and useful in these days of heavy demands for electrical measuring instruments. The article by B. Swift is entitled "Universal Shunt for Multirange Meters—Some Factors Affecting Their Design," which deals quite comprehensively, in two pages with such matters as the effects of instrument resistance, temperature coefficient of the shunt, effects of series resistance, examples of universal shunt, low resistance shunt and limitations of shunt values.

It is pointed out that in designing a universal shunt for a meter, the following data must be obtained: (1) The resistance of the instrument to be shunted, and whether this is all copper or part of it of material with a negligible temperature coefficient such as Manganin. The proportion of each type of material should be found as this is required to determine the temperature coefficient. (2) The accuracy required for shunted instruments. This affects the accuracy of the shunt adjustment, and more important still determines whether the temperature error of the shunted instrument is to be less than a specified value. (3) The current for full-scale deflection of unshunted meter.

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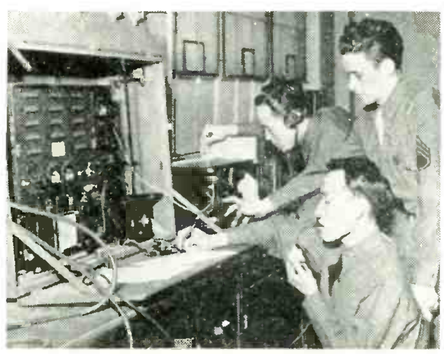
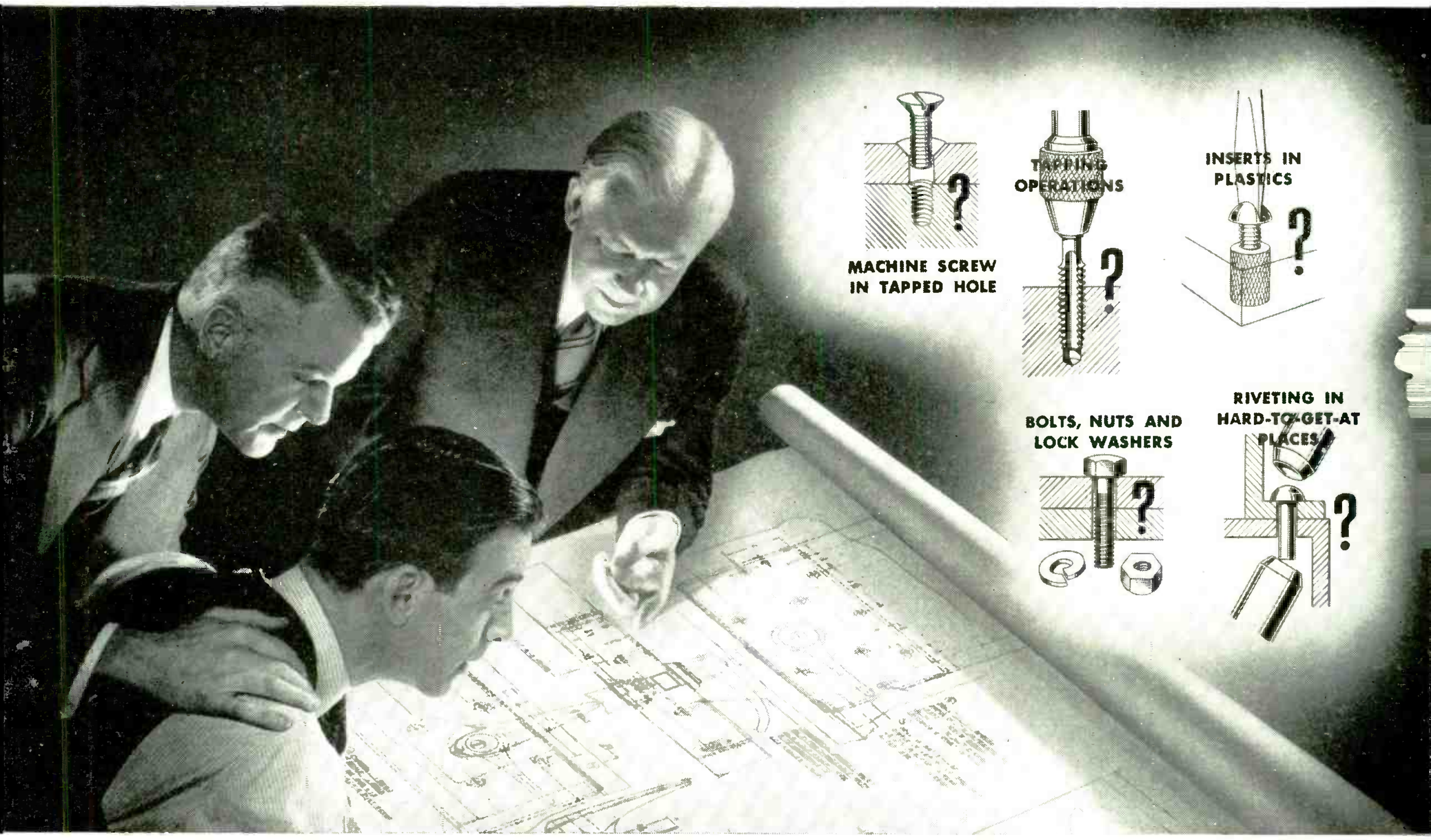
U. S. TRAINS CHINESE RADIOMEN



A group of twenty Chinese have been trained at Scott Field, Ill., so that they can instruct fellow soldiers in China. These cadets are shown operating a radio communications set in a ground station at the U. S. Army Air Corps radio communication school under the direction of Staff Sgt. Herbert J. Tye

Question every fastening job...



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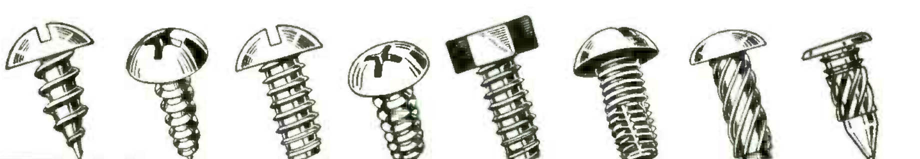
No matter what material you're working with . . . light or heavy steel, cast iron, aluminum, brass, plastics . . . you can adopt P-K Self-tapping Screws to advantage. And you can make the change-over without interrupting production. No special tools or skilled help are required. Parker-Kalon Corp., 192-194 Varick Street, New York, N. Y.



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Give the Green Light to War Assemblies

NEWS OF THE INDUSTRY

Dr. L. P. Wheeler, FCC, becomes President, Institute of Radio Engineers for 1943; John Fritz medal awarded to W. R. Whitney; critical communications jobs listed by Selective Service headquarters

Selective Service Headquarters Determines Critical Jobs In Communications

SELECTIVE SERVICE Headquarters has notified local boards of 92 occupations which are to be considered "critical" when classifying men for the call to arms. The list was issued in accordance with certification by the War Manpower Commission that communication services are essential to the support of the war effort.

Draft deferment of men on this list continues to be at the discretion of the local boards, Selective Service information men emphasized. In general, deferment is determined by the answers to three questions:

1. Is the man in an essential service?
2. Is his job essential to the functioning of that service?
3. Is he irreplaceable in that job?

The new listing is designed to answer questions 1 and 2.

In classifying registrants employed in these activities, Selective Service Director Hershey said, consideration should be given to the following:

(a) The training, qualification, or skill required for the proper discharge of the duties involved in his occupation;

(b) the training, qualification, or skill of the registrant to engage in his occupation; and

(c) the availability of persons with his qualifications or skill, or who can be trained to his qualification, to replace the registrant and the time in which such replacement can be made.

Here are the communications jobs of interest to the radio industry which are to be considered "critical."

Accountant, cost; carpenter, maintenance; control-room man; control supervisor, junior; control supervisor, senior; director, international broadcasting; electrician (all around); engineer, professional and technical; foreign-language; announcer-translator; foreign-language-news-or-script writer; foreman, electrical work; instrument maker; machinist (all around); manager, employment and personnel; manager, production; mechanic, electric maintenance; mechanic, maintenance; mechanic, mechanical tabulating equipment; mechanic, radio communication office; production man, bilingual; program-transmission supervisor; radio operator; radio repairman, broadcasting; recording engineer; rigger, radio; station installer, station repairman; traffic chief, radio communications, transformer repairman; translator; transmission engineer; war correspondent; wire chief.

Prof. Burris-Meyer Gives Definite Figures on Effect of Music on Production

IN A PAPER DELIVERED to the American Society of Mechanical Engineers recently Prof. Harold Burris-Meyer presented the results of what is claimed to be the first scientific, statistical investigation conducted in this country for the purpose of evaluating the effects of industrial music on employee morale and factory production. The data showed that in 75 percent of the investigations production was considerably higher where music was used than where it was not used. Increases in production rates, resulting from the introduction of music ranged from 1.3 percent to 11.1 percent. Further studies indicated that the effect was not a transient one. The production increases are even more surprising when it is considered that many of the groups measured consisted of employees on piece work who were already producing at what was considered top speed. In addition to increasing the production rate, Monday morning absenteeism and early end-of-the-day departures decreased considerably.

The effect of a carefully selected and planned musical program in a plant already using music, but with indiscriminate selection, was studied and an increase in the production rate of 6.8 percent was noted. This would seem to bear out the theory that while music is better than no music, programming will not be satisfactory until it is undertaken on the basis of a careful analysis of the results it gets. We have to date only the showmanship and experience of the programmers. More statistical analysis of factory performance should teach us much. Programming must ultimately be undertaken for the factory, if not for the specific operation. Fatigue curves vary in shape and amplitude and it is difficult to find one remedy for dips occurring at different times in different operations. The remedy for this exists and the technique for employing it is in hand.

In closing Prof. Burris-Meyer observed, "Little of the music used in the factory is germane to the endeavor it accompanies. The work song took not only its rhythm but its mood and lyric from the work operation. The transcription carried something composed for the concert hall, the stage or the night club. The leisure music is not in the idiom of the modern industrial plant and yet the industrial audience

DOUBLE DRAFT. When Uncle Sam drafted KALB's junior and his two male successors, the station management drafted the Alexandria, La. high school debating coach, Miss Dorothy Aden. With a few weeks of training Miss Aden obtained her Third Class Operator's License and is well on her way to getting the Second Class rating

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...meets war's hardest tests!

In aircraft and other mechanical weapons — where requirements are unusually severe — Walker-Turner Flexible Shafting has thoroughly demonstrated exceptionally high quality of design and materials. As one of the largest manufacturers of flexible shafting for industry, Walker-Turner has gained wide experience in design, production and application of flexible shafting for remote control and power transmission.

Although it is one of the busiest departments of this Company, we are always glad to help other concerns who may wish to learn more regarding the possibility of simplifying design through the use of flexible shafting. Walker-Turner Flexible Shafting is available today in products used for war purposes, in a wide range of sizes and specifications.

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will at present rate soon be the largest audience for the musician. No artist undertakes a composition or performance without the consciousness of his audience, and insofar as his art is valid he undertakes to exercise emotional control over that audience. When the composer starts to think of his work as being first and oftenest performed in a factory, before people who are working while they listen, we may well have a musical idiom which is something new on the face of the earth, and what industry can do for music may be as important when the record of this civilization is written, as anything music can do for industry."

John Fritz Medal Awarded to Willis Rodney Whitney

WILLIS RODNEY WHITNEY, chemist, engineer, inventor, author and educator, has been announced as the recipient of the 1943 John Fritz Medal, the highest American engineering award. The medal was first awarded in 1902 to John Fritz, pioneer iron master and engineer in whose honor the award established. It has been awarded annually since that time for "notable scientific or industrial achievement, without restriction on account of nationality or sex." It is conferred by a board composed of representatives of four national engineering societies, the American Society of Civil Engineers, The American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers.

Dr. Whitney's most notable achievement was the creation and development of the General Electric research laboratory, one of the earliest of its kind in the United States. This laboratory, pioneer in the application of science to industry, has gained a world-wide reputation by the quality of its work and the importance of its results. He became vice-president and director of research of the General Electric Co., in 1928, and in 1932 vice-president in charge of research.

Other recipients of the John Fritz Medal are Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas Alva Edison, Charles T. Porter, Alfred Noble, Sir William H. White, Robert W. Hunt, John E. Sweet, James Douglas, Elihu Thomson, Henry M. Howe, J. Waldo Smith, George W. Goethals, Orville Wright, Sir Robert A. Hadfield, Charles Prosper, Eugene Schneider, Guglielmo Marconi, Ambrose Swasey, John Frank Stevens, Edward Dean Adams, Elmer Ambrose Sperry, John Joseph Carty, Herbert Hoover, Ralph Modjeski, David Watson Taylor, Michael Idvorsky Pupin, Daniel Cowan Jackling, John Ripley Freeman, Frank Julian Sprague, William Frederick Durand, Arthur Newell Talbot, Paul Dyer Merica, Frank Baldwin Jewett, Clarence Floyd Hirshfeld, Ralph Budd, and Everette Lee De Golyer.

FCC Radio Intelligence Division Proves to be Invaluable in the War Effort

THE RADIO INTELLIGENCE Division of the Federal Communications Commission has been rendering a service to the nation in its war program which has proved its worth many times over. The demands of war have necessitated an increase of personnel of this division of about 50 percent to bring the total to about 900 engineers, technicians and cartographers. The work goes on 24 hours a day, 7 days a week to bring to the attention of our military staffs all possible information which is transmitted by radio throughout the world.

The United States and its territories are divided into twelve monitoring areas in each of which is located a primary fixed monitoring station. These stations are equipped for recording all high-speed code transmissions, direction finding, and general monitoring work. In addition, there are 96 secondary monitoring stations and a number of mobile units located throughout continental United States, Hawaii, Alaska, and the West Indies. To coordinate the activities of all these stations Radio Intelligence Centers are located at Washington, San Francisco, and Honolulu which act as clearing houses for the exchange of information. The primary monitoring stations and the three Intelligence Centers are connected to each other by radiotelegraph and wire teletypewriter services.

In addition to its services in gathering information concerning the activ-

FIGHTING FOR HIS HOMELAND IN AMERICAN INDUSTRY.

Dr. Chao-Chen Wang is at work in the electronics laboratory of Westinghouse E & M Co. where his efforts are speeding up the delivery of vital communications equipment to China and other United Nations. He was sent here by the Chinese government on a university scholarship and his specialty is uhf.

ities of our enemies, the Radio Intelligence Division also intercepts many distress signals of ships at sea and airplanes forced down at sea and at isolated points, intercepts reports on submarine sightings by ships under attack, and with its direction finding equipment many airplanes are guided to safety, especially in the vicinity of Hawaii. An outstanding example of its interception of distress signals was the picking up of the signal transmitted by a Navy plane forced down in the South Pacific near the Galapagos Islands by a monitoring station in Pennsylvania. The information was passed on to the Navy Department and the crew rescued promptly.

The division also conducts research and development work in new radio devices for use in its special field, especially in the tracking down of illicit transmitters. Advanced training schools for its personnel are operated and recently, under the auspices of the State Department and the Coordinator of Inter-American Affairs, a number of students from Latin America and Mexico have been enrolled.

Industrial Representatives Attend Army Staff School

A FOUR-WEEK ORIENTATION course in Army organization and procedures is being conducted at the Command and General Staff School at Fort Leavenworth, Kansas for 83 industrial executives and representatives whose work is closely associated with the war program. Of the 83 men attending the school nine are from the communication industry. L. Myles Regottaz, export manager of the RCA Manufacturing Co., H. Leslie Atlass, vice-president of the Columbia Broadcasting System, and Henri C. Bohle, assistant vice-president of the International Standard Electric Corp., manufacturing subsidiary of the International Telephone and Telegraph Co. represent the radio portion of the communication industry.

The course will consist of 146 hours of instruction and will cover the general picture of the military forces of the United States, their organization, administration and operations; the duties and responsibilities of the several divisions of the War Department and of the governmental agencies connected with the war effort; the duties and functions of the War Department's field agencies and some general principles of tactics, strategy, supply and administration.

Coast Guard Takes Over Mackay Station

STATION WSL, the coastal radio telegraph marine station of the Mackay Radio & Telegraph Co. located at Amagansett, Long Island, has been leased by the Coast Guard for the duration of the war.

Signal Corps Deliveries

MORE THAN $3,000,000 worth of communications equipment is being delivered to and accepted by the Signal Corps daily. This rate is twenty times the rate of a year ago. This remarkable performance is the result of cooperation between the Signal Corps, the WPB, and industry. The radio manufacturing industry had to be expanded many fold in a very short time. The telephone industry was in a little better shape for adjustment to the vastly increased requirements for manufactured materials.

Even at the rate of $3,000,000 worth of equipment daily, several years would be required to complete delivery of all equipment on order by the Signal Corps which amounts to about six billion dollars. Thus, even more spectacular figures for production by the communications industry can be expected in the near future.

St. Louis Utility Installs F-M System

ST. LOUIS IS THE latest city to have installed a two-way f-m radio system to give instant communication during emergency periods in a utility system. The Union Electric Co. of Missouri has recently put into service three f-m transmitter-receiver units for emergency service. One unit is located on the top floor of the Union Electric building in the downtown area and the other two are carried on trouble shooting emergency trucks. The operating frequency is 39.6 Mc.

Col. John Stilwell Elected Director of American Standards Association

COL. JOHN STILWELL has just been elected to serve a three-year term on the board of directors of the American Standards Association. He is now serving his third term as president of the National Safety Council. He has also served as president of the Greater New York Safety Council and of the American Museum of Safety. As general superintendent of Transportation and later vice-president of the Consolidated Edison Co. of New York, Col. Stilwell has had much to do with the safety program of that company.

Denny Appointed FCC General Counsel

CHARLES R. DENNY, JR., has been appointed general counsel of the Federal Communications Commission to succeed Telford Taylor who has been commissioned a major in the Army. Denny was an assistant general counsel of the FCC since February when he transferred from the Justice Department.

GENERAL RADIO COMPANY

FOUNDED 1915

Manufacturers of RADIO AND ELECTRICAL LABORATORY APPARATUS

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CABLE ADDRESS GENRADCO, BOSTON
BENTLEY'S CODE
TELEPHONE TROWBRIDGE 4400

TO USERS OF
GENERAL RADIO INSTRUMENTS

Gentlemen:

When instruments, built for intermittent service, are worked "around the clock" -- when years of normal instrument operation are compressed into a few months -- prompt repair service is essential. There must be no avoidable interruption of urgent war production.

Our service department is organized and equipped to handle today's unprecedented volume of service problems promptly and capably. Years of experience with adjustments and repairs have long since convinced us of the importance of service. Today this service is doubly necessary. A complete case history file is kept on every major instrument. Reconditioned instruments are guaranteed for one year to the same specifications as when new.

You can help to speed necessary repairs by doing all possible repair work in your own plant with the aid of our SERVICE AND MAINTENANCE NOTES. They have already helped hundreds of General Radio customers to cut down returns for repairs, to save valuable production time, and to get better service from their equipment.

When requesting your set of SERVICE AND MAINTENANCE NOTES, please list your General Radio instruments by type number and serial number.

Sincerely

H. H. Dawes

Service Manager

Alaskan Broadcast Station Raises Power

STATION KFAR AT Fairbanks, Alaska has stepped up its power from 1000 watts to 5000 watts by permission of the Federal Communications Commission and is prepared to increase it further to 10,000 watts after the war, or sooner if conditions warrant it. Military considerations emphasized the necessity for higher power broadcasting in Alaska because even on 1000 watts this station had been a distinct aid to both Army and commercial aviation. Also, this station was the only means by which military authorities could reach the population with instructions in case of an emergency. With these things in mind, the FCC gave permission and the WPB granted the necessary priorities to get the station operating at the higher power in very short order.

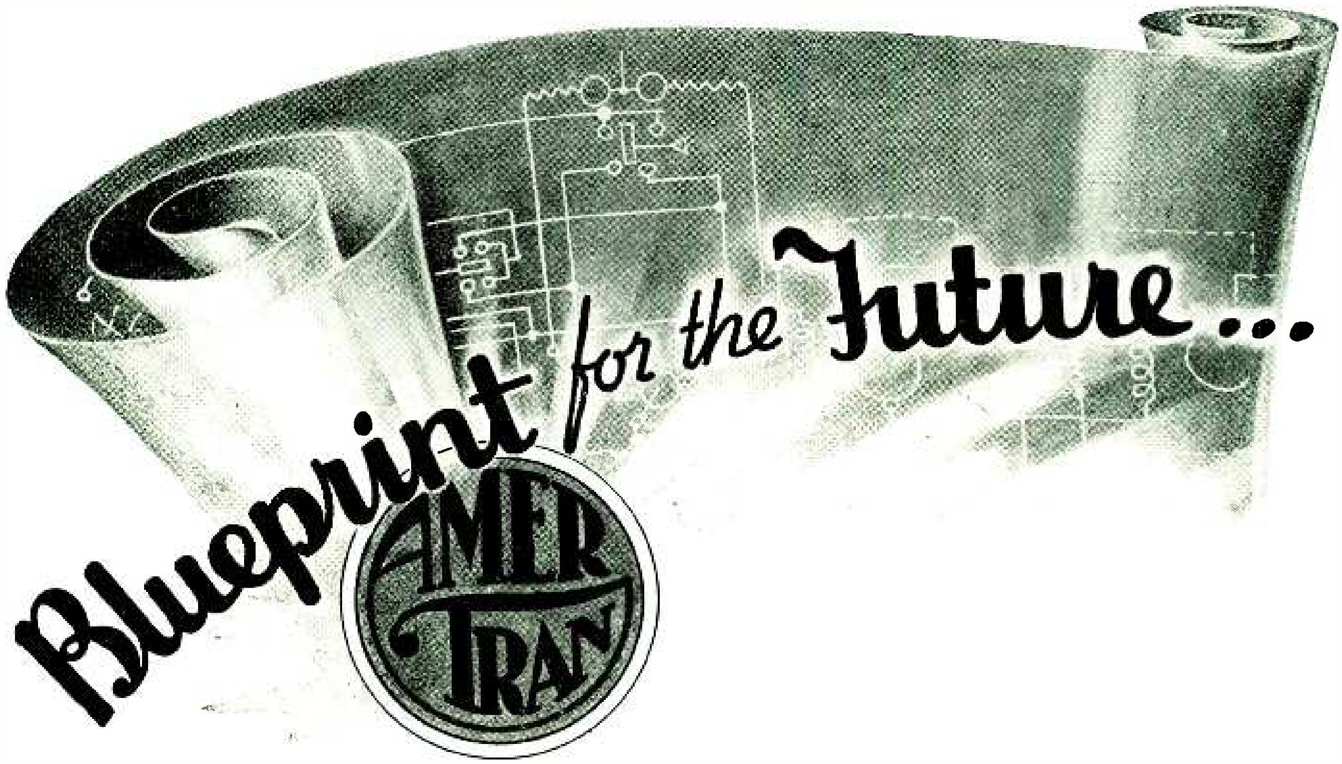
Radio Club Hears deRosa on Synthetic High Fidelity

AT THE DECEMBER 10 meeting, Radio Club of America, L. A. deRosa will describe the work he has been doing with improving auditory reception by taking advantage of the fact that the ear is fundamentally a distorting translating device. According to Mr. de Rosa, an analysis of the operation of the human hearing mechanism leads to the conclusion that the ear supplies the brain with signal patterns which are highly distorted versions of the externally impressed acoustical energy. By the cognizance of the general rules governing the distortion characteristic of the ear it is possible to supply the hearing mechanism with sounds consisting entirely of externally generated extraneous products and yet produce natural and apparently distortion free responses. The ear apparently acts as a narrow band transducer and by applying certain patterns of distortion lying only within the middle range of audio frequencies, it is possible to simulate low and high frequency sensations; this, despite the absence of low and high frequency signals in the sound conveyed to the ear.

One of the many applications of the development is the reproduction of an apparently high-fidelity signal from a receiver having a poor bass and high frequency response. The theory underlying the production of various effects will be discussed at the meeting and a practical demonstration will be given.

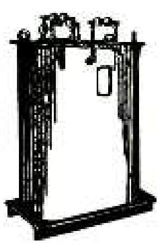
Blind Persons Used in Precision Assembly

THE UNIVERSAL MICROPHONE CO. of Inglewood, Calif. is using blind men and women in certain types of precision assembly with very good results. These workers are placed in normal working positions with other workers at jobs in which their blindness offers no handicap.

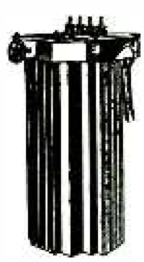


Serving America's War Work Now... the better to serve all American Industry later

Here in AmerTran's factories under the accelerated tempo of war production, we are designing and building better transformers that will help meet the competitive conditions of the general business upswing of the future. Here in blueprint form, and in the shape of refined designs and improved construction, better AmerTran equipment is being produced to serve war-time America now . . . to serve peace-time industry later. Tomorrow these improvements will be available to the whole of the communications field for general electronic and radio applications. The confidence you have placed in the AmerTran pre-war products you are using today—a confidence merited by 41 years of leadership—will be many times justified when the splendid results of the work AmerTran is doing today become generally available to a victorious American industry.



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.

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

Manufactured Since 1901 at Newark, N. J.

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

AMERTRAN

I. T. & T. Merger

Two associate manufacturing companies of the International Telephone and Telegraph Corp., the International Telephone and Radio Manufacturing Corp. and the Federal Telegraph Co., have been merged and the name of the resulting corporation is Federal Telephone and Radio located at Newark, N. J. The new organization consists of about 5500 persons and is devoted almost entirely to the production of communication and radio equipment for the war program. A new factory is being built in New Jersey and will be the home of the new corporation. It is planned that all laboratory and manufacturing operations associated with I. T. & T. in the United States shall eventually be centered there.

General Limitation Order L-183 Interpreted

General Limitation Order L-183, issued by the War Production Board on September 18, and which became effective on October 3, has given rise to numerous questions regarding its applicability and method, and the extent to which various operators are affected by its terms. In order to clarify the situation, the Radio and Radar Branch of the War Production Board has summarized the questions gleaned from its correspondence. The most frequent questions and their answers are given below:

Q. What apparatus is governed by the Order?

A. The definition of electronic equipment is interpreted very broadly and includes within its meaning anything and everything in the electronic field which is not specifically exempted in Schedule A of the Order.

Inter-communicating equipment involving the use of vacuum tubes is covered by the Order.

Q. Are replacement and repair parts covered by the Order?

A. Yes. Replacement and repair parts in the hands of the manufacturer may not be transferred except on orders bearing a preference rating of A-3 or higher.

Q. Are distributors affected by the Order?

A. No. Distributors are restricted only to the extent that they must obtain preference ratings before they may acquire any new supplies.

Q. Does L-183 apply to export sales?

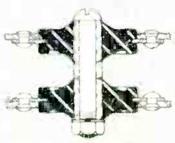
A. Yes. The terms of the Order are entirely general and apply to all transfers regardless of conditions, destination or purpose.

Q. What is the basic purpose of the Order?

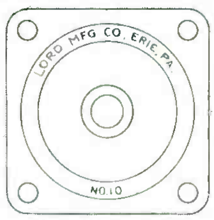
A. The purpose of the Order is

THERE'S A LORD MOUNTING
BONDED RUBBER
TO KEEP HARMFUL VIBRATION FROM
EVERY *Electronic* DEVICE

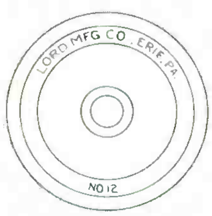
TYPICAL INSTALLATION



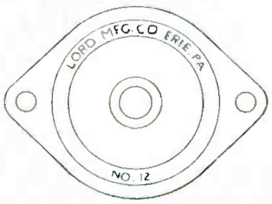
DOUBLE MOUNTING



SQUARE PLATE



ROUND PLATE



DIAMOND PLATE

TO keep mechanical and electrical equipment operating at peak efficiency and also prolong its operating life are factors of prime importance in today's program of high speed, precision production. Lord's contribution toward this end is the development of a series of Shear Type Bonded Rubber Mountings, particularly adaptable to electronic equipment.

Lord Mountings are made in two main types, Plate Form and Tube Form, and in load capacities ranging from a few ounces up to 1500 pounds. Due to the Lord method of bonding rubber to metal, the rubber, when loaded on main axis, is stressed in free shear. This design for free shear softness in the direction of the disturbing forces, results in an exceptional reduction in the natural frequency of the mounted system. Where very delicate, sensitive equipment is to be protected, the use of double or series mountings is recommended, thereby doubling the axial softness, and increasing the lateral softness. Lateral softness may be varied by changing the length of connection between mounting units. Double mountings give ideal protection where disturbing vibratory forces emanate from more than one direction.

No intricate layout, no special tooling or close machining is necessary to accommodate Lord Mountings. Properly installed, they absorb sudden shock and undue stresses, isolate harmful vibration and eliminate noise translated through solid conduction, all of which prolong equipment life and keep it operating at maximum efficiency. Regardless of size or weight there is a Lord Mounting for every electronic device. Send for Bulletins 103 and 104 on Lord Shear Type Mountings, or better still, call in a Lord vibration engineer for consultation on your design problems. There is no obligation.

LORD MOUNTINGS

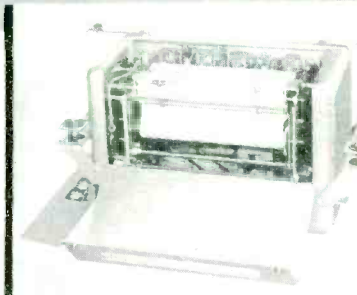
PROLONG EQUIPMENT LIFE by isolating vibration, which reduces metal fatigue, thereby preventing subsequent failure.

INCREASE PRODUCTION by eliminating the necessity for close machining and precision alignment.

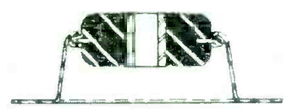
SAVE VITAL MATERIAL by reducing equipment weight; heavy inertia masses of machinery bases can be eliminated.

INCREASE PERSONNEL EFFICIENCY by eliminating nerve wearing noise and vibration, translated through solid conduction.

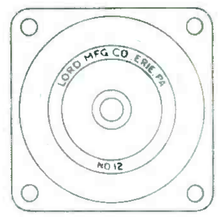
LOWER MAINTENANCE COSTS by protecting equipment against sudden load shocks and stresses, thereby minimizing repair and replacement operations.



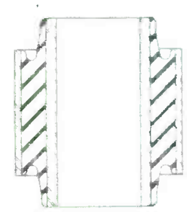
TYPICAL INSTALLATION



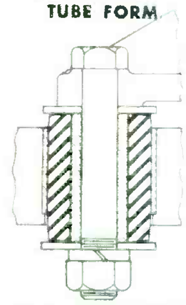
HOLDER TYPE



V. S. PLATE FORM



TUBE FORM



V. S. TUBE FORM

ORIGINATORS OF SHEAR TYPE BONDED RUBBER MOUNTINGS
LORD MANUFACTURING COMPANY... ERIE, PA.

PLATE FORM MOUNTINGS

LORD
BONDED RUBBER
SHEAR TYPE VIBRATION MOUNTINGS

TUBE FORM MOUNTINGS

FRACTIONAL H. P. FLEXIBLE COUPLINGS

SALES REPRESENTATIVES . . . NEW YORK, 280 Madison Ave. . . . CHICAGO, 520 N. Michigan Ave. . . . BURBANK, CAL., 245 E. Olive Ave.

IT TAKES RUBBER IN SHE

twofold: (1) To prevent the consumption of new raw material and the manufacture of non-essential apparatus; (2) To distribute existing inventories on an equitable basis.

Q. Are dry batteries subject to the Order?
A. No. The production of dry batteries is controlled by Limitation Order L-71.

Q. How may parts for maintenance and repair be obtained?
A. Maintenance and repair parts will be available through normal channels. Distributors of such parts may obtain preference ratings through the use of PD-1X, the Distributor's Application for Preference Rating.

Q. Are recording discs subject to the Order?
A. Yes. Recording discs are subject to the restrictions of L-183 and may be obtained through distributors who may apply for preference ratings on Form PD-1X or the consumer may apply on Form PD-1A for his requirements.

Van Dyck Announces I. R. E. Officers for 1943

AT THE NEW YORK MEETING of the Institute of Radio Engineers on November 4, Arthur F. Van Dyck, President of the I. R. E. for 1942, announced the formation of the New York Section. New York has always been a stronghold for radio engineers and meetings have been since the inception of the Institute in 1912. With the formation of the New York Section, this metropolitan area assumes the same position as that of Institute sections in other cities in this country and in Canada. Programs for the New York Section will be under the direction of a locally elected group of officers. The officers for the New York Section for 1943 were announced by Mr. Van Dyck as follows: President, H. M. Lewis, consulting engineer; Vice President, Murray G. Crosby, RCA Communications; Secretary, Harry F. Dart, Westinghouse Lamp Division.

In addition to these local officers for the newly created section, Mr. Van Dyck also announced the results of the election of national officers. Dr. L. P. Wheeler, of the Federal Communications Commission has been elected to the office of President, with F. S. Barton, of the British Air Commission, in Washington, D. C., as Vice President. The directors, elected by the membership, to begin their term of office on the Board of Directors include Dr. W. L. Barrow of the Massachusetts Institute of Technology, H. A. Wheeler, of the Hazeltine Service Corporation, and Dr. F. B. Llewellyn, of the Bell Telephone Laboratories.

Army Specialist Corps and Officer Procurement System Consolidated

AFTER A PERIOD OF testing officer procurement through the Army Specialist Corps as a civilian agency of the War Department, it has been found that the purposes of the Corps could not be accomplished to the best advantage in the midst of the war because of the civilian status of those appointed in it to serve with the Army. In the interest of efficiency, uniformity of operations, discipline, and the avoidance of duplication of effort, it is not deemed advisable to have two uniformed services. Accordingly, the Army Specialist Corps will cease to function as a separate organization, and the procurement of specially qualified persons required by the Army for service in other than civilian positions will be accomplished by Specialist commissions in the Army of the United States.

F. R. Lack Appointed Director of Army-Navy Electronics Expediting Agency

FREDERICK R. LACK, vice president and manager of the radio division of the Western Electric Co., has been appointed director of the Army-Navy Electronics Expediting Agency, a newly created post. He will coordinate and supervise all Army and Navy joint activities in production expediting of communications and radio apparatus and equipment. Major General Roger B. Colton, chief of the Signal Supply Services, and Captain Jennings Dow, in charge of the Radio and Sound Branch of the Bureau of Ships, will serve as associate directors.

A. M. Hageman Appointed General Engineering Manager of Westinghouse Lamp Works

DR. A. M. HAGEMAN has been appointed general engineering manager of the Westinghouse Lamp Works at Bloomfield, N. J. He will be in charge of all development and engineering activities involved in the production of lamps and electronic devices. He was formerly in charge of lamp engineering.

Admiral Noyes Rescued After Sinking of Aircraft Carrier Wasp

REAR ADMIRAL Leigh Noyes, former director of Naval Communications, was among those rescued when the aircraft carrier Wasp was sunk by Japanese submarines off the Solomon Islands on September 15. Admiral Noyes was commander of the task force at the time of the attack and was using the Wasp as his flagship.

WAAC's to Receive Radio Training

THE FIRST GROUP of WAAC's to replace enlisted men as radio operators and mechanics in Army Air Forces Headquarters Companies will begin training on November 30 at the Midland Radio and Television Schools, Inc., in Kansas City, Mo. Additional groups will be started in training at intervals of one month until a sufficient number of women radio specialists have been trained.

Gerard Swope to Receive Hoover Medal

GERARD SWOPE, president of the General Electric Co., has been selected as the sixth recipient of the Hoover Medal with the following citation:

"Gerard Swope, engineer and distinguished leader of industry, ever deeply interested in the welfare of his fellowmen, whose constructive public service in the field of social, civic and humanitarian effort has earned for him the Hoover Medal for 1942."

The medal will be presented to Mr. Swope during the Winter Convention of the American Institute of Electrical Engineers during the week of January 25, 1942. Previous recipients of the Hoover Medal were Herbert Hoover, in whose honor the medal was named, Ambrose Swasey, John Frank Stevens, Gano Dunn, and D. Robert Yarnell.

Mr. Swope was elected president of the General Electric Co. for the second time in September 1942 when his successor, Charles E. Wilson, was named vice chairman of the War Production Board.

Radio in Homes Figures Released by Bureau of Census

THE METROPOLITAN area of Boston leads the country on the coverage of radio in the home with receivers in 97 percent of the homes according to figures just released by the Bureau of the Census. The figures for other areas are Chicago, 96.2 percent; Philadelphia, 96.2 percent; Los Angeles, 95.8 percent; Pittsburgh, 95.2 percent; Grand Rapids, Mich., 96 percent; Paterson, N. J., 94.8 percent, and Sacramento, Calif., 91.8 percent.

FM Broadcasters Report

IN SEPTEMBER THIS YEAR, FM Broadcasters, Inc., questionnaired the FM broadcast stations on various matters of general interest to the cause. A report has now been issued; the gist of which follows:

(1) The average length of the FM program day is 10½ hours, ranging in some areas from 24-hour service to, in others, the six-hour minimum that the Federal Communications Commission requires.

(2) The average FM program schedule is 73.2 percent non-duplicated in contrast with AM service offered to the same area. In other words, 73.2 percent of the programs are planned for FM and heard only over FM stations. Percentages range from a minimum of 10 percent to a full 100 percent non-duplication over eight others.

(3) At least 28 of the commercial stations maintain full or partial staffs, aside from any personnel that also works for an affiliated AM outlet. Six FM outfits have no connection with any AM interests and are operated as independent ventures.

(4) Not a single one of all the operating stations which returned the questionnaire reports any intention of curtailing its operating schedule. Three admit maybe it might be necessary at some later date if no provision could be made to replace transmitting tubes when they wear out. Rather than go off the air entirely they'd prefer to cut down on daily schedules and thus prolong the life of the tubes.

(5) Nine FM broadcasters are unable to serve their entire assigned area. Today they're serving somewhat less than 60 percent of the territory they will eventually whenever full installation of antennas and higher wattage transmitters becomes possible. Only one of them expects this to happen before the war's end; another says "maybe."

A. H. Phelps New Westinghouse VP

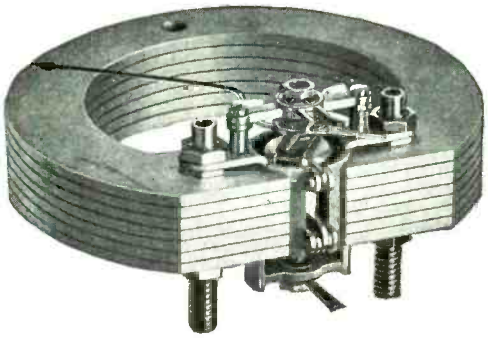
ANDREW H. PHELPS has been named vice president of Westinghouse Electric & Mfg. Co. Before joining Westinghouse he was affiliated with McGraw-Hill Co. as Sales Manager and Director of Public Relations. At one time he was also connected with U. S. Chamber of Commerce having charge of all district offices and the field forces. In 1919 he served as executive secretary of the International Trade Conference at Washington.

Technical Valuation Society to Hold Annual Forum

THE ANNUAL FORUM of The Technical Valuation Society will be held on December 12, 1942, at New York. The morning session will be devoted to prominent economists, appraiser and valuation engineers who will present papers and direct discussion on many pressing valuation problems, particularly in their relation to the war effort.

The afternoon session will consist of committee meetings and the annual business meeting of the Society.

Further information may be obtained from W. C. Fisher, Technical Valuation Society, 33 W. 39th St., New York, N. Y.



It's the movement that counts

IF you want to find out how accurately, and for how long, an instrument will *do* its work, you've got to examine the part that *makes* it work.

In every Simpson Instrument this basic operating mechanism is a movement which incorporates both full bridge construction and soft iron pole pieces. There is nothing new about this type of design. It has been recognized for many years that such a movement is more accurate, more rugged, and more expensive, . . . *but*—

—there is something entirely new in the patented Simpson expression of this design. For out of the long experience in instrument-making on which the Simpson organization is founded, there has been developed a movement which offers this better design in its best form, and which permits substantial economies through 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 searched out the facts, best means . . . Simpson.

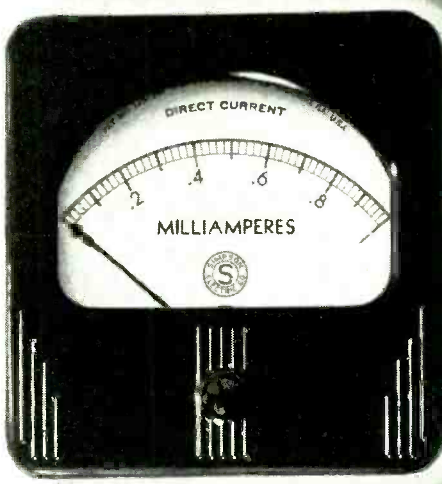
MODEL 260
High Sensitivity Tester

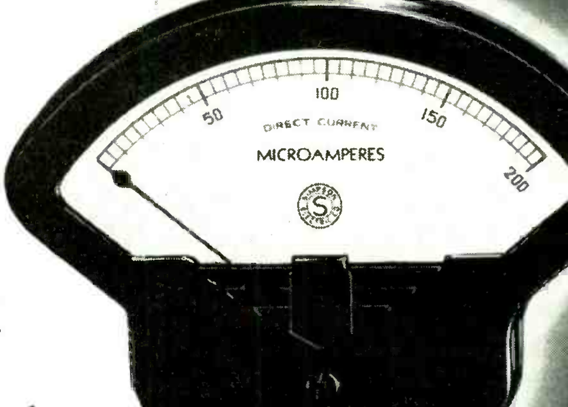
A typical example of Simpson leadership. Ranges to 5,000 volts, both AC and DC, at 20,000 ohms per volt DC, and 1,000 ohms per volt AC. Current readings from 1 microampere to 500 milliamperes. Resistance readings from ½ ohm to 10 megohms. Five decibel ranges, —10 to +52 DB.

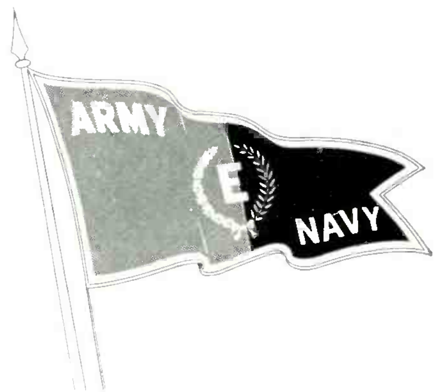
SIMPSON ELECTRIC CO.
5200-5220 Kinzie St., Chicago, Ill.

Simpson

INSTRUMENTS THAT STAY ACCURATE







ALLEGHENY LUDLUM STEEL CORP.
(Two plants)

BELMONT RADIO CORP.
Chicago, Ill.

CLAROSTAT MANUFACTURING CO.
Brooklyn, N. Y.

CONNECTICUT TELEPHONE & MANUFACTURING CO.
Meriden, Conn.

FAIRCHILD AVIATION CORP.
Jamaica, N. Y.

FEDERAL MANUFACTURING & ENGINEERING CORP.
Brooklyn, N. Y.

INTERNATIONAL NICKEL CO.
Huntington, West Virginia.

LAPP INSULATOR CO.
LeRoy, N. Y.

THE PERKIN-ELMER CORP.
Glenbrook, Conn.

THE REMLER CO., LTD.
San Francisco, Cal.

SUMMERILL TUBING CO.
Bridgeport, Pa.

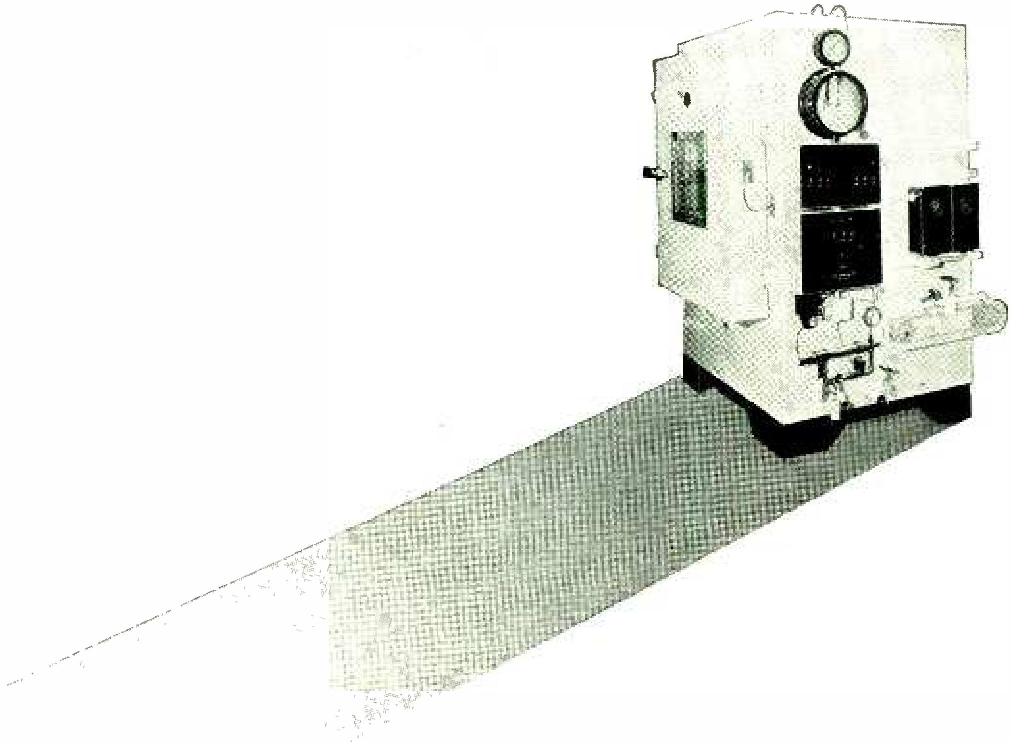
SYLVANIA ELECTRIC PRODUCTS, INC.,
Emporium, Penna.

S. S. WHITE DENTAL MANUFACTURING CO.
Staten Island, N. Y.

Rauland Corp. Acquires American Rights to British Patents

THE RAULAND CORP. OF Chicago has acquired the American interests and patents of the Gaumont-British Picture Co. of America, Cinema-Television, Ltd., and Baird Television and also the American rights of all present and future patents of the Gaumont-British Picture Corp., Ltd. of London in the fields of television, electronic tubes, and photoelectric devices. Rauland has taken over in its entirety the laboratory and engineering staff as well as the equipment of the first-mentioned three companies.

★ ★



TESTING the stamina of materials and instruments in the "Tenneyzphere" High Altitude Chamber removes the last vestige of guesswork.

Standard range of temperatures run from —40° to 150° Fahrenheit. (Special units test from —90° to 320° Fahrenheit.)

Observation ports permitting full visibility are sealed to prevent interior condensation. The interior is scientifically air-conditioned.

To make mechanical adjustment of the apparatus under test, small rotating shafts are installed. These are manually turned from the outside and studs extend through suitable packing to keep them airtight.

These cabinets meet the test requirements of all U. S. Government Agencies: Army Signal Corps, Navy Bureau of Aeronautics, National Advisory Committee for Aeronautics.

For illustrated booklet describing "Tenneyzphere" High Altitude Chambers, Constant and Variable Temperature Baths, Humidity Chambers, and All-Weather Rooms, with tables giving specifications for many important installations write Dept. E-12.

TENNEY ENGINEERING INCORPORATED

TENNEY ENGINEERING, INC.

8 ELM STREET, MONTCLAIR, N. J.

2 *small* POWER RELAYS

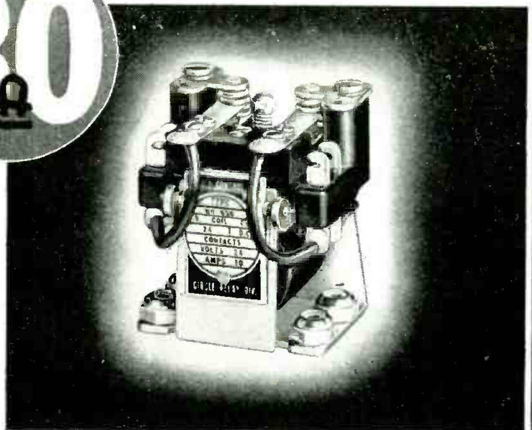
PROVEN BY TWO YEARS UNDER THE FIRE OF EXPERIENCE
ACCEPTED FOR THEIR DEPENDABLE & UNWAVERING PERFORMANCE

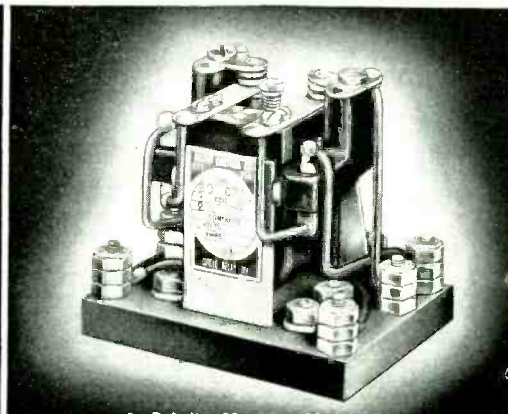
B&O

BO and BJ power relays meet every known requirement for flight, firing and communication control.

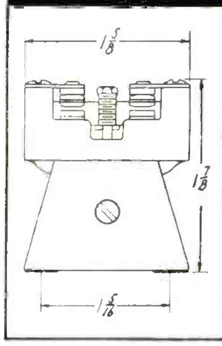
BO and BJ are Relay Veterans. They have seen two years on the firing line of experience . . . on the sea . . . in the air . . . and on land. They have proven themselves durable and completely dependable.

BO and BJ have semi-balanced armatures which require minimum wattage to withstand shock and vibration up to 12 G . . . they operate at temperatures of 120 plus or 50 minus . . . they are corrosion resistant beyond specifications . . . their weights are significantly low . . . their dimensions are minute . . . their double pole double throw design permits abundant contact arrangements . . .

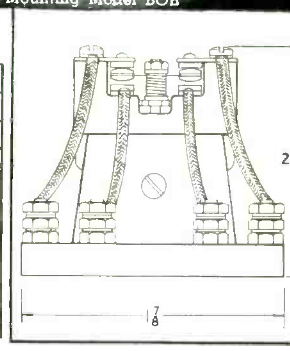




In Bakelite Mounting Model BOB



Coil Number	Nominal Volts	Amperes	Resistance	Watts
28	5.0	.500	10.0	2.5
29	6.0	.422	14.2	2.5
30	7.8	.319	24.5	2.5
32	13.2	.190	70.0	2.5
33	15.4	.162	95.0	2.5
34	20.	.125	160.	2.5
35	24.	.106	230.	2.5
36	32.	.078	415.	2.5
38	50.	.049	1024.	2.5
42	112.	.022	5000.	2.5

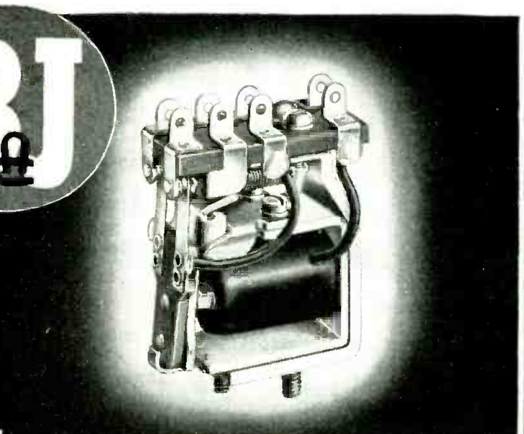


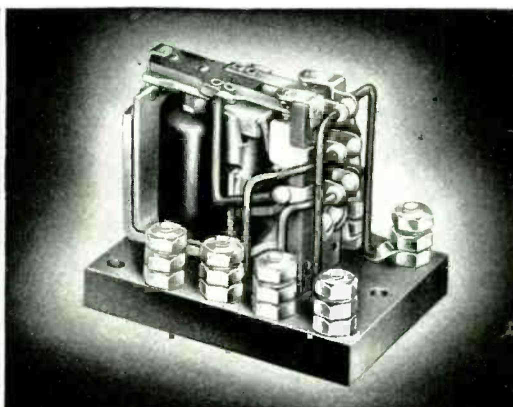
The above coil data is based on continuous duty at nominal operating voltages. Coils are impregnated to withstand humidity and salt spray. Bakelite parts are molded. Contact arrangement D.P.S.T. Double break normally open or closed and D.P.D.T. Contact rating non-inductive 15 amperes for 12 and 24 volts D.C. and 110 volts A.C.

B&J

***. . . and they are* INTERCHANGEABLE**

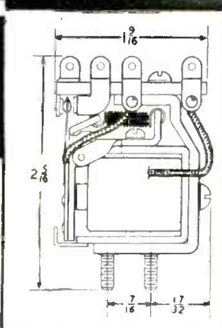
. . . variations in the mounting base can be made to make this relay widely interchangeable



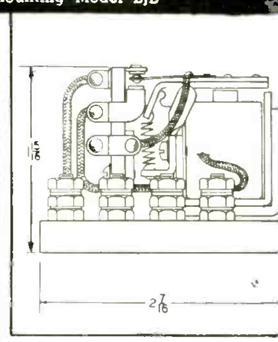


In Bakelite Mounting Model BJB

BO and BJ are *Accepted* and *Approved* RELAYS



Coil Number	Nominal Volts	Amperes	Resistance	Watts
24	1.61	1.243	1.293	2
26	2.56	.8003	3.270	2
28	4.07	.4918	8.267	2
30	6.47	.3093	20.90	2
32	9.92	.2017	49.16	2
34	15.0	.1332	112.6	2
36	25.4	.0786	323.5	2
38	39.5	.0506	780.6	2
40	59.6	.0339	1738.	2
42	86.3	.0232	3725.	2



The above coil data is based on continuous duty at nominal operating voltages. Coils are impregnated to withstand humidity and salt spray. Bakelite parts are XXXP laminated wax impregnated. Contact arrangement D.P.S.T. Double break normally open or closed and D.P.D.T. Contact rating non-inductive 5 amperes for 12 and 24 volts D.C. and 110 volts A.C.

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

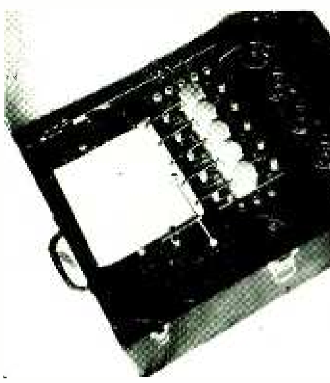
NEW PRODUCTS

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

Garceau Velograph

THE GARCEAU VELOGRAPH is a direct writing oscillograph for use in the lower frequency range. Applications of this instrument include the study of vibration in airplanes, analysis of pressure in rotating and reciprocating machinery, seismography, oscillographic analysis of welding and other electrical equipment operating on commercial power line frequencies, and, in medicine, electrocardiography and electroencephalography.

The recording system utilizes an electrically sensitive paper chart which is marked upon by a charged stylus. The trace is produced in a dry state and is immediately visible and permanent, requiring no processing or developing. It does not blur even at high speeds. Since no pens are used the equipment is particularly adapted to automatic remote control operation. The instrument will operate in any position and in the presence of excessive acceleration and vibration. The charts can be marked only by the electric current and therefore their subsequent handling does not produce unwanted scratches.



Garceau Velograph

The high speed forms of this instrument have a maximum trace amplitude, peak-to-peak, of the order of an inch. They respond in substantially linear fashion to frequencies from zero to the order of 100 cps, with 120 cps as the present practical upper limit. Chart speeds for these instruments are recommended in the range from 2.5 cm per second to 30 cm.

The oscillograph elements operate on an electro-magnetic principle. There are no permanent magnets, piezoelectric crystals, nor moving coils. The elements are designed for ruggedness and are practically unbreakable and fool-proof. The stylus arm is a solid bar of aluminum ¼ inch in diameter which cannot be accidentally bent or broken. If it is forcibly pushed beyond its normal limit of travel a slipping clutch in the head prevents destruction of the vibrating element.

The entire equipment operates on 115 volts 60 cps and requires approximately 125 watts per channel. Power at 50 cps may be used but requires change in the gearing to obtain correct chart speeds. The input impedance is approximately one meghom. This may be balanced to ground. With the usual single-stage d-c amplifier, an input signal of approximately 30 volts peak-to-peak is required for full scale deflection. An additional built-in direct-coupled amplifier stage allows maximum deflection with an input signal of approximately 0.5 volts. A continuously adjustable gain control is supplied.

These instruments are supplied for multiple channel operation with up to 20 recording elements. The single channel tape width is 1⅜ inches per channel and a four channel instrument uses a seven-inch tape. Prices for single-speed Garceau Velographs are $250 for the first channel plus $225 for each additional channel. The quintuplet instrument illustrated costs $1150. Chronograph channels are added at $50 each. Gear shifts permitting two speeds, are added at $150. Other devices such as remote control starting, automatic time stamps, etc., are provided in special installations.

Electro-Medical Laboratory, 1505 Highland St., Holliston, Mass.

Water Detector Lock

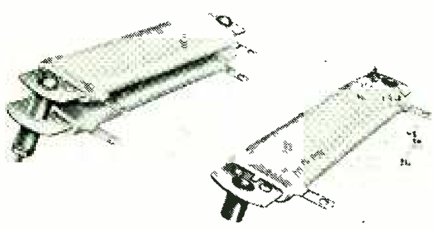
AN ELECTRONIC WATER DETECTOR LOCK (type P15NH) when used in conjunction with a unit called probe fitting (type H31) will indicate water seepage in gasoline storage tanks. The probe fitting unit is mounted in a standard pipe fitting on the top surface of the tank, with the probe rod projecting down through the tank to the level at which water seepage is to be detected (about three inches from the bottom of the tank). The water detector lock is wired to the probe fitting unit and is located at any point remote from the tank. When water seepage rises to contact the probe tip, an electrical circuit is completed and the water detector lock operates by turning off pumping equipment and actuating an alarm circuit. The water detector lock operates on 115 or 230 volts, alternating current, and will handle output loads up to 10 amps at 115 volts, alternating current. It comes in a weatherproof. pressed-steel housing, although an explosion-proof housing is available, if desired. Probe fitting unit comes in brass, stainless steel, and other metals.

Photoswitch Inc., 21 Chestnut St., Cambridge, Mass.

Ward Leonard Products

THREE PRODUCTS FROM Ward Leonard Electric Co., Mount Vernon, N. Y., include the following.

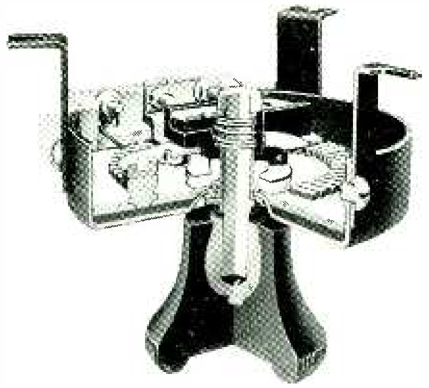
Vitrohm Strip Resistors are especially suited to applications in aviation, radio, and installations where space limitations and high unit space watt ratings are important requirements. These resistors employ a strong, flat refractory core for the resistance wire winding. Terminals are mechanically banded and spot welded in position on the core; the core and winding are then sealed in a fused-on Vitrohm enamel.



Vitrohm Strip Resistors

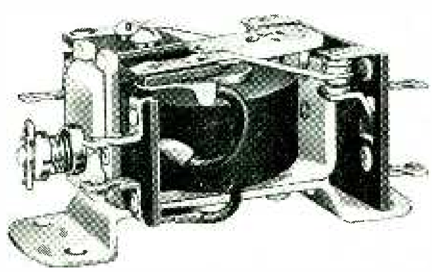
Each unit is fitted with a self-sustained mounting bracket and spacer. These spacers and end brackets are riveted to metal strips that extend through the core providing additional heat radiating facilities. Several sizes of Vitrohm strip resistors are available, ranging from 1½ to 6 inches in length with ratings of 30 to 75 watts. Bulletin 23, available on request, gives dimensions, ratings, ohmic values, and other information.

Bulletin 69 Pressed Steel Rheostats meet the need for a small, sturdy, power rheostat having a large number of steps and ample current carrying capacity. These rheostats are 4 inches in diameter with as many as 43 steps



Pressed Steel Rheostats

of control and are rated for 100 watts. Spacings through air and creepage distances between parts of opposite polarity and between current carrying and grounded parts meet the requirements of AIEE, NEMA and the Underwriters' Laboratories for 300 volt service. In addition to these characteristics, Bulletin 69 Rheostats feature balanced contact arm, "dead" shaft construction, copper graphite contact shoes and front or back-of-board mounting in single and multiple assemblies.



Midget Metal Base Relays

Bulletin 104 Relays are small compact remote control units adapted to applications within their ratings where space is limited. These relays are available for operation on alternating and direct current circuits. Standard relays are of the open type, front connected solder type terminals, double pole, double throw, silver-to-silver contacts. Contacts are rated: 4 amps up to 24 volts alternating or direct current and 4 amps alternating current; 1 ampere direct current from 25 to 115 volts. These relays are vibration resistant up to ten times gravity in the energized position. The overall height from base to armature is 1¼ inches.

New Tube Types

THE FOLLOWING TUBE types for use in connection with WPB rated orders are available to equipment manufacturers. Type 1C21 is a cold-cathode, glow-discharge triode designed for use primarily as a relay tube; 2AP1 is a high-vacuum, cathode-ray tube similar to type 902 except that it has separate leads to all deflating electrodes and the cathode; 5R4-GY is a coated-filament type of full-wave, high-vacuum rectifier; 6AG5 is a heater-cathode type of r-f pentode with a sharp cut-off characteristic and a high value of transconductance; 6J6 is a miniature twin triode having two grids and two plates with a common cathode indirectly heated; the 934 is a small high-vacuum phototube intended primarily for use in sound and facsimile equipment but it is also suitable for light-operated relays and light-measuring equipment; the 935 is a high-vacuum phototube possessing extraordinarily high sensitivity to radiant energy rich in blue and near ultraviolet and will respond in the region down to about 2000 Angstrom units.

Literature describing these tube types more thoroughly is available from the manufacturer, RCA Mfg. Co., Harrison, N. J.

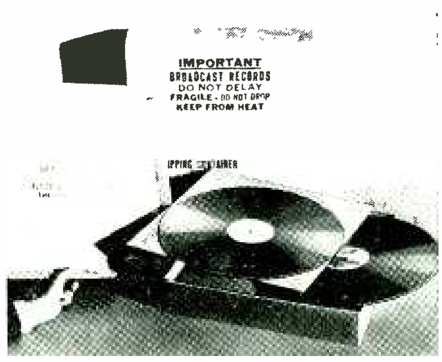
Cut-off Blade

THIS NEW DIAMOND ABRASIVE cut-off blade, designated Di-Met Rimlock, is particularly efficient in cutting all hard, brittle non-metallic materials, such as quartz, glass porcelain, tile, ceramics, clay products, etc. This blade utilizes a special bonding process which rigidly locks the diamonds in the rim of the wheel without crushing. Two Rimlock types are available. The first is a hard steel bond that makes an exceptionally stiff and fast cutting blade, and the second is a copper bond which, though not quite so fast or stiff as the steel, operates with a softer action and with some increase in life.

Felker Mfg. Co., Torrance, Cal.

Recording Disc Shipping Container

"PACKARTON" IS THE name of a new light-weight, corrugated container which is designed to safeguard the shipment of delicate glass base records via air, railway or truck. The construction of the container utilizes a suspension-cushioning principle whereby the records are kept in position between protective coverings. The container is easy to handle, is dustproof and needs no excelsior for packing.



Shipping Container

Gould-Moody Co., 395 Broadway, New York, N. Y.

We need a man Who can Read and Write

QUALIFICATIONS:

He can read with intelligence, understanding and sympathy, this and every issue of ELECTRONICS; he has an interest in both the highly technical and the severely practical sides of electronic engineering; he has a feeling for our objectives in publishing quickly and accurately material on all phases of design, production and use of radio, communication and industrial applications of electron tubes.

He can write as he would like to be written to as a reader of ELECTRONICS — informatively and with a feeling for the current (and future) needs of our 18,000 subscribers on subjects both theoretical and practical; subscribers for whom we must expand our editorial department as a service to the rapid expansion in this industry.

Such a man will realize that the publishing business can afford an unusual stability through the readjustment period to come; that a job with ELECTRONICS offers him an opportunity to serve in a broad capacity in the present emergency; to make a name for himself in his chosen field; to work for a fine company as one of the editors of ELECTRONICS. Are you built along these lines? If so —

PLEASE WRITE TO

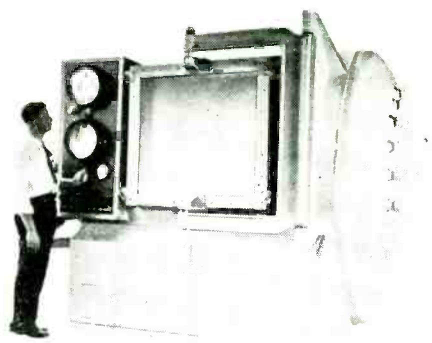
Keith Henney, Editor

ELECTRONICS

330 W. 42nd St., New York, N. Y.

Stratosphere Chamber

THIS UNIT TESTS mechanical parts of aircraft and radio which are to be used in high altitude work. The chamber operates between the temperatures of plus 200 deg. F and minus 75 deg. F with an internal pressure variation from ambient at the location of the unit to 3 inches of mercury absolute. Both the pressure and temperature variations are controllable throughout their ranges. Humidity control is from 25 percent to 95 percent, relative to all temperatures above plus 40 deg. F, or at a fixed bottom temperature of plus 32 deg. F. Below this level, absolute humidity will correspond to the air saturation at the coil temperature, which will average 15 deg. to 20 deg. lower than the chamber temperature.



Heating equipment for higher temperatures is composed of strip heaters so arranged that the forced convection circulates air during the heat cycle.

Three indicating recorders are provided for continuous recording of temperature, pressure and humidity. Twelve mechanical connector shafts through the outer shell of the chamber project inside the liner, permitting the attachment of either a flexible shaft, an angular rigid shaft, or a small belt drive to any mechanical part that may be mounted in test position in the chamber. Eighteen electrical connections are provided. A separate machine compartment is located back of the unit, but may be placed adjacent to the end.

Kold-Hold Mfg. Co., Lansing, Mich.

Rubber Substitute Material for Strippings

A SUBSTITUTE FOR CRITICAL materials formerly used in gaskets and strips is a new strip material called Fel-Pro Thiokol. This new strip material is produced by the application (by special methods) of Thiokol to a specially processed felt base. The result is a spongy rubber cushioning effect. The material is weather resistant and is available, in quantity, in lengths over six feet. It may be used in any applications which requires a spongy type rubber strip.

Felt Products Mfg. Co., 1530 Carroll Ave., Chicago, Ill.

2
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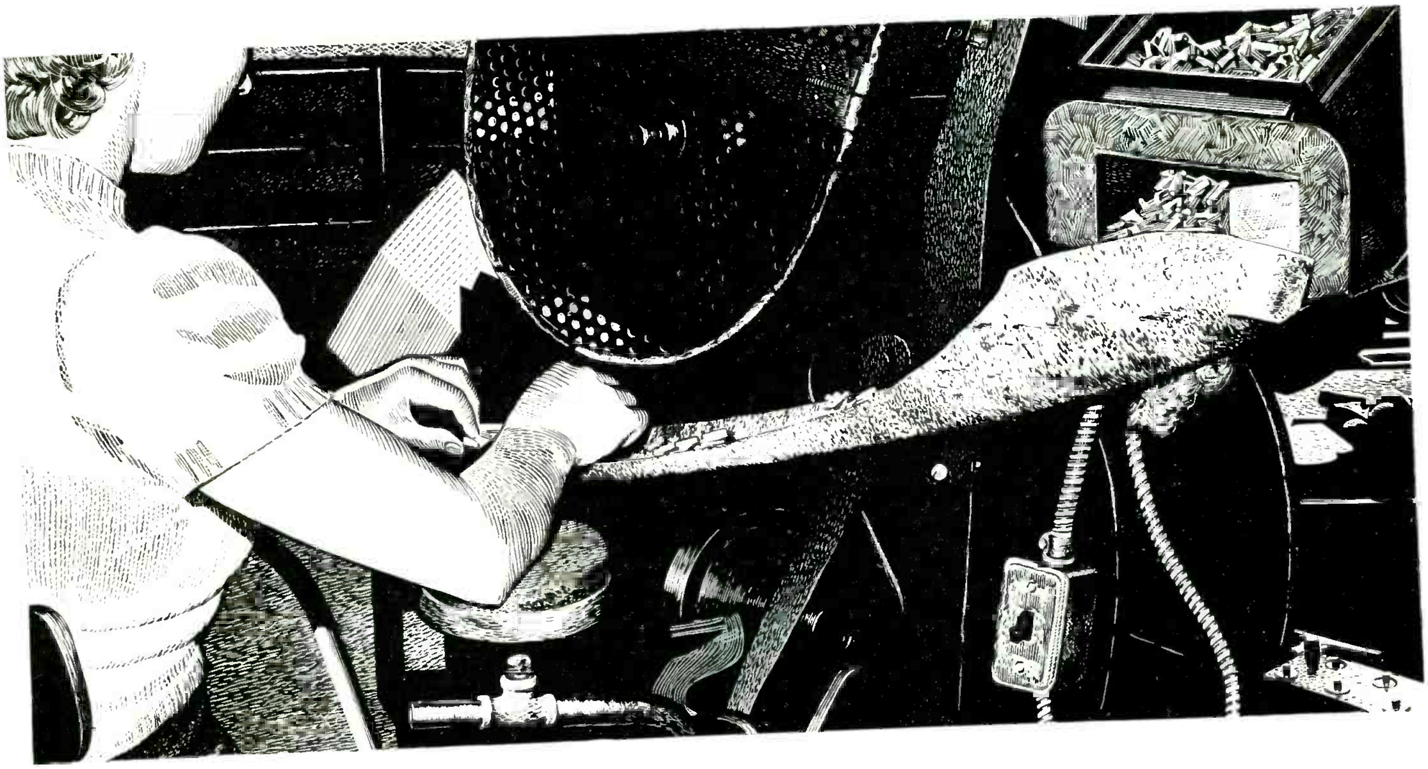
1
COMMUNICATIONS
...directing arm of combat
This battle drawing was prepared with the aid of Army and Navy authorities.
IN modern battle, our fighting units may be many miles apart. Yet every unit, every movement, is closely knit into the whole scheme of combat—through communications.
Today much of this equipment is made by Western Electric, for 60 years manufacturer for the Bell System.
Here are some examples of communications in action.
1 Field H.Q. guides the action through field telephones, teletypewriters, switchboards, wire, cable, radio. Back of it is G. H. Q., directing the larger strategy . . . also through electrical communications. The Signal Corps supplies and maintains all of this equipment.
2 Air commander radios his squadron to bomb enemy beyond river.
3 On these transports, the command rings out over battle announcing system, "Away landing force!"
4 Swift PT boats get orders flashed by radio to torpedo enemy cruiser.
5 From observation post goes the telephone message to artillery, "Last of enemy tanks about to withdraw across bridge . . ."
6 Artillery officer telephones in reply, "Battery will lay a 5 minute concentration on bridge."
7 Tanks, followed by troops in personnel carriers, speed toward right on a wide end-run to flank the enemy. They get their orders and keep in contact—by radio.
Western Electric
ARSENAL OF COMMUNICATIONS



How Sally used up a copper mine

LOOK at the picture carefully. See that elbow-rest under Sally's arm?

It is significant. In fact, it's a humble sermon on war production.

Understand the existence of that arm-rest and you understand one of the basic reasons why, in less than seven months after war-conversion, American industry is hollering for Washington to provide more copper and other basic raw materials.

► Before Sally got her arm-rest, she reached over to a box, picked up a tiny part for an airplane instrument and placed it in the machine . . . Now the supply box is tilted and constantly jiggled, so that the parts flow to her finger-tips. With each motion Sally saves a fraction of an ounce of energy and half a second of time.

Without such tiny savings of time and effort, America's 20,000,000 factory workers would be hopelessly handicapped in their race against the millions at work with a head-start of years in Germany, Japan and Italy.

► The muscle-misers and second-savers of our factories come in handy in this war, when splitting seconds in production is as important as it is in battle.

Who are the men that provide the arm-rests, jiggle the supply-boxes, conduct the ceaseless hunt for wasted half-seconds and needless human motion?

► They are the "methods" men of industry. They have all sorts of titles: plant managers, operations managers, methods engineers, efficiency engineers, etc. But their job is "to manage men and machines to save time and materials."

In peace, these men were the core of the industrial system that gave you the world's highest living standard at the world's lowest cost in hours of work.

► In war, these same "methods-managers," with the intelligent cooperation of American workmen, are cutting years from our arming task by splitting seconds from its millions of individual operations. This example of time-saving is just an indicator of what a plant operating man does. Such men have many other jobs, including the important job of plant maintenance, but "second-splitting" is the field in which they are the envy of the whole world.

The American Production Manager is the product of the American industrial system. Complex, loose-jointed and aimless though our system may seem to the theorist, it meets every challenge, because it is the best system ever devised by man for discovering, developing and rewarding individual initiative.

Reprints of this advertisement are available in handy booklet form.

McGRAW-HILL PUBLISHING COMPANY, Inc.

330 WEST 42ND STREET • • NEW YORK

SALLY—

IS UP YOUR ALLEY!

WASHINGTON, and other large city newspapers were used for the advertisement shown opposite, because government and public need to understand the asset which America has in its trained industrial staffs.

Read what we said about "methods management" in the advertisement, then ask yourself the secret of American genius for production economies in men, materials and time.

One big advantage we have in this country is the interchange of know-how between industries. If an instrument maker reduces a fourth-class hand motion to third-class, all other managers of small part assembly can, and do, find out how it was done.

By means of the articles and advertisements in FACTORY,* a plant operations magazine, tens of thousands of plant operating men keep abreast of each new development in equipment and technique.

The magazines of the McGraw-Hill Network of Industrial Communication exist solely for swapping ideas. They are backed by the editors and engineer-correspondents, who gather information wherever it is developed, and funnel it out to the fields where it is needed.

So valuable is this interchange of technical information that many companies are surveying their organizations to make sure that the supply of Industrial Magazines is adequate.

If you would like suggestions as to how to conduct such a survey, just write to Reading Counselor Department, 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 1,500,000 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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THE McGRAW-HILL NETWORK OF INDUSTRIAL COMMUNICATION:

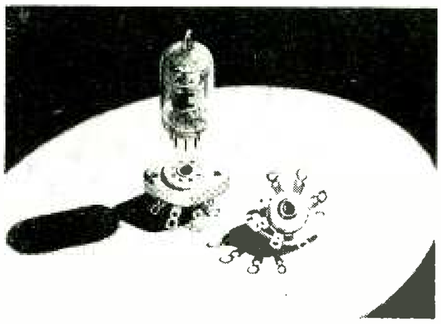
*Factory Management & Maintenance—*SHOWS HOW TO MANAGE MEN AND MACHINES TO SAVE TIME AND MATERIALS*

American Machinist	Coal Age	Electronics	Mill Supplies
Aviation	Construction Methods	Engineering & Mining Journal	Power
Bus Transportation	Electrical Contracting	E. & M. J. Metal and Mineral Markets	Product Engineering
Business Week	Electrical Merchandising	Engineering News-Record	Textile World
Chemical & Metallurgical Engineering	Electrical West	Food Industries	Transit Journal
	Electrical World		Wholesaler's Salesman

ALSO AFFILIATED WITH BUSINESS PUBLISHERS INTERNATIONAL CORPORATION, PUBLISHERS OF BUSINESS AND TECHNICAL MAGAZINES FOR OVERSEAS CIRCULATION

Miniature Tube Socket

A MINIATURE TUBE SOCKET, designated as No. 267 (Navy type designation CEJ-49401) is a new addition to the line of "Viking" products of the manufacturer. The socket utilizes government grade G steatite insulation which consists of glazed top and sides, with the bottom wax impregnated. The socket is designed for use with the 9000 series and miniature series tubes including RCA 1S4, 1S5, 1T4, 1R5,



etc. Contacts are phosphor bronze, heavily silver plated, and are self-aligning so that they receive the tube prongs without danger of fracturing the glass base of the tube. Other features include orientation of contacts for minimum capacity effect and a center shield for grounding to chassis. Folder D and general products catalog 967D give additional information as well as prices and delivery on this item.

E. F. Johnson Co., Waseca, Minn.

Solder Pots

SMALL CAPACITY SOLDER pots are available for continuous operation in radio, motor and similar electrical equipment plants where individual soldering melting pots are desired for each operator or for small repair and homecraft shops. The pots are sturdily constructed, consisting of a cast iron pot which is mounted by a single screw

onto a plated steel stand. The pot is heated by a single heat, porcelain nickel-chrome heating element which can be quickly and inexpensively replaced when necessary. These pots are available in two capacities. The first is Model No. 200 with a $1\frac{3}{4}$ lb capacity. and the other is Model No. 250 which has a 2 lb capacity.

Lectrohm, Inc., 5125 West 25th St., Cicero, Ill.

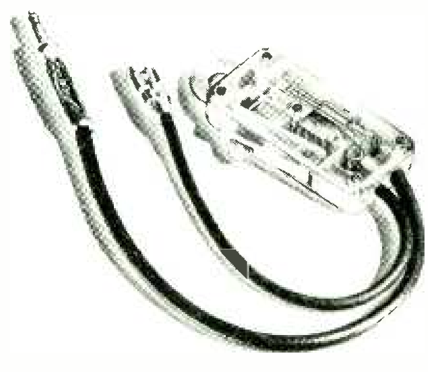
Diamond Saws

"VRECO" DIAMOND SAWS are designed for use in speeding up production and in cutting manufacturing costs in the production of piezo quartz crystals for Army and Navy radio communication systems. The machine utilizes a special rolling-in process which eliminates hammering and makes a perfect flange or bead. Other features of the machine include a more uniform spacing and depth of nicks; and a more even distribution of the diamond. Immediate deliveries are subject to priority. Sizes available are 6, 8, 10, 12, 14 and 16 inch.

Vreeland Lapidary Mfg. Co., 2020 S. W. Jefferson St., Portland, Ore.

Phone-Switch

TYPE SW-141 PHONE-SWITCH is a connecting link between air and ground communications. It is a double circuit microphone switch designed for use by an operator wearing heavy mittens, and is so constructed as to permit easy on and off switching. It remains in open position normally and can be locked into closed position. High impact strength Tenite 11 is used in its con-



struction. The instrument is heavily nickel plated, and uses Bakelite insulation. The switch is mounted on sturdy brass brackets, with blades made of a phosphor bronze material. Cordage clamps for taking up cable strain are provided as an integral part of the housing. The device measures $4\frac{15}{32}$ inches in length, $\frac{3}{4}$ inches in thickness, and $1\frac{3}{4}$ inches in width.

American Radio Hardware Co., 476 Broadway, New York, N. Y.

Gummed Labels

A NEW GUMMING which is called "stick-to-metal" is available for either paper or linen fabric stickers to be used on tools, machines, etc. The stickers may be used to carry inspection data, instructions, or warnings. Samples of "stick-to-metal" gumming on either paper or linen fabric for test purposes are available from the manufacturer, as well as a free booklet entitled "War Production Labels."

Ever Ready Label Corp., 141 East 25th St., New York, N. Y.

A BETTERMENT . . .

Not a Substitute

Has there been a substitution for the "Good Old Days" Saturday night lavation?

No, the modern shower is a BETTERMENT!

Romantic as we may be, few, if any of us, would want to go back to the old tub bath in the stove-heated kitchen (often the only heated room in the house).

Neither will many of you designers and engineers want to go back to commonly used materials . . . now practically impossible to get . . . once you replace these materials, not with substitutes, but with materials designed to do a better job for you.

Getting the right NON-metallic material need not involve tedious delays for research and experiment. The CONTINENTAL-DIAMOND Laboratory has been doing experimental work of this nature for more than 27 years. Its files contain records of hundreds of difficult material problems solved. C-D is not limited to working with one or two NON-metallics, but manufactures FIVE distinctly different materials. One of these may be the answer to your "What Material?" problem.

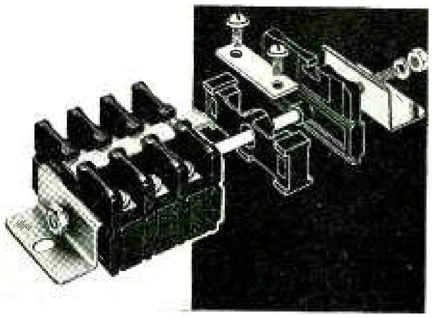
Avoid substitute materials . . . so you won't have to go back to the kitchen-tub bath. . . . Write us today about your problems. . . . Send for Booklet GF-13.

Continental-Diamond FIBRE COMPANY

Established 1895 . . Manufacturers of Laminated Plastics since 1911 — NEWARK • DELAWARE

Terminal Blocks

THESE BLOCKS ARE DESIGNED with ample clearance and leakage distances for use in circuits up to 750 volts, and are conservatively rated at 30 amps. The dielectric strength at 60 cps (50 percent relative humidity) is approximately 373 volts per mil. All blocks are tested at the factory at 2500 volts to ground. The molded sectional design of the blocks makes it possible to have terminal blocks from one to fifty terminals, eliminating waste space and saving time in mounting. The blocks are equipped with white marker strips, washer head terminal screws and large section terminal strips held firmly in place. Steel mounting brackets are provided with slotted mounting holes $\frac{5}{16}$ inch long to accommodate a No. 10 screw, facilitating easy mounting.

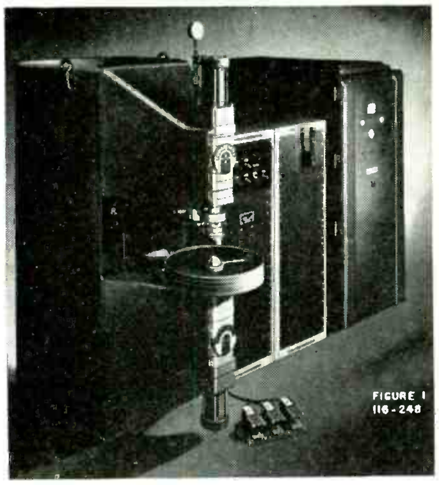


To make ordering easier these blocks are available in sets of unassembled parts. The parts come in kits. The CDM-100 kit contains 50 center barriers and terminals, while the CDM-101 Kit contains five sets of end barriers, mounting brackets, marking strip, threaded through rod and other necessary hardware. These kits come in handy for use where terminal block requirements are varied.

Curtis Development & Mfg. Co., 1 North Crawford Ave., Chicago, Ill.

Forge Welder

"TEMP-A-TROL" IS THE NAME of a forge welder which makes possible combined automatic spot welding and heat-treating of alloy steels and heavy sections. It permits the employment of relatively unskilled labor for spot welding operations. In operation, the weld itself automatically controls the functioning of the machine. It isn't necessary to change the machine controls since welds of exactly equal quality can be produced consecutively in $\frac{1}{4}$ to $\frac{1}{4}$ inch material, $\frac{3}{16}$ to $\frac{1}{4}$ inch, in $\frac{1}{4}$ to $\frac{3}{8}$ inch, or in three sections of $\frac{1}{4}$ inch material at the same time. The welder can be used to automatically heat-treat the weld in the same operation. This post-heat refines the grain size of the weld and eliminates coarse and brittle grain structures. In setting the control of the welder it is necessary only to determine the temperatures which will produce the best weld and heat-treat characteristics in



any given material. The basic element of the control is a welding electrode of a highly sensitive thermocouple which shuts off the current when the correct temperature is reached, and turns it on again when the weld has been cooled to the proper degree.

Bulletin No. 301 gives line drawings of the thermocouple electrode, a typical "Temp-A-Trol" cycle, comparisons of grain structure, diagram of automatic phase-shift heat control, etc., and is available from the manufacturer, Progressive Welder Co., 3100 East Outer Drive, Detroit, Mich.

Transceiver

"AIRPHONE" (MODEL BRT) is a simple to install piece of equipment which is designed for operation with aircraft type microphones. It weighs eight pounds and operates from self-contained standard batteries. Both the transmitter and the receiver are crystal controlled. The receiver section is manually operated and has automatic volume control and automatic audio

level control. The output impedance to earphones is 500 ohms. The transmitter has an output of ½ watt with push-to-talk operation, and no stand-by current drain. Both transmitter and receiver operate on a frequency range of 2000 to 8500 kcs. The transceiver measures 4 x 3 x 8 inches. Orders for Model BRT should specify the desired operating frequency in kilocycles, and the desired type of microphone jack.

Airphone Div., United Cinephone Corp., Torrington, Conn.

Communication System With Interceptor Control

THIS IMPROVED Executive-Monitor communication system consists of two or more master stations connecting up to nineteen remote stations in the system. The executive and monitor stations can talk to each other, or either can carry on two-way amplified voice conversations with remote desk or trumpet-type sub-stations in outlying departments. The interceptor-control feature enables the assistant at the monitor station to intercept all incoming calls originating at the remote stations. Both the executive and monitor stations are equipped with busy signals to show when other stations are in use. A paging button enables the user of any master station to call all other stations simultaneously, for paging and locating persons instantly, and for issuing emergency warnings or general announcements to the entire staff. High-powered trumpet-type substations provide extra sound volume. All wiring lines are connected to inconspicuous junction boxes for neat and simplified installation. The unit utilizes 110–120 volts, alternating or direct current. Power consumption for the entire system is rated at 46 watts. This system is UL approved and is licensed under A.T. & T. patents.

Executone, Inc., 415 Lexington Ave., New York, N. Y.

Flexible Heating Element

"GLASOHM" IS A glass-insulated, low-power, flexible heating element which is available in any length, by the inch, foot or yard, and is particularly useful in very limited spaces. Its construction consists of a resistance wire which is wound on a fibre-glass core and is protected by a fibre-glass braided covering. The fibre-glass can be readily bent and compacted to fit snugly about parts to be heated, or jammed into very tight spots. Wattage ratings are from 1 to 4 watts per body inch, depending on the application. Operating temperatures may be as high as 750 deg. F.

Clarostat Mfg. Co., Inc., 285 North 6th Street, Brooklyn, N. Y.

Inter-communicating System

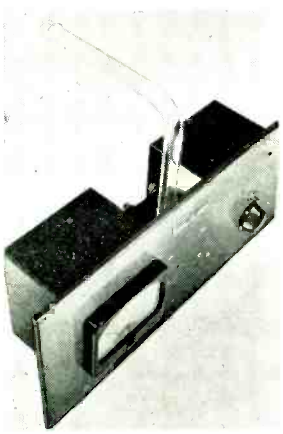
THIS SYSTEM IS designated as the KS-60 Super Selective system and is made up exclusively of master stations and permits a number of two-way conversations to be held simultaneously without crosstalk. The master stations can call one another regardless of whether the station being called has power on or not. Systems may be built up progressively beginning with two master stations to any amount of stations desired. A feature of the unit is its use of private earphones. When an earphone is used the "talk-listen" switch does not have to be operated, and the unit works exactly the same as a telephone. Volume for earphones is adjustable.

These units have an amplifier of super sensitive design which delivers a maximum output of 2½ watts and permits operation with undiminished power and efficiency with the units as far as 3000 feet from one another. Systems consisting of 2 to 10, 20, 30, 40, 60, 80, etc., stations are available.

Talk-A-Phone Mfg. Co., 1219 W. Van Burren St., Chicago, Ill.

Continuous-Flow Colorimeter

"LUMETRON" (MODEL 400-S) is a continuous-flow colorimeter for immediate and direct indication of the light transmission of a liquid flowing through the instrument. It is suitable for continuous registration of concentration, color or turbidity of solutions in chemical processes. The operating principle of the instrument is similar to the one of the usual type of photoelectric colorimeters except that the liquid under test passes through a glass tube



rather than being contained in an absorption cell or a test tube. Once calibrated by means of a solution of known concentration, the instrument indicates the concentration directly and continuously, obviating the necessity of taking samples and analyzing them at regular intervals. The instrument operates from 105–125 volts, 50–60 cps alternating current, and has a constant voltage transformer and a built-in color filter. The price of the instrument is approximately $170.

Photovolt Corp., 95 Madison Ave., New York, N. Y.

Literature

Phenolite Handbook. This handbook contains technical and descriptive data on Phenolite, laminated Bakelite. The handbook describes how Phenolite is made, its general properties, various sheets made, grades of paper base, grades of fabric base, grades of asbestos base, how Phenolite tubing is made, tubing grades, values and tolerances, tolerances of Phenolite rods and the typical uses of all Phenolite. Also included in this handbook, in chart form, are the related Navy and Federal specifications. This forty-four page handbook available from National Vulcanized Fibre Co., Wilmington, Del.

Replacement Sheets. Several new sheets are available for the following bulletins to bring them up-to-date: Bulletin 1—discounts and terms; Bulletin 23—Vitrohm strip resistor; Bulletin 60A—Vitrohm and Ribohm field rheostats; Bulletin 69—4 inch pressed steel rheostats; Bulletin 2721—Type C motor disconnect switches; Bulletin 2722—motor disconnect switches Type C; Bulletin 2751—tumbler type motor starting switches; Bulletin 4021—a-c combination starters; Bulletin 4201—a-c automatic motor starters; Bulletin 4221—automatic transfer switches; Bulletin 351—thermal time delay relays. These replacement sheets are available from Ward Leonard Electric Co., Mount Vernon, New York.

Low Temperature Brazing. In a recent issue of "Low Temperature Brazing News" No. 19 a typical war application of Easy-Flo-Silver brazing alloy is illustrated. It describes the problem of brazing a ¾ inch threaded flange into a completely closed 20 gauge sheet steel container. Issued by Handy & Harman, 82 Fulton St., New York, N. Y.

Color Code Resistor Card. This pocket size color code resistor card shows clearly the A, B, C and D color denotations of a resistor. It explains the resistor color code and gives examples. On the reverse side of the card is Ohm's Law. This card is free to all Sylvania radio servicemen. Available through Sylvania jobbers or from Sylvania News, Emporium, Pa.

Screws. In this 20 page illustrated booklet, on self-tapping screws, is described the quality routine; the functions and advantages of each type; stock sizes and head styles; packing, finishes and special screws. All types of self-tapping screws are covered and their typical applications. Booklet No. 475 available from Parker-Kalon Corp., 200 Varick St., New York, N. Y.

Colloidal Graphite. A 4 page bulletin, No. 421-T on the use of "dag" colloidal graphite as a lubricant for running-in internal combustion engines, compressors and other mechanical equipment is obtainable from Acheson Colloids Corp., Port Huron, Mich.

Tube Base Data Connections and Chart. In an 8 page folder the element connection and base layout of over 600 different types of radio tubes are given. This folder permits rapid socket selection for practically any tube now in commercial use. Tube base connections are illustrated by diagrammatic sketches of the bottom view of the tube bases. A tube base chart is included which indicates the proper base to use for any of the tubes listed. This folder may be obtained from Weston Electrical Instrument Corp., Newark, N. J.

Selenium Rectifiers. Bulletin R-40 contains general information on selenium rectifiers, including their assembly, plate sizes, efficiency, input voltage, stability, cooling, regulation, etc. Illustrations and graphs covered by the text matter are included in the bulletin. Benwood Linze Co., 1815 Locust St., St. Louis, Mo.

Frequency Assignment Chart. A chart showing the frequency assignments in the radio spectrum for stations in the United States is available from ELECTRONICS Editorial Department at ten cents per copy, payable when ordering. This chart was compiled in September 1940 from data of the Federal Communications Commission, and includes revisions above 30 Mc, adopted in May and June 1940. The chart is printed on heavy coated paper and is suitable for framing since it is mailed unfolded.

ASA Price List for 1942. More than 550 American Standards are listed in the price list for 1942 by the American Standards Association, 71 of these represent new and revised standards approved since the last (Feb. 1942) issue of the list. There is a separate heading for standards developed specifically for the war effort. Another section is devoted to safety standards. Other standards include definitions of technical terms, specifications for metals and other materials, test methods for finished products, dimensions, etc. Send requests to American Standards Association, 29 W. 39th St., New York, N. Y.

Also available is the new standard methods of testing and tolerances for fabric tubular sleeving and braids. This specifies permissible variations on inside diameter and wall thickness of sleevings and braids, also governs tolerances as to weight, number of carriers, ends on bobbin, yarn number and imperfections. Available from American Standards Association at the above address.

Electrical Connectors. This 16 page illustrated condensed catalog supplement covers the most popular types of electrical connectors. The catalog deals briefly with the two leading types used in aircraft applications and details more complete information on connectors for radio microphones, sound equipment, power heavy-duty control circuits, public address systems and geophysical research, electronic low-level circuits and small power applications. Obtainable from Cannon Electric Development Company, Los Angeles, Calif.

House Organ. In the May 1942 issue of *The Aerovox Research Worker* is published the article "Taking Complete A-F Amplifier Data". This article describes the procedure for the routine inspection of audio amplifiers in maintenance and trouble shooting.

In the June 1942 issue is an article "Amplitude Modulation". This article covers the use and advantages of complete modulation, side band generation and amplitude modulation circuits.

"High-Efficiency R-f Amplifiers" are described in the July 1942 issue. Class B operation, the Doherty high-efficiency amplifier and Terman-Woodyard amplifier are covered. Available from Aerovox Corp., New Bedford, Mass.

Industrial Instruments. Catalog 95-A describes instruments for the measurement and control of industrial process conditions. The bulletin is made up of ten sections: grouping and description of all instruments, accessories and supplies appropriate to a particular field of application, such as temperature, flow, pressure, level, humidity, etc., combination instruments, valves, instrument panels and similar subjects. Copies from The Foxboro Co., Publicity Dept., Foxboro, Mass.

Switches. This is a preliminary bulletin which describes Type DX mu-switch, designed especially for direct current. The technical specifications and operating characteristics are included. Mu-Switch Corp., Canton, Mass.

House Organ. The October-November issue of *National Radio News* contains an article "Electronics Promises Bright Future". This article, based on the General Electric Company's quarterly report to its stockholders, states that electronics is the new science for the new world and the bright promise for the future. Other interesting articles covered in this issue are: How Recordings are Made, Thordarson 15-watt Amplifier, Interchangeability Chart for Discontinued Tubes, Questions and Answers for Radio Operator Examinations. This is the official house organ of the National Radio Institute Alumni Assoc., 16th & You St., N. W., Washington, D. C.

Thermocouple and Tube Data. A new 6 page bulletin which acts as a guide in the selection of the most satisfactory thermocouples, thermocouple protecting tubes and lead wire for a given instrument application in line with restrictions placed upon certain critical materials. It supplements the first bulletin ever issued by an instrument manufacturer to list thermocouples by materials, rather than by trade names, it gives recommendations on thermocouples, lead wire, protecting tubes, plugs and sockets; information on thermocouple checking; millivolt conversion tables and other useful data.

In the September 1942 issue of *Wheelco Comments* appears an article "Universal Controllers Offer Unusual Approach to Temperature Control Problems". This article describes and illustrates design features of the company's universal controllers.

Both releases obtainable from Wheelco Instruments Co., Harrison & Peoria St., Chicago, Ill.

Maintenance and Operation Instruction. "Keep 'Em Working" is the title of a new book which aids owners of "Caterpillar" products in getting the most out of their machines. It gives the reasons behind the maintenance and operation instructions, goes into detail on the care of certain critical parts and gives general information that is not conveniently available elsewhere. Form No. 7609 available from Caterpillar Tractor Co., Peoria, Ill.

New Type Calendar. This calendar, built on a War Week basis, with its 52 weekly sheets has an overall size of $15\frac{7}{8} \times 24\frac{1}{2}$ inches. A section of technical data for the engineer and draftsman is included. This section contains charts on wire and sheet metal gages, screw threads, etc. Request should be written on business letterheads to Frederick Post Co., Box 803, Chicago, Ill.

Metal Shielded Wire. Bulletin 202 describes Precision metal shielded wire. The bulletin describes the method of protecting insulated wire enclosed in either thin wall seamless aluminum, copper or lead tubing. Bulletin 202 available from Precision Tube Co., 3824 Terrace St., Philadelphia, Pa.

Capacitors. Bulletin GEA-2027 describes a-c Pyranol capacitors for use with motors, in control, fluorescent lamp ballasts, luminous tube transformers and other a-c equipment. Bulletin GEA-2621 describes d-c Pyranol capacitors for use with radio transmitters, electronic devices and various d-c industrial applications. Bulletin GEA-3966 describes Navy type capacitors for d-c filter applications. All three bulletins from General Electric Co., Schenectady, N. Y.

Electron Tube Terminology

(*Continued from page* 45)

because of this very fact that certain of the vacuum tube names are so well established.

About six years ago, Westinghouse and General Electric agreed between themselves to the use of certain definitions so as to minimize misunderstandings. This list is reproduced in Table 1 and was published in the February, 1937, issue of *Electrical Engineering* (page 284). This list, of course, includes no trademarked words.

Adoption of These Special Names

A survey of the available latest editions of general, as well as technical, dictionaries indicates the extent to which these tube names have been adopted. Table 2 summarizes this point.

Certain other tube names also appear in these same dictionaries as shown in Table 3. The definitions accompanying these words vary to some extent and some even appear to be incorrect.

The classification shown in Table 1 is by no means a closed or finished affair. Whenever some real new electron tube incorporating a new combination of these variables or new variables comes into the picture, a new name is in order if it can take the place of a long descriptive phrase and can later be standardized as it comes into general use. For instance, in the June issue of ELECTRONICS, a classification of electron tubes is shown on page 52. This contains the word "permatron," which is a combination of a hot-cathode, gas, or vapor-content diode with magnetic control. If this word is not trademarked, there is no reason why it should not be a candidate for standardization if and when it comes into common use and takes the place of a more cumbersome description.

As was indicated in the reception to the use of the early term 'audion,' there is a considerable weight of opinion against new names and much is to be said for this viewpoint. Experience has shown, however, that such a name for a new device cannot be discouraged by official pronouncements if it fills the need and it is just as true that a new name with official or sponsored backing may make little practical headway. This is just another way of saying that new names come into general use in their own field entirely on the basis of a need for them, the ease of remembering them, and their general phonetic quality. The word "mutator" is an example of a good name that has made little progress even in the face of international standardization. On the other hand, it is difficult to find many references in which the device we call an "ignitron" is given any other name.

One basic difficulty in this whole matter arises from the fact that electron tubes are used in so many widely different spheres that complete adoption of any group of names is too much to be expected. For instance, mercury-arc, tank rectifiers, fluorescent lamps, and X-ray tubes all employ basic and, in certain respects, similar electronic phenomena. However, the engineers involved in their development, design, and use are in such widely separated fields that it is very difficult for any single standardizing group or organization to include these items. However, an agency like the American Standards Association can standardize on certain names when their usage and meaning indicate that they are definite and are quite universally accepted. Such standardization by the A.S.A. is already an accomplished fact in the case of the word 'phototube.'

This body might well consider certain other suitable names for standardization, such as grid-glow tube, ignitron, thyratron, and possibly others that are definite, commonly accepted, and regularly used.

REFERENCES

(1) Millikan, R. A., "The Electron." The University of Chicago Press, Chicago, Ill., 1917.

(2) Thomson, J. J., "Conduction of Electricity Through Gases." University Press, Cambridge, England, 1906.

(3) Fleming, J. A., "The Principles of Electric Wave Telegraphy and Telephony." Longmans, Green & Co., London, England, 1910.

(4) Langmuir, Dr. Irving, The Pure Electron Discharge, *Proc. I. R. E.*, 3, 261, 1915.

(5) Hull, A. W., The Dynatron, a Vacuum Tube Possessing Negative Resistance, *Proc. I. R. E.*, 11, p. 5, 1938.

(6) Tronton, Prof. F. T., Obituary of Dr. Stoney, *Nature*, July 13, 1911.

Harmonic Wave Analyzer (Continued from page 62)

used as it gave very nearly a straight line scale. It was thought that this system would also require no zero adjustment. This did not prove true as a steady current of about 0.05 milliampere had to be bucked out by feeding a small voltage back from the power supply. The tap on the voltage divider is determined by trial as the current to be bucked out varies for different tubes.

Since the calibration of the voltmeter was very nearly linear, it was found convenient to provide three ranges having full scale distortion readings of 100 percent, 50 percent and 10 percent. These scales will give readily ascertainable readings of harmonics to a low as 0.2 of 1 percent. The scale change was accomplished by means of a series of resistors and a three point tap switch connected as the grid resistor of the 75 triode. With R_1 and R_2 equal, and R_3 equal to 8 R_1, the full scale readings of the meter will be 100, 50, and 10 percent.

Instrument Calibration

Calibration of this instrument is a rather simple procedure and can be done in either of two ways. The first method used was to feed a 2000 cps signal of adjustable amplitude into the instrument and to determine the output meter reading in terms of the input voltage. This procedure was then repeated with adjustable voltages of 4,000 and 6,000 cps. The harmonic distortion was then calculated and calibration curves were then plotted showing the percent of harmonic distortion against the output current. With this method there will be little error introduced by aging of the tubes.

The second method of calibration uses two oscillators, the first of which must be free of harmonics. Such a sinusoidal oscillator may be obtained by inserting a 2000 cps band-pass filter in the output of the laboratory oscillator or generator. The output of the second oscillator is fed into the instrument in series with that of the 2000 cps oscillator as shown in Fig. 4. Meters are placed across the output of both oscillators and the harmonic voltage, which is thus artifically generated, can be read directly. It is important that the mixing resistances be linear (i.e., independent of voltage or current) to prevent modulation of one oscillator by the other.

The voltage of the No. 1 or distortionless oscillator is adjusted for full scale reading of the meter with the 2000 cps filter connected in the wave analyzer. The 4000 cps filter of the analyzer is then cut in. The voltage of the 4000 cps oscillator is gradually increased and a curve of harmonic voltage against output current is plotted for second harmonic distortion. This procedure is repeated for the third harmonic and the percentage distortion is determined as in the previous method. These two methods of calibration checked with a maximum difference of 2 percent, which occurred near full scale readings. Calibration curve for the second harmonic is shown in Fig. 5. The third harmonic calibration was practically identical.

By properly apportioning the scale changing resistances R_1, R_2 and R_3, as previously described, a single calibration curve may be used for the instrument if all filters have the same mid-frequency attenuation. The mid-frequency attenuation of the filters may be adjusted by connecting an appropriate resistor across the shunt arm inductance, L_2. In this instrument, it was necessary to shunt the 4000 cps filter with a 220 ohm resistance to make the attenuation equal to that of the 6000 cps filter.

Operation of this analyzer is relatively simple and rapid. The device to be measured is supplied with a 2000 cps distortionless or sinusoidal voltage and the output from the device connected directly to the analyzer. With the 2000 cps filter in the circuit and the meter switched to the 100 percent position, the gain control of the analyzer is adjusted to give full scale reading of the meter. The 4000 and 6000 cps filters are then switched in and the magnitudes of the second and third harmonic voltages are read respectively. The minimum voltage necessary to operate this instrument is approximately 4 volts.

This instrument has been found very useful in measuring the harmonic content of various amplifiers constructed in the laboratory and in other experiments.

Time Control

(*Continued from page* 49)

teries. Change-over takes place so quickly that the operation of the clocks is not affected.

Technically Simple System

In its technical essentials, the timing system is not complicated. The output of the tuning fork is amplified by eight 50-watt amplifiers with outputs connected in parallel to provide a total power output of 400 watts.

The stand-by power supply is equally simple. A 60-cps a-c generator is on a common shaft with a 110-v a-c motor and a 32-v d-c motor. Under normal conditions, the generator is driven by the a-c motor which, in turn, is connected to the city mains. If this source of power should fail, an automatic switch causes the d-c motor to assume the load, operating from storage batteries.

Rear-panel view of precision clock control equipment, showing tuning-fork units, amplifiers and power supplies. All units are in duplicate and are interchangeable

As an additional precaution, the clocks in all studios are placed on one circuit, while those in all studio control booths are placed on another circuit. Thus, if trouble should develop in one circuit the programming staff would have recourse to the clocks on the remaining circuit.

When checking the master clock with Naval Observatory time signals, the engineer in charge may

An inter-office distribution panel for the precision clock control circuits

speed up or retard the entire time clock system for correction purposes by bringing into play either one of two secondary tuning forks. One of these vibrates at 65 cps; the other at 55 cps. The actual correction is accomplished automatically, the proper correction frequency being applied for the required period of time by an auxiliary clock device.

The new system is now transmitting time signals to the NBC network at 9 AM and at 5 PM, EWT. Each of the pulses transmitted consists of a 750 cps tone of approximately one-half second duration, transmitted at a volume somewhat less than that of programs carried on the same lines. The reduced volume minimizes any objections by listeners if the time signals should occur during broadcasts.

• • •

INDUCTION PROBES FOR MEDICAL USES

Samuel Berman, New York engineer, holds two of his electromagnetic induction probes, designed to speed the location of imbedded metal. The device can be used directly in an incision and in some instances has cut the probing time from three hours to ten minutes

Power Amplifier Performance

(*Continued from page* 56)

slight effect upon the driving power or grid dissipation. If, on the other hand, power output is a primary consideration, we would move A slightly in the direction (b) until the plate or grid dissipation would limit operation. The possible positions which A may assume on the $e_b - e_c$ plate are restricted by excessive electrode dissipation in the manner indicated qualitatively on Fig. 5.

The calculating device which has been described has been used quite successfully by the students at the Illinois Institute of Technology. A zinc plate was made of the drawing shown in Fig. 6, and the calculators were printed from it on plastic sheets. It was found convenient to include on the sheet the formulae used in the calculating process, so that they might be readily available. The book store at the Illinois Institute of Technology or the Harvard Cooperative Society, Harvard Square, Cambridge, Massachusetts, will be glad to supply the calculators, at manufacturer's cost, to anyone who desires them.

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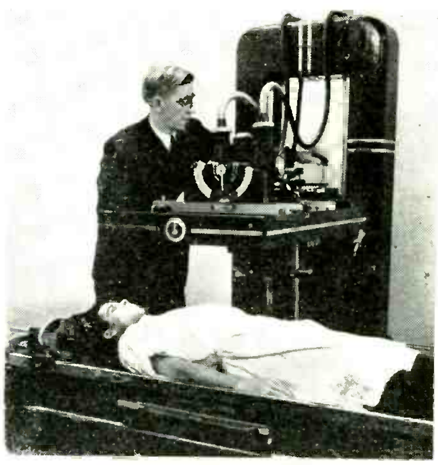
NEW NAVAL HOSPITAL



A new Naval medical center with the most modern medical devices was opened recently. Commander C. F. Behrens is shown adjusting the Kieffer laminagraph machine, which is used for x-rays of any predetermined layer in the body, without showing any other tissues

Avoiding Patent Pitfalls

(Continued from page 78)

himself translate his abstract idea into an embodiment in order to provide the basis for a patentable invention.

Records

The necessity of keeping records of the invention and all work relating thereto is due to the fact that in this country a patent is granted to the first inventor. If two or more inventors apply within certain time limits for a patent covering the same invention, the Patent Office assumes that the applicant who filed his application first is also the inventor, but gives the later applicant the opportunity to contest this position and to prove, if he can, that he is the first inventor and entitled to the patent although he is the later applicant. The proceedings instituted by the Patent Office to determine the priority of inventorship is called an "interference". The decision on the priority of inventorship is made by the Patent Office on the basis of the evidence submitted. This evidence consists of the records kept by the inventor and his co-workers, if any, his oral testimony as well as that of his co-workers and other witnesses. Since oral testimony alone does not carry too much weight, written records are of great importance.

The important factors in an interference proceeding are the conception of the invention, the disclosure thereof to others, continuous diligence in completing and perfecting the invention, the reduction to practice thereof, and the filing of a patent application.

There are two types of reduction to practice which constitute a completion of the invention, actual reduction to practice by successful operation of a model or of the method according to the invention, and constructive reduction to practice by filing a patent application. Both types generally bear the same weight.

The evidence of these acts on the part of the inventor must be conclusive as to fact and date.

In order that a later applicant

may prevail over an earlier applicant, it is necessary that the later applicant present a complete history of his activities, supported by evidence, consisting of a preferably uninterrupted chain of events in the sequence: conception of the invention, disclosure to others, diligence in perfecting and completing the invention and (a) actual reduction to practice and filing of a patent application or, (b) constructive reduction to practice by filing a patent application. The earlier applicant may also present a complete history of his activities or rely solely on his constructive reduction to practice as evidenced by the filing of the application, if he believes the opponent's case is weak or, if he has insufficient evidence to support his history.

Due to particular fact situations in the activities of the contestants various complications can arise, which will not be discussed here.

The best proof of conception is a complete description of the embodiment of the invention shown in the patent application, preferably illustrated where feasible, written by, or at least signed by the inventor and bearing the date of the signature.

Proof of disclosure is established by having the person to whom the disclosure is made, sign the description under the words "witnessed and understood", together with the date of the signature. It is essential that the person to whom the disclosure is made be sufficiently skilled in the art to which the invention relates, to understand the invention, otherwise the disclosure is not considered valid.

Diligence in perfecting or completing the invention or in preparing a patent application must be proven in order to show that the invention was not abandoned. Diligence may consist in improving the embodiment of the invention, in calculations to determine preferred dimensions of the elements of the invention, in work on a theory of operation, or in work leading to the construction of a model or to the operation of the method according to the invention. Diligence may also consist in the preparation of a patent application, but it should be noted that the applicant cannot be excused for any lack of diligence on the part of his attorney.

Actual reduction to practice can be proven by recording the successful operation and preferably demonstration thereof to others. Proof of the constructive reduction to practice obviously lies in the patent application.

Records should preferably be kept in a bound notebook in which daily entries of the inventor's activities are made. Notes not relating to the invention need not be revealed in the interference proceedings.

It is essential that the disclosure show all elements of the invention and their correlation. If the invention relates to a device for use in a complex system, care should be taken to show how the new device fits into the complete system. Conventional elements may be shown by blocks bearing legends. For inventions relating to electrical circuits it may suffice to provide the circuit terminals with the proper legends to indicate its relationship with associated circuits. For inventions relating to tubes, a characteristic circuit is preferably shown, or at least the leads to the various electrodes marked by the proper legends.

Some inventors are much concerned about establishing the proof of the dates of their records. If a witnessed notebook is kept in which entries are made regularly, no difficulty arises in convincing the Patent Office of the veracity of these dates. So much thought is given to the dates that sometimes the importance of the subject matter of the records is overlooked, particularly the completeness of the disclosure. An incomplete disclosure even with a perfectly established and proven date is worthless.

The records should include notes relating to the ordering and receipt of materials and parts needed to a model of the invention, for the purpose of explaining inactivity over any appreciable length of time. The purpose of such notes is to prevent inactivity during periods of waiting from being construed as evidence of an abandonment of the invention, which can happen if the lack of activity is unexplained or inexcuseable. Other business is not an acceptable excuse for inactivity.

If models of mechanical inventions are made, they should be preserved in exactly the same condition in which they were first successfully operated. If this is not possible, photographs showing all significant details should be made, preferably showing a calendar page with the date on which the photograph was taken. A model from which vital parts have been removed is mostly useless as evidence of a reduction to practice.

The importance of all these records might be questioned in view of the fact that many patents are issued on applications which never became involved in interferences. However, it is not possible to foretell whether another inventor has filed an application on the same invention, and the probability that this is the case is relatively high, since the same problems are being attacked simultaneously by a number of different inventors. If the invention is worth the expense of filing a patent application, it is certainly worth while to keep accurate records, thereby to safeguard the rights to a patent as much as possible.

Information required by the attorney

It is necessary that all information concerning the invention be transmitted to the attorney. It is his business to convince the Patent Office that the invention submitted is new and useful and merits a patent, and for this purpose he requires all information available to the inventor as to the aims of the invention, the improvement which the invention represents over known devices, structures and methods, and wherein it differs therefrom. The complete disclosure of the invention together with all records pertaining to the invention should be shown to the attorney. He should also be made familiar with the theory of operation of the invention and with the equivalents of the elements of the embodiment which can be used successfully, in order to enable him to choose terms of proper scope in the claims.

The inventor should familiarize the attorney with the embodiment of the invention, as well as its aims, advantages and novelty. The time required therefor is well spent and the inventor should keep in mind that the attorney is usually not as familiar as he is with the particular problems leading to the invention, and therefore should not place upon the attorney the burden of reconstructing or and re-inventing the invention from meager information supplied.

Temperature Instrumentation

(*Continued from page 74*)

properties which are (although not in order of importance): (1) Accuracy, (2) precision, (3) scale law, (4) unit sensitivity, (5) ultimate sensitivity and dead zone, (6) hysteresis, sticking, etc., (7) readability, (8) lag, (9) damping, (10) stability (and its opposite, drift) and (11) error source.

Temperature, the Variable Factor

Some electrically-trained workers need re-educating when entering the field of temperature instrumentation because "That peculiar thing, temperature," is so unlike any other measurable magnitude. It is an intensive magnitude, like voltage, but here the resemblance ends. Voltage bears an exact relation to other electrical magnitudes and its scale of values from microvolts to megavolts is a "regular" scale. Not so with temperature.

When you read an indicating ammeter you know that it indicates what the current is—not what the current was fifteen seconds ago. When you observe the indicating element of an industrial temperature-responsive system, however, you are reading what the temperature was—perhaps only a quarter-minute ago, perhaps a quarter-hour ago. And if the reading is what the temperature was a quarter-second ago, the case is neither average nor typical but exceptional because there are relatively few low-lag electronic systems today.

It is in connection with this all-important measuring property, known as thermometric lag, that the readers of ELECTRONICS will be able to make their greatest contributions to the advancement of industrial temperature instrumentation. A study of Table I will disclose numerous opportunities. Some of these opportunities have already been discovered. As far back as 1932–34, several industrial systems were developed, utilizing low-lag photocells, phototubes or total-radiation receivers, some with and some without radiation filters, whose output was fed to electronic amplifiers and thence to indicators and recorders likewise characterized by extremely low lag. Some of these have won acceptance beyond the special trial installations for which they were originally made to order; and they are on the market today in practical forms. None of them is customarily referred to as an electronic type. This is not due to prejudice but to usages and to nomenclature based on functional classification. None is "an electronic instrument" to a greater extent than it is some other functional type. Electronic products minimized the lag but did not contribute to accuracy.

Accuracy, Sensitivity and Sensitiveness

This brings up the question of accuracy. Here again some electrical concepts must be erased from one's mind. The zero point, so easily attainable in electrical phenomena by simply opening a circuit, is not attainable in thermal phenomena because there is no sure way of removing all heat from a substance. By international agreement, the ice-point and the steam-point (at normal atmospheric pressure and with other precautions specified) are assigned the values "0.000" and "100.000," thereby defining the fundamental interval of the thermodynamic scale. This scale is only an ideal. The scales of tangible thermometers and pyrometers follow it more or less closely, depending upon factors too numerous to discuss. Suffice it to mention that a thousandth of a degree Centigrade is the limit of accuracy between the ice point and steam point, a hundredth of a degree between the steam point and the sulphur point (44.60 deg. C) a tenth of a degree thence to the silver point (960.5 deg. C) and only one degree to the gold point (1063 deg. C). It is not permissible to assert that a pyrometer can measure the temperature of steel with an accuracy of a hundredth of a degree, not even a tenth of a degree, because the nearest reference point on the International Standard is defined as a whole degree. Various temperature effects, however, permit measuring temperature changes of a millionth of a degree or better. The measuring property here involved is not accuracy but sensitivity—specifically the ultimate sensitivity of the device. Needless to say, a thermometer guaranteed accurate to a tenth of a degree will probably be sensitive to a hundredth. If its ultimate sensitivity were only a tenth, its uncertainty would be two tenths and its certified accuracy about four tenths.

In industrial temperature work, sensitivity is often preferred to absolute accuracy. This is particularly true in temperature control applications, where speed of response to temperature changes is often specified as the essential requirement. Rapid response to temperature changes usually means sensitiveness** to small temperature changes. Here, then, is another promising field for electronic devices, some of which possess the property of sensitivity to a superlative degree. Several excellent starts have been made, although none (to the author's knowledge) has been a purely electronic solution to this particular problem.

Closely linked with ultimate sensitivity are its enemies, friction and other effects usually denoted by the term sticking. This term is usually applied to a measuring element per se. In industrial temperature instrumentation, a primary measuring element often has no other function than to actuate the relay or pilot of a servo mechanism which in turn operates a recording device, a rheostat, a valve, or other power-driven unit. In such cases the primary element commands the servo without effort. The pilot or relay must not impose any drag on the primary element because such drag would impair its sensitivity and accuracy. To this well-known problem of temperature instrumentation, the science of electronics has provided four distinct solutions:

(1) Retain the usual temperature-measuring system which ends in a deflecting pointer or pen-arm. To this pointer or pen-arm, associate without contact the pick-up of an electronic system. This is the solution introduced by a Chicago firm some ten years ago. Several firms now offer it.

(2) Substitute an electrical system for the previously-used temperature-measuring system ending in a pointer. Make the electrical output of this system the input of an electronic system. This solution, too, is found in various commercial embodiments.

** Sensitive*ness* is the term for the property of a controller also known as "dead zone" and sometimes as "differential setting." It is always greater in scale value than the sensit*ivity* of the primary measuring element; example, a two contact thermostat.

(3) Replace the old temperature-measuring system by a strictly electronic device such as a gas or vapor triode, a crystal oscillator, for example, which is temperature-sensitive. Feed its output either to an electronic or to an electrical servo system. The author has heard of this being done but he had not yet seen any commercial announcement.

(4) Replace the old primary system and servo by only one strictly electronic device which is temperature-sensitive and whose output is sufficiently powerful to operate a recording mechanism, a solenoid valve, a proportional-action voltage regulator or even a proportional-action motorized valve.***

It may not be amiss to conclude with a quotation from one of the author's writings on automatic-control technology, and which outlines the essentials of a satisfactory temperature control system.

The Four Requirements

A thermometer or pyrometer merely reports—as would a subordinate sent by a manager to look over a situation; an automatic controller takes action—as would an

*** This paragraph constitutes a partial disclosure without surrender of inventor's rights.

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SHORTWAVE RADIO TRANSMITTER

The new 100 kw transmitter of General Electric's shortwave station WGEO in Schenectady, is one of the most powerful stations in the western hemisphere. Robert E. Sherwood, director of overseas branch of Office of War Information, throws the switch to place the transmitter in operation alert executive to whom reports are submitted. All controllers are active, operating, "live" devices, to be judged by active performance, not by passive qualities.

The proper performance of a controller depends, as does that of a manager, on the correctness and timeliness of the information it receives, and on the limits within which its power may be exercised. Summarizing, we lay down the basic requirements for automatic control of process temperatures in industry:

(1) The temperature to be controlled, or its variation, must be measurable. No controller can be better than its primary measuring element!

(2) The primary element of the automatic controller must be suitable for the measurement involved and must be properly installed.

(3) The power device commanded by the control instrument must adequately control an adequate source of heat supply.

(4) The measuring means must command the corrective means effortlessly, i.e., without having its own measuring properties impaired.

Obvious and simple as are these four basic requirements, they are sometimes lost sight of in the maze of engineering details that have to be taken into account when working out elaborate installations.

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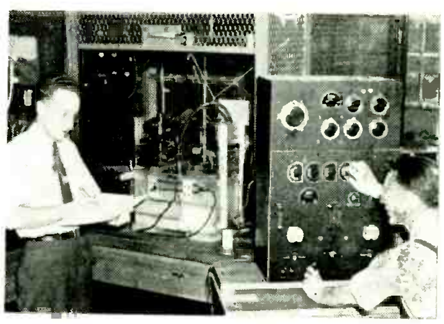
MOLECULES WRIGGLE LIKE WORMS



Dr. Raymond M. Fuoss, of the General Electric research laboratory, has found that some molecules wriggle like worms when an alternating electric field is applied to them. This phenomenon has been useful in the development of artificial silk, rubber, and many plastics used for electrical applications are made from them. Drs. Raymond M. Fuoss and D. J. Mead are shown with the apparatus which makes the molecules wriggle

Remote Control

(*Continued from page 60*)

switch to any desired position. Actuation of the release key energizes the release magnet, through the off-normal contact of the switch, and restores the wiper to normal.

In conventional telephone practice, it is not ordinarily possible to have separate operating and release wires such as those shown in Fig. 4D and, additionally, it is rarely possible to handle the power required by the stepping magnet over the small remote control wires, so the scheme shown in Fig. 4E is frequently used to accomplish step-by-step selection. The operating dial, such as is used in the usual automatic dial telephone, is equipped with two contacts in series with each other. Contact 1 is closed when the dial is not in use and contact 2 is normally open. The construction of the dial is such that contact 2 is immediately closed the instant the dial is used and stays closed throughout the entire cycle of operation. Contact 1 is alternately opened and closed a certain number of times by the rotating cam in accordance with the amount of rotation of the dial. Thus, the initiator circuit is open until the dial is operated and then rapidly opened and closed until rotation of the dial ceases.

When studying the circuit of Fig. 4E it is particularly important to remember that relay *A* is of the fast operating type and that while relay *B* operates quickly it releases slowly. With this in mind, the effect of initially closing the dial circuit by closing contact 2 is to ground one side of relay *A* through contacts 1 and 2, thereby causing relay *A* to operate and transfer a second ground connection from contact 3 to contact 4, operating relay *B*. When relay *B* is operated in this manner it closes contact 5, preparing a circuit to ground for the magnet of the rotary switch. Thereafter, transmission of a series of rapid and closely-spaced impulses from the rotated dial causes rapid operation of relay *A*, with relay *B* remaining energized due to the fact that its release delay time is greater than the spacing times between initiator impulses. Thus current flows from the battery attached to the rotary switch magnet, through the magnet of the rotary relay, through closed contact 5 and through rapidly opened and closed contact 3 to ground, stepping the ganged arms of rotary switch levels No. 1 and No. 2 around to switch points corresponding to the number of impulses transmitted by the dial. (Throughout this operation, contact 6 remains open and rapid action of interrupter-spring contact 7, actuated by the magnet of the rotary switch, is of no consequence while this condition applies.) When the dialing operation has been completed, all relay contacts are restored to the positions shown in the diagram but the rotary switch arms are resting upon some particular switch points. It will be seen that when this is the case the magnet of the rotary switch is energized as follows: current flows from the rotary switch magnet battery through the magnet coil, through interrupter spring contact 7, through one of the arms on the level No. 2 deck of the rotary switch, through the bank wiring of this switch deck, through contacts 6 and 3 to ground. This "homing" current flows through the rotary switch magnet long enough to rotate both switch arms to the next switch points and then interrupter spring contact 7 is opened. When contact 7 opens current flow through the rotary switch magnet ceases so contact 7 again closes, rotating the rotary switch arms to the next switch points. This process continues, the switch arms rapidly stepping or "buzzing" toward the home position, until the arm of level No. 2 reaches the home position and opens the circuit. The system is thus entirely de-energized.

A variation of the step-by-step selection scheme may be accomplished by the use of relays of the non-stepping variety. Fig. 4F shows a circuit commonly known as a "counting chain." Closure of the operate key energizes relay *A*. Operation of relay *A* prepares an energizing circuit for relay *A′* through contact 1 and the release key but *A′* does not operate at this time since its winding is effectively short-circuited inasmuch as both the operate and release keys are grounded. As soon as the operate key is opened, relay *A′* is energized in series with relay *A*, through the previously prepared circuit, and transfers the operating circuit to relay *B* by opening contact 2 and closing contact 3. Thus, successive closures of the operate key operate successive pairs of relays in the chain while operation of the release key restores all operated relays. The chain may be made endless by carrying the locking circuit of any preceding pair of relays through a break contact on the prime relay of any succeeding pair and by carrying the locking circuit for the last pair of relays through a break contact on the prime relay of the first pair. If this is done, only one pair of relays will remain operated at a time yet the chain will repeat endlessly.

A time relation selection scheme commonly used in printing telegraphy consists of two brushes, driven by local motors so that they traverse identical switch-point paths at opposite ends of the transmission line. A circuit of this type is shown in elemental form in Fig. 4G. As the sending brush passes a given point the receiving end brush passes a corresponding point and, consequently, if power is applied to a given point at the sending end a relay may be operated from a corresponding point at the receiving end. Contact 1 merely locks the particular relay that is energized in the operate position. Time relation systems of this type frequently use synchronous electric driving motors operating from the same a-c power source and inter-connected by means of three wires. Inasmuch as we are here concerned primarily with the utilization of relays in remote control work such motors will not be discussed in greater detail.

Many of the electrical remote control circuits shown in elemental form within this paper may be used in combination. For example: A pair of relays such as those shown in Fig. 3C could be inserted ahead of the counting chain shown in Fig. 4F to provide impulses to the counting chain at half the speed of impulses transmitted by the operating key or initiator. In this case the counter relay would operate at the beginning of one impulse and its associated prime relay would operate at the beginning of the next impulse. With such an arrangement, ten selections could be made using five pairs of counters and two inter-lock relays.

Literally thousands of circuit actions can be obtained by modifying and combining control circuits. Many additional refinements may be made by using such circuits in combination with vacuum tubes.

Experimental Television System

(Continued from page 71)

resonate at the desired frequency with the tuning capacitor at maximum. Any attempt to trim an inductance much too large will result in a tank impedance less than that obtained using a parallel-tuned circuit. As the tuning range obtained by series-tuning is quite restricted, it is usually necessary to take into account the capacity involved in coupling to the following stage.

The output of the 815 driver-amplifier stage is transferred by link coupling to the input circuit of the final amplifier, and is largely dissipated in two resistors of 150 ohms in series across the grid coil of the final amplifier. The input impedance of the final amplifier is thus kept low and good regulation is obtained, while sufficient energy remains to drive the final amplifier.

Bias for the final amplifier is provided by combining cathode and battery bias. Adjustment of battery bias for proper operation of the final amplifier is critical and must be made carefully. A resonant line plate circuit is employed in the final amplifier. The plate is tuned by adjusting the shorting-bar and/or the disc-type capacitor across the line.

The power supply for the radio frequency portion of the transmitter uses two type 83 rectifiers and supplies 500 v. A similar power supply, using one type 83 rectifier, supplies plate power at 400 v for the modulator unit.

The antenna used during pre-war air tests was a three-quarter wave folded dipole fed by an open two-wire, 440 ohm transmission line. Inductive coupling to the transmitter provided sufficient loading and was not critical.

Modulator Unit

The modulator unit consists of a pre-amplifier employing an 1852 tube fed directly from the picture tube through a transmission line, and two 807 tubes. The pre-amplifier is capacitively connected to the modulator stage as shown in Fig. 4.

Originally, the transmitter was grid-modulated and satisfactory linearity of modulation necessitated operating the final amplifier in such a manner that the grid would just begin to draw grid current at the positive peak of video modulation (sync-pulses). Despite the use of battery bias, poor regulation of radio frequency driving voltage caused clipping of the sync-pulses. To avoid this condition a comparatively high power driver was used and most of its output was dissipated in the 300 ohm load already mentioned.

Under these conditions it was found possible to obtain linear grid modulation but this was accomplished at the expense of power input and final amplifier efficiency. In an effort to obtain higher power output and less critical operation the circuits were revised to permit cathode modulation. The addition of a d-c restorer tube for automatic background control was contemplated as a future addition. It was therefore desirable to maintain the d-c coupling between the radio-frequency amplifier and the modulator. Such coupling also resulted when cathode modulation was used. D-c coupling between modulator and r-f amplifier has the added advantage of eliminating the large coupling capacitance which would otherwise be necessary to insure satisfactory square wave response.

The 400-ohm resistor in the cathode circuit of the modulator was a compromise between the desire to obtain from the 807 tubes a gain as near unity as practicable and yet not place an excessive impedance in the cathode circuit of the 829 r-f amplifier. It was further desired to retain the low output impedance offered by the 807 when connected in this fashion. The gain of the modulator stage is about 0.8. The output impedance of the 807 tubes is approximately 70 ohms.

Since the bias on the grid of the 807 tubes is produced by the combined action of the plate current of these tubes and the plate current of the 829, it was necessary to make provision to adjust this voltage to the proper value. The voltage between grid and cathode at the 807 tubes was adjusted to 20 v by means of a bucking battery. Before turning on the modulator power supply it is necessary to reduce the bucking voltage to zero so that the tubes do not heat up because of high positive grid voltage. The bucking battery switch can later be set to the proper point, as indicated by plate current.

The output impedance of the cathode-modulated stage is given by ME_b/I_b, where M is the percentage of modulation desired, E_b is the plate voltage and I_b is the plate current. If a value of 20 percent (0.20) is assigned to M and the values of E_b and I_b are 400 v and 200 ma. respectively, an impedance of 400 ohms is obtained. It is therefore possible to obtain a reasonable match between the modulator and r-f amplifier impedances.

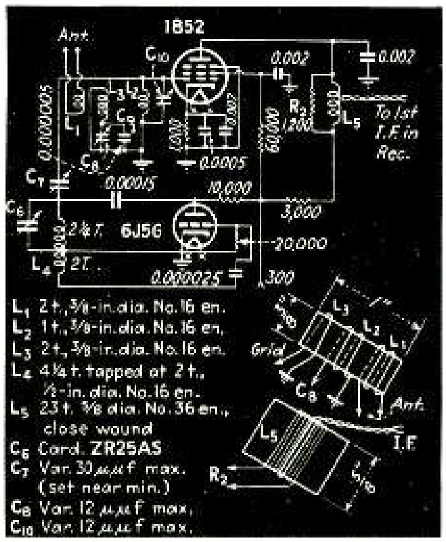


Fig. 5—Circuit of converter permitting reception of 114 Mc video signals when used in conjunction with a standard commercial type television receiver. The converter turns out a 12.75 Mc signal

Unlike audio circuits, video amplifiers require connection of proper polarity if the standard negative modulation is to be obtained. It is interesting to note that cathode modulation requires a signal of polarity opposite to that required for grid modulation. Change from plate output at the modulator to cathode output, simultaneously with the change in the type of modulation, automatically insures this.

The Receiver Converter

The design of a converter for receiving 114 Mc video signals presents several problems of interest since the following points have to be carefully considered: (1) oscillator stability, (2) minimum interaction between oscillator and converter, (3) temperature and humidity effects and (4) adequate band-pass.

The oscillator in the converter under discussion and diagrammed in Fig. 5 was set to operate at a frequency on the high side of the signal carrier frequency by adjusting C_6 and tuning the circuit to 126.75 Mc. The converter grid has oscillator voltage injected into it through C_7, which is of the postage stamp variety and has one plate drawn out to the near-minimum capacity. Oscillator frequency adjustment must take this capacity into consideration. Too great an oscillator voltage should not be injected as erratic operation results.

Overall adjustments for proper band-pass require that consideration be given to the link coupling from converter to the intermediate frequency of the first amplifier. Since a standard television receiver is used, it was found advisable to use a coupling method which would allow any commercial television receiver to be easily adapted to the 114 Mc carrier frequency. Removal of the commercial receiver's regular oscillator and its link adjustment to the first i-f amplifier of the receiver was the only alteration found necessary. One turn of wire was used in coupling the auxiliary converter to the i-f amplifier and this was drawn directly over the grid input coil of the first i-f stage. The position of the link over the grid coil appreciably affects the band-pass of the system. Alignment for proper band-pass width 3.5 of Mc necessitated using a television alignment oscillator, an absorption-type frequency-meter and a cathode-ray oscilloscope. Adjustment of capacitors C_8 and C_{10} and the link from L_3 will give the full band-pass required.

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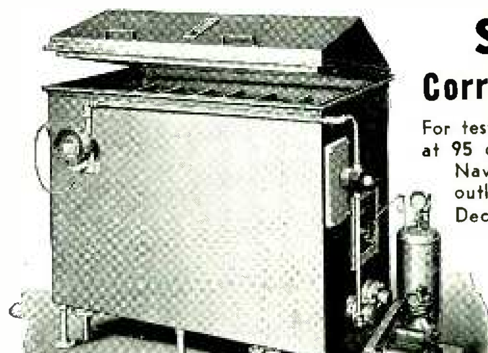
• • •

AGING TRANSMITTER TUBES

Radio transmitter tubes are operated at General Electric radio factories before they are tested and shipped to the armed forces. E. M. Scheiber, assistant general foreman of G-E radio tube factory, is shown before one of the aging racks



Welding Control

(*Continued from page 67*)

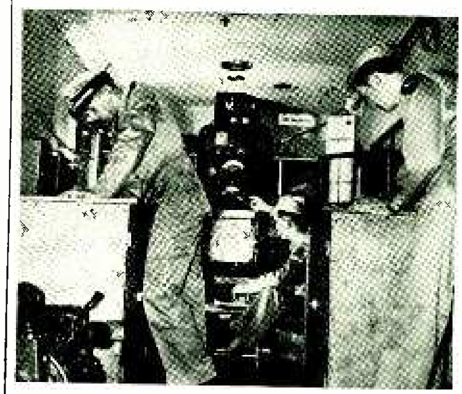
biased negative at the start of the load capacitor *CL* charge and moved in a positive direction as the voltage across *CL* increases. At a voltage determined by the setting of P_2 the grid of tube 12 becomes positive and this tube conducts to energize the relay CR_2. The contacts of this relay are in the welder control circuit and prevent welding unless CR_2 is energized. Once P_2 has been properly set, changing the setting of P_1 to change the output voltage automatically adjusts the undervoltage indicating circuit for the changed conditions.

Discharge Circuits

To discharge a capacitor bank into a welding transformer primary and prevent reversal of capacitor voltage should the *R*, *L*, and *C* combination be less than critically damped, the circuit shown in Fig. 9 is used. The discharge circuit consists of the ignitron tube 13 and the thyratron tube 14. Tube 14 is normally biased sufficiently negative to prevent conduction. As the discharge indication is given by the welding machine sequence, a small capacitor is discharged into the primary of transformer T_{11}. This discharge produces an impulse in the secondary of T_{11} sufficient to momentarily drive the grid of tube 14 positive. Tube 14 conducts to the ignitor of tube 13, which then conducts the discharge

• • •

WEATHER SPOTTERS ON WHEELS



Army and Navy personnel obtaining weather data in a mobile weather station, making use of the most modern meteorological equipment. Left to right. Cadet Otey adjusting the receiving equipment and Cadet Knudson finding the surface pressure with microbarograph

of the capacitor CL into the primary of the welding transformer.

Should the combination of R, L, and C in the discharge circuit be such that the circuit is oscillatory, the voltage across the primary of the welding transformer will tend to reverse as the discharge proceeds. Instantly, when this occurs, the anodes of the thyratron tube 16 and the ignitron tube 15 becomes positive. When the reverse voltage reaches a sufficient value (100 to 150 volts) tube 16 conducts sufficient current to the ignitor of tube 15 to ionize this tube. This operation effectively limits the inverse voltage applied to the capacitors to a low value.

Other Considerations

In addition to the electronic circuits described complete control for electrostatic energy storage welding includes sequencing controls and protective equipment for overload, overvoltage and faulty operation. In addition, reversing contactors are provided to reverse the connections of the welding transformer on alternate welds to prevent accumulative effects of discharge and possible saturation of the transformer.

To illustrate some effects of changing constants in the discharge circuit, Fig. 10 has been included. It will be seen from this that a very wide control of discharge waveforms may be obtained to meet the characteristics of the metal being welded.

• • •

PORTABLE X-RAY UNIT

Ground crews of the Armed forces will be able to give aircraft a speedy and thorough check for structural faults by the use of a portable x-ray unit, which is being built by Lockheed Aircraft. The unit can be wheeled along behind a car directly up to the plane. The x-ray exposure is taken on the field, the operator enters a dark room within the trailer to develop the negatives. A Lightning P-38 fighter plane is shown drawing up to the device

NEW BOOKS

Principles of Radio

BY KEITH HENNEY. *John Wiley and Sons, New York, N. Y. Fourth Edition. 549 pages. Price, $3.50.*

IN THIRTEEN YEARS, "Principles of Radio" has gone through four editions. Originally intended to provide a foundation of practical radio knowledge for the student who had little background upon which to build and yet who wanted to know the basis upon which radio communication existed, the author has constantly kept in mind the needs of those who must learn without benefit of an instructor.

This book has been used in trade schools, for which it was intended, and in colleges, for which it was not aimed, according to the preface. During the past year the volume has been extensively used in radio instruction on an elementary level and was recommended by the National Association of Broadcasters as a suitable text for courses of instruction given under their sponsorship. The fourth edition contains nineteen chapters, the first of which deals with general electrical fundamentals based on the circuit elements of *L*, *R*, and *C*, and Ohm's and Kirchoff's laws. The next three chapters deal with alternating currents, resonance phenomena, and properties of coils and condensers. Chapters IX to XIII inclusive deal with the design of audio and radio frequency amplifiers, while Chapter XIV treats detection. Receiving Systems are treated in Chapter XV, Rectifiers and Power Supplies in Chapter XVI, and Oscillators, Transmitters, etc., in Chapter XVII. The last two chapters deal with Antennas, Transmission, and Facsimile and Television Transmission, respectively. There is a thirteen page chapter and useful tables on the inside covers.

Throughout, the aim has been to provide practical information. Problems are provided in each chapter for the student to obtain a sense of values of electrical quantities involved in radio communication.—B.D.

• • •

The Future of Television

BY ORRIN E. DUNLAP, JR., *Harper & Brothers, 1942. 194 pages. Price $2.50.*

TEN YEARS AGO, 1932, Mr. Dunlap published "The Outlook for Television," a chronological story of the development of television up to that time. This 1942 book appropriately takes up the television story and looks ahead from where we stand today. The book not only looks into the future, but gives

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Of Electronics, published monthly at Albany, N. Y., for October 1, 1942.

State of New York }
County of New York } ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared J. A. Gerardi, who, having been duly sworn according to law, deposes and says that he is the Secretary of the McGraw-Hill Publishing Company, Inc., publishers of Electronics, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

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5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the twelve months preceding the date shown above is. (This information is required from daily publications only.)

J. A. GERARDI, Secretary.
McGRAW-HILL PUBLISHING COMPANY, INC.

Sworn to and subscribed before me this 29th day of September, 1942.

[SEAL] CHESTER W. DIBBLE.

Notary Public, Queens County. Queens County Clerk's No. 4166. Certificate filed in N. Y. Co. Clerk's No. 889.

(My commission expires March 30, 1943)

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enough of the background and the present status so that it stands on its own feet as a brief summary of the science of seeing by radio.

The author asks the pertinent questions that have bothered everyone who has considered television at all seriously, aside from its purely technical aspects. What is to become of sound broadcasting? Who is to pay for television? Does television threaten the theatre? How much will the public pay to see as well as hear by their radio sets? This book does not attempt to answer finally all or even many of these questions; it lays the facts before the reader as though to apprise him of the difficulties and problems the better to equip him to answer the questions in his own way. But if the reader thinks he will find a neat solution to the broader aspects of television's future in this book, he is due to be disillusioned. Mr. Dunlap is not näive enough to "stick his neck out" sufficiently in this direction to have his head cut off.

This book is for non-technical people; but the technicians will find it very useful as a survey of the non-engineering problems.—K.H.

• • •

Fundamentals of Radio

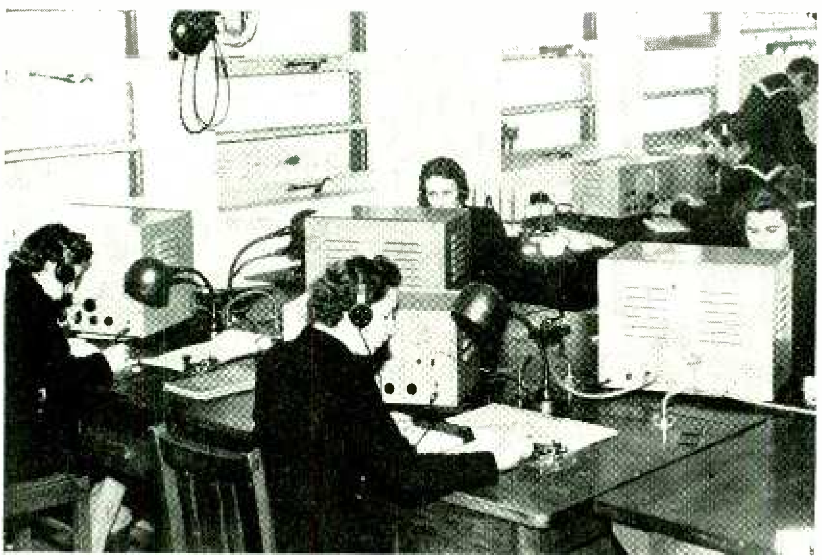
BY E. C. JORDAN, P. H. NELSON, W. C. OSTERBROCK, F. H. HUMPHREY, L. C. SMEBY, and W. L. EVERITT, *editor*. *Prentice-Hall, Inc. 400 pages. Price, $5.00.*

ACCORDING TO THE PREFACE, "the purpose of this volume is to present the basic material of radio required for all types of radio work, both civil and military". Accordingly, it is written on a level such that those with high school physics and mathematics should be able to obtain an introduction to radio theory and practice, although probably not without some assistance from an instructor. Five of the authors are associated with colleges teaching electrical engineering and this assures a sound pedagogical point of view.

In wisely devoting the first chapter to the Mathematics of Radio the authors aim to overcome a weakness which radio instructors find in their students, namely a lack of facility in manipulating algebraic and trigonometric expressions even among those who have been exposed to those topics only recently. The following two chapters are devoted to principles of direct and alternating currents. There are chapters on electronics, power supplies, sound, amplifiers, vacuum tube instruments, reception, transmission, wave propagation, antennas and modulation methods. Each of the sixteen chapters contains numerous problems, with the answers to each at the end of the chapter. Occasionally the student's attention is specifically drawn to important principles or applications in the ultra-high frequency field, but so much space is necessarily devoted to basic fundamentals that this cannot be regarded as a volume of u-h-f methods. There are several folded pages inserted between appropriate pages, showing complete circuit diagrams of radio equipment.

The book is designed for men seeking induction into military services, for radio operators, and men in the communication industry. The material covers fundamentals of radio as outlined by the National Association of Broadcasters.—B.D.

WOMEN IN THE NAVY



Telegraphist "WRANS" operate in a pleasant, well lighted room of the Harman Naval Station. The Women's Royal Australian Naval Service is portraying a large part in the vital job of defending the seas. Out-door exercise and games keep them fit for their work which demands a great deal of concentration

4000 Years of Television

By RICHARD HUBBELL, *Published by G. P. Putnam's Sons, New York, N. Y. 1942. Price $2.25.*

THE STORY OF SEEING at a distance has been published at a propitious time, because it initiates the reader into America's next great industry, an industry that is to play a revolutionary role when once again a brighter horizon is to dawn. It should prove an interesting story to all who anticipate a tomorrow and are willing to prepare for that tomorrow.

The author has treated the subject with seriousness and with grace like an important romance culled from history. He commences with the principles upon which television is based, speaks of the rock crystal lens discovered in 2000 B.C. in Assyria, and of Thales the founder of Greek geometry who made practical use of amber. It dwells on the lodestone found in Magnesia, of which our present magnets are the modern counterpart, and acquaints the reader with William Gilbert and the various "stones" he called "electrics". From 1891 A.D. after the smallest natural unit of electricity had been named "electron" the story gains in leaps and bounds on astounding information, embracing with due reverence the important role of the science of "electronics". It tells of the performances at Alexandra Palace, popularly called the "Palace of Magic" (where this reviewer witnessed intriguing performances), the fateful day of September 1, 1939 which closed high-definition television at London's Olympia, and of the vistas that will open in a televisionized America after the war.

"4000 Years of Television" is an excellently written book and worthy the attention of the engineer. To the layman its reading should be regarded as a fascinating experience because it brings in nontechnical, yet precise terms the history and the development of one of the most miraculous sciences. Mr. Hubbell comes well prepared for his task; for many years he has devoted his time and ambition to television. At present he is in charge of CBS' Television News Dept. and is a commentator with an appreciable following. It is being said that political and geographical history has to be written again and again, but television's history shall remain the result of several important sciences combined into one, and it has found a capable interpreter in Mr. Hubbell.—B.D.

• • •

A Short Course in Tensor Analysis for Electrical Men

BY GABRIEL KRON, *Consulting Engineer, General Electric Company, Schenectady. John Wiley & Sons, New York. 250 pages. 146 figures. Price $4.50.*

THE MATERIAL IN THIS VOLUME is essentially that contained in a series of lectures delivered to students in the advanced course in engineering of the General Electric Company, and already recorded in considerable detail in a series of articles in the *General Electric Review* during the past seven or eight years. The primary purpose of the volume is to establish an organized system for solving the equations of performance of engineering problems. Specifically the volume is concerned with problems encountered in the field of electric power generation and distribution, but the electrical applications are only used to illustrate the basic concepts which are of considerably wider application.

The book is divided into two parts: In the first part of the volume which contains 112 pages divided into fourteen chapters, the fundamentals of matrix algebra are established after which they are applied to unbalanced multi-winding transformers, symmetrical components, phase shift transformers, and the field equations of Maxwell, and the mercury arc rectifier.

Part II of the volume is devoted to rotating machinery and contains eighteen chapters. In this section the principles of tensor analysis are applied to various systems employing rotating electrical machinery.

In general the volume is one which will make its appeal to the mathematically inclined investigator or research engineer who is concerned with generalizing the methods available to him through the usual three-dimensional vector analysis.—B.D.

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January to December issues, inclusive, 1942

McGraw-Hill Publishing Company

330 West 42nd St., New York City

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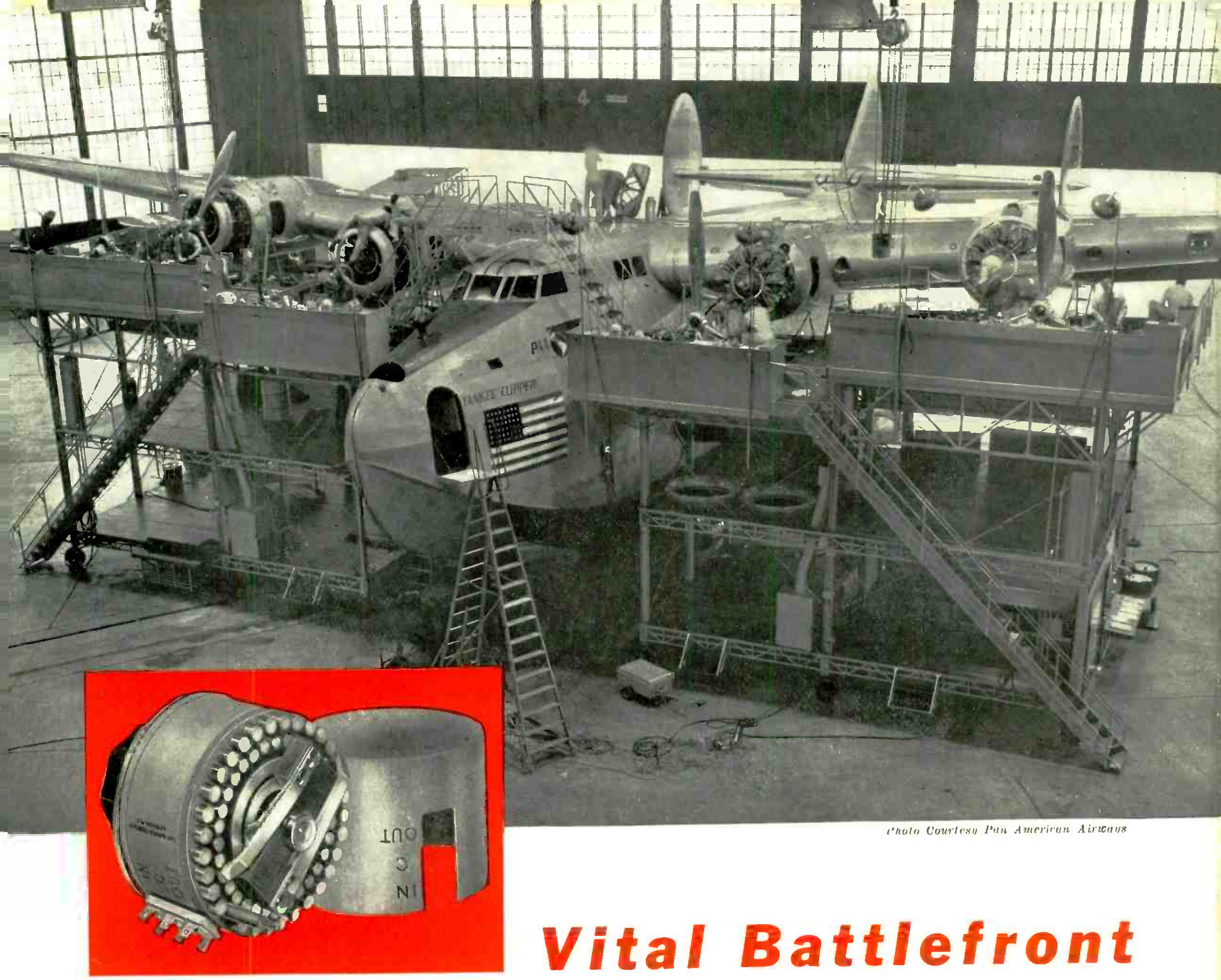

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Actually, almost all of the important rules for tire conservation find a close parallel in the job of making Transmitting Tubes last longer.

Just as tires should be rotated from wheel to wheel, from spare to active, so should tubes be interchanged. Tube spares should be used from time to time in order to guard against deterioration.

Just as proper, specified air pressure will add much to tire life, so does operating tubes in strict accordance with specified conditions and conservative ratings provide the best assurance against premature failure.

Just as slower driving and careful handling are important tire conservation measures, so is it important to avoid unnecessary strains on tubes. As pointed out previously, as little as 5% reduction in filament voltage of pure-tungsten-filament types increases life 100%!

Another way of making an easier schedule for your tubes is to keep them cooler—by reducing plate voltage and dissipation, and by additional air cooling even beyond what may be specified. Still another way is by reducing filament voltage to 80%, whenever feasible, during standby periods.

Just as wheel alignment has an important bearing on tire life, so does the performance of related parts have much to do with tube life. For instance, properly designed smoothing filters are essential to obtaining optimum life from mercury-vapor rectifier tubes.

In short, these are the days when tube handling and operation are dictated by the necessity of obtaining every possible hour of tube life—just as is true of tires. Care in this direction—far above what you might consider giving in ordinary times—will pay worthwhile dividends.

RCA

TRANSMITTING TUBES

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